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Discussion Paper

CANST THOU BEGGAR THY NEIGHBOUR? EVIDENCE FROM THE 1930S

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SCIENCES PO ECONOMICS DISCUSSION PAPER

No. 2026-09

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First version: November 2021
This version: June 2026

Abstract

Does an exchange rate depreciation depress trading partners' output? I address this question through the lens of a classic episode: from 1931 to 1936, the largest economies in the world successively devalued their currency. In theory, the effect is ambiguous for countries that had not devalued: expenditure switching can lower their output, but the monetary stimulus to foreign demand might raise it. Newly constructed high-frequency devaluation shocks and a multi-country model disciplined by cross-sectional evidence concur. Contrary to the popular narrative in modern policy debates, devaluation did not dramatically lower the output of trading partners in this context. Meanwhile, devaluation substantially raised the output of the devaluing country itself: it was a potent stimulus, not a zero-sum game.

Keywords: beggar-thy-neighbour, devaluations, Great Depression, trade elasticities
JEL codes: E5, F3, F4

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1 Introduction

"Beggar thy neighbour, zero-sum game, currency war": currency depreciation gets a bad rap. In theory, exchange rate depreciation can cause a contraction in foreign output: if prices or costs are sticky in the producer's currency, a depreciation cheapens domestic goods on international markets, which shifts demand towards those goods, possibly lowering output in foreign countries. This mechanism is at play in prominent international macroeconomic models since at least Fleming (1962) and Mundell (1963). In policy circles, recriminations fly when a country engages in a monetary expansion that leads to a depreciation of the currency. In 2010, Guido Mantega, then Brazil's finance minister, famously equated the Federal Reserve's quantitative easing (QE) to monetary warfare.[1] Such claims resurfaced when the European Central Bank took the QE route in 2015.[2]

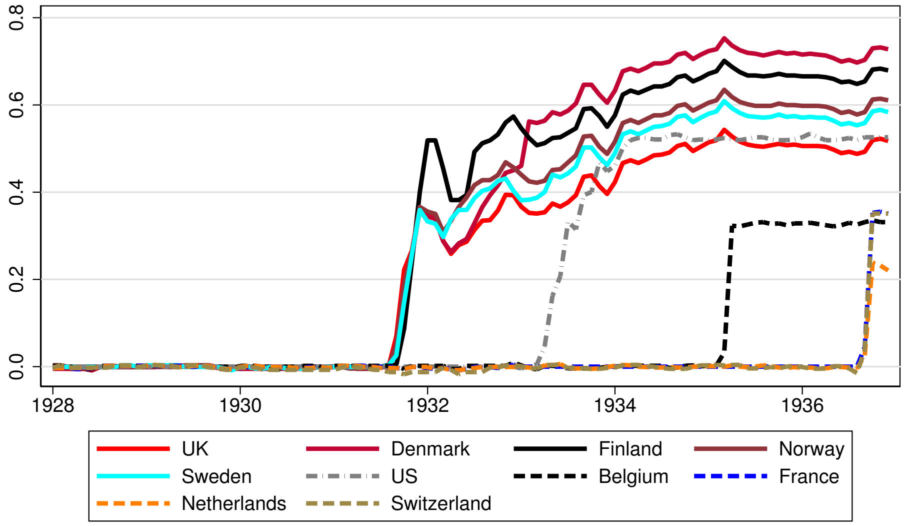
Are these concerns justified? My answer is no: a devaluation has a small effect on foreign output. It is, however, a big stimulus for domestic output. I reach that conclusion in two ways. The first one is a high-frequency identification strategy: I develop a series of exchange rate shocks and trace their domestic and foreign effects. The second one is a micro to macro approach: I use empirical moments in cross-country and newly digitized product-level trade data to estimate a model, in which I run counter-factual experiments. I do so in a specific historical context: the currency devaluations of the 1930s.

The 1930s currency devaluations are an attractive setting for several reasons. First, they are a classic example of what are generally thought to be competitive devaluations. Second, they form a sequence of large events: many countries, including the biggest economies in the world, devalued their currencies by 30 to 40% against gold. Last but not least, the staggered way in which these countries devalued is ideal for identification. This staggered feature is apparent on figure 1, which shows the nominal price of gold in selected currencies. Until 1931, the countries on the chart were on the gold-exchange standard: the price of gold — hence the exchange rate with other currencies that are tied to gold — was stable. In September 1931, Britain left the gold standard. It was quickly followed into devaluation by, among others, Scandinavian countries. On the other hand, several countries stayed on the gold standard, sometimes for years: the United States (US) devalued in April 1933; the so-called gold bloc, led by France, only dislocated in October 1936. Such discrepancies in timing create sharp cross-sectional variation that I exploit below.

[1] "We're in the midst of an international currency war, a general weakening of currency." See Jonathan Wheatley, "Brazil in 'currency war' alert," *Financial Times*, September 27, 2010, `https://www.ft.com/content/33ff9624-ca48-11df-a860-00144feab49a`.

[2] David Keohane, "All currency war, all the time", *Financial Times*, February 5, 2015, `https://www.ft.com/content/c259d418-d0ca-37d5-a3bd-27748fc1024e`.

Figure 1: Gold price in selected currencies



Note: log of the nominal price of gold expressed in country's currency — 1930 is normalized to 0. An increase corresponds to a devaluation.

Eichengreen and Sachs (1985) offer the classic treatment of this episode. They show that countries that devalued earlier recovered earlier from the Great Depression. Albeit foundational, this result has several limitations. The first one is that it's not necessarily causal since it is only a regression of the change in industrial production on the change in the exchange rate. If the decision to devalue was endogenous to output, these estimates are biased. Second, even interpreted in a causal way, this evidence only speaks to the relative effect, not the absolute one. That is, one does not know if British output was going up compared to French output because British output was going up compared to a counter-factual scenario where Britain hadn't devalued, or because French output was going down. Finally, as Eichengreen and Sachs (henceforth ES) emphasize, the exchange rate is not the only channel through which devaluations might have affected output. Cutting the gold content of the currency relaxes the gold cover constraint of the central bank. The latter can then expand the money supply or lower its discount rate, thereby stimulating aggregate demand. So the ES regression might capture a closed-economy monetary stimulus, instead of the effect of a competitive devaluation. Part of my contribution is to overcome these three limitations.

I first revisit the Eichengreen-Sachs evidence in a difference-in-difference (DD) framework. Since some countries devalued in 1931 while others stayed on the gold standard, the episode is an ideal setup. Countries that devalued produced more, exported more, and experienced a drop in real wages following the devaluation, relative to countries that did not. They did not import less – in fact, they imported more after a few years – which runs against the beggar-thy-neighbour presumption. Nominal variables such as price and wage indices also increased. On the monetary side, the action did not come from the nominal but from the real interest rate: inflation was higher in devaluing countries, which pushed the real rate down. Finally, devaluing countries do not exhibit preexisting trends in these variables.[3] That they do not rules out some endogeneity concerns – the devaluation decision does not depend on recent economic performance – but it does not rule out all of them. Devaluation may occur in reaction to a contemporaneous shock that would not appear in the preexisting trend but would affect future output. Moreover, by construction, this exercise only captures the relative effect. These caveats motivate another identification strategy.

I estimate the absolute effect of currency devaluation with high-frequency identification (HFI). I construct series of policy announcements based on newspaper articles. Most of these events are a devaluation or an announcement that makes devaluation less likely, such as the fall of an easy money cabinet. I use the change in the forward exchange rate around these announcements as a measure of the shock. As long as financial markets anticipate devaluations that systematically correlate with economic conditions, changes in the forward exchange rate around policy announcements are exogenous to those same economic conditions. Armed with these shocks, I can use them as instruments for the spot exchange rate in low-frequency regressions of macroeconomic variables. The identification assumption is conceptually similar to that made by researchers who use changes in federal funds rate futures around Federal Open Market Committee (FOMC) meetings – a well-established identification scheme to infer the causal effect of monetary policy on macroeconomic variables.

I find strong evidence that devaluation stimulated output, trade, and prices, and that it lowered the real interest rate in absolute terms. Adding a time fixed effect to the regression, thus falling back on the relative effect, does not affect the results, which suggests that the relative effect is in fact the absolute effect: foreign spillovers are small. This conjecture is confirmed by running regressions of a country's output on foreign devaluation shocks. Although they appreciate the trade-weighted exchange rate, the foreign shocks have no discernible effect on macroeconomic performance. The estimates are often positive and never statistically significant. There is even suggestive evidence that a foreign devaluation lowered the real interest rate abroad. Standard errors are large, however, so this exercise cannot entirely reject negative spillovers. This caveat motivates a second approach, which combines cross-sectional evidence and a general equilibrium model.

A model is necessary to translate cross-sectional evidence into an absolute effect. I develop

[3] Eichengreen and Sachs (1985) run a regression of the change in industrial production (and other variables) on the change in the exchange rate from 1930 to 1935. My DD specification is conceptually similar, but it allows the estimation of preexisting trends and avoids pooling countries that devalued at different times, for example Britain (1931), Italy (1934), and Belgium (1935). I also study a larger set of variables that are crucial to discipline the model, real imports, trade prices, and the real interest rate in particular.

a multi-country model that features three main ingredients: (i) incomplete pass-through of the exchange rate to international prices (which I show later is an essential feature of the data), (ii) sticky wages to generate monetary non-neutrality, and (iii) a gold standard to engineer the devaluation. The model allows for both expenditure switching and monetary stimulus. In the model, the strength of the expenditure switching channel depends on the elasticity of substitution between domestic and foreign varieties, the elasticity of substitution among imported varieties, and the pass-through of the exchange rate to international prices.

Since those parameters are important, I digitize new product-level data on US imports to estimate the last two – the first one is estimated later out of cross-country data. This data comes from an official publication of the Department of Commerce, the *Foreign Commerce and Navigation of the United States*. Estimating a demand elasticity is always challenging: in general, the price of a good is correlated with demand shocks. An ordinary least squares (OLS) regression of quantity on price would suffer from simultaneity bias. The 1930s, however, offer a readily available instrument: the exchange rate. I show that, as long as devaluation is exogenous to demand shocks for different national varieties of the same product, this instrument identifies the within-product elasticity of substitution among foreign goods. I defend this assumption by checking that prices and quantities do not display pre-existing trends. I find a demand elasticity between 2 and 4, and a pass-through of about 0.4. For a one percent decline in their relative price, US imports of British varieties increased by 2–4%, compared to French varieties. For a 1% depreciation of the pound, dollar prices of British products go down by 0.4%.

I estimate the model by matching moments from cross-country and trade data and run counter-factual experiments. I find that the 1930s devaluations had limited effects on non-devaluing countries' output but a large effect on devaluing ones'. British output was going up compared to French output mostly because British output was going up compared to a counter-factual scenario where Britain hadn't devalued – not because French output was going down. An equivalent way to state this conclusion is that the effect estimated in the cross-section is mostly attributable to higher output in devaluing countries, not less output in non-devaluing ones: the absolute effect is close to the relative one. The exact number depends on the specification. When estimated on the DD responses, the model implies that a 30% devaluation against gold lowers non-devaluing countries' output by less than 2% on average over 3 years, while it raises devaluing countries' output by 7%. When estimated on the HFI responses, the spillovers even become positive and the effect on devaluing countries is 3 times as large. These differences can be tied to the stronger response of industrial production implied by the HFI exercise.

Finally, I clarify which ingredients matter for what conclusion by changing parameters in turn and studying how the fit deteriorates. First, incomplete exchange rate pass-through and low substitution between imports and domestic goods dampen the negative spillovers to non-devaluing countries. If I assume full pass-through and higher substitutability, non-devaluing countries' output falls by 5%. This recalibration, however, implies a highly implausible cross-sectional response of imports. Second, making demand less responsive to the real interest rate lessens the boom in devaluing countries and, to a lesser extent, worsens the negative spillovers to non-devaluing countries. This recalibration implies a cross-sectional response of output and imports that is too low because devaluing countries' demand increases less. Third, a modern level of wage rigidity dampens both monetary stimulus and expenditure switching, weakening the boom in devaluing countries and the spillovers to non-devaluing ones. In the 1930s context, this recalibration implies a relative response of wages that is more than twice as large as in the data.

Literature review: I contribute to the literature on the Great Depression. Friedman and Schwartz (1963, p. 362) were the first ones to note a cross-country correlation between devaluation and recovery. Building on Eichengreen and Sachs's (1985) contribution, Campa (1990) or Bernanke and Carey (1996) study currency devaluations across countries; Mitchener and Wandschneider (2015) study capital controls. Eichengreen (1992) analyses the interwar gold standard. Mathy and Meissner (2011) are interested in how trade and exchange rates affect business cycle co-movement. Accominotti (2009) investigates the credibility of the gold standard in Britain before the devaluation. Cohen-Setton et al. (2017) examine the consequences of supply-side reforms in France – reforms that were contemporaneous to its 1936 devaluation. Hausman et al. (2019) argue that the US devaluation bailed out US farmers through its effect on agricultural prices. de Bromhead et al. (2019) or Albers (2019) delve into tariff policies. Ellison et al. (2024) argue that devaluation affected ex-ante real interest rates, echoing the point made by Eggertsson (2008) in a New Keynesian model. In contemporaneous work, Candia and Pedemonte (2025) are also interested in the spillovers of exchange-rate policy on trading partners. The present paper is the first to bring causal evidence of the absolute effect of currency devaluation at home and abroad. Its novelty also lies in the translation of cross-sectional evidence into an estimate of the absolute effect to answer the beggar-thy-neighbour question.

The real effects of exchange rates have long been contested in international economics. The early New Keynesian open-economy (NKOE) literature downplayed competitive devaluation concerns. Obstfeld and Rogoff (1995) show that a foreign monetary expansion can be welfare improving. In their handbook chapter on optimal monetary policy, Corsetti et al. (2011) argue that policy responses abroad offset strategic terms-of-trade manipulations.

Fornaro (2018) points out that depreciation can foster economic activity in times of weak demand. The exchange rate pass-through literature casts doubt on the allocative properties of exchange rates (Gopinath and Itskhoki, 2010, Amiti et al., 2014a, Burstein and Gopinath, 2014). On the other hand, McLeay and Tenreyro (2026) argue that with mixed currency pricing and sticky wages, the economy behaves as it would under producer currency pricing, the most potent scenario for expenditure switching following a depreciation. Camara et al. (2025) show that, even though it causes an appreciation of the dollar, a monetary contraction in the United States has negative spillovers on foreign output, mainly because of its effect on US imports (Ozhan, 2020, Müller and Verner, 2024). My paper brings together these strands of the literature: I emphasize sticky wages, so exchange rates are in principle a powerful expenditure-switching mechanism. But incomplete pass-through dampens expenditure switching, and the rise in domestic demand that follows a devaluation may fully offset it. In my model, the various channels are tightly disciplined by cross-sectional evidence on currency devaluations. The model is closest to Itskhoki and Mukhin's (2021). To their framework, I add a multi-country environment inspired by Galí and Monacelli (2008) and, of course, a gold standard.

Auclert et al. (2024) study exchange rate depreciation with heterogeneous agents in a small-open economy: they stress that depreciation leads to a drop in real income in the depreciating country, making the depreciation contractionary in the short run. In my model, the real income channel is small because markets are complete within countries. In a multi-country context, however, the real income channel is a wash: it is contractionary in depreciating countries and expansionary in appreciating ones, so a sized-up real income channel would dampen the negative spillovers of expenditure switching even further. Besides, my evidence suggests that devaluations were strongly expansionary and that this mechanism was not dominant in the 1930s.

I add to empirical studies of large devaluations. Most of them deal with developing countries in a modern context. For instance, Verhoogen (2008) analyses firm-level data around the 1994 peso devaluation. Burstein et al. (2005, 2007) argue that the behaviour of the real exchange rate after a devaluation is attributable to the slow adjustment of non-tradable goods and services. Mattoo et al. (2017), Rose (2021), Alessandria et al. (2018), Rodnyansky (2019), Kohn et al. (2020) study the behaviour of exports following a large depreciation. In contemporaneous work, Fukui et al. (2025) study the effect of pegging to the dollar when it depreciates. Delgado et al. (2025) find experimental evidence of firms' intertemporal elasticity of import demand. Compared to these papers, I answer the beggar-thy-neighbour question. As far as I know, this is also the first paper to develop high-frequency shocks for the exchange rate. The closest precedent is Weiss (2020), who constructs shocks for devaluation risk in the United States at the end of the 19th century.

2 Cross-Country Evidence

From an empirical standpoint, the 1931 devaluations have an appealing feature: before 1931, most countries were on a fixed exchange rate; in 1931, a group of countries devalued their currencies while others stayed on the gold standard for several years, some until 1936. Setting endogeneity aside for now, it is tempting to see the first set of countries as a treated group, and the second one as a control group.

To apply this insight, I run the following specification:

$$\log\left(\frac{Z_t^j}{Z_{1930}^j}\right) = \beta_t \log\left(\frac{XR_{1932}^j}{XR_{1930}^j}\right) \times \mathbb{1}_t + \mu_t + e_t^j \tag{1}$$

where Z_t^j is an aggregate variable of interest (industrial production, prices, etc.) in country j in year t; XR_t^j the exchange rate, expressed as the local-currency price of gold; $\mathbb{1}_t$ a year dummy; and μ_t a year-fixed effect. The sample is restricted to countries that either devalued in 1931 (e.g. Britain) or did not devalue before 1936 (e.g. France).[4] I study years 1928 to 1935 in order to include pre- and post-treatment years.

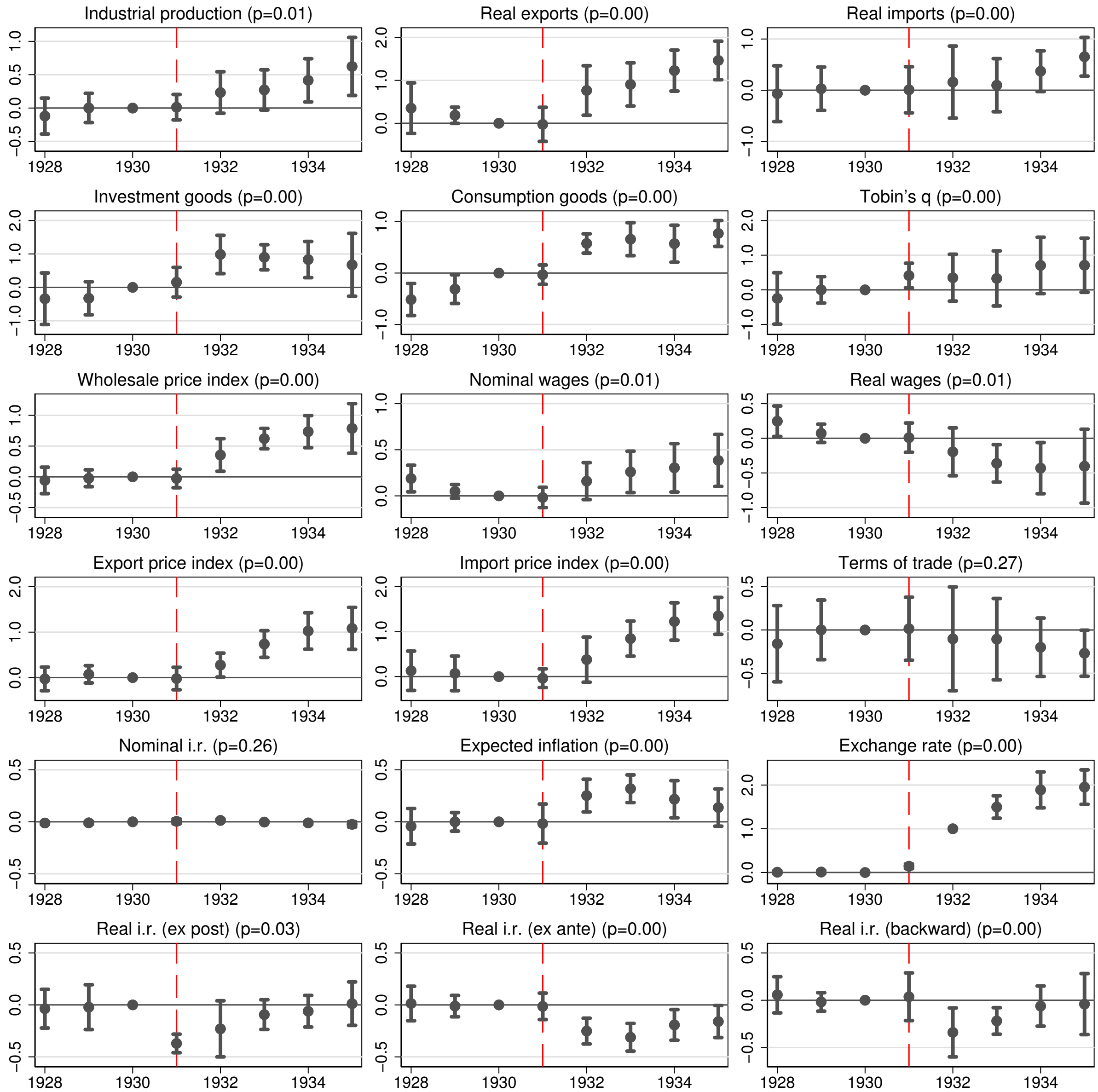
The change in the exchange rate is instrumented with a devaluation dummy, so that β_t can be interpreted as the performance of devaluing countries, relative to non devaluers, scaled by the average change in the exchange rate. Figure 2 displays those coefficients for 12 macroeconomic variables and 3 different concepts of the real interest rate. F-statistics for the first stage are reported in table A.4 in the appendix. I also present results for a specification where I estimate equation (1) by ordinary least squares (figure A.2). These results are denoted DD-OLS while the baseline is DD-IV.

The devaluations were followed by a sharp relative increase in industrial production, exports and, after a few years, imports. The increase in imports may seem surprising since the expenditure switching channel would predict a fall as these become dearer. Consistent with a demand boom, the production of investment and consumption goods increased, so did Tobin's q, which I compute here as the ratio of the stock market index to the wholesale price index. Investment goods appear more cyclical than consumption ones. The second row of figure 2 should be regarded as the most speculative: the distinction between investment and consumption goods is not available for many countries. For example, neither series is available for France or the UK, so I use the output of the mechanical industry as a proxy for investment goods in these countries.[5] Consumption goods production is consistently

[4] Country samples are summarized in the appendix (table A.1).

[5] In countries for which both are available (Germany, Japan, Poland, Sweden, and the US), both industries are similarly cyclical: a regression of the logarithm of mechanical production on the logarithm of investment

Figure 2: Aggregate variables (DD-IV)



Note: response of relevant variable in devaluing countries, relative to non-devaluing ones. Formally, the plots show the estimate of β_t in equation (1). The dots are the point estimates, brackets represent 95% confidence intervals. β_{1930} is normalized to 0. Standard errors are bootstrapped with 2,000 replications, and clustered at the country level. The number in parenthesis is the P-value of a test of the joint significance of the 1932 to 1935 coefficients. "i.r." stands for interest rate. The ex post, ex ante and backward real interest rate are respectively equal to: $i_t - \pi_{t+1}$, $i_t - E_t\pi_{t+1}$, and $i_t - \pi_t$, where i_t is the nominal interest rate and π_t is inflation. The y-axis scale of the nominal and real interest rates is identical for visual convenience.

available for only 5 countries in my sample. Still, this second row paints a picture that is consistent with the first one.

Nominal quantities also increased, but not one for one. Since the impulse response

goods production returns a coefficient of 1.12 with 1 in the confidence interval.

functions (IRF) are normalized by the change in the exchange rate, full pass-through of the 1930-32 change in the exchange rate to nominal quantities would correspond to a coefficient of 1. For instance, in 1935, wholesale prices had increased by about 100% in countries that devalued, relative to countries that didn't. The pass-through is lower for nominal wages, so that real wages went down in countries that devalued.

On the monetary front, the action did not come from the nominal interest rate, but from the real interest rate. The devaluations did not coincide with significant cuts in the discount rate of the central bank. Unfortunately inflation expectation surveys or inflation-indexed bonds did not exist in the 1930s. So, I use the measure proposed by Ellison et al. (2024), who employ the New York Federal Reserve Bank's modern nowcasting model to infer inflation expectations from data available at the time. Expected inflation one year ahead responds by 0.25–0.50 percentage point for every percentage point of depreciation of the exchange rate. In the last row of figure 2, I show 3 different concepts of the real interest rate. The first one is the ex-post real rate, where I subtract realized inflation π_{t+1} from the nominal rate $(i_t - \pi_{t+1})$; the second one is the ex-ante real rate, where I subtract Ellison et al.'s inflation expectations $(i_t - E_t\pi_{t+1})$; the last one is the backward-looking real rate $(i_t - \pi_t)$, which would be the relevant rate if agents had adaptive expectations: $E_t\pi_{t+1} = \pi_t$. The three measures agree that devaluations were associated with a sizeable cut in the real interest rate. For instance, the 1931 coefficient for the ex-post rate of -0.37 entails an 11 percentage points cut in the real interest rate for a devaluation of 30%. Predictably, the response of the ex-post rate is more front-loaded than that of the backward-looking one; the ex-ante interest rate, which relies on realized data to predict inflation, sits in-between.

Calling the 1931 depreciation of the pound a devaluation is a slight abuse of language. In truth, British authorities suspended the gold convertibility of the pound, let it depreciate for a few months, and actively managed the exchange rate from July 1932 onward. The tie to gold was never formally re-established. Other devaluers similarly allowed their currency to depreciate before pegging to the pound Eichengreen (1992, ch. 10). Therefore, I investigate the behaviour of the exchange rate after 1932 by estimating equation (1) with the exchange rate on the left-hand side – $\hat{\beta}_{1932} = 1$ by construction. The exchange rate kept depreciating after 1932 (bottom right panel of figure 2).

The behaviour of imports is a first dent into the beggar-thy-neighbour story. One side of that story is that, through devaluation, the country makes its domestic goods cheaper, importing less itself, and forcing others to import more. I find no evidence for that mechanism, suggesting either a low substitution between imports and domestic goods, or an offsetting response of domestic demand... or both. In fact, after a few years, those countries imported more, which is suggestive of a strong response of domestic demand. These estimates conflict with the findings of a contemporaneous paper by Candia and Pedemonte (2025). Looking at a cross-section of US cities around 1931, they argue that those that were more exposed to sectors that were exporting to devaluing countries experienced a fall in bank debits. (Bank debits are the only city-level measure of economic activity that is available at monthly frequency.) This is puzzling in light of my results: a necessary condition for those cities to be hurt would seem to be that devaluing countries imported less. That devaluing countries did not import less will be confirmed by the cleaner high frequency identification.

Did other policies correlate with exchange rate depreciation? The first possibility is changes in tariff. A relative tariff decline in countries that devalued may explain the behaviour of imports on figure 2. Figure A.3 in the appendix shows that countries that devalued indeed experienced a relative decline in the ratio of tariff revenues divided by the value of their imports. These changes were driven by tariff hikes in countries that did not devalue, instead of tariff cuts in countries that did (Eichengreen and Irwin, 2010). The second possibility is fiscal policy. After all, the pound devaluation occurred in the face of stalling negotiations around the government budget. It is conceivable that, by relaxing the constraint that it exerted on monetary policy, leaving the gold standard allowed the central bank to print money to finance the fiscal authority. Through higher spending, fiscal policy might have stimulated output. Evidence shown on figure A.3 casts doubt on this story. If anything, real government spending declined after the devaluations. The test of joint significance of the 1932 to 1935 coefficients returns a p-value that is too high to reject the null that all coefficients are 0. The same is true about revenues.[6] In any case, these policies do not explain the results. In figure A.1, I add the changes in tariff and fiscal variables as controls, without discernible effects on the point estimates of the main variables. They can, however, lower statistical significance for some variables (table A.3).

Why did countries devalue, why did they not? According to Eichengreen and Sachs (1985) and Eichengreen (1992), the decision to devalue was shaped by past experience with the gold standard more than contemporaneous economic performance. In Britain, where the pound had been brought back to its pre-WWI parity at the expense of deflation and unemployment, there was little appetite for more austerity. France, on the other hand, had come close to hyperinflation in 1926. The franc convertibility had been restored after a protracted war of attrition between political parties to decide who would bear the costs of adjustment. In 1930s France, even Communists opposed devaluation, which they thought would reduce workers' living standards.

[6] Inspecting these results, I found that this (insignificant) fall in real spending and revenues was primarily driven by the increase in the wholesale price index (figure 2), which I use to deflate nominal spending and revenues. Thus, it is plausible that the decline in spending and revenues was due to nominal stickiness in civil servants' salaries or tax brackets.

Can figure 2 be interpreted as evidence of a causal link from devaluation to recovery? That none of the variables exhibits a preexisting trend – except consumption goods perhaps – is at least suggestive of a causal relationship. In particular, it rules out the possibility that results are driven by the economy bouncing back from a shock that would have led to devaluation. Nevertheless, devaluing countries may have been reacting to a contemporaneous shock that would have affected future output, such as banking difficulties.[7] That kind of bias, however, would go in a direction opposite to my results.

I now turn to a second, complementary identification strategy that exploits high-frequency variation. Rather than comparing realized outcomes across countries, it isolates the market's response to news about a prospective devaluation, identified from movements in the three-month forward rate in narrow windows around policy announcements. This strategy has the added benefit of allowing the estimation of the absolute effect of currency devaluation.

3 Time Series Evidence

3.1 High-Frequency Identification (HFI) Strategy

3.1.1 HFI Motivation

The decision to devalue may of course be influenced by fundamentals; but different policy-makers may take different decisions in the face of similar circumstances. The 1933 devaluation of the dollar is a good example. Franklin D. Roosevelt, who had just become president, had been unclear about his intentions. The Senate was sympathetic to a *de facto* abandonment of the gold standard in the form of massive purchases of silver. To avoid this radical policy, Roosevelt negotiated in secret an amendment to the Farm Relief Act that gave him authority to cut the gold content of the currency by up to 50%. Edwards (2018, pp. 57–58) tells the story of how he broke the news to his advisers:

> On the night of April 18, the president met with his close advisers to discuss issues related to the impending visit of British Prime Minister Ramsay MacDonald. [...] Only [Assistant Secretary of State] Moley knew that Roosevelt had been negotiating a new initiative for "controlled inflation" with a group of key senators, including Elmer Thomas from Oklahoma. When FDR told them, with a chuckle, that the next day he would announce his support for the Thomas Amendment, [adviser] Feis, [Budget Director] Douglas, and [Secretary of State] Warburg became livid; they couldn't believe what they were hearing and in-

[7] For instance, Accominotti (2012) argues that London merchant banks were in serious trouble because they were the guarantors of important quantities of Central European debt, whose payments were frozen when Austria, Germany and Hungary implemented capital controls.

> terrupted each other in their efforts to convince the president that this was a mistake of historical proportions. In 1934, Warburg wrote that as late as April 18, those who were in daily contact with FDR had no "idea that he was seriously considering such a move." [...] After leaving the White House late that night, Lew Douglas told the rest of the group that without a doubt this was "the end of Western civilization."

That Roosevelt's closest advisers were stunned by his decision suggests there was nothing ineluctable about it. Had he been president, Budget Director Douglas would have probably chosen a different path for the exchange rate. The silverites of the Senate would have picked yet another path.

That kind of variation is exogenous and can be isolated. To do so, I construct series of policy announcements and use changes in the 3-month forward exchange rate around those announcements as instruments for the exchange rate. Being an asset price, the forward exchange rate should incorporate market expectations about the future path of the exchange rate. So, as long as markets and policymakers have similar information about current and future economic conditions, movements in the forward rate that are prompted by policy announcements are exogenous and can be used to infer the effect of exchange rate policy on the economy. Within that framework, a shock can be an unexpected devaluation that happened, or an expected devaluation that did not happen. This strategy is conceptually similar to that of a literature that uses, in a modern context, changes in federal funds rate futures on FOMC days as an instrument for changes in the federal funds rate target in a VAR or a local projection.[8]

3.1.2 Shock Construction

The main challenge of this identification strategy is to find the dates of the policy announcements. I implement a four-step procedure:

1. Search in ProQuest Historical Newspapers for articles featuring appropriate keywords for each day of the period during which the country is on the gold standard. The keywords are: (i) the name of the country or currency, and (ii) mentions of devaluation, leaving the gold standard, or exchange controls. ProQuest Historical Newspapers is a database of archives of the main US newspapers: New York Times, Wall Street Journal, Chicago Tribune;

[8] See Ramey (2016) for a survey. Bagliano and Favero (1999), Cochrane and Piazzesi (2002), Faust et al. (2004), Barakchian and Crowe (2013), Gertler and Karadi (2015) are early contributors to this identification scheme. Weiss (2020) applies it to silverite agitation during the pre-WWI gold standard era. The use of forward exchange rates to infer devaluation expectations has some precedents in the Great Depression literature (Hsieh and Romer, 2006, Accominotti, 2009). These authors, however, do not study the effect of devaluation shocks on macroeconomic variables.

2. Retain dates whose number of articles is 6 standard deviations above the mean. With this step, I seek to select days where an important amount of news is released about future exchange rate policy. The threshold of 6 is somewhat arbitrary. I picked it by trading-off quantity and relevance of those dates. A much higher threshold would leave me with too few days, a much lower one would return too many dates where nothing particular is announced;
3. Read those articles to identify the nature and exact timing of the news: retain dates that correspond to a policy announcement (e.g. devaluation), reject them if they're only conveying news about the economic situation (e.g. strike).
4. Use variation in the 3-month forward exchange rate around the announcement as a shock. For most events, this variation is a one- or two-day trading window. The exchange rate data is quoted by the *Financial Times* at the close of the market in London. If it is clear that the news was known before the market closed, for instance because the newspaper explicitly attributes a market movement to the news, I use the one-day change; if the timing of the arrival of the news is unclear, I use the two-day change. Rates are quoted against sterling: I convert them by triangulation into an exchange rate with the stable currency of the moment: the dollar until the pound devaluation (September 1931), the French franc from that time until the repegging of the dollar to gold in January 1934, the dollar again after that.

I illustrate this procedure with the case of France; other countries' details are given in a data appendix. France is an ideal example because it waited until 1936 to devalue, and because its decision to finally devalue was preceded by several false alarms – expected devaluations that did not happen. Figure 3 shows the number of daily articles returned by a search of the keywords:

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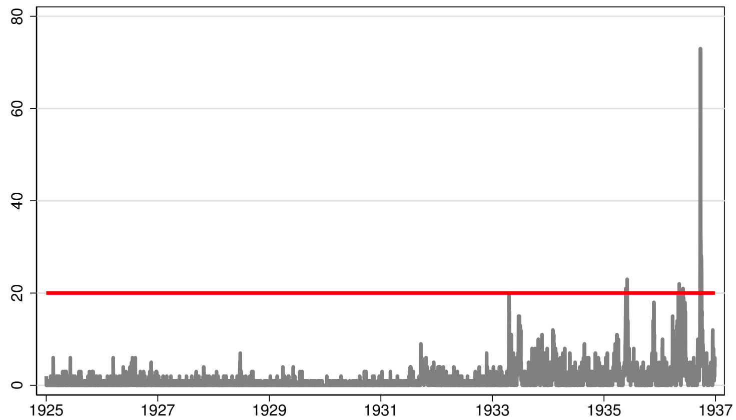
ti(France OR French OR franc) AND (devaluation OR ((off OR suspension
OR leave OR quit) AND "gold standard") OR (exchange control))
```

These keywords mean that: (i) "France", "French" or "franc" must be in the title of the article; and (ii) "devaluation", or a reference to leaving the gold standard or "exchange control" must be in the title or text of the article. Over the period during which France was on the gold standard (June 1928 to September 1936), the mean of the number of such articles was 1.3 and the standard deviation 3.1. So a day must feature more than 20 articles in order to be retained. The red line on figure 3 is the cutoff.

Table 1 lists the dates that are above that cutoff. First, many dates neighbour each other. For instance, the September 1936 devaluation of the franc, which was announced on September 26, and officially ratified on October 2, sparked a flurry of articles from September 25 to October 5. Since these articles deal with the same event, I take them as a single shock

Figure 3: Daily number of articles for France



Note: number of daily articles returned by ProQuest Historical Newspapers with the keywords described above. The red line is the cutoff defined by the formula: mean + 6 × standard deviations.

that happens on September 26, the day the devaluation was announced. Before devaluation happened, my procedure detects two announcements that correspond to non-devaluations. The first one is the fall of Pierre-Etienne Flandin's cabinet. While officially opposed to devaluation, Flandin's government implemented policies that ran against the gold standard constraint: low interest rates, budget deficit, cartelization of the French industry... Flandin's fall and replacement by Fernand Bouisson, whose government was more committed to deflationary policies, were interpreted as a contractionary shock by the forward exchange rate market. The second non-devaluation is Léon Blum's speech on May 10, 1936. Blum was a Socialist who led a left-wing coalition, the Popular Front, to victory on May 3, 1936. This victory led to speculation that France would devalue. With that speech, the future head of government reassured financial markets about his commitment to the gold standard, thereby generating a contractionary shock. Five months later, the same Blum would take the decision to devalue the franc...

One last difficulty is that, sometimes, financial markets were closed after major announcements. For instance, in 1936, the Paris bourse was closed from September 25 until October 1, when the devaluation law was passed. So there were no forward exchange quotations during that time. As a result, I take the narrowest possible window – 7 days in that case – around the announcement. The French devaluation, however, is an extreme example. In most cases, that narrowest window is 1 or 2 trading days.

3.1.3 Potential Objections

What about the "information effect" (Nakamura and Steinsson, 2018)? If monetary authorities possess superior information about present and future economic conditions, policy shocks are not exogenous to those same economic conditions. They only reflect superior information. In this context, however, this is less likely to be a problem than with modern data.

Table 1: France, shocks

Date	# articles	Event	Shock
27may1935	21	Fall of Flandin's cabinet	-0.046
31may1935	21		
04jun1935	21		
05jun1935	23		
11may1936	22	Blum's devaluation speech	-0.013
05jun1936	21	Strikes	×
25sep1936	30	Devaluation	+0.234
26sep1936	60		
27sep1936	73		
28sep1936	59		
29sep1936	33		
30sep1936	31		
01oct1936	25		
02oct1936	28		
03oct1936	28		
04oct1936	27		
05oct1936	24		

Note: shocks selected by the procedure described in section 3. The mean and standard deviation of the daily number of articles are 1.3 and 3.1 respectively. Other countries are shown in table A.4.

Governments and central banks had smaller staff than they do today, and they shouldn't be expected to have had better information about the state of the economy. Even if that were the case, the expected direction of the bias is downward: devaluation is presumably a sign of weakness not of strength. For the information effect to explain my result, one would have to believe that governments took their countries off the gold standard because they had private information that the economy was improving.

Isn't the timing of the policy announcements endogenous? It certainly is. But this is not a problem as long as this endogeneity is reflected in the forward rate on the eve of the announcement. This would only be a problem if the announcements reflected information about future economic conditions that became known during the day. Since devaluations tended to be protracted affairs whose decisions took months, if not years, to be taken, this is unlikely to be an issue. In the case of the US, the quote above suggests that Roosevelt took his decision at least one day before announcing it.

Don't daily variations in the forward rate partly reflect background noise that correlates with economic fundamentals? It is possible. With modern data, one can keep background noise to a minimum by using 30-minute windows around the announcement. Since only daily data is available in the 1930s, this cannot be done here. Hence, I must assume that there is more good (driven by the announcement) than bad (background noise that correlates with fundamentals) variation on the days of policy announcements. Put another way, the identifying assumption is really that most, if not all, variation in the forward rate, around policy announcements, is exogenous. At any rate, this assumption is much milder than the one required by the DD strategy: that all variation, every day, is exogenous.

Do forward exchange rates capture expectations about future spot rates? Even though, in modern data, the forward rate tends to be a poor proxy for the future spot rate (Fama, 1984), this is less so under fixed exchange rates. For instance, Accominotti et al. (2019) find zero return to the carry trade under fixed exchange rate regimes with the same data, currencies and time period. Their result is in line with other studies from different eras: Flood and Rose (1996) find smaller deviations from uncovered interest rate parity among currencies of the European Monetary System than under floating exchange rates; so do Colacito and Croce (2013) with Bretton-Woods data. I verify this argument by running a regression of the change in the spot exchange rate on the forward premium:

$$xr^j_{t+s} - xr^j_t = \alpha + \beta \left(fw^j_{t,s} - xr^j_t \right) + e^j_{t,s}, \tag{2}$$

where xr^j is the logarithm of the spot exchange rate and $fw^j_{t,s}$ that of the s month-forward exchange rates, both for country j at time t. Data is taken on the last trading day of the month. To avoid overlapping windows, I use the data at the end of every month for $s = 1$, every two months for $s = 2$ (February, April, June, August, October, December), and every three months for $s = 3$ (March, June, September, December). If the forward exchange rate is a good predictor of the spot ($fw^j_{t,s} = E_t xr^j_{t+s}$), the coefficients of this regression should be $\alpha = 0$ and $\beta = 1$. Table A.5 shows that the truth is not far from this ideal benchmark: the intercept is close to 0 and the coefficient on the forward premium is significantly positive. It tends to be larger than 1, which implies that the forward rate under-predicts the extent of devaluation, but the difference is not statistically significant at the 5% level. A formal test, whose p-value is shown in the foot of the table, can never reject the joint hypothesis $\alpha = 0$ and $\beta = 1$ at the 5% level. Finally, the R^2 implies that the forward rate explains 12% of the variation at quarterly frequency. For comparison, Fama (1984, table 2) obtains a negative β – a forward discount predicts an appreciation – and R^2s below 5% with 1973–82 data.

3.2 HFI Results

3.2.1 HFI Results: Domestic Effect

I estimate a panel local projection with instrumental variable (Jordà, 2005, Jordà et al., 2015):

$$z^j_{t+k} - z^j_{t-1} = \beta_k \Delta\epsilon^j_t + \gamma'_k X^j_{t-1} + \zeta^j_k + e^j_{t,k}, \tag{3}$$

where z_t^j is the logarithm of the variable of interest in country j in month t, $\Delta\epsilon_t^j$ is the logarithm change in the nominal price of gold, X_{t-1}^j is a vector of controls, and ζ_k^j is a country fixed effect. The price of gold is instrumented with the aforementioned shocks. The controls are a quarter of lags of the outcome variable, the domestic and foreign price of gold, and a lag of the shock. Variables other than interest rates and inflation expectations enter in log first differences. I estimate equation (3) at monthly frequency. F-statistics for the first stage are reported in table A.6 in the appendix.

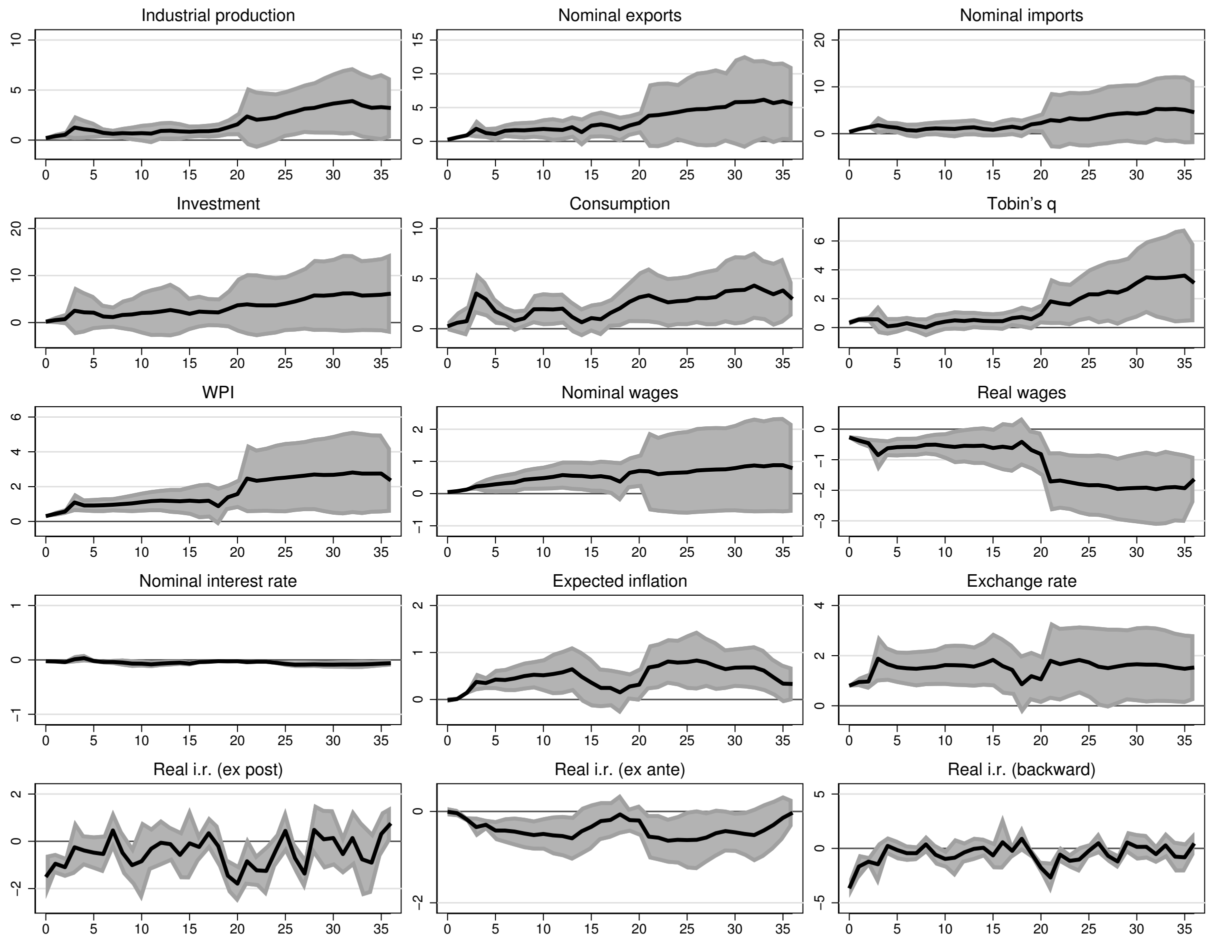
Compared to the ES regression or equation (1), equation (3) leverages time series variation: so far, the specification does *not* include time fixed effects. β_k can be interpreted as the absolute effect: it is a causal estimate of the absolute effect of currency devaluations on the domestic economy.

The countries and outcome variables differ from those of the difference-in-difference exercise. Before, the choice of countries was dictated by the desire to construct a quasi-experimental setup. Now, the sample is determined by data availability: it is made of the eight countries for which forward exchange rate data is continuously available from *The Financial Times* – Germany, Belgium, France, Italy, the Netherlands, Switzerland, the United Kingdom and the United States. Another difficulty is that industrial production and nominal wages are sometimes unavailable at frequency above annual. Industrial production, for instance, is only available at quarterly frequency for the UK and at annual frequency for the Netherlands and Switzerland. To circumvent this problem, I estimate monthly series with the methodology proposed by Stock and Watson (2010). They use a Kalman filter to apportion quarterly GDP and GDP deflator data into monthly estimates thanks to a set of monthly indicators closely linked to economic activity and prices. Since no single indicator is consistently available across countries, I use an index of business activity or a labour market indicator (employment or unemployment) to infer industrial production.[9] I add the wholesale price index to this indicator to infer nominal wages. In a data appendix available on my website, I summarise which series are interpolated, which variables inform this interpolation, and what the original frequency is.

Figure 4 shows the results for the domestic specification. They are qualitatively similar to those of section 2. The devaluation stimulated industrial production, nominal exports and imports, prices and nominal wages and led to a fall in real wages. Again, the monetary action comes not from the nominal interest rate, but from the real one: inflation expectations increased and the 3 concepts of the real interest rate declined.

[9] I use what is available in the dataset of Albers (2018). He combines data from various publications of the German Statistisches Reichsamt and the International Statistical Institute. Those publications themselves are compilations of series published by national statistical agencies.

Figure 4: Domestic absolute effect (HFI)



Note: response of relevant variable to an exogenous 100 log-points devaluation in the exchange rate. Formally, the plots show the estimate of β_k in equation (3). Time is in months. The black line is the point estimate; the grey area is the 95% confidence interval with Driscoll-Kraay standard errors.

In table 2, I compute the 2-year effect of a 100 log-point devaluation. For flow variables such as industrial production, I obtain that object by averaging the response β_k over the horizon of interest. Following Coibion et al. (2017), I capture correlation between the different β_k by jointly estimating the equations. For prices such as the wholesale price index, I report the effect after 2 years, which corresponds to β_{24} in equation (3). The results corresponding to figure 4 are gathered in column (1). The coefficients can be read as elasticities. A coefficient of 1.06 for industrial production means that, for each log point that a country initially devalued against gold, its industrial production increased by roughly one log point.

Once again, these are estimates of the absolute effect, not the relative one. They imply that Britain's industrial production increased by about 30% for a 30% devaluation, compared to a counter-factual where it hadn't devalued. This statement is absolute, it is not made relative to France.

Table 2: 2-year effect

		Domestic		Spillovers			
		(1) Absolute	(2) Relative	(3) 8 coun.	(4) 18 coun.	(5) Gold bloc	(6) Gold bloc+
Cumulative							
Industrial production	Domestic	1.06**	0.95***	0.85**			
		(0.46)	(0.30)	(0.34)			
	Foreign			0.14	1.94	−0.12	0.57
				(1.66)	(1.81)	(1.17)	(2.04)
Nominal exports	Domestic	2.05**	2.08***	1.91***			
		(0.87)	(0.59)	(0.67)			
	Foreign			−0.51	3.07	−0.91	−0.26
				(3.99)	(3.82)	(4.29)	(5.28)
Nominal imports	Domestic	1.49	1.64**	1.29			
		(1.08)	(0.64)	(0.81)			
	Foreign			−0.65	1.92	−0.97	0.17
				(3.43)	(4.08)	(2.77)	(3.82)
Real i.r. (ex ante)	Domestic	−0.37***	−0.33**	−0.30**			
		(0.14)	(0.15)	(0.13)			
	Foreign			−0.29	−0.84	−0.25	−0.29
				(0.52)	(0.68)	(0.49)	(0.51)
Exchange rate	Domestic	1.49***	1.80***	1.67***			
		(0.38)	(0.49)	(0.48)			
	Foreign			−1.63**	0.63	−1.15**	−1.10*
				(0.62)	(1.07)	(0.53)	(0.57)
Level							
WPI	Domestic	1.24***	0.92***	0.83***			
		(0.34)	(0.21)	(0.21)			
	Foreign			1.52	2.07***	1.75	1.70
				(1.46)	(0.52)	(1.43)	(1.41)
Nominal wages	Domestic	0.44*	0.57***	0.47**			
		(0.24)	(0.19)	(0.22)			
	Foreign			−0.53	−0.27	−0.36	−0.29
				(0.57)	(0.43)	(0.50)	(0.56)

Note: domestic and foreign effects of devaluation as estimated in section 3. The specification of column (2) includes time fixed effects. In column (1–3), the sample is made of the 8 countries for which forward exchange rate data is available. The list of 18 countries used in column (4) is given in table A.1. Gold bloc is made of Belgium, France, the Netherlands, and Switzerland; gold bloc+ also includes Poland.

In column (2), I add time fixed effects to equation (3). Their inclusion means that the estimand is a relative concept once again. Thus, the specification of column (2) is a comparison of a country that experiences a devaluation shock to one that does not. Just as in column (1), the point estimate for industrial production suggests an elasticity around 1: a

30% devaluation increased industrial production by 30%. In the case of column (2), however, the statement is relative: Britain increased industrial production by 30% compared to France. Being relative effects, the coefficients of column (2) are directly comparable to the results of section 2.

A comparison of columns (1) and (2) of table 2 offers a tentative answer to the beggar-thy-neighbour question: that answer is negative. A larger coefficient in column (2) compared to column (1) – the relative effect is larger than the absolute one – would indicate negative spillovers on countries that did not experience the same shock, a smaller coefficient positive spillovers. The coefficients are remarkably similar across the two columns, which suggests small spillovers in either direction to countries that did not devalue. Naturally, a comparison of columns (1) and (2) is not a definitive answer to the question that motivates this paper. A more direct way to answer that question would be to replace domestic shocks with foreign ones on the right-hand side of equation (3), an avenue that I pursue in the next section.

3.2.2 HFI Results: International Spillovers

I now construct a measure of each country's exposure to foreign devaluation. I define this measure as:

$$\epsilon_t^{-j} = \sum_{\substack{c=1 \\ c \neq j}}^{n} w_j^c \epsilon_t^c$$

where ϵ_t^c is the logarithm of the nominal price of gold in country c and month t. w_j^c is the share of country c in country j's trade (exports plus imports) in 1929. Such a measure can be constructed for the foreign price of gold and for the devaluation shocks constructed in section 3.1.2.

I re-estimate equation (3), adding $\Delta\epsilon_t^{-j}$ or substituting it for $\Delta\epsilon_t^j$ depending on the specification. The (trade-weighted) foreign price of gold is instrumented with the foreign shocks. The results are in columns (3–6) of table 2 for different country samples. In column (3), the sample is the same as for columns (1–2): it is restricted to the 8 countries for which forward exchange rate data is available from *The Financial Times*. In column (4), I extend the sample to the 18 countries for which I was able to marshal monthly industrial production data, either because it is directly available or because I could find a proxy for aggregate production with which to interpolate annual data following the procedure described above (Stock and Watson, 2010). In column (5), I restrict the sample to the so-called gold bloc, the countries that maintained strict adherence to the gold standard for several years after the pound devaluation (Belgium, France, the Netherlands, and Switzerland) – I end the sample once they devalue (March 1935 for Belgium, September 1936 for the other three). In column (6), I enlarge the gold bloc to Poland, which stayed on the gold standard until it implemented exchange controls in April 1936.

Columns (3–6) of table 2 display no evidence of a negative effect of currency devaluation on foreign output. The coefficients are either positive or close to 0 and always insignificant. The only variable for which there is consistent evidence of international spillovers is, predictably, the exchange rate, which appreciates under the influence of the foreign devaluation. Figure A.4, where I show the entire impulse response functions for the 4-country gold bloc, is another illustration of this finding: the foreign shock has no discernible effect on economic activity, be it industrial production or trade.

Absence of evidence is not evidence of absence. An important limitation of columns (3–6) is the size of the standard errors. Strictly speaking, the exercise cannot rule out significantly negative numbers. Still, the conclusion remains: high-frequency devaluation shocks have a large effect on the domestic economy, be it in the cross-section or the time series, but no discernible effect on foreign economies. This statistical uncertainty motivates another line of argumentation, which relies on cross-sectional evidence and a structural estimation.

4 A Multi-Country Model

I consider a world made of a continuum of symmetric countries whose combined size is normalized to 1. In each country, there still is a continuum of firms that each produce a variety of the single good. Production can be consumed by households, used as intermediate goods in the production process or invested to become capital. I relegate detailed proofs to the appendix and focus on the main equations. Unless specified otherwise and throughout the model, lower case letters denote logs and hats denote deviations from steady state.

4.1 Demand System

In country j, the household minimizes expenditures:

$$\int_f P_t^{jj}(f) C_t^{jj}(f)\,\mathrm{d}f + \int_k \int_f P_t^{jk}(f) C_t^{jk}(f)\,\mathrm{d}f\,\mathrm{d}k$$

subject to a Kimball (1995) aggregator:

$$C_t^j = (1-\bar{\Gamma}) C_t^j \times g\left(\int_f g^*\left(\frac{C_t^{jj}(f)}{(1-\bar{\Gamma})C_t^j}\right)\mathrm{d}f\right) + \bar{\Gamma} C_t^j \times g\left(\int_k\int_f g^*\left(\frac{C_t^{jk}(f)}{\bar{\Gamma}C_t^j}\right)\mathrm{d}f\,\mathrm{d}k\right) \tag{4}$$

$P_t^{jj}(f)$ and $C_t^{jj}(f)$ are the price and consumption, in country j, of the variety produced by firm f of country j. Their product is expenditures on that variety. Summing over all firms f corresponds to expenditures on domestic varieties. $P_t^{jk}(f)$ and $C_t^{jk}(f)$ are the price and consumption, in country j, of the variety produced by firm f of country k. Their product is expenditures on that variety. Summing over all firms f and foreign countries k corresponds to expenditures on foreign varieties. $\bar{\Gamma}$ is the coefficient of openness: the higher $\bar{\Gamma}$, the more the household consumes of the foreign good.

Equation (4) governs aggregation of those varieties through the functions $g(.)$ and $g^*(.)$. I assume particular functional forms for those. $g(.)$, the function that governs aggregation between domestic and foreign varieties, is of the form:

$$g(x) = 1 + \frac{1}{1-\tilde{\rho}}\left(x^{1-\tilde{\rho}} - 1\right)$$

$g^*(.)$ is the function that governs aggregation among domestic and foreign firms. I borrow the functional form used by Klenow and Willis (2016):

$$h(x) = \left(g^{*'}\right)^{-1}(x) = \left(1 - \bar{m}' \log(x)\right)^{\frac{\theta}{\bar{m}'}}, \qquad \theta > 1, \quad \bar{m}' > 0$$

The constant elasticity of substitution (CES) model is nested: this formulation collapses to a CES demand system with elasticity θ if $\tilde{\rho} = 0$ and $\bar{m}' \to 0$.

Solving the expenditure-minimization problem and log-linearizing around a symmetric steady state gives the following demand functions:

$$\hat{c}_t^{jk} = -\theta\left(p_t^{jk} - p_t^{j*}\right) + \hat{c}_t^{j*} \tag{5}$$

$$\hat{c}_t^{j*} = -\rho\left(p_t^{j*} - p_t^{j}\right) + \hat{c}_t^{j} \tag{6}$$

$$\hat{c}_t^{jj} = -\rho\left(p_t^{jj} - p_t^{j}\right) + \hat{c}_t^{j} \tag{7}$$

Prices are expressed in logarithms but they do not carry hats since they do not have a well-defined steady state value. On the other hand, relative prices ($p_t^{jk} - p_t^{j*}$, $p_t^{j*} - p_t^{j}$, $p_t^{jj} - p_t^{j}$) do: in a symmetric steady state that value is 1. Equation (5) is the demand for country k's varieties in country j as a function of their price (p_t^{jk}) relative to the import price index (p_t^{j*}) and of country j's imports (c_t^{j*}). Equations (6) and (7) are the demand for imports (c_t^{j*}) and domestic goods ($\hat{c}_t^{jj}$) as a function of their prices (p_t^{j*} and p_t^{jj}) relative to the consumer price index (p_t^{j}).

These equations introduce a new parameter, ρ, the elasticity of substitution between domestic and foreign goods, which is given by: $\rho \equiv \theta/(1+\theta\tilde{\rho})$. If $\tilde{\rho} > 0$, $g(.)$ is concave so domestic and foreign varieties become less substitutable ($\rho < \theta$). If $\tilde{\rho} < 0$, $g(.)$ is convex and the opposite happens. In the estimation, I shall argue that $\rho < \theta$ is the relevant case. In theory, however, the relationship is not restricted.

Kimball demand is a standard tool to generate incomplete pass-through of the exchange rate to international prices (Amiti et al., 2014b, Burstein and Gopinath, 2014, Itskhoki and Mukhin, 2021). Compared to these papers, however, I innovate along one dimension: the introduction of an extra aggregator, $g(.)$. This addition allows me to distinguish the elasticity of substitution among imports (θ) from that between imports and domestic varieties (ρ). If $g(.)$ is the identity, then: $\rho = \theta$. Nested CES demand systems within and across sectors can also generate incomplete pass-through if firms are not atomistic within their sectors (Atkeson and Burstein, 2008). To be calibrated, however, this framework requires information on the share of exporting firms and on the concentration of production among producers in a sector, which is not available for this period. Therefore, I opt for the more parsimonious Kimball apparatus.

Intermediate and capital goods are subject to the same aggregator (4) such that equations (5–7) also describe the demand for domestic and foreign goods for these purposes:

$$\hat{d}_t^{jk} = -\theta\left(p_t^{jk} - p_t^{j*}\right) + \hat{d}_t^{j*} \qquad \hat{d}_t^{j*} = -\rho\left(p_t^{j*} - p_t^{j}\right) + \hat{d}_t^{j} \qquad \hat{d}_t^{jj} = -\rho\left(p_t^{jj} - p_t^{j}\right) + \hat{d}_t^{j}, \quad (8)$$

where domestic demand $\hat{d}_t^j$ is the sum of the demand for intermediate, capital, and consumption goods: $\hat{d}_t^j = \nu\hat{v}_t^j + (1-\nu)\bar{x}\hat{x}_t^j + (1-\nu)(1-\bar{x})\hat{c}_t^j$.

4.2 Pass-Through

Prices are flexible for now—an assumption that will be relaxed during the estimation. Firm f sets its local currency price subject to the demand function that arises from the expenditure minimization of the household. I show in the appendix that this problem implies:

$$p_t^{jk} = (1-\zeta_1-\zeta_2)(\Theta + mc_t^k - xr_t^{kj}) + \zeta_1 p_t^{j*} + \zeta_2 p_t^j \quad (9)$$

where mc_t^k is the marginal cost and xr_t^{kj} is the exchange rate (in logarithms).

ζ_1, ζ_2, and $\bar{m}$ are the strategic complementarity parameters:

$$\zeta_1 = \frac{\bar{m}(1-\rho/\theta)}{1+\bar{m}} \qquad \zeta_2 = \frac{\bar{m}\rho/\theta}{1+\bar{m}} \qquad \bar{m} = \frac{\bar{m}'}{\theta-1}.$$

Their presence implies that, when they set their price, foreign producers adapt their price to the import (p_t^{j*}) and domestic (p_t^j) price indices of the country of destination. Like the elasticities, the strategic complementarity parameters depend on the aggregator functions $g(.)$ and $g^*(.)$. For $\rho < \theta$, they lie between 0 and 1. In the CES case, these parameters are equal to 0.

Equation (9) implies that the pass-through of the exchange rate is:

$$1-\zeta_1-\zeta_2 = \frac{1}{1+\bar{m}} < 1 \quad (10)$$

In general this pass-through is below 1. Once again, the CES model is nested. A CES demand implies that the firm charges a constant markup, hence transmits any exchange rate movement one for one – the pass-through is 1. This is apparent in the latter formula: the pass-through converges to 1 if $\bar{m}$ goes to 0. In fact, $\bar{m}$ is the elasticity of the markup. With $\bar{m} \to 0$, the markup is inelastic, hence constant, which is a feature of the CES case.

4.3 Output

Gathering equations (9) implies that output in country j is equal to:

$$\hat{y}_t^j = \underbrace{\psi\left(\int_m (mc_t^m - xr_t^{mj})\,\mathrm{d}m - mc_t^j\right)}_{\text{expenditure switching}} + \underbrace{(1-\bar{\Gamma})\hat{d}_t^j}_{\text{domestic demand}} + \underbrace{\bar{\Gamma}\int_k \hat{d}_t^k\,\mathrm{d}k}_{\text{foreign demand}} \tag{11}$$

$$\psi \equiv \bar{\Gamma}\left(\frac{(1-\bar{\Gamma})\rho}{1+\bar{m}\rho/\theta} + \frac{\theta}{1+\bar{m}}\right)$$

The last two terms (domestic and foreign demands) are easy to interpret. If country j consumes or invests more, it demands more of its own goods, hence produces more. Similarly, if its trading partners consume or invest more, they demand more of the country's goods, hence country j produces more.

The first term embodies expenditure switching. It gathers marginal cost in the rest of the world (mc_t^m), adjusted for the bilateral exchange rate (xr_t^{mj}), relative to marginal cost in country j (mc_t^j). If country j's currency depreciates (xr_t^{mj} decreases), it lowers the marginal cost expressed in foreign currency. The depreciation finds its way into the price of country j's varieties through equation (9). Consumers shift expenditures towards those varieties. For given levels of domestic and foreign consumption, country j must produce more.

The beggar-thy-neighbour question amounts to whether the first term dominates the third one – and if so, by how much? Expenditure switching weighs non-devaluing countries' output down, but the monetary stimulus to foreign demand pushes it up. In theory, the latter may trump the former. Of course, in equilibrium, whichever dominates will feed into domestic consumption.

The strength of the expenditure switching term is governed by ψ which, besides the coefficient of openness $\bar{\Gamma}$, depends on three parameters: (i) ρ, the elasticity of substitution between foreign and domestic varieties, (ii) θ, the elasticity of substitution among foreign varieties, and (iii) $\bar{m}$, the elasticity of firms' markup, which determines the pass-through.

I now turn to granular trade data to estimate the last two parameters, θ and $\bar{m}$ – the first one, ρ, will be estimated out of the cross-country moments. Doing so, I relax some of the assumptions of this section: single product, absence of demand shocks, symmetric and atomistic countries.

5 Trade Evidence

5.1 Identification Strategy

I assume that demand for product r in country j, D^j_{rt}, is governed by a Kimball (1995) aggregator:

$$\begin{aligned} D^j_{rt} =& (1-\Gamma^j_{rt})D^j_{rt} \times g\left(\int_f g^*\left(\frac{D^{jj}_{rt}(f)}{(1-\Gamma^j_{rt})D^j_{rt}}\right)\mathrm{d}f\right) \\ &+ \Gamma^j_{rt}D^j_{rt} \times g\left(\sum_{\substack{k\in\mathcal{J}\\k\neq j}}\mathcal{K}^{jk}_{rt}\int_f g^*\left(\frac{D^{jk}_{rt}(f)}{\Gamma^j_{rt}\mathcal{K}^{jk}_{rt}D^j_{rt}}\right)\mathrm{d}f\right), \end{aligned} \tag{12}$$

where $D^{jk}_{rt}(f)$ is demand in country j for product r from firm f of country k.

Equation (12) is a generalization of equation (4). The first generalization is the introduction of many products r: there is now an aggregator within each product category. The second generalization is the introduction of taste shocks for imported (Γ^j_{rt}) and foreign varieties ($\mathcal{K}^{jk}_{rt}$).

Solving the expenditure minimization problem and log-linearizing, I can write:

$$\Delta d^{jk}_{rt} = -\theta\Delta p^{jk}_{rt} + \theta\Delta p^{j*}_{rt} + \Delta d^{j*}_{rt} + \Delta\kappa^{jk}_{rt}, \tag{13}$$

Δ denotes time differentiation, and lower case letters logarithms. d^{jk}_{rt} is country j's demand for country k's varieties of product r and p^{jk}_{rt} their price index. d^{j*}_{rt} and p^{j*}_{rt} are country j's quantity and price of imports of product r. κ^{jk}_{rt} shifts expenditures to country j's variety away from other foreign varieties.

θ is the price elasticity of substitution among foreign varieties. It is the parameter that I seek to estimate. It is given by: $\theta = -h'(1)$ where $h(.) = (g^{*'})^{-1}(.)$. Importantly, I did not assume a constant elasticity of substitution (CES) demand system to arrive at equation (13). The elasticity is not necessarily constant. On the other hand, θ is the elasticity around a symmetric equilibrium where relative prices are equal to 1.

The empirical analogue of equation (13) is:

$$\Delta d^{jk}_{rt} = -\theta\Delta p^{jk}_{rt} + \mu^j_{rt} + e^{jk}_{rt}. \tag{14}$$

The fixed effect μ^j_{rt} soaks up the $\theta\Delta p^{j*}_{rt} + \Delta d^{j*}_{rt}$ term. Yet, simultaneity bias would be looming if I were to estimate equation (14) by OLS. To solve this problem, I instrument the price, p^{jk}_{rt}, with the exchange rate, xr^k_t. Since I use data on US imports ($j = us$), this strategy identifies θ as long as devaluation is uncorrelated with within-product US relative demand shocks, $\Delta\kappa^{us,k}_{rt}$.

Proposition 1 (Elasticity) *Provided devaluation is exogenous to within-product US demand shocks, instrumenting prices with the exchange rate in regression (14) identifies the within-product elasticity of substitution among foreign varieties, θ.*

To understand the strengths and limitations of proposition 1, consider two examples, one where the identification assumption is satisfied and one where it's not. If Britain devalued because it exported a lot of steel and the world demand for steel had collapsed because of the Great Depression, the identification assumption holds. Indeed, such a confounding factor is controlled for by the product-time fixed effects, μ_{rt}^j. If, on the other hand, Britain devalued because the US was suddenly importing less steel from Britain than from France, then the identification assumption fails. Such a story doesn't seem particularly plausible. The identification assumption also allows for any correlation of devaluation with supply-driven shocks. Its failure can only come from a mechanism involving relative demand shocks.

5.2 Data

Probably because tariff revenues were the main source of revenues of the federal government in the first hundred years of its existence, the United States was already collecting detailed trade data in 1790. The first Secretary of the Treasury, Alexander Hamilton, would thus transmit to Congress annual statements on exports and imports. This tradition lasted for the whole 19th century. In the late 1890s, the Bureau of Statistics of the Treasury even started issuing monthly data. In 1904, this responsibility shifted to the newly created Department of Commerce and Labor.

In the 1930s, the annual data would be published in a report of the Department of Commerce called the *Foreign Commerce and Navigation of the United States*. This publication, which lasted until the 1960s, contains the equivalent of the trade data that one can download nowadays from the Census' website. It features yearly information at the product level, broken down by countries. Products are fairly narrow categories. For instance, in 1930, there are 98 products in the metals group alone. Among them are steel bars, hand-sewing and darning needles, or manganese ore. For each product, I observe yearly imports both in value and in the relevant quantity. For example, I know that, in 1931, the US imported 1,260,496 golf balls from the United Kingdom, for a value of $387,513. Table A.2 is a snapshot taken from the 1931 issue. The data was digitized with optical character recognition software, ABBYY FineReader. In contemporaneous and independent work, Irwin and Soderbery (2021) also digitized this data to study optimal tariff policy in the interwar era.

A notable feature of this data is the way the value of imports is computed. Imported goods were appraised based on the prices prevailing in the country of origin, for domestic or export purposes, inflated with shipping costs. The procedure, as it is described in the Tariff

Act of 1930 (p. 132 and following), worked as follows: (i) the importer filed an invoice that included "the purchase price of each item in the currency of the purchase", (ii) an individual mandated by the Treasury appraised "the merchandise in the unit of quantity in which the merchandise is usually bought and sold by ascertaining or estimating the value thereof by all reasonable ways and means in his power, any statement of cost or cost of production in any invoice, affidavit, declaration, or other document to the contrary notwithstanding", and (iii) the customs "collector shall give written notice of appraisement to the consignee [...] if the appraised value is higher than the entered value". This procedure was meant to avoid invoicing fraud. It is unclear how often and how much appraisers deviated from the value contained in the invoice. It is also unclear that it should bias my estimates in a particular way.

5.3 Samples

Since the bulk of the devaluations happened in 1931, I estimate equation (14) with data for two separate years: 1932 and 1933. The year that serves as the basis for comparison is 1930 in both cases. In each case, the identifying variation lies in the change in the exchange rate between 1930 and the relevant year. Moreover, the panel is made exclusively of countries that devalued in 1931, or had not devalued at the end of the relevant year. For instance, Australia, whose currency depreciated as soon as 1930, is dropped from both panels. Estonia, which devalued in 1933, is kept in the first panel (1932), but kicked out of the second one (1933). Among countries that make it in both panels are of course the United Kingdom (it devalued in 1931) and France (it waited until 1936 to devalue). The point of this procedure is to use as large a panel as possible, while avoiding mixing countries that did not devalue at the same time. Table A.1 in the appendix gives the country list of each sample.[10]

5.4 Results: Elasticity

I show the baseline results in panel A of table 3. Columns (1), (2) and (3) respectively feature the results for the reduced form, first stage and instrumented equations using the 1930-32 change. The estimated elasticity of quantity with respect to the exchange rate is 0.910 in 1932, while the price response is -0.443. This means that, thanks to its devaluation of 28%, Britain increased the quantity of its exports by 26% compared to France that did not and decreased their average dollar price by 13% compared to French products. The implied elasticity of substitution among foreign varieties, $\hat{\theta}$, is 2.054. Columns (4), (5) and (6) show

[10] I noticed only one case where this selection procedure seems to affect the results: Chile in the 1932 weighted specification. Chile officially devalued in 1932 so I do not include it in my sample. However, it set up an export exchange rate whose devaluation started in 1931. By 1933, this exchange rate was so devalued (-75.4%) that the log-change goes wild and that a few heavily weighted observations can significantly affect the final result.

the results using the 1930-33 change. The point estimate of the elasticity goes up to 3.084.

Table 3: Elasticity baseline

	1930-32 change			1930-33 change		
	(1) RF	(2) FS	(3) IV	(4) RF	(5) FS	(6) IV
Panel A: Estimate						
XR	0.910**	−0.443***		1.205***	−0.391***	
	(0.349)	(0.110)		(0.233)	(0.105)	
Elasticity			2.054***			3.084***
			(0.578)			(0.413)
Observations	3742	3742	3742	3446	3446	3446
F-statistic			16.142			13.915
Panel B: Placebo						
XR	0.027	0.049		0.102	0.024	
	(0.122)	(0.047)		(0.069)	(0.034)	
Elasticity			−0.550			−4.310
			(2.527)			(6.439)
Observations	3755	3755	3755	3579	3579	3579
F-statistic			1.097			0.482

Note: reduced form (RF), first stage (FS) and instrumented (IV) estimates of equation (14). Standard errors are in parentheses. They are double clustered at the country and product levels. F-statistic is the Kleibergen-Paap Wald rk F-statistic of the first stage.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Were devaluations exogenous to US demand shocks? To answer this reverse causality concern, I regress pre-devaluation changes in quantity and price on the later change in the exchange rate. To be precise, I estimate equation (14) with the 1929-30 change for Δd_{rt}^{jk} and Δp_{rt}^{jk}, and the 1930-32 and 1930-33 changes for the instrument. The results of this exercise are presented in panel B. None of the quantity coefficients is significantly different from 0. Their sign varies with the specification. The price coefficients are always close to 0. The estimates for the elasticity of substitution are negative.

5.5 Results: Pass-Through

5.5.1 Empirical Results

The coefficients of columns (2) and (5) of table 3 are not exactly comparable to standard pass-through estimates. Indeed, that literature usually adds a control like the price level to proxy for marginal cost (Burstein and Gopinath, 2014). Thus, to estimate pass-through, I

Table 4: Pass-Through

	1930-32 change		1930-33 change	
	(1)	(2)	(3)	(4)
	Unwght.	Wght.	Unwght.	Unwght.
XR	-0.370^{**}	-0.491^{***}	-0.442^{***}	-0.355^{**}
	(0.159)	(0.176)	(0.148)	(0.144)
WPI	-0.279	0.417	0.159	0.091
	(0.286)	(0.353)	(0.300)	(0.357)
Observations	3592	3592	3405	3405

Note: Standard errors are in parentheses. They are double clustered at the country and product levels.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

now run:

$$\Delta p_{rt}^{jk} = \alpha \Delta xr_t^{kj} + \beta \Delta wpi_t^k + \nu_{rt}^i + e_{rt}^{jk}, \tag{15}$$

where wpi_t^k is the logarithm of the wholesale price index in the country of origin.

I show the results in table 4. The pass-through estimates are around 0.4. This number is similar to those reported by Burstein and Gopinath (2014).

5.5.2 Identification

Equation (9) makes clear that, if I were equipped with a proper control for marginal cost, I could identify $1 - \zeta_1 - \zeta_2$ by regressing p_t^{jk} on the exchange rate, that control and a time fixed effect with the data of section 5. Since marginal cost is hard to observe, the standard approach – which I followed in section 5.5 – is to use the price level as a proxy. It turns out this control is not entirely valid in this model. As a matter of fact, the consumer (CPI) or producer (PPI) price indices – which are the model analogue to the wholesale price index – are given by:

$$\text{CPI:} \quad p_t^k = \Theta + (1 - \bar{\Gamma}) mc_t^k + \bar{\Gamma} \int_m (mc_t^m - xr_t^{mj}) \, \mathrm{d}m + \bar{\Gamma} xr^{kj} \tag{16}$$

$$\text{PPI:} \quad p_t^{kk} = \Theta + (1 - \bar{\zeta}\bar{\Gamma}) mc_t^k + \bar{\zeta}\bar{\Gamma} \int_m (mc_t^m - xr_t^{mj}) \, \mathrm{d}m + \bar{\zeta}\bar{\Gamma} xr^{kj} \tag{17}$$

The first term after the constant Θ is the desired variation, the second terms – which account for the marginal cost of foreign producers – do not depend on k and can be absorbed by a time fixed effect. The third terms are problematic because they depend on the exchange rate. They imply that the movement in the marginal cost will be overestimated, hence that pass-through will be overestimated. Those biases, however, are likely to be small since $\bar{\Gamma}$ is the coefficient of openness (0.08 in my calibration) and $\bar{\zeta}$, the strategic complementarity between domestic and foreign varieties, is below 1. Formally, I prove in the appendix that:

Proposition 2 (Pass-through) *Under flexible prices, the pass-through regression (15) featuring the wholesale price index (WPI) as control identifies:*

$$\hat{\alpha} = -\frac{1/(1+\bar{m})}{1-\bar{\Gamma}}, \quad \textit{if the model analogue is the CPI,}$$
$$\hat{\alpha} = -\frac{1/(1+\bar{m})}{1-\bar{\zeta}\bar{\Gamma}}, \quad \textit{if the model analogue is the PPI.}$$

$\bar{\zeta}$ *depends on the elasticity of markups,* $\bar{m}$*, and the trade elasticities,* ρ *and* θ*:*

$$\bar{\zeta} = \frac{\bar{m}\rho}{\theta + \bar{m}\rho},$$

where: $\bar{m} = \bar{m}'/(\theta - 1)$.

The problem highlighted by proposition 2 should be expected if the control variable is the CPI: the CPI has an imported component, whose price depends on the exchange rate. It is perhaps surprising that some bias remains even when the control variable is the PPI. With CES demand, markups are constant so $\bar{m}$, the elasticity of markups, is 0. In that case, the pass-through is just 1. As markups become elastic, the true pass-through $(1/(1+\bar{m}))$ declines and the bias $(1/(1-\bar{\zeta}\bar{\Gamma}))$ increases. So $\hat{\alpha}$ moves away from -1. Proposition 2 also makes clear that, given ρ, θ and $\bar{\Gamma}$, the pass-through regression pins down $\bar{m}$, from which one can recover $\bar{\zeta}$.

To summarize section 5, I have used granular trade data to estimate an elasticity and a pass-through coefficient. Those will be key in disciplining expenditure switching in the model. I now go back to the model, and close it by presenting its dynamic side.

6 Model: Dynamics

6.1 Monetary Policy

The central bank commits to buy and sell gold at price $\mathcal{E}_t^j$, and it issues money in proportion to its gold reserves:

$$\Lambda M_t^j = \mathcal{E}_t^j G_t^j. \tag{18}$$

Λ is the gold cover ratio, which is assumed to be constant. Gold is in fixed supply at the world level, and can only be held for monetary purposes. As a result, the world supply of money varies only with the price of gold, up to a first-order approximation:

$$\int_j m_t^j \,\mathrm{d}j = \int_j \epsilon_t^j \,\mathrm{d}j + \int_j g_t^j \,\mathrm{d}j. \tag{19}$$

The exchange rate between countries j and k is pinned down by arbitrage between the relative prices of gold:

$$XR^{jk} = \frac{\mathcal{E}_t^j}{\mathcal{E}_t^k}. \tag{20}$$

Otherwise, households could buy gold where it is cheap, sell it where it is expensive and make a risk-free profit on the exchange rate market. In logarithmic terms, this can be written as: $xr^{jk} = \epsilon_t^j - \epsilon_t^k$. If the gold standard is credible, agents expect a constant nominal price of gold: $E_t \Delta \epsilon_{t+1}^j = 0$. I model the devaluation as an exogenous departure from this commitment: $\Delta \epsilon_0^j > 0$.

Figure 2 exhibits a conditional deviation from uncovered interest rate parity (UIP). The exchange rate kept depreciating until 1933 (at least), but there was no corresponding movement of nominal interest rates. This pattern is also apparent on figure 4, albeit not to the same extent. There are two possibilities to match this pattern: (i) assume that further depreciation was unexpected, (ii) allow for UIP deviations. I will explore both possibilities, which deliver similar conclusions, in section 7.

The modelling of UIP deviations follows Itskhoki and Mukhin (2021), who build on the work of Jeanne and Rose (2002) and Gabaix and Maggiori (2015). Imperfect capital mobility and the presence of noise traders imply the following condition:

$$i_t^j - i_t^k - E_t \Delta xr_{t+1}^{jk} = \upsilon_1(\psi_t^k - \psi_t^j) - \upsilon_2(b_t^j - b_t^k), \tag{21}$$

where ψ_t^j are noise trading shocks and υ_1, υ_2 are coefficients that depend on parameters and the underlying exchange rate volatility.

6.2 Rest of the Model

In each country, the representative household derives utility from consumption with internal habits, and money holdings. These assumptions yield an Euler equation and a demand for money:[11]

$$\hat{\mu}_t^j = E_t \hat{\mu}_{t+1}^j + \hat{\imath}_t^j - E_t \pi_{ct+1}^j \tag{22}$$

$$\hat{\imath}_t^j = \frac{1-\beta}{\beta^2}\left(-\chi(\widehat{m_t^j - p_t^j}) - \hat{\mu}_t^j\right) \tag{23}$$

where μ_t^j is the marginal utility of consumption, i_t^j is the nominal interest rate, π_t^j inflation, and m_t^j the money stock. The world interest rate can be obtained by integrating over countries in the money demand and substituting out the world money supply thanks to equation (19):

$$\hat{\imath}_t^W = \frac{1-\beta}{\beta^2}\left(\chi \int_j (\widehat{p_t^j - \epsilon_t^j})\, \mathrm{d}j - \int_j \hat{\mu}_t^j \, \mathrm{d}j\right) \tag{24}$$

[11] Once again, formal derivations are relegated to the appendix.

Each firm produces output with capital, labour, and intermediate goods as an input:

$$Y_t^j(f) = \left(K_t^j(f)^{\alpha} N_t^j(f)^{1-\alpha}\right)^{1-\nu} V_t^j(f)^{\nu}$$

The firm rents capital at rate R_t^{Kj}, hires labour at rate W_t^j, and buys intermediate goods at price P_t^j. Therefore, marginal cost is, in log-linear terms:

$$mc_t^j = \Phi + \alpha(1-\nu)\log(R_t^{Kj}) + (1-\alpha)(1-\nu)w_t^j + \nu p_t^j, \tag{25}$$

where Φ is a constant. Households face quadratic adjustment costs $\kappa(\Delta K_{t+1}/K_t)^2$ in the stock of capital. Their Euler equation for capital is:

$$\hat{r}_t^j + \hat{q}_t^j = (1-\beta(1-\delta))E_t\hat{r}_{t+1}^{K,j} + \beta E_t\hat{q}_{t+1}^j, \tag{26}$$

where $r_t^{K,j} = \log(R_t^{Kj}/P_t^j)$ and $q_t^j = 1 + \kappa\Delta K_{t+1}/K_t$.

Wages are set *à la* Calvo, which yields a New Keynesian wage Phillips curve:

$$\pi_{wt}^j = \beta E_t\pi_{wt+1}^j + \kappa^w\phi\hat{n}_t^j - \kappa^w\hat{\mu}_t^j - \kappa^w(w_t^j - p_t^j) \tag{27}$$

Through collective bargaining, wage inflation depends on expected future wage inflation, the labor supply, marginal utility, and the real wage. In the baseline, prices are flexible, but I explore price rigidity in producer, local, or dominant currency as robustness.

Now that the static and dynamic sides of the model have been presented, I can estimate it and run counter-factual experiments.

7 Structural Estimation and Counterfactual Analysis

7.1 Structural Estimation

7.1.1 Structural Estimation: Strategy

I simulate a devaluation in half of the world, and estimate 7 parameters by matching a set of empirical moments. Devaluation is modelled as exogenous. While I took endogeneity seriously in the empirical part, the goal of this theoretical exercise is not to model endogenous devaluation, but to infer the effect of a devaluation, for given economic conditions. Although the results are cast in terms of deviations from steady state, the linearity of the model guarantees that they can be interpreted as deviations from any set of fundamentals.

Following standard practice in the estimation of general equilibrium models, I calibrate some parameters with standard values from external sources, and estimate those that are essential to match the empirical moments (table 5).[12]

The calibration uses the macroeconomic aggregates of the United Kingdom for 1930.

[12] See Christiano et al. (2005) or Auclert et al. (2020) for instance.

Table 5: Parameters (DD-IV)

	Surprises	UIP deviations	Concept	Target or source
			Calibrated	
β	0.99	0.99	Discount rate	Interest rate of 4%
ι	0.90	0.90	Habit	SGU (2012)
χ	1.00	1.00	Utility for money	Logarithm
η	21	21	Labor demand	Christiano et al. (2005)
α	0.33	0.33	Profit share	Labor share of 2/3
δ	0.012	0.012	Depreciation rate	Investment to capital ratio
ν	0.55	0.55	Intermediate share	Cost of material to output
υ_2	0.0007	0.0007	Stationarity	SGU (2003)
$\bar{\Gamma}$	0.08	0.08	Openness	Trade to GDP
g^*	0.06	0.06	Gold to output	Gold reserves to GDP
			Estimated	
σ^{-1}	0.97	0.43	IES	IP, Consumption
	[0.20, 2.74]	[0.05, 1.44]		
κ^k	110	152	Capital adjustment	IP, Investment
	[68, 169]	[91, 252]	cost	
ξ^w	0.91	0.94	Calvo wage parameter	Nominal wages
	[0.83, 0.96]	[0.88, 0.98]		
θ	3.08	3.08	Micro trade elasticity	US imports
	[2.36, 3.87]	[2.28, 3.85]		
ρ	0.55	0.48	Macro trade elasticity	Imports and IPI
	[0.06, 2.88]	[0.05, 3.29]		
$\bar{m}$	1.45	1.45	Markup elasticity	Pass-through
	[0.52, 5.07]	[0.44, 5.83]		
ρ_1^ϵ	0.78	0.78	AR(1) coefficient	Exchange rate
	[0.75, 0.81]	[0.75, 0.81]		

Note: calibrated and estimated parameters. Calibration targets use macroeconomic aggregates for the United Kingdom taken from the Bank of England's Millenium dataset, the Annual Statement of the Trade of the United Kingdom, and the Fourth Census of Production of the United Kingdom (1930). SGU (2003, 2012) stand for Schmitt-Grohé and Uribe (2003, 2012). The estimation follows the procedure described in section 7.1. The targets are the DD-IV cross-country moments of section 2 and the trade estimates of section 5.

The steady-state cost share of intermediate goods, ν, matches the cost of material relative to gross output of the Fourth Census of Production. The coefficient of openness, $\bar{\Gamma}$, pins down the trade-to-GDP ratio to: $2 \times \bar{\Gamma}/(1-\nu)$. The trade (exports plus imports) to GDP ratio of the UK was 34% in 1930.

I estimate 4 parameters, σ^{-1}, κ^k, ξ^w and ρ, with the impulse response functions of industrial production, investment goods production, consumption goods production, the wholesale price index, nominal wages, imports, and the import price index. σ^{-1} is the intertemporal elasticity of substitution (IES). In this environment, a devaluation is a proportional increase in the money supply. This stimulates domestic demand by lowering the real interest rate. So it is natural to adjust the IES in order to match the relative response of output. κ^k indexes the adjustment cost of capital. Like σ^{-1} for consumption, it governs how responsive to monetary policy investment is (equation 26). ξ^w is the Calvo parameter for wages. I adjust it to match the response of nominal wages. Finally, ρ is the elasticity of substitution between domestic goods and imports. I target the response of imports and of import prices.

I estimate 2 parameters, θ and $\bar{m}$, in order to match the estimates of section 5. By proposition 1, the elasticity of substitution among foreign varieties, θ, was estimated in table 3. I take the consumer price index as the model-equivalent of the wholesale price index. By proposition 2, the pass-through regression recovers $\bar{m}$ for given $\bar{\Gamma}$. I use the point estimates and standard deviations of the 1930-33 change in the unweighted case.

In section 4, I introduced the three parameters that determine the strength of expenditure switching: ρ, θ, and $\bar{m}$. In section 5, I explained how θ and $\bar{m}$ are identified. I now focus on ρ. Looking back at equation (8), the demand for imports is a function of two terms: the import price index (IPI) relative to that of domestic consumption (CPI), scaled by the elasticity (ρ), and domestic demand: the cheaper imports are, the more a country imports; the more a country demands, the more it imports. Playing with this equation, I can express ρ as: $\rho = -\left(\hat{d}_t^{D*} - \hat{d}_t^{N*} - \left(\hat{d}_t^{D} - \hat{d}_t^{N}\right)\right) / \left(p_t^{D*} - p_t^{N*} - \left(p_t^{D} - p_t^{N}\right)\right)$. Superscripts D and N respectively denote devaluing and non-devaluing countries. This formula means that what is informative about ρ is the relative response of imports $(\hat{d}_t^{D*} - \hat{d}_t^{N*})$ compared to the relative response of domestic demand $(d_t^{D} - d_t^{N})$, versus the relative response of import prices $(p_t^{D*} - p_t^{N*})$ compared to the relative response of the domestic price index $(p_t^{D} - p_t^{N})$. Intuitively, for any given response of consumption and prices, a low response of imports is suggestive of a low elasticity of substitution.

7.1.2 Structural Estimation: Results

I focus on the results where I use the DD-IV estimates as empirical targets and will explore using the HFI ones as robustness. I simulate the model at quarterly frequency with the devaluations happening in the last quarter of 1931. I then aggregate the simulated data over years to obtain regression coefficients that are consistent with the empirical ones.

Formally, I assume that before time 0, the economy is in steady state. At time 0, half of the world experiences a sequence of cuts in the gold content of their currencies. These cuts follow an AR(1) process: $\Delta\epsilon_t^j = \rho_1^\epsilon \Delta\epsilon_{t-1}^j$. ρ_1^ϵ is estimated to minimize the distance with the empirical response of the exchange rate. An alternative route would be to assume that the whole path is expected from time 0 onward. As explained in section 6.1, if UIP holds, an expected depreciation sequence implies a counterfactual jump in the nominal interest rate. There are two possibilities to fit the absence of response of nominal interest rates: assume that the depreciation sequence is unexpected, or assume that UIP deviations exactly offset the expected depreciation. In the notation of equation (21), I set: $\upsilon_1(\psi_t^k - \psi_t^j) = E_t(\Delta\epsilon_{t+1}^k - E_t\Delta\epsilon_{t+1}^j)$. I denote these specifications "surprises" and "UIP deviations."

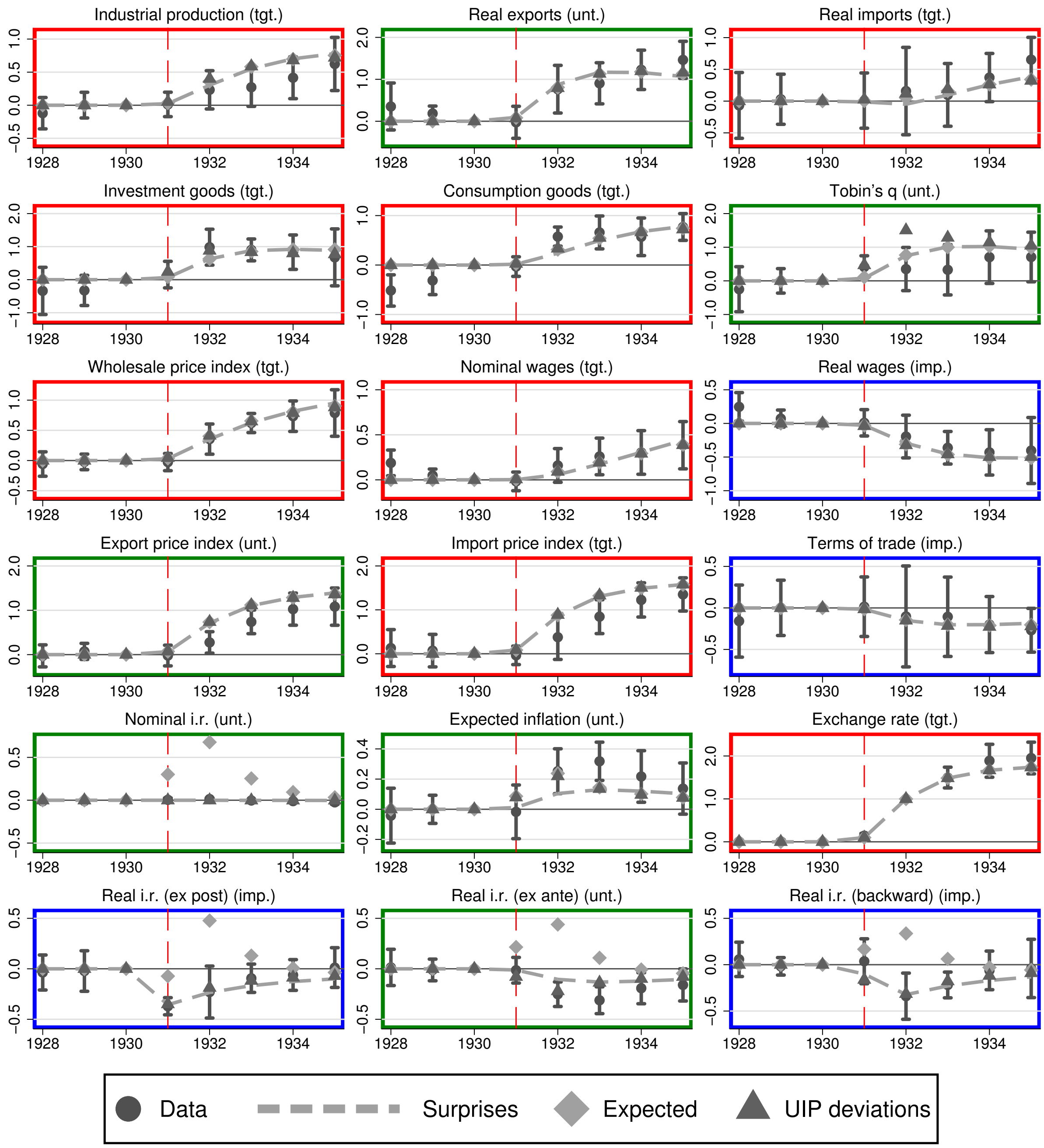
I estimate the model by the simulated method of moments (SMM). Technical details are relegated to appendix A.4. The estimation yields values for σ^{-1} that are not far from standard values, the most commonly used values in calibration exercises being 1/2. The capital adjustment cost, κ^k, has the following interpretation: a 1 percentage point increase in investment has a shadow cost of $\delta\kappa^k$, where δ is the depreciation rate. At quarterly frequency, $\delta = 0.012$, so a 1 percentage point increase in investment increases the shadow cost by 1.2 percentage points for $\kappa^k = 100$. ξ^w above 0.9 implies very sticky wages, with a mean duration of more than 10 quarters. This is the price of matching the data: 4 years after the devaluation, the pass-through of the exchange rate to nominal wages was only 20%. $\rho \approx 0.5$ is low but not out of line with other estimates, especially when considering the large confidence interval. For instance, using data from that period, Irwin (1998) estimates an elasticity of 0.8.

Figure 5 shows the fit of the model for real and nominal variables. For the reader's convenience, targeted IRF are circled in red and denoted "tgt." Untargeted IRF are circled in green and denoted "utg." Implicitly targeted IRF are circled in blue and denoted "imp." By implicitly targeted, I mean that the variable is a function of variables that have been targeted. For instance, real wages are nominal wages divided by the price index. Since both are targeted, real wages are implicitly targeted. The model is able to match the cross-country evidence well for both the surprises (grey line) and UIP deviations specifications (triangles). The fit is particularly good for wholesale prices and nominal wages. Even moments that I have not targeted, real exports and the export price index, are decently predicted. This is true of both the unexpected and UIP deviations specifications. For completeness, I also show the fit of the model for a case where further depreciation is anticipated and UIP holds ("expected," grey diamond). As expected, this version of the model implies a completely implausible response of nominal and real interest rates, so I focus the presentation of the results on the other two cases.

7.2 Counterfactual Experiment

Armed with these parameter values, I can now answer the counterfactual questions of interest: how did devaluation affect countries that devalued, and countries that didn't? I consider a simple scenario: the world economy is in steady state; at time 0, half of the world devalues

Figure 5: Model fit (DD-IV)



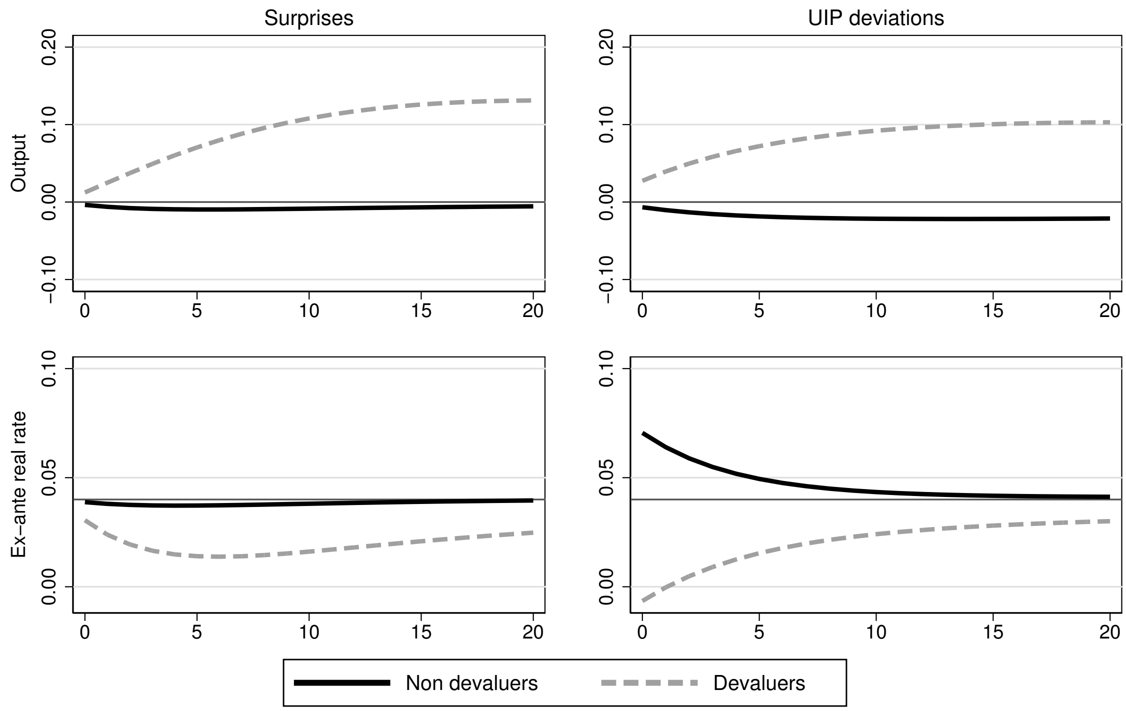
Note: empirical and theoretical responses of relevant variables under estimated parameter values. The responses circled in red (tgt.) are explicitly targeted. Those circled in green (utg.) are not. Those circled in blue (imp.) are implicitly targeted since they are functions of targeted moments.

against gold. The devaluation pattern follows the AR(1) process estimated in the data. The initial depreciation is such that the currency eventually depreciates by 30 log points.[13]

Figure 6 illustrates that a foreign devaluation only makes a small difference for output

[13]Formally, the depreciation process is: $\Delta\epsilon_t^j = \rho_1^\epsilon \Delta\epsilon_{t-1}^j$, with: $\Delta\epsilon_0^j = 0.3 \times (1-\rho_1^\epsilon)$.

Figure 6: Counterfactual analysis



Note: response of output and the real interest rate to a 30% devaluation by half of the world under parameter values estimated with the DD-IV cross-country moments of section 2 and the trade estimates of section 5. Those parameter values are shown in table 5.

(top row). In the surprises case, output slightly goes down, but this effect is small and quickly dissipates. The 3-year average decline of output is less than a log point (table A.7). The lower bound of the 95% confidence interval of the output response is -2.8 log points. These confidence intervals are constructed conservatively by reestimating the model for a subset of the bootstrap draws of the DD-IV estimates.[14] The explanation lies in the bottom row. The devaluation entails a powerful real interest rate cut in countries that devalue. Through inter-temporal substitution, this cut stimulates consumption, hence demand. Beggar-thy-neighbour effects are dwarfed by this stimulus: the devaluation makes some countries more competitive, but those same countries consume more. On balance, the two effects compensate each other. The importance of real interest rates echoes the focus of Eggertsson (2008), who argues that the 1933 devaluation of the dollar was a successful case of forward guidance.

The UIP deviations case delivers a more pronounced and persistent, albeit relatively small, fall in the output of non devaluers. The three-year average response of output is -1.7 log points, with a lower bound at -3.8. The trade parameters are nearly identical, but the general equilibrium effect of monetary policy tends to be less powerful in this context, for two reasons. First, the real interest rate increases in non-devaluing countries: since the

[14]See section A.4 for details on the estimation procedure.

exchange rate is expected to appreciate further, the price of imports, hence consumption, is expected to fall. Although this channel has received some attention in the economic history literature (Kindleberger, 1973, chapters 7–8), it does not seem prevalent in light of the results of section 3: if anything, foreign depreciation seems to have lowered real rates abroad (table 2). Second, the estimated IES is smaller (table 5): since the entire path of depreciation is expected, the change in the ex ante real interest rate is larger than in the surprises case (figure 5). So, a given relative response of consumption can be rationalized with a lower IES. Those two features conspire to make the spillovers more negative. Still, the effect remains relatively small and dwarfed by the boom in devaluing countries.

An equivalent way to state the conclusion is that the absolute effect is not very different from the relative effect. Britain was booming compared to France mostly because Britain was booming compared to a counterfactual scenario where it wouldn't have devalued, not because France was collapsing. As we will see in the next section, the conclusion was not foregone; the model can imply large negative spillovers on foreign output. Important ingredients for the result are incomplete exchange rate pass-through, a low elasticity of substitution between imports and domestic goods, and moderately powerful monetary policy.

Robustness: In table A.7, I show the same experiment for different versions of the model. In column (1), I estimate a version of the model without investment. Columns (2–3) contain the specifications shown in figure 6. In columns (4–6), I introduce price rigidity with producer currency pricing (PCP), local currency pricing (LCP), or dominant currency pricing (DCP). For DCP, I assume that the dominant currency (sterling) is part of the devaluation block. The estimation under LCP and DCP picks up no price rigidity. The reason is that the flexible price version already fits wholesale and import prices well and no price rigidity is called for. Under PCP, some price rigidity is found ($\xi^p = 0.43$). But this is at the cost of an implausible strategic complementarity parameter ($\bar{m} = 13$), which severely deteriorates the fit of untargeted moments (exports and terms of trade, unreported) and implies a desired degree of strategic complementarity that is close to 1 – firms would barely take their marginal cost into account. Anyhow, the conclusion of limited foreign spillovers is robust. In the second panel of table A.7, I fit the high-frequency evidence (figure A.6). This evidence implies a stronger domestic effect of the devaluation, so the spillovers turn positive, often significantly so.

7.3 Which Ingredients Matter?

To illustrate which parameters matter and how they are informed by the data, I study several recalibrations of the model, emphasizing how its predictions change and how the fit deteriorates.

CES case: The first recalibration is the constant elasticity of substitution (CES) case. I set $\bar{m}$ to 0 and $\rho = \theta$, where θ is drawn from the estimates of section 5. This case corresponds to the textbook two-country model of Corsetti et al. (2011). In both specifications, the recalibration implies a fall in output that is larger by a factor of 3–4 (table 6). The boom is much more pronounced in devaluing countries. In fact, non-devaluing countries' output losses translate one-for-one into gains in the devaluing country.[15] This calibration, however, has unrealistic implications: by construction, it implies a pass-through of 1, which is inconsistent with the estimates of section 5. Moreover, it fits the cross-country evidence very poorly: the response of trade, the terms of trade, and to a lesser extent industrial production is too strong (figure A.5, grey diamonds). The response of imports, in particular, is highly implausible in light of the evidence of section 2. This exercise illustrates that incomplete pass-through and distinguishing the elasticity of exports and imports are important ingredients for the result.

Table 6: Recalibration – 3-year response

Country	Estimation	CES	Low IES	Wages
		Surprises		
Domestic	7.0	10.5	3.0	4.8
	[4.4, 10.4]	[7.6, 13.2]	[2.1, 4.1]	[3.0, 7.9]
Foreign	-0.8	-4.3	-1.6	-0.5
	[-2.8, 0.7]	[-6.9, -2.0]	[-2.9, -0.6]	[-1.4, 0.4]
		UIP deviations		
Domestic	7.0	10.6	3.7	4.1
	[4.1, 11.2]	[7.9, 14.3]	[2.6, 5.5]	[2.3, 7.2]
Foreign	-1.7	-5.4	-2.0	-0.4
	[-3.8, 0.5]	[-8.7, -2.2]	[-4.1, -0.6]	[-1.1, 0.5]

Note: 3-year average response of output with different values for a recalibration of a subset of the parameters. The CES case corresponds to $\rho = \hat{\theta}$ and $\bar{m} = 0$; the low IES case corresponds to $\sigma^{-1} = 0.1$; the wages case corresponds to $\xi^w = 0.75$.

Low IES: The second recalibration assumes a low IES of 0.1. This recalibration slightly increases the negative spillovers in non-devaluing countries. Most importantly, it makes the devaluation much less stimulative in devaluing countries: the increase in output is half as large. A smaller IES means that monetary policy is less powerful: devaluing countries experience a lesser boom, which lessens the positive spillovers of devaluation. In the UIP deviations specification, a low IES seems less important for the output of non devaluers because it lessens their sensitivity to the real rate hike that is triggered by the foreign devaluation

[15]It can be shown analytically that trade parameters (θ, ρ, $\bar{m}$) are irrelevant to world-level variables. So, the response of world-level output is constant across the estimated and CES calibration.

on figure 6. The two effects (lower foreign demand and higher domestic demand) roughly compensate each other. This recalibration does not deteriorate the fit as spectacularly, but it delivers responses of industrial production, imports, or consumption goods production that are too low compared to the empirical targets (figure A.5, black triangles).

Modern wage rigidity: The final recalibration deals with a modern degree of wage rigidity. I assume $\xi^w = 0.75$, which corresponds to an annual probability of not resetting one's wage of 32%, consistent with evidence from Beraja et al. (2019) or Grigsby et al. (2021). This recalibration lessens both the boom in devaluing countries and the negative spillovers on foreign countries. Indeed, lesser nominal wage rigidity makes the world less Keynesian, which tends to make monetary policy and expenditure switching less powerful. Of course, this degree of nominal wage rigidity is inconsistent with the cross-country response of nominal wages (figure A.5, black squares). This recalibration also undershoots industrial production and trade.

To summarize, a departure from CES demand is a crucial ingredient to obtain relatively small foreign spillovers of a large currency devaluation. A large domestic effect requires reasonably powerful monetary policy, both because demand responds to interest rates and because there is significant monetary non-neutrality. Nominal rigidities tend to amplify expenditure switching and monetary stimulus. In the limit without nominal rigidity, prices adjust immediately and the devaluation has no real effect.

External validity: In light of these ingredients, two elements stand out. Incomplete pass-through of the exchange rate to international prices has been documented at length in the modern literature (Burstein and Gopinath, 2014). The distinction between different trade elasticities has also received support in modern data (Feenstra et al., 2018). So, the trade aspect of the model seems relevant to the modern world. On the other hand, the size of the monetary channel may be a byproduct of the depressed demand conditions of the Great Depression. For instance, asymmetric wage rigidity would imply state-dependent wage stickiness (Schmitt-Grohé and Uribe, 2016); high unemployment might also have made interest rates less responsive to inflation (Fornaro and Romei, 2019). Hence, my results seem more informative about monetary stimulus in a context of depressed demand, such as quantitative easing during the Great Recession, than about foreign exchange intervention at a time of high inflation and flexible wages, as in the inflation surge of 2021–23.

8 Conclusion

In this paper, I showed that currency devaluation has a large effect on domestic output, but a more limited effect on foreign output. I reached that conclusion from two strains of evidence: high-frequency devaluation shocks and a model estimated out of well-identified cross-country moments and granular trade data. The takeaway of this exercise is that, in the 1930s, devaluations had quantitatively small effects on the output of countries that did not devalue. Incomplete exchange rate pass-through and a strong recovery of domestic demand conspired to make the net foreign spillovers of currency depreciation limited. To the question "canst thou beggar thy neighbour," this episode suggests a negative answer.

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ONLINE APPENDIX

A.1 Additional Tables

Table A.1: Country Samples

Group	Countries	Comment
	Difference-in-difference (section 2)	
Group	Countries	Comment
Treatment	Austria, Canada, Denmark, Finland, Japan, Mexico, Norway, Salvador, Sweden, United Kingdom	Devaluation in 1931
Control	France, Germany, Hungary, Netherlands, Poland, Switzerland	No devaluation before 1936
	High frequency identification (section 3)	
8 countries	Belgium, France, Germany, Italy, Netherlands, United Kingdom, United States, Switzerland	Countries for which forward exchange rate data is available
18 countries	8 countries + Austria, Canada, Chile, Czechoslovakia, Denmark, Finland, Japan, Norway, Poland, Sweden	Countries for which monthly industrial production is available or can be constructed
	US imports (section 5)	
Specification	Countries	Comment
1932, 1933	Austria, British India, British Malaya, Canada, Denmark, Egypt, Finland, Japan, Mexico, Norway, Portugal, Salvador, Sweden, United Kingdom	Devaluation in 1931
1932, 1933	Albania, Belgium, Bulgaria, Czechoslovakia, France, Germany, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland and Danzig, Rumania, Switzerland	No devaluation before 1934
1932	Estonia, South Africa	Devaluation in 1933
none	Argentina, Australia, Bolivia, Brazil, New Zealand, Uruguay, Venezuela	Devaluation before 1931
none	Chile, Costa Rica, Colombia, Ecuador, Greece, Peru, Siam, Yugoslavia	Devaluation in 1932
none	China, Hong Kong, Iran	Silver standard
none	Spain, Turkey	Floating currency
none	Cuba, Philippine Islands	Preferential tariff rates

Table A.2: An example of the data

288 No. 4.—GENERAL IMPORTS, 1931—GROUP 6—METALS

COUNTRY	Zinc—Continued			Antimony									
	6558. Blocks, pigs, etc., dross, and old (dut.)		6559. Sheets, dust and manufactures (dut.)	6650. Ore (free)			6651. Needle or liquated, and regulus or metal (dut.)		6660. Cobalt ore and metal (free)		6662. Quicksilver or mercury (dut.)		6740. Other ores, metals and alloys (free)
				Gross weight	Antimony content								
	Pounds	*Dollars*	*Dollars*	*Pounds*	*Pounds*	*Dollars*	*Pounds*	*Dollars*	*Pounds*	*Dollars*	*Pounds*	*Dollars*	*Dollars*
TOTAL	549, 185	14, 829	24, 999	28, 030, 059	9, 726, 015	259, 952	10, 390, 599	445, 369	248, 862	262, 973	27, 054	32, 649	88, 344
Austria			2, 874										
Belgium	11, 235	401	4, 480				6, 720	504	99, 198	159, 299			3, 931
France			947										327
Germany	414	157	13, 812				220	27	3, 016	5, 876			7, 699
Italy			261										303
Soviet Russia in Europe													150
Spain											26, 609	32, 027	
Sweden			7										
Switzerland			255										
United Kingdom	276, 919	8, 934	212				226, 464	20, 624	4, 480	10, 084			9, 998
Canada	567	35	2, 023						118, 872	83, 172			63, 216
Panama													243
Mexico	260, 050	5, 302		26, 917, 859	9, 358, 575	238, 151	486, 169	27, 656			445	622	775
Trinidad and Tobago													107
Cuba													156
Dominican Republic													264
Argentina				1, 112, 200	367, 440	21, 801							80
Brazil													161
Chile													17
British India													10
China							9, 671, 026	396, 558					35
Hong Kong													9
Japan			128										194
Palestine													41
Siam													46
Australia									23, 296	4, 542			
Union of South Africa													582

Table A.3: P-values for DD Exercise

	IV			OLS		
	Baseline	Tariffs	Gov.	Baseline	Tariffs	Gov.
Industrial production	0.01	0.04	0.06	0.00	0.00	0.00
Real exports	0.00	0.00	0.00	0.00	0.00	0.00
Real imports	0.00	0.03	0.01	0.00	0.00	0.00
Wholesale price index	0.00	0.00	0.00	0.00	0.00	0.00
Export price index	0.00	0.00	0.00	0.00	0.00	0.00
Import price index	0.00	0.00	0.00	0.00	0.00	0.00
Nominal wages	0.01	0.01	0.01	0.01	0.05	0.00
Real wages	0.01	0.07	0.03	0.00	0.00	0.06
Terms of trade	0.27	0.92	0.15	0.04	0.97	0.01
Nominal i.r.	0.26	0.24	0.10	0.30	0.26	0.22
Expected inflation	0.00	0.00	0.00	0.00	0.87	0.01
Real i.r. (ex post, WPI)	0.03	0.15	0.05	0.00	0.04	0.01
Real i.r. (ex ante)	0.00	0.00	0.00	0.97	0.95	1.00
Real i.r. (backward)	0.00	0.00	0.15	0.00	0.00	0.02

Note: p-value of a test of the joint significance of the 1932 to 1935 coefficients in equation (1) with no controls (baseline), controlling for the change in tariffs (tariff), or real government revenues and expenditures (government). In the IV columns, the change in the exchange rate is instrumented with a devaluation dummy. Standard errors are clustered at the country level, and bootstrapped with 2,000 replications. Point estimates are shown on figures A.1 and A.2.

Table A.4: F-statistics for DD-IV Exercise

	Baseline	Tariffs	Gov.
Industrial production	38.2	41.5	29.7
Real exports	36.6	36.6	25.6
Real imports	36.6	36.6	25.6
Investment goods	92.7	92.7	58.1
Consumption goods	67.8	67.8	28.4
Tobin's q	35.9	35.9	29.7
Wholesale price index	35.9	35.9	29.7
Export price index	41.5	41.5	29.7
Import price index	41.5	41.5	29.7
Nominal wages	35.9	35.9	29.7
Real wages	35.9	35.9	29.7
Terms of trade	41.5	41.5	29.7
Nominal i.r.	63.6	63.6	52.4
Expected inflation	21.1	21.1	17.3
Real i.r. (ex post, WPI)	63.6	63.6	52.4
Real i.r. (ex ante)	36.4	36.4	29.6
Real i.r. (backward)	52.3	52.3	41.2
Effective F critical values: 37.4 (5%), 23.1 (10%), 15.1 (20%).			

Note: first-stage F-statistics for the IV specifications of the difference-in-differences exercise based on equation (1), in which the change in the exchange rate is instrumented with a devaluation dummy, for each of the dependent variables and $t = 1932$. The two-stage least squares (TSLS) critical values reported in the last row are computed by implementing the test of Montiel Olea and Pflueger (2013). A given critical value corresponds to a worst-case bias of the TSLS estimator (relative to a benchmark) of 5%, 10%, or 20%; an F-statistic exceeding that critical value rejects the null that the instrument is weak at the associated bias threshold. These values are valid for a single-instrument case (baseline) only.

Table A.5: Forward premium regressions

	(1) 1 month	(2) 2 months	(3) 3 months
Intercept	-0.00	-0.01	-0.01
	(0.00)	(0.01)	(0.01)
Forward premium	1.65^{**}	1.76^{**}	1.83^{***}
	(0.76)	(0.88)	(0.51)
Observations	671	332	219
P-value	0.30	0.51	0.18
R^2	0.08	0.04	0.13

Note: regression of the change in the spot exchange rate on the forward premium as in equation (2). Driscoll-Kraay standard errors are in parentheses. The p-value corresponds to a joint test of $\alpha = \beta - 1 = 0$.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.6: F-Statistics for HFI Exercise

	Domestic		Spillovers			
	(1) Absolute	(2) Relative	(3) 8 coun.	(4) 18 coun.	(5) Gold bloc	(6) Gold bloc+
Cumulative						
Industrial production	171	189	16	50	20	14
Nominal exports	177	187	16	52	20	14
Nominal imports	173	186	16	51	19	14
Real i.r. (ex ante)	170	165	17	36	22	15
Exchange rate	177	187	16	51	22	15
Level						
WPI	192	192	16	50	19	13
Nominal wages	173	173	16	42	21	14

Note: each entry is the Kleibergen-Paap Wald rk F-statistic of the first stage whose estimate is reported in the corresponding cell of Table 3 in the main text. The specification of column (2) includes time fixed effects. In columns (1–3), the sample is made of the 8 countries for which forward exchange rate data is available. The list of 18 countries used in column (4) is given in the data appendix. Gold bloc is made of Belgium, France, the Netherlands, and Switzerland; gold bloc+ also includes Poland.

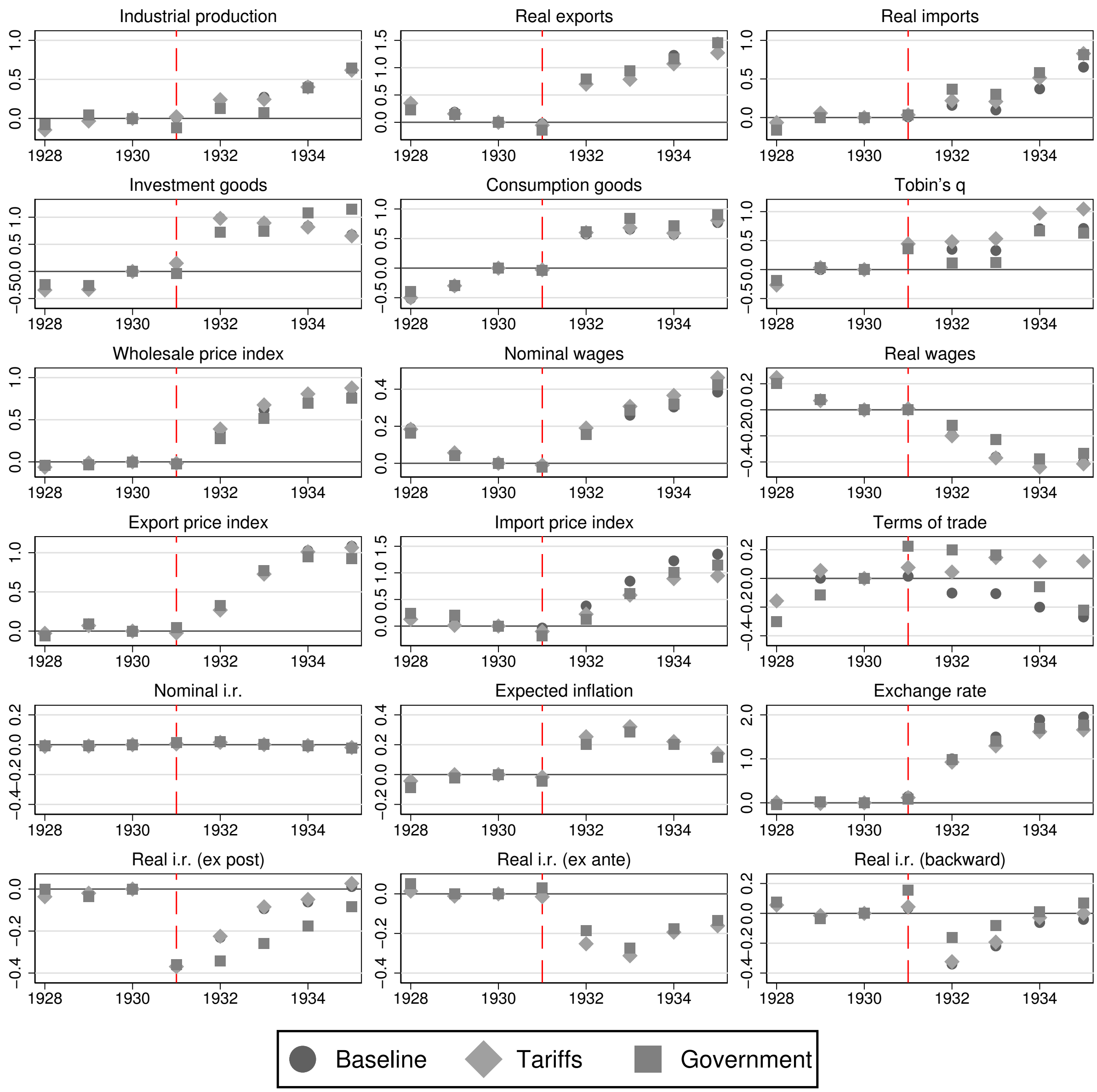
Table A.7: Robustness — 3-year average response

Effect	(1)	(2)	(3)	(4)	(5)	(6)
DD						
Domestic	5.7	7.0	7.0	8.4	7.4	7.4
	[2.3, 10.0]	[4.4, 10.4]	[4.1, 11.2]	[5.1, 11.9]	[4.2, 11.0]	[4.5, 11.1]
Foreign	-0.9	-0.8	-1.7	0.7	-1.1	-1.1
	[-2.4, 0.7]	[-2.8, 0.7]	[-3.8, 0.5]	[-1.7, 2.4]	[-3.6, 0.6]	[-3.3, 0.8]
HFI						
Domestic	20.1	21.8	22.1	21.6	22.7	25.6
	[11.3, 28.2]	[11.9, 29.4]	[12.3, 31.5]	[12.3, 30.6]	[14.5, 39.2]	[15.6, 38.4]
Foreign	1.4	1.7	1.7	2.3	2.3	2.7
	[0.4, 3.5]	[0.3, 4.0]	[-0.2, 5.3]	[1.0, 5.5]	[0.5, 6.3]	[1.2, 5.0]
Investment	✗	✓	✓	✓	✓	✓
UIP dev.	✗	✗	✓	✓	✓	✓
Pricing	Flex.	Flex.	Flex.	PCP	LCP	DCP

Note: 3-year average response of output to the devaluation in devaluing ("Domestic") and non-devaluing ("Foreign") countries, expressed in log points. Each column corresponds to a different model specification, with the ingredients included indicated at the bottom of the table.

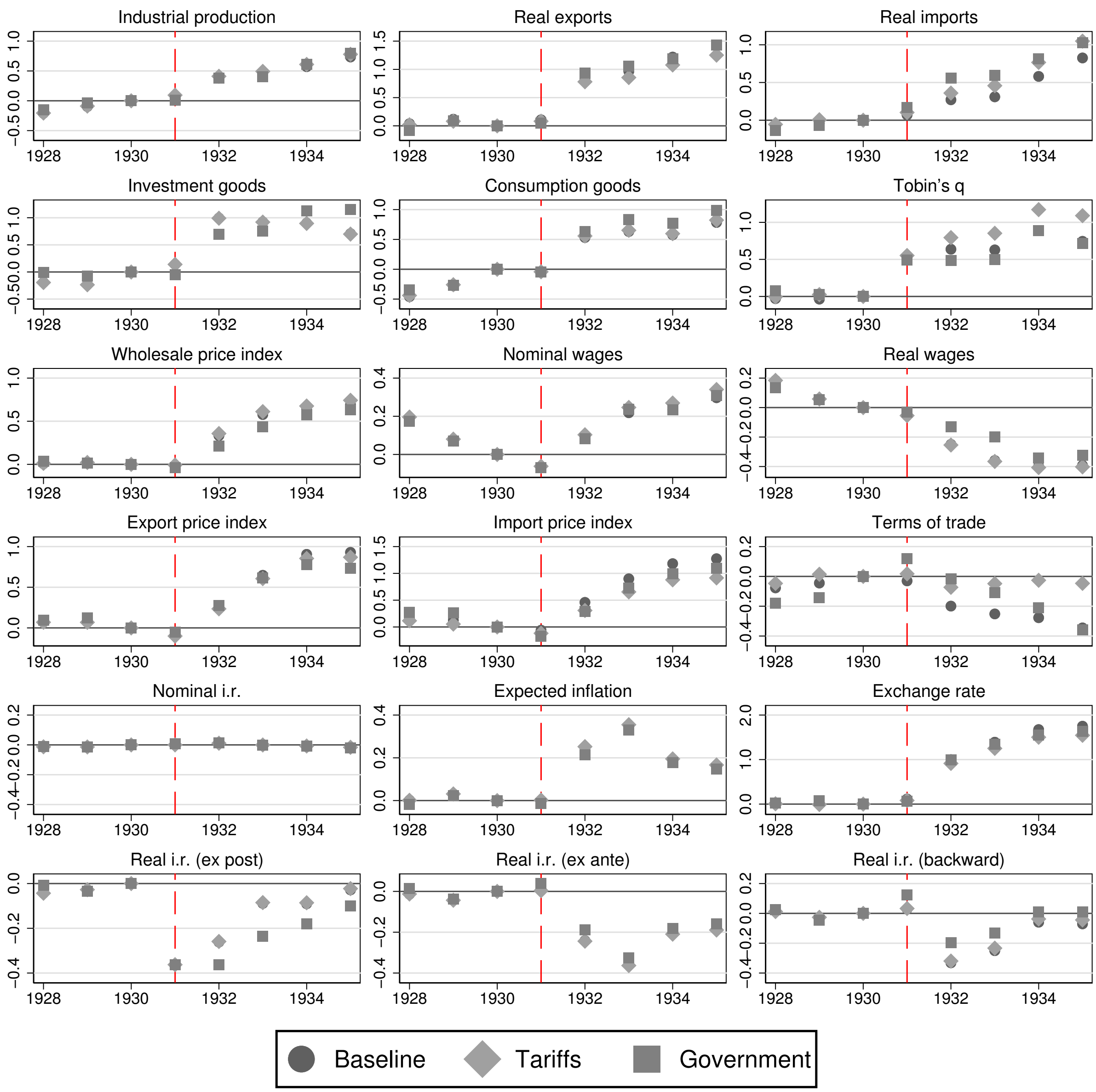
A.2 Additional Figures

Figure A.1: DD-IV with controls



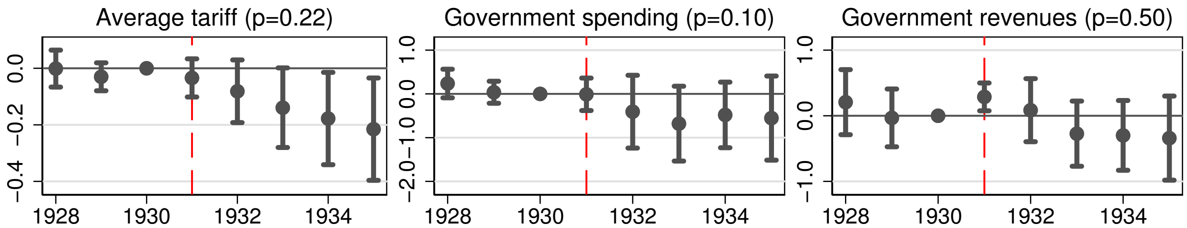
Note: response of relevant variable in devaluing countries, relative to non-devaluing ones. Formally, the plots show the estimate of β_t in equation (1) with no controls (baseline), controlling for the change in tariffs (tariff), or real government revenues and expenditures (government). The change in the exchange rate is instrumented with a devaluation dummy. β_{1930} is normalized to 0. P-values are shown in table A.3.

Figure A.2: DD-OLS with controls



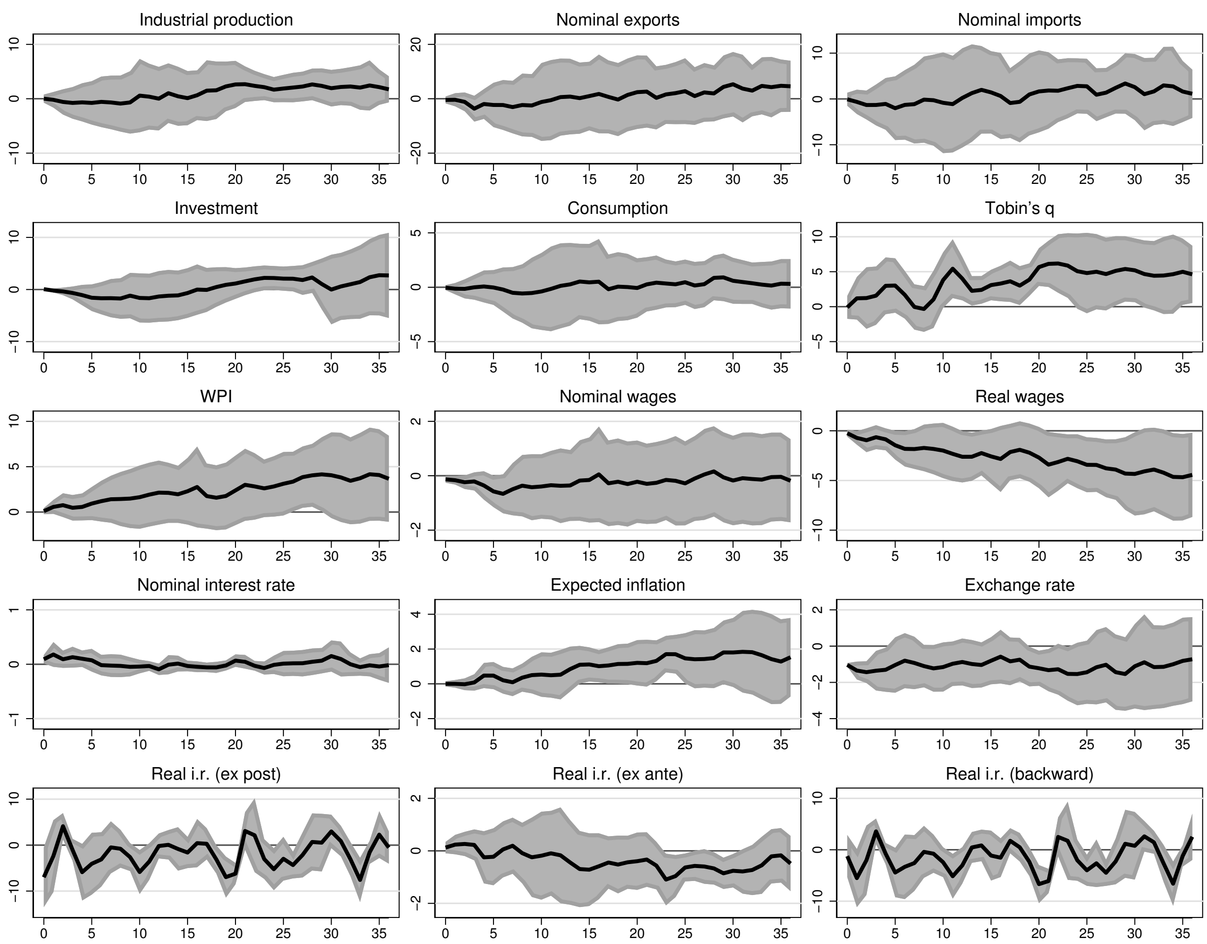
Note: response of relevant variable in devaluing countries, relative to non-devaluing ones. Formally, the plots show the estimate of β_t in equation (1) with no controls (baseline), controlling for the change in tariffs (tariff), or real government revenues and expenditures (government). β_{1930} is normalized to 0. P-values are shown in table A.3.

Figure A.3: Government variables



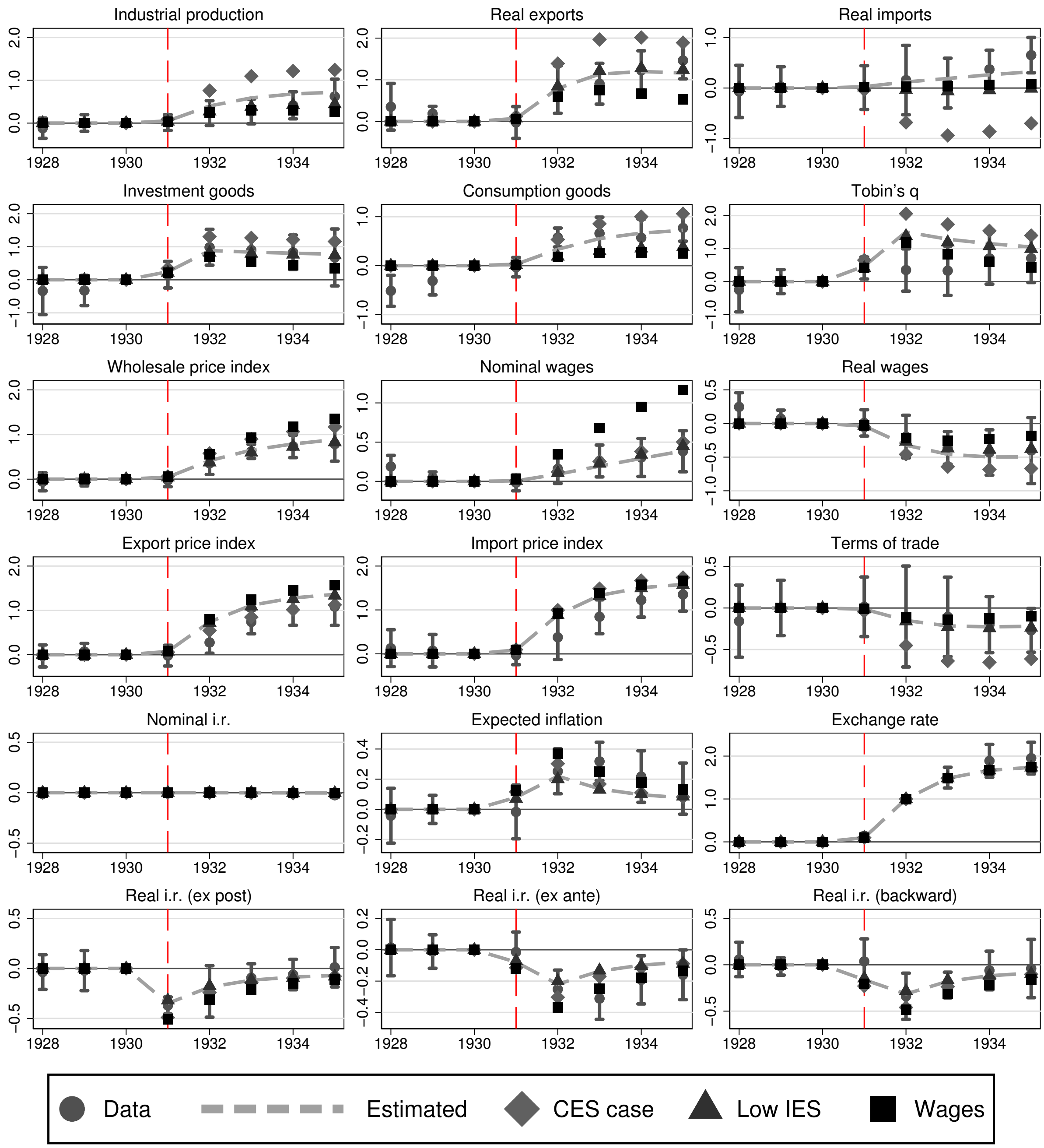
Note: response of relevant variable in devaluing countries, relative to non-devaluing ones. Formally, the plots show the estimate of β_t in equation (1). β_{1930} is normalized to 0. Standard errors are bootstrapped with 2,000 replications, and clustered at the country level. The number in parenthesis is the p-value of a test of the joint significance of the 1932 to 1935 coefficients.

Figure A.4: International spillovers (HFI)



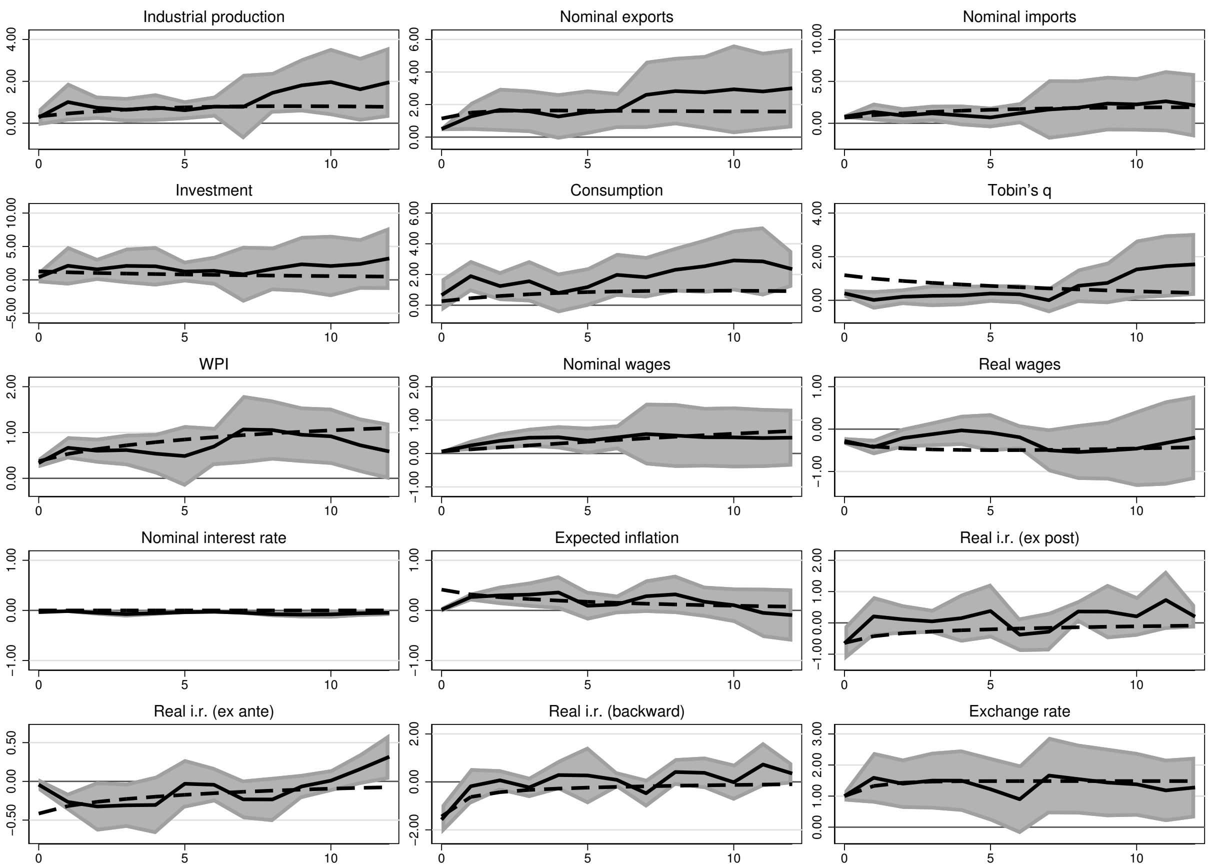
Note: response of relevant variable to an exogenous 100 log-points devaluation in the exchange rate. Formally, the plots show the estimate of β_k in equation (3). Time is in months. The black line is the point estimate; the grey area is the 95% confidence interval with Driscoll-Kraay standard errors. The y-axis scale of the nominal and real interest rates is identical for visual convenience.

Figure A.5: Model fit (DD-UIP deviations) — Parameter change



Note: empirical and theoretical responses of relevant variables under estimated parameter values. The black line is the point estimate, the grey area the 95% confidence interval, and the dashed grey line the theoretical response. Time is in quarters. The responses of industrial production, nominal imports, wholesale prices, and nominal wages are explicitly targeted. Those of nominal exports are not. Real wages and the real interest rate are redundant since they respectively are the ratio of nominal wages to the wholesale price index and the difference between the nominal interest rate and wholesale price inflation.

Figure A.6: Model fit (HFI)



Note: empirical and theoretical responses of relevant variables under estimated parameter values. The black line is the point estimate, the grey area the 95% confidence interval, and the dashed grey line the theoretical response. The responses of industrial production, nominal imports, wholesale prices, and nominal wages are explicitly targeted. Those of nominal exports are not. Real wages and the real interest rate are redundant since they respectively are the ratio of nominal wages to the wholesale price index and the difference between the nominal interest rate and wholesale price inflation. Time is in quarters: the response underlying column (3) of table 2 is aggregated by quarter before conducting the estimation of the model at quarterly frequency.

A.3 Theoretical Derivations

A.3.1 Demand Functions

The household minimizes expenditures: $\sum_{k\in\mathcal{J}}\int_f P_{rt}^{jk}(f)C_{rt}^{jk}(f)\,\mathrm{d}f$, subject to

$$C_{rt}^{j}=(1-\Gamma_{rt}^{j})C_{rt}^{j}\times g\left(\int_f g^{*}\left(\frac{C_{rt}^{jj}(f)}{(1-\Gamma_{rt}^{j})C_{rt}^{j}}\right)\,\mathrm{d}f\right)+\Gamma_{rt}^{j}C_{rt}^{j}\times g\left(\sum_{\substack{k\in\mathcal{J}\\k\neq j}}\Xi_{rt}^{jk}\int_f g^{*}\left(\frac{C_{rt}^{jk}(f)}{\Gamma_{rt}^{j}\Xi_{rt}^{jk}C_{rt}^{j}}\right)\,\mathrm{d}f\right),\tag{A.1}$$

with: $g(1)=g^{*}(1)=g^{*\prime}(1)=g^{\prime}(1)=1$ and $\sum_{\substack{k\in\mathcal{J}\\k\neq j}}\Xi_{rt}^{jk}=1$. The measure of firms is normalized to 1.

The first-order conditions are:

$$P_{rt}^{jj}(f)=g^{*\prime}\left(\frac{C_{rt}^{jj}(f)}{(1-\Gamma_{t}^{j})C_{rt}^{j}}\right)\times g^{\prime}\left(\int_f g^{*}\left(\frac{C_{rt}^{jj}(f)}{(1-\Gamma_{rt}^{j})C_{rt}^{j}}\right)\,\mathrm{d}f\right)\Lambda_t^j$$

$$P_{rt}^{jk}(f)=g^{*\prime}\left(\frac{C_{rt}^{jk}(f)}{\Gamma_{rt}^{j}\Xi_{rt}^{jk}C_{rt}^{j}}\right)\times g^{\prime}\left(\sum_{\substack{k\in\mathcal{J}\\k\neq j}}\Xi_{rt}^{jk}\int_f g^{*}\left(\frac{C_{rt}^{jk}(f)}{\Gamma_{rt}^{j}\Xi_{rt}^{jk}C_{rt}^{j}}\right)\,\mathrm{d}f\right)\Lambda_t^j,$$

where Λ_t^j is the Lagrange multiplier on the constraint. Rearranging:

$$C_{rt}^{jj}(f)=(1-\Gamma_{t}^{j})\times h\left(\frac{P_{rt}^{jj}(f)}{\Lambda_t^j\times g^{\prime}\left(\int_f g^{*}\left(\frac{C_{rt}^{jj}(f)}{(1-\Gamma_{rt}^{j})C_{rt}^{j}}\right)\,\mathrm{d}f\right)}\right)C_{rt}^{j}\tag{A.2}$$

$$C_{rt}^{jk}(f)=\Gamma_{t}^{j}\Xi_{t}^{jk}\times h\left(\frac{P_{rt}^{jk}(f)}{\Lambda_t^j g^{\prime}\left(\sum_{\substack{k\in\mathcal{J}\\k\neq j}}\Xi_{rt}^{jk}\int_f g^{*}\left(\frac{C_{rt}^{jk}(f)}{\Gamma_{rt}^{j}\Xi_{rt}^{jk}C_{rt}^{j}}\right)\,\mathrm{d}f\right)}\right)C_{rt}^{j},\tag{A.3}$$

where $h(.)=(g^{*\prime})^{-1}(.)$. Note that $h(1)=1$ since $g^{*\prime}(1)=1$.

Using the first-order conditions, one can check that if relative prices are equal to 1:

$C_{rt}^{jj}(f) = (1-\Gamma_t^j)C_{rt}^j$ and $C_{rt}^{jk}(f) = \Gamma_{rt}^j \Xi_{rt}^{jk} C_{rt}^j$. Log-linearizing around that symmetric equilibrium when demand shocks are equal to their mean ($\Gamma_{rt}^j = \bar{\Gamma}_{rt}^j$ and $\Xi_{rt}^{jk} = \bar{\Xi}_r^{jk}$):

$$\hat{c}_{rt}^j = (1-\bar{\Gamma}^j)\hat{c}_{rt}^{jj} + \bar{\Gamma}^j \sum_{\substack{k\in\mathcal{J}\\ k\neq j}} \bar{\Xi}_r^{jk}\hat{c}_{rt}^{jk},$$

where $\hat{c}_{rt}^{jj} \equiv \int_f \hat{c}_{rt}^{jj}(f)$ and $\hat{c}_{rt}^{j*} \equiv \int_f \sum_{k\in\mathcal{J},k\neq j} \bar{\Xi}_r^{jk}\hat{c}_{rt}^{jk}(f)\,\mathrm{d}f$. Similarly defining the price index as $P_{rt}^j C_{rt}^j \equiv \sum_{k\in\mathcal{J}} \int_f P_{rt}^{jk}(f) C_{rt}^{jk}(f)\,\mathrm{d}f$, one can show:

$$p_{rt}^j = (1-\bar{\Gamma}^j)p_{rt}^{jj} + \bar{\Gamma}^j \sum_{\substack{k\in\mathcal{J}\\ k\neq j}} \bar{\Xi}_r^{jk} p_{rt}^{jk},$$

where: $p_{rt}^{jj} \equiv \int_f p_{rt}^{jj}(f)$ and $p_{rt}^{j*} \equiv \int_f \sum_{k\in\mathcal{J},k\neq j} \bar{\Xi}_r^{jk} p_{rt}^{jk}(f)\,\mathrm{d}f$.

I now log-linearize the demand functions around the symmetric equilibrium:

$$\hat{c}_{rt}^{jj}(f) = \hat{c}_{rt}^j - \theta\left(p_{rt}^{jj}(f) - \lambda_t^j + \tilde{\rho}\left(\hat{c}_{rt}^{jj} - \hat{c}_{rt}^j\right)\right) - \frac{\bar{\Gamma}^j}{1-\bar{\Gamma}^j}(1+\theta\tilde{\rho})\hat{\gamma}_{rt}^j$$
$$\hat{c}_{rt}^{jk}(f) = \hat{c}_{rt}^j - \theta\left(p_{rt}^{jk}(f) - \lambda_t^j + \tilde{\rho}\left(\hat{c}_{rt}^{j*} - \hat{c}_{rt}^j\right)\right) + (1+\theta\tilde{\rho})\hat{\gamma}_{rt}^j + \hat{\xi}_{rt}^{jk},$$

where $\hat{c}_{rt}^{jj} \equiv \int_f \hat{c}_{rt}^{jj}(f)\,\mathrm{d}f$, $\hat{c}_{rt}^{j*} \equiv \sum_{k\in\mathcal{J},k\neq j} \bar{\Xi}_r^{jk} \int_f \hat{c}_{rt}^{jk}(f)\,\mathrm{d}f$, $\theta \equiv -\frac{h'(1)}{h(1)}$, and $\tilde{\rho} = -\frac{g^{*\prime}(1)g''(1)}{g'(1)}$. I then aggregate over f:

$$\hat{c}_{rt}^{jj} = \hat{c}_{rt}^j - \theta\left(p_{rt}^{jj} - \lambda_t^j + \tilde{\rho}\left(\hat{c}_{rt}^{jj} - \hat{c}_{rt}^j\right)\right) - \frac{\bar{\Gamma}^j}{1-\bar{\Gamma}^j}(1+\theta\tilde{\rho})\hat{\gamma}_{rt}^j \tag{A.4}$$
$$\hat{c}_{rt}^{jk} = \hat{c}_{rt}^j - \theta\left(p_{rt}^{jk} - \lambda_t^j + \tilde{\rho}\left(\hat{c}_{rt}^{j*} - \hat{c}_{rt}^j\right)\right) + (1+\theta\tilde{\rho})\hat{\gamma}_{rt}^j + \hat{\xi}_{rt}^{jk}. \tag{A.5}$$

The demand for imports is given by averaging over k in equation (A.5):

$$\hat{c}_{rt}^{j*} = \hat{c}_{rt}^j - \theta\left(p_{rt}^{j*} - \lambda_t^j + \tilde{\rho}\left(\hat{c}_{rt}^{j*} - \hat{c}_{rt}^j\right)\right) + (1+\theta\tilde{\rho})\hat{\gamma}_{rt}^j. \tag{A.6}$$

Subtracting equation (A.6) from equation (A.5):

$$\hat{c}_{rt}^{jk} = \hat{c}_{rt}^{j*} - \theta\left(p_{rt}^{jk} - p_{rt}^{j*}\right) + \hat{\xi}_{rt}^{jk}. \tag{A.7}$$

Taking the weighted average of equations (A.4) and (A.6), I can check that: $\lambda_{rt}^j = p_{rt}^j$. Then, equations (A.4) and (A.6) can be rearranged to:

$$\hat{c}^{jj}_{rt} = \hat{c}^{j}_{rt} - \rho\left(p^{jj}_{rt} - p^{j}_{rt}\right) - \frac{\bar{\Gamma}^j}{1-\bar{\Gamma}^j}\hat{\gamma}^j_{rt} \tag{A.8}$$

$$\hat{c}^{j*}_{rt} = \hat{c}^{j}_{rt} - \rho\left(p^{j*}_{rt} - p^{j}_{rt}\right) + \hat{\gamma}^j_{rt}, \tag{A.9}$$

where $\rho \equiv \frac{\theta}{1+\theta\tilde{\rho}}$. ρ is the elasticity of substitution between domestic and foreign varieties, while θ is the elasticity of substitution among foreign varieties.

CES case: Suppose that: $g(x) = x$ and $g^*(x) = 1 + \frac{\theta}{\theta-1}\left(x^{\frac{\theta-1}{\theta}} - 1\right)$. The Kimball aggregator simplifies to:

$$C^j_rt = (1-\Gamma^j_{rt})C^j_{rt} \times \int_f \left(\frac{C^{jj}_{rt}(f)}{(1-\Gamma^j_{rt})C^j_{rt}}\right)^{\frac{\theta-1}{\theta}} \mathrm{d}f + \Gamma^j_{rt}C^j_{rt}\sum_{\substack{k\in\mathcal{J}\\k\neq j}}\Xi^{jk}_{rt}\int_f \left(\frac{C^{jk}_{rt}(f)}{\Gamma^j_{rt}\Xi^{jk}_{rt}C^j_{rt}}\right)^{\frac{\theta-1}{\theta}} \mathrm{d}f,$$

which can be rewritten in a more traditional form:

$$C^j_{rt} = \left[(1-\Gamma^j_{rt})^{\frac{1}{\theta}}\int_f \left(C^{jj}_{rt}(f)\right)^{\frac{\theta-1}{\theta}} \mathrm{d}f + (\Gamma^j_{rt})^{\frac{1}{\theta}}\sum_{\substack{k\in\mathcal{J}\\k\neq j}}(\Xi^{jk}_{rt})^{\frac{1}{\theta}}\int_f \left(C^{jk}_{rt}(f)\right)^{\frac{\theta-1}{\theta}} \mathrm{d}f\right]^{\frac{\theta}{\theta-1}}.$$

A.3.2 Strategic Complementarities

A.3.2.1 Flexible Prices

A firm maximizes: $\left(P^{jk}_{rt}(f) - (1-\tau)\frac{MC^k_t(f)}{XR^{kj}_t}\right)C^{jk}_t(f)$, subject to equations (A.2) or (A.3). τ is a production subsidy, which may allow the steady state to be efficient. The first-order condition for $k \neq j$ is:

$$h(X) + \left(1 - (1-\tau)\frac{MC^k_{rt}(f)/XR^{kj}_t}{P^{jk}_{rt}(f)}\right)Xh'(X) = 0,$$

where: $X = P^{jk}_{rt}(f)/\Lambda^j_t g'\left(\sum_{\substack{k\in\mathcal{J}\\k\neq j}}\Xi^{jk}_{rt}\int_f g^*\left(\frac{C^{jk}_{rt}(f)}{\Gamma^j_{rt}\Xi^{jk}_{rt}C^j_{rt}}\right)\mathrm{d}f\right)$. Rearranging: $P^{jk}_{rt}(f) = \mathcal{M}(X)(1-\tau)\frac{MC^k_{rt}(f)}{XR^{kj}_t}$, where: $\mathcal{M}(X) = -\frac{Xh'(X)}{h(X)}/\left(-\frac{Xh'(X)}{h(X)} - 1\right)$. Log-linearizing:

$$p^{jk}_t(f) = -\bar{m}\left(p^{jk}_t(f) - p^j_t + \tilde{\rho}(\hat{c}^{j*}_{rt} - \hat{c}^j_t - \hat{\gamma}^j_t)\right) + (\Theta + mc^k_t(f) - xr^{kj}_t)$$

where: $\bar{m} = -\frac{\mathrm{d}\log \mathcal{M}(X)}{\mathrm{d}\log X}|_{X=1}$ and $\Theta = \log\left((1-\tau)\frac{\theta}{\theta-1}\right)$. Aggregating over f:

$$p_{rt}^{jk} = -\bar{m}\left(p_{rt}^{jk} - p_t^j + \tilde{\rho}(\hat{c}_{rt}^{j*} - \hat{c}_{rt}^j - \hat{\gamma}_{rt}^j)\right) + (\Theta + mc_{rt}^k - xr_t^{kj}).$$

Substituting equation (A.9) and rearranging:

$$p_{rt}^{jk} = \frac{\bar{m}\tilde{\rho}\rho}{1+\bar{m}} p_{rt}^{j*} + \frac{\bar{m}(1-\tilde{\rho}\rho)}{1+\bar{m}} p_{rt}^j + \frac{1}{1+\bar{m}}(\Theta + mc_{rt}^k - xr_t^{kj}).$$

Aggregating over k:

$$p_{rt}^{j*} = \frac{\bar{m}(1-\tilde{\rho}\rho)}{1+\bar{m}(1-\tilde{\rho}\rho)} p_{rt}^j + \frac{1}{1+\bar{m}(1-\tilde{\rho}\rho)} \sum_{\substack{k\in\mathcal{J}\\ k\neq j}} \bar{\Xi}^{jk}(\Theta + mc_{rt}^k - xr_t^{kj}).$$

Similarly, for the domestic good:

$$p_{rt}^{jj}(f) = -\bar{m}\left(p_{rt}^{jj}(f) - p_{rt}^j + \tilde{\rho}\left(\hat{c}_{rt}^{jj} - \hat{c}_{rt}^j + \frac{\bar{\Gamma}^j}{1-\bar{\Gamma}^j}\hat{\gamma}_{rt}^j\right)\right) + \Theta + mc_{rt}^j(f).$$

Aggregating over f:

$$p_{rt}^{jj} = \frac{\bar{m}(1-\tilde{\rho}\rho)}{1+\bar{m}(1-\tilde{\rho}\rho)} p_{rt}^j + \frac{1}{1+\bar{m}(1-\tilde{\rho}\rho)}(\Theta + mc_{rt}^j).$$

Therefore:

$$p_{rt}^{jk} = \zeta_1 p_{rt}^{j*} + \zeta_2 p_{rt}^j + (1-\zeta_1-\zeta_2)(\Theta + mc_{rt}^k - xr_t^{kj}) \tag{A.10}$$

$$p_{rt}^{j*} = \bar{\zeta} p_{rt}^j + (1-\bar{\zeta}) \sum_{\substack{k\in\mathcal{J}\\ k\neq j}} \bar{\Xi}^{jk}(\Theta + mc_{rt}^k - xr_t^{kj}) \tag{A.11}$$

$$p_{rt}^{jj} = \bar{\zeta} p_{rt}^j + (1-\bar{\zeta})(\Theta + mc_{rt}^j), \tag{A.12}$$

where $\zeta_1 \equiv \frac{\bar{m}\tilde{\rho}\rho}{1+\bar{m}}$, $\zeta_2 \equiv \frac{\bar{m}(1-\tilde{\rho}\rho)}{1+\bar{m}}$, and $\bar{\zeta} \equiv \frac{\bar{m}(1-\tilde{\rho}\rho)}{1+\bar{m}(1-\tilde{\rho}\rho)}$. Substituting in the formula for $\tilde{\rho}$:

$$\zeta_1 = \frac{\bar{m}(1-\rho/\theta)}{1+\bar{m}} \qquad \zeta_2 = \frac{\bar{m}\rho/\theta}{1+\bar{m}} \qquad \bar{\zeta} = \frac{\bar{m}\rho}{\theta+\bar{m}\rho}.$$

Combining equations (A.11) and (A.12):

$$p_{rt}^j = \Theta + (1-\bar{\Gamma}^j) mc_{rt}^j + \bar{\Gamma}^j \sum_{\substack{k\in\mathcal{J}\\ k\neq j}} \bar{\Xi}^{jk}(mc_{rt}^k - xr_t^{kj}). \tag{A.13}$$

Invoking equation (A.11) one more time:

$$p_{rt}^{j*} = \Theta + \bar{\zeta}(1 - \bar{\Gamma}^j) mc_{rt}^j + (1 - \bar{\zeta}(1 - \bar{\Gamma}^j)) \sum_{\substack{k \in \mathcal{J} \\ k \neq j}} \Xi^{jk} (mc_{rt}^k - xr_t^{kj}). \tag{A.14}$$

Plugging the latter two results into equation (A.10):

$$\begin{aligned} p_{rt}^{jk} =& \Theta + \bar{\zeta}(1 - \bar{\Gamma}^j) mc_{rt}^j + \left(\zeta_1 + \zeta_2 - \bar{\zeta}(1 - \bar{\Gamma}^j)\right) \sum_{\substack{m \in \mathcal{J} \\ m \neq j}} \Xi^{jm} (mc_{rt}^m - xr_t^{mj}) \\ &+ (1 - \zeta_1 - \zeta_2)(mc_{rt}^k - xr_t^{kj}). \end{aligned} \tag{A.15}$$

Klenow and Willis (2016) case: Suppose that: $h(x) = (1 - \bar{m}' \log(x))^{\frac{\theta}{\bar{m}'}}$. Then: $\bar{m} = \bar{m}'/(\theta - 1)$. $\bar{m}$ can take any value from 0 to infinity as long as $\theta > 1$. So $(1 - \zeta_1 - \zeta_2)$ can take any value between 0 and 1.

A.3.2.2 Proof of Proposition 2

Under flexible prices, the price set by an exporter is given by equation (A.10). The pass-through regression (15) controls for the wholesale price index of the origin country, whose model analogue is either the producer price index (PPI) or the consumer price index (CPI). I treat each case in turn.

PPI case. The producer price index is given by combining equations (A.12) and (A.13):

$$p_t^{kk} = \Theta + (1 - \bar{\zeta}\bar{\Gamma}) mc_t^k + \bar{\zeta}\bar{\Gamma} \int_m (mc_t^m - xr_t^{mk}) \, \mathrm{d}m.$$

Rearranging, and using the identity $xr_t^{mk} = xr_t^{mj} - xr_t^{kj}$:

$$\begin{aligned} mc_t^k &= -\frac{\Theta}{1 - \bar{\zeta}\bar{\Gamma}} + \frac{1}{1 - \bar{\zeta}\bar{\Gamma}} p_t^{kk} - \frac{\bar{\zeta}\bar{\Gamma}}{1 - \bar{\zeta}\bar{\Gamma}} \int_m (mc_t^m - xr_t^{mk}) \, \mathrm{d}m \\ &= -\frac{\Theta}{1 - \bar{\zeta}\bar{\Gamma}} + \frac{1}{1 - \bar{\zeta}\bar{\Gamma}} p_t^{kk} - \frac{\bar{\zeta}\bar{\Gamma}}{1 - \bar{\zeta}\bar{\Gamma}} \int_m (mc_t^m - xr_t^{mj}) \, \mathrm{d}m - \frac{\bar{\zeta}\bar{\Gamma}}{1 - \bar{\zeta}\bar{\Gamma}} xr_t^{kj}. \end{aligned}$$

Plugging this expression into the simplified version of equation (A.10):

$$\begin{aligned} p_t^{jk} =& -\frac{(1 - \zeta_1 - \zeta_2)\bar{\zeta}\bar{\Gamma}}{1 - \bar{\zeta}\bar{\Gamma}} \Theta - \frac{1 - \zeta_1 - \zeta_2}{1 - \bar{\zeta}\bar{\Gamma}} xr_t^{kj} \\ &+ \frac{1 - \zeta_1 - \zeta_2}{1 - \bar{\zeta}\bar{\Gamma}} \left(p_t^{kk} - \bar{\zeta}\bar{\Gamma} \int_m (mc_t^m - xr_t^{mj}) \, \mathrm{d}m \right) + \zeta_1 p_t^{j*} + \zeta_2 p_t^j. \end{aligned}$$

CPI case. The consumer price index is given by equation (A.13):

$$p_t^k = \Theta + (1-\bar{\Gamma})mc_t^k + \bar{\Gamma}\int_m (mc_t^m - xr_t^{mk})\,\mathrm{d}m.$$

Rearranging, and using the same identity $xr_t^{mk} = xr_t^{mj} - xr_t^{kj}$:

$$\begin{aligned} mc_t^k &= -\frac{\Theta}{1-\bar{\Gamma}} + \frac{1}{1-\bar{\Gamma}}p_t^k - \frac{\bar{\Gamma}}{1-\bar{\Gamma}}\int_m (mc_t^m - xr_t^{mk})\,\mathrm{d}m \\ &= -\frac{\Theta}{1-\bar{\Gamma}} + \frac{1}{1-\bar{\Gamma}}p_t^k - \frac{\bar{\Gamma}}{1-\bar{\Gamma}}\int_m (mc_t^m - xr_t^{mj})\,\mathrm{d}m - \frac{\bar{\Gamma}}{1-\bar{\Gamma}}xr_t^{kj}. \end{aligned}$$

Plugging this expression into the simplified version of equation (A.10), the xr_t^{kj} terms combine into $-\frac{1-\zeta_1-\zeta_2}{1-\bar{\Gamma}}xr_t^{kj}$, so that:

$$\begin{aligned} p_t^{jk} = &-\frac{(1-\zeta_1-\zeta_2)\bar{\Gamma}}{1-\bar{\Gamma}}\Theta - \frac{1-\zeta_1-\zeta_2}{1-\bar{\Gamma}}xr_t^{kj} \\ &+ \frac{1-\zeta_1-\zeta_2}{1-\bar{\Gamma}}\left(p_t^k - \bar{\Gamma}\int_m (mc_t^m - xr_t^{mj})\,\mathrm{d}m\right) + \zeta_1 p_t^{j*} + \zeta_2 p_t^j. \end{aligned}$$

In both cases, running the pass-through regression (15) amounts to regressing p_t^{jk} on the exchange rate xr_t^{kj} and the origin-country price index used as control (p_t^{kk} for the PPI, p_t^k for the CPI), with a product-time fixed effect. The fixed effect absorbs every term that does not vary across origins k: the constant in Θ, the integral $\int_m (mc_t^m - xr_t^{mj})\,\mathrm{d}m$, and the destination-country indices p_t^{j*} and p_t^j. The coefficient on the exchange rate therefore identifies $\hat{\alpha}$. Since $\zeta_1+\zeta_2 = \bar{m}/(1+\bar{m})$, so that $1-\zeta_1-\zeta_2 = 1/(1+\bar{m})$, this yields:

$$\hat{\alpha} = -\frac{1/(1+\bar{m})}{1-\bar{\Gamma}}\ \text{(CPI)}, \qquad \hat{\alpha} = -\frac{1/(1+\bar{m})}{1-\bar{\zeta}\bar{\Gamma}}\ \text{(PPI)},$$

which is the statement of proposition 2.

A.3.3 Price Rigidity

The baseline model only features wage rigidity. As a robustness check, I introduce nominal price rigidity *à la* Calvo. Each period, a firm may reset the price it charges in a given market with probability $1-\xi^p$, independently across markets, firms, and dates; with probability ξ^p it keeps the previous price, fixed in its currency of invoicing. The firm's desired price in market j is the static optimum derived in section A.3.2 — equation (A.10) for an imported variety and equation (A.12) for a domestic one — which I restate as the frictionless target:

$$\Psi_t^{jk} \equiv \begin{cases} (1-\zeta_1-\zeta_2)\left(\Theta + mc_t^k - xr_t^{kj}\right) + \zeta_1 p_t^{j*} + \zeta_2 p_t^j & \text{if } k \neq j, \\ (1-\bar{\zeta})\left(\Theta + mc_t^j\right) + \bar{\zeta}\, p_t^j & \text{if } k = j. \end{cases} \tag{A.16}$$

Ψ_t^{jk} is expressed in the destination currency j, and under flexible prices $p_t^{jk} = \Psi_t^{jk}$. For an imported variety ($k \neq j$), it combines the marginal cost of the country-k producer, converted into currency j ($mc_t^k - xr_t^{kj}$), with the import and consumer price indices of the destination market, p_t^{j*} and p_t^j, which capture the strategic complementarities within the import nest. A domestically produced variety ($k = j$) instead competes in the home nest: the complementarity loads on the consumer price index p_t^j alone (with weight $\bar{\zeta}$), and the marginal-cost pass-through coefficient is $1-\bar{\zeta}$ in place of $1-\zeta_1-\zeta_2$.

Calvo reset. Consider a firm from k selling in j that invoices in some currency c and resets its price at t. Because the price is sticky in currency c, the relevant target is the frictionless price expressed in that currency, $\Psi_t^{jk} + xr_t^{cj}$, where I use the identity that a destination-currency price is converted into currency c by adding xr_t^{cj}. Log-linearizing the optimal reset price around the zero-inflation steady state gives the standard forward-looking expression:

$$\tilde{p}_t^{jk} = (1-\beta\xi^p)\, E_t \sum_{s=t}^{\infty} (\beta\xi^p)^{s-t} \left(\Psi_s^{jk} + xr_s^{cj}\right), \tag{A.17}$$

where $\tilde{p}_t^{jk}$ denotes the reset price, expressed in currency c: the firm sets its price equal to a discounted weighted average of current and expected future frictionless prices, with weights reflecting the probability ξ^p that the price survives into each future period. The price index in currency c, $p_t^{jk} + xr_t^{cj}$, evolves according to the Calvo law of motion:

$$p_t^{jk} + xr_t^{cj} = \xi^p \left(p_{t-1}^{jk} + xr_{t-1}^{cj}\right) + (1-\xi^p)\, \tilde{p}_t^{jk}.$$

Defining destination-currency inflation as $\pi_t^{jk} \equiv p_t^{jk} - p_{t-1}^{jk}$, the inflation rate of the price index in currency c is therefore:

$$\pi_t^{jk} + \Delta xr_t^{cj} = \frac{1-\xi^p}{\xi^p} \left(\tilde{p}_t^{jk} - p_t^{jk} - xr_t^{cj}\right).$$

Eliminating the reset price between this law of motion and equation (A.17) yields a New Keynesian Phillips curve. Since the gap between the target and the price index, $\Psi_t^{jk} - p_t^{jk}$, is independent of the unit of account, the result is:

$$\pi_t^{jk} + \Delta xr_t^{cj} = \kappa^p \left(\Psi_t^{jk} - p_t^{jk}\right) + \beta E_t \left(\pi_{t+1}^{jk} + \Delta xr_{t+1}^{cj}\right), \qquad \kappa^p \equiv \frac{(1-\xi^p)(1-\beta\xi^p)}{\xi^p}. \tag{A.18}$$

The three invoicing regimes correspond to three choices of the invoicing currency c. They describe how an exporter prices in a foreign market, so the formulas below apply to imported varieties ($k \neq j$); the domestic case ($k = j$), in which $c = j$ and the regimes coincide, is treated separately at the end of this section.

Producer currency pricing (PCP). The exporter invoices in its own currency, $c = k$, so $xr_t^{cj} = xr_t^{kj}$. Expressing each term of the gap in producer currency, the Phillips curve (A.18) becomes:

$$\pi_t^{jk} + \Delta xr_t^{kj} = \kappa^p \Big[(1-\zeta_1-\zeta_2)(\Theta + mc_t^k) + \zeta_1(p_t^{j*} + xr_t^{kj}) + \zeta_2(p_t^j + xr_t^{kj}) - (p_t^{jk} + xr_t^{kj})\Big] + \beta E_t \left(\pi_{t+1}^{jk} + \Delta xr_{t+1}^{kj}\right). \tag{A.19}$$

Marginal cost enters in the producer's own currency, while the competitor indices and the price index are converted into that currency. The sticky object is the producer-currency price $p_t^{jk} + xr_t^{kj}$, so a depreciation of the destination currency raises the import price p_t^{jk} one-for-one on impact, except for the fraction of firms that reset.

Local currency pricing (LCP). The exporter invoices in the destination currency, $c = j$, so $xr_t^{cj} = 0$ and the Phillips curve (A.18) reduces to:

$$\pi_t^{jk} = \kappa^p \Big[(1-\zeta_1-\zeta_2)(\Theta + mc_t^k - xr_t^{kj}) + \zeta_1 p_t^{j*} + \zeta_2 p_t^j - p_t^{jk}\Big] + \beta E_t\, \pi_{t+1}^{jk}. \tag{A.20}$$

The destination-currency price is now sticky, so the exchange rate enters only through the marginal-cost term $mc_t^k - xr_t^{kj}$ and does not move the import price until it is reset: pass-through into import prices is delayed.

Dominant currency pricing (DCP). The exporter invoices in a third, dominant currency d (e.g. the US dollar), so $xr_t^{cj} = xr_t^{dj}$. Using the identity $mc_t^k - xr_t^{kj} + xr_t^{dj} = mc_t^k - xr_t^{kd}$ to express marginal cost in the dominant currency, the Phillips curve (A.18) becomes:

$$\pi_t^{jk} + \Delta xr_t^{dj} = \kappa^p \Big[(1-\zeta_1-\zeta_2)(\Theta + mc_t^k - xr_t^{kd}) + \zeta_1(p_t^{j*} + xr_t^{dj}) + \zeta_2(p_t^j + xr_t^{dj}) - (p_t^{jk} + xr_t^{dj})\Big] + \beta E_t \left(\pi_{t+1}^{jk} + \Delta xr_{t+1}^{dj}\right). \tag{A.21}$$

The sticky object is the dominant-currency price $p_t^{jk} + xr_t^{dj}$. This regime nests the other two: PCP obtains when $d = k$ (the producer's currency is dominant, so $xr_t^{dj} = xr_t^{kj}$ and $xr_t^{kd} = 0$), and LCP obtains when $d = j$ (the destination's currency is dominant, so $xr_t^{dj} = 0$ and $xr_t^{kd} = xr_t^{kj}$).

Domestic sales. For goods sold in the country where they are produced, $k = j$: the producer and destination currencies coincide, so $xr_t^{jj} = 0$ and the invoicing regime is irrelevant. The Phillips curve (A.18) then applies with the domestic target Ψ_t^{jj} from equation (A.16):

$$\pi_t^{jj} = \kappa^p \left(\Psi_t^{jj} - p_t^{jj}\right) + \beta E_t \, \pi_{t+1}^{jj} = \kappa^p \Big[(1-\bar{\zeta})(\Theta + mc_t^j) + \bar{\zeta}\, p_t^j - p_t^{jj}\Big] + \beta E_t \, \pi_{t+1}^{jj}, \quad \text{(A.22)}$$

which governs producer-price inflation. Because the domestic good competes in the home nest, its target loads on the consumer price index alone, with the coefficients $\bar{\zeta}$ and $1-\bar{\zeta}$ of equation (A.12) — not on the import price index p_t^{j*} as for an imported variety. Together with the wage Phillips curve derived in the Households section, equations (A.19)–(A.22) close the sticky-price version of the model. Letting $\xi^p \to 0$ sends $\kappa^p \to \infty$ and forces $p_t^{jk} = \Psi_t^{jk}$, recovering the flexible-price benchmark, equations (A.10) and (A.12).

A.3.4 Market Clearing

To a first order, output of country j equals the total demand — for consumption, investment, and intermediate use — that every country directs at its varieties:

$$\hat{y}_t^j = (1-\bar{\Gamma})\hat{d}_t^{jj} + \bar{\Gamma} \int_k \hat{d}_t^{kj} \, \mathrm{d}k,$$

where $\hat{d}_t^{kj}$ is country k's total demand for the varieties of country j. The investment and intermediate bundles aggregate individual varieties exactly as the consumption basket does and are purchased at the same price index P_t^k, so each use is allocated across origins by the same relative prices. The demand for the varieties of country j therefore takes the same form whatever use it serves, with total domestic demand $\hat{d}_t^k$ replacing consumption $\hat{c}_t^k$ in equations (A.7), (A.9) and (A.8):

$$\begin{aligned}
\hat{d}_t^{kj} &= \hat{d}_t^{k*} - \theta\left(p_t^{kj} - p_t^{k*}\right) = \hat{d}_t^k - \rho\left(p_t^{k*} - p_t^k\right) - \theta\left(p_t^{kj} - p_t^{k*}\right), \\
\hat{d}_t^{jj} &= \hat{d}_t^j - \rho\left(p_t^{jj} - p_t^j\right).
\end{aligned}$$

Country k's demand for j's varieties loads on the price of its import basket relative to its CPI (elasticity ρ) and on the price of the origin j relative to that import basket (elasticity θ); the second line is the analogue for home goods. Substituting into the expression for output gives the general market-clearing condition, expressed in terms of the export (p^{kj}), import

(p^{k*}) and consumer (p^k) price indices. It holds whether prices are flexible or rigid:

$$\begin{aligned}\hat{y}_t^j =& -\rho\left[(1-\bar{\Gamma})\left(p_t^{jj}-p_t^j\right)+\bar{\Gamma}\int_k\left(p_t^{k*}-p_t^k\right)\mathrm{d}k\right]-\theta\bar{\Gamma}\int_k\left(p_t^{kj}-p_t^{k*}\right)\mathrm{d}k\\ &+(1-\bar{\Gamma})\hat{d}_t^j+\bar{\Gamma}\int_k\hat{d}_t^k\,\mathrm{d}k. \end{aligned}\tag{A.23}$$

When prices are flexible, marginal cost pins down each relative price in equation (A.23). The import-price gap follows from equations (A.13) and (A.14), the export-price gap from equations (A.14) and (A.15), and the home-price gap from equations (A.12) and (A.13):

$$\begin{aligned}p_t^{k*}-p_t^k &= (1-\bar{\zeta})(1-\bar{\Gamma})\left(\int_m\left(mc_t^m-xr_t^{mk}\right)\mathrm{d}m-mc_t^k\right),\\ p_t^{kj}-p_t^{k*} &= (1-\zeta_1-\zeta_2)\left(mc_t^j-xr_t^{jk}-\int_m\left(mc_t^m-xr_t^{mk}\right)\mathrm{d}m\right),\\ p_t^{jj}-p_t^j &= -(1-\bar{\zeta})\bar{\Gamma}\left(\int_m\left(mc_t^m-xr_t^{mj}\right)\mathrm{d}m-mc_t^j\right).\end{aligned}$$

Using the identity $xr_t^{mk}=xr_t^{mj}-xr_t^{kj}$ to express foreign marginal costs in country j's currency, the import-price gap integrates to zero, $\int_k\left(p_t^{k*}-p_t^k\right)\mathrm{d}k=0$, while the export-price gap integrates to:

$$\int_k\left(p_t^{kj}-p_t^{k*}\right)\mathrm{d}k=-(1-\zeta_1-\zeta_2)\left(\int_m\left(mc_t^m-xr_t^{mj}\right)\mathrm{d}m-mc_t^j\right).$$

Substituting these into equation (A.23), the ρ term retains only the home-price gap and the θ term the export-price gap, so the price block collapses onto country j's marginal cost relative to its competitors' and the two trade elasticities combine into a single coefficient:

$$\begin{aligned}\hat{y}_t^j =&\,\psi\left(\int_m\left(mc_t^m-xr_t^{mj}\right)\mathrm{d}m-mc_t^j\right)+(1-\bar{\Gamma})\hat{d}_t^j+\bar{\Gamma}\int_k\hat{d}_t^k\,\mathrm{d}k\\ \psi \equiv&\,\bar{\Gamma}\left[(1-\bar{\zeta})(1-\bar{\Gamma})\rho+(1-\zeta_1-\zeta_2)\theta\right].\end{aligned}\tag{A.24}$$

This marginal-cost form holds under flexible prices. Because the model allows for price rigidity, the model summary instead uses the general condition (A.23), which reduces to the expression above as $\xi^p\to 0$.

A.3.5 Households

The utility of the country's representative household is:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{(C_t^j - \iota C_{t-1}^j)^{1-\sigma} - 1}{1-\sigma} - \int_l \frac{(N_t^j(l))^{1+\phi}}{1+\phi} \,\mathrm{d}l + \frac{\left(M_t^j/P_t^j\right)^{1-\chi} - 1}{1-\chi} \right),$$

subject to:

$$\frac{B_t^j}{1+i_t^j} - B_{t-1}^j + M_t^j - M_{t-1}^j + P_t^j \left(K_{t+1}^j - (R_t^j - \delta)K_t^j + \frac{\kappa^k}{2} \frac{\left(K_{t+1}^j - K_t^j\right)^2}{K_t^j} \right)$$
$$= \int_l W_t^j(l) N_t^j(l) \,\mathrm{d}l - P_t^j C_t^j + \text{profits}$$
$$N_t^j(l) = \left(\frac{W_t^j(l)}{W_t^j} \right)^{-\eta} N_t^j.$$

The Euler equation is:

$$U_{C,t}^j = \beta(1+i_t^j) E_t \left[U_{C,t+1}^j \frac{P_t^j}{P_{t+1}^j} \right]$$
$$U_{C,t}^j \equiv \left(C_t^j - \iota C_{t-1}^j\right)^{-\sigma} - \beta\iota E_t \left(C_{t+1}^j - \iota C_t^j\right)^{-\sigma},$$

where $U_{C,t}^j$ is the marginal utility of consumption. Log-linearizing:

$$\hat{\mu}_t^j = E_t \hat{\mu}_{t+1}^j + \hat{\imath}_t^j - E_t \pi_{ct+1}^j$$
$$\hat{\mu}_t^j \equiv \frac{\sigma}{(1-\iota)(1-\beta\iota)} E_t \left(\beta\iota \hat{c}_{t+1}^j - (1+\beta\iota^2)\hat{c}_t^j + \iota \hat{c}_{t-1}^j \right).$$

The first-order condition for money holdings is:

$$\hat{\imath}_t^j = \frac{1-\beta}{\beta^2} \left(-\chi (\widehat{m_t^j - p_t^j}) - \hat{\mu}_t^j \right).$$

The household also chooses how much capital to accumulate. The first-order condition for K_{t+1}^j equates the marginal cost of installing a unit of capital today to its expected discounted return:

$$U_{C,t}^j \left(1 + \kappa^k \frac{K_{t+1}^j - K_t^j}{K_t^j} \right) = \beta E_t \left[U_{C,t+1}^j \left(R_{t+1}^j - \delta + \kappa^k \frac{K_{t+2}^j - K_{t+1}^j}{K_{t+1}^j} + \frac{\kappa^k}{2} \frac{\left(K_{t+2}^j - K_{t+1}^j\right)^2}{\left(K_{t+1}^j\right)^2} \right) \right],$$

where R_t^j is the gross rental rate of capital. The terms in κ^k are the marginal installation cost paid today and the marginal adjustment cost saved next period. Without adjustment costs ($\kappa^k = 0$), it collapses to $U^j_{C,t} = \beta E_t \left[U^j_{C,t+1}\left(R^j_{t+1} - \delta\right)\right]$, equating the real return on capital to that on bonds.

Defining Tobin's q as $Q^j_t \equiv 1 + \kappa^k \left(K^j_{t+1}/K^j_t - 1\right)$, the left-hand side is $U^j_{C,t}Q^j_t$. Log-linearizing the first-order condition and this definition around the steady state gives:

$$
\begin{gathered}
r^j_t + \hat{q}^j_t = \beta E_t \hat{q}^j_{t+1} + [1 - \beta(1-\delta)]\, E_t \hat{r}^{K,j}_{t+1} \\
\hat{q}^j_t = \kappa^k \left(\hat{k}^j_{t+1} - \hat{k}^j_t\right),
\end{gathered}
$$

where $\hat{q}^j_t$ is the log-deviation of Q^j_t, $\hat{r}^j_t \equiv \hat{\imath}^j_t - E_t \pi^j_{ct+1}$ is the deviation of the expected real interest rate, $\hat{k}^j_t$ is (log) capital, and $\hat{r}^{K,j}_t$ is the deviation of the net rental rate $R^j_t - 1$, whose steady-state value is $\delta + \beta^{-1} - 1$.

Households set wages à la Calvo: each period, a fraction $1 - \xi^w$ of them reoptimize. A reoptimizing household chooses W^{j*}_t to maximize utility subject to the labor demand $N^j_t(l) = \left(W^j_t(l)/W^j_t\right)^{-\eta} N^j_t$, internalizing that the wage stays in place with probability ξ^w each subsequent period. The first-order condition is:

$$
\sum_{k=0}^{\infty} (\beta\xi^w)^k E_t \left[N^j_{t+k|t} U^j_{C,t+k} \left(\frac{W^{j*}_t}{P^j_{t+k}} - \frac{\eta}{\eta - 1} \frac{\left(N^j_{t+k|t}\right)^{\phi}}{U^j_{C,t+k}} \right) \right] = 0,
$$

where $N^j_{t+k|t} = \left(W^{j*}_t / W^j_{t+k}\right)^{-\eta} N^j_{t+k}$ is the labor demand faced at $t+k$ by a household that last reset its wage at t. Log-linearizing around the zero-inflation steady state and combining with the law of motion of the wage index, $\left(W^j_t\right)^{1-\eta} = \xi^w \left(W^j_{t-1}\right)^{1-\eta} + (1-\xi^w)\left(W^{j*}_t\right)^{1-\eta}$, gives:

$$
\pi^j_{wt} = \beta E_t \pi^j_{wt+1} + \kappa^w \left(\phi \hat{n}^j_t - \hat{\mu}^j_t - (\widehat{w^j_t - p^j_t})\right),
$$

where $\kappa^w \equiv \frac{(1-\xi^w)(1-\beta\xi^w)}{\xi^w(1+\eta\phi)}$ and $\hat{n}^j_t$ denotes hours worked.

A.3.6 Firms

In each country j, a continuum of monopolistically competitive firms, indexed by f and of total measure 1, each produce a single variety. Firm f combines capital $K^j_t(f)$, labor $N^j_t(f)$, and a bundle of intermediate goods $V^j_t(f)$ with the constant-returns technology:

$$
Y^j_t(f) = \left(K^j_t(f)^{\alpha} N^j_t(f)^{1-\alpha}\right)^{1-\nu} V^j_t(f)^{\nu}.
$$

Value added, $K_t^j(f)^\alpha N_t^j(f)^{1-\alpha}$, is Cobb-Douglas in capital and labor with capital share α; gross output is in turn Cobb-Douglas in value added and intermediate goods, whose cost share is ν. The intermediate bundle aggregates varieties exactly as the consumption basket does, so it is purchased at the consumer price index P_t^j. Capital is rented at the gross rate R_t^{Kj} and labor is hired at the wage W_t^j.

The firm's problem splits into cost minimization and price setting; the latter, common to the domestic and export markets, is derived in section A.3.2. Here I derive the cost of production. Since all firms face the same factor prices and the technology has constant returns to scale, the cost-minimization problem is identical across firms, so I drop the index f.

The firm chooses inputs to minimize total cost subject to producing Y_t^j:

$$\min_{K_t^j, N_t^j, V_t^j} R_t^{Kj} K_t^j + W_t^j N_t^j + P_t^j V_t^j \qquad \text{s.t.} \qquad \left(K_t^{j\,\alpha} N_t^{j\,1-\alpha} \right)^{1-\nu} V_t^{j\,\nu} = Y_t^j.$$

Letting MC_t^j denote the Lagrange multiplier on the technology constraint, the first-order conditions for capital, labor, and intermediate goods are:

$$\begin{aligned} R_t^{Kj} &= MC_t^j\, \alpha(1-\nu)\, \frac{Y_t^j}{K_t^j} \\ W_t^j &= MC_t^j\, (1-\alpha)(1-\nu)\, \frac{Y_t^j}{N_t^j} \\ P_t^j &= MC_t^j\, \nu\, \frac{Y_t^j}{V_t^j}. \end{aligned}$$

The multiplier MC_t^j is marginal cost: each condition equates an input's marginal product, valued at marginal cost, to its rental price. Equivalently, each input's share in total cost equals its exponent in the production function:

$$\frac{R_t^{Kj} K_t^j}{MC_t^j Y_t^j} = \alpha(1-\nu), \qquad \frac{W_t^j N_t^j}{MC_t^j Y_t^j} = (1-\alpha)(1-\nu), \qquad \frac{P_t^j V_t^j}{MC_t^j Y_t^j} = \nu.$$

Solving the first-order conditions for the conditional input demands and substituting them back into the production function, the Y_t^j terms cancel because the exponents $\alpha(1-\nu)$, $(1-\alpha)(1-\nu)$ and ν sum to 1. This delivers the unit cost function:

$$MC_t^j = \exp(\Phi) \left(R_t^{Kj} \right)^{\alpha(1-\nu)} \left(W_t^j \right)^{(1-\alpha)(1-\nu)} \left(P_t^j \right)^{\nu},$$

where: $\Phi = -\log\left(\alpha^{\alpha(1-\nu)} (1-\alpha)^{(1-\alpha)(1-\nu)} (1-\nu)^{1-\nu} \nu^\nu \right)$. Because the technology exhibits constant returns to scale, marginal cost is independent of the quantity produced and is therefore common to all firms, which justifies dropping the index f in the price-setting derivation. Taking logs yields the (log) marginal cost:

$$mc_t^j = \Phi + \alpha(1-\nu)\log R_t^{Kj} + (1-\alpha)(1-\nu)\, w_t^j + \nu\, p_t^j,$$

which is equation (25) in the main text once the constant Φ is omitted; here p_t^j is the (log) price of the intermediate-goods bundle, equal to the CPI.

In a symmetric steady state, the first-order condition for intermediate inputs implies: $V_t^j/Y_t^j = \nu MC_t^j/P_t^j = \nu(\theta-1)/\theta/(1-\tau)$. Itskhoki and Mukhin (2021) propose setting $1-\tau = (\theta-1)/\theta$ to avoid calibrating another parameter and ensure that the share of output allocated to intermediate goods is ν in steady state. I follow that strategy here.

A.3.7 UIP Deviations

The micro-foundations of uncovered interest parity (UIP) deviations follow Itskhoki and Mukhin (2017), who embed in general equilibrium the noise-trader and limits-to-arbitrage model of Jeanne and Rose (2002) and Gabaix and Maggiori (2015). I extend their derivation to a multi-country setting. Each country issues a bond denominated in its own currency, and the cross-border trade in the bonds of any pair of countries (j,k) is intermediated by a financial market with three types of participants.

First, the households of country j trade only their own-currency bond, a zero-coupon nominal bond. The face value of the holdings of country j's households is B_t^j, redeemed at time $t+1$ and purchased at time t for $B_t^j/(1+i_t^j)$. Second, on each bilateral exchange rate market, a measure $n\bar{Y}$ of noise traders (where $\bar{Y}$ is steady-state output) take a zero-capital position, going long country j's bond and short country k's (or vice versa). Their net demand for country j's bond, expressed in that country's currency, is:

$$\frac{N_t^{jk}/P_t^j}{1+i_t^j} = \beta n \bar{Y}\left(e^{\psi_t^j} - e^{\psi_t^k}\right), \tag{A.25}$$

where ψ_t^j is a country-specific noise-trader demand shock, so that the bilateral order flow is driven by the relative shock $\psi_t^j - \psi_t^k$. Third, a measure $m\bar{Y}$ of competitive arbitrageurs takes a zero-capital position D_t^{jk} in the same carry trade. The gross return on one unit of country j's currency invested long in the j-bond and short in the k-bond, measured in j-currency, is:

$$\tilde{R}_{t+1}^{jk} \equiv (1+i_t^j) - (1+i_t^k)\frac{XR_t^{kj}}{XR_{t+1}^{kj}} = (1+i_t^j)\left(1 - e^{i_t^k - i_t^j - \Delta xr_{t+1}^{kj}}\right), \tag{A.26}$$

where $XR_t^{kj} = \mathcal{E}_t^k/\mathcal{E}_t^j$ is the price of one unit of country j's currency in terms of country k's. Each arbitrageur chooses a position of time-t value $d_t^{jk}/P_t^j/(1+i_t^j)$ to maximize the mean-variance objective $E_t\tilde{R}_{t+1}^{jk} \cdot d_t^{jk}/P_t^j/(1+i_t^j) - \frac{\omega}{2}\mathrm{var}_t(\tilde{R}_{t+1}^{jk}) \cdot \left(d_t^{jk}/P_t^j/(1+i_t^j)\right)^2$, where ω is the risk-aversion parameter. The resulting demand for the j-currency bond is:

$$\frac{D_t^{jk}/P_t^j}{1+i_t^j} = m\bar{Y}\frac{E_t\tilde{R}_{t+1}^{jk}}{\omega\,\mathrm{var}_t(\tilde{R}_{t+1}^{jk})}. \tag{A.27}$$

Each country's bond is in zero net supply, in particular for country j:

$$B_t^j + \int_k N_t^{jk}\,dk + \int_k D_t^{jk}\,dk = 0. \tag{A.28}$$

Log-linearizing around a symmetric state where there are no gross asset positions ($B^j = B^k = 0$), shocks are zero ($\psi^j = \psi^k = 0$) but the variance of the exchange rate is not zero ($\sigma_{xr}^2 > 0$):

$$n_t^{jk} = n(\psi_t^j - \psi_t^k) \qquad d_t^{jk} = -\frac{m}{\omega\sigma_{xr}^2}(i_t^k - i_t^j + E_t\Delta xr_{t+1}^{jk}),$$

where: $n_t^{jk} = N_t^{jk}/P_t^j/\bar{Y}$ and $d_t^{jk} = D_t^{jk}/P_t^j/\bar{Y}$. So, equation (A.28) becomes:

$$b_t^j + n\left(\psi_t^j - \int_k \psi_t^k\,dk\right) + \frac{m}{\omega\sigma_{xr}^2}\left(i_t^j - E_t\Delta\epsilon_{t+1}^j - \int_k (i_t^k - E_t\Delta\epsilon_{t+1}^k)\,dk\right) = 0,$$

which can be rewritten into:

$$i_t^j - E_t\Delta\epsilon_{t+1}^j - \int_k (i_t^k - E_t\Delta\epsilon_{t+1}^k)\,dk = \upsilon_1\left(\int_k \psi_t^k\,dk - \psi_t^j\right) - \upsilon_2 b_t^j.$$

Since the latter is true for every j, it is equivalent to equation (21) in the main text:

$$i_t^j - i_t^k - E_t\Delta xr_{t+1}^{jk} = \upsilon_1\left(\psi_t^k - \psi_t^j\right) - \upsilon_2(b_t^j - b_t^k).$$

Itskhoki and Mukhin (2021) obtain this result with constant relative risk aversion (CRRA) utility, instead of mean-variance, for arbitrageurs. I follow Itskhoki and Mukhin (2017) for simplicity.

A.3.8 International Payments

Profits of the central bank are:

$$\Pi_{cbt}^j = M_t^j - M_{t-1}^j - \mathcal{E}_t^j\left(G_t^j - G_{t-1}^j\right).$$

Profits of the firms equal sales revenue net of the cost of all inputs. Since marginal cost MC_t^j summarizes the cost of capital, labour, and intermediate goods, the profit of firm f is:

$$\Pi_{ft}^j = \left(P_t^{jj} - MC_t^j\right) D_t^{jj}(f) + \int_k \left(\frac{P_t^{kj}}{XR_t^{kj}} - MC_t^j\right) D_t^{kj}(f)\,\mathrm{d}k,$$

where $D_t^{kj}(f)$ is the total demand — for consumption, investment, and intermediate use — in country k for the variety of firm f located in country j.

The noise traders and arbitrageurs that operate on the bilateral exchange rate market between countries j and k are owned by households. A position opened at $t-1$ earns at t the carry-trade return $\tilde{R}_t^{jk} = (1+i_{t-1}^j) - (1+i_{t-1}^k)\, XR_{t-1}^{kj}/XR_t^{kj}$, so the financial sector remits to the household in country j:

$$\Pi_{Ft}^j = \int_k s^{jk} \tilde{R}_t^{jk}\, \frac{N_{t-1}^{jk} + D_{t-1}^{jk}}{1+i_{t-1}^j}\,\mathrm{d}k = \int_k s^{jk} \left(1 - \frac{1+i_{t-1}^k}{1+i_{t-1}^j} \frac{XR_{t-1}^{kj}}{XR_t^{kj}}\right) \left(N_{t-1}^{jk} + D_{t-1}^{jk}\right)\,\mathrm{d}k,$$

where s^{jk} is the share of profits on the bilateral market between countries j and k that is remitted to country j ($s^{jk} + s^{kj} = 1$). Around a steady state with no gross position, those profits are second-order terms, so the sharing rule across countries is irrelevant.

The balance of payments of the country is given by:

$$\begin{aligned}\frac{B_t^j}{1+i_t^j} - B_{t-1}^j + \mathcal{E}_t^j\left(G_t^j - G_{t-1}^j\right) = \int_f P_t^{jj} D_t^{jj}(f)\,\mathrm{d}f + \int_k \int_f \frac{P_t^{kj}}{XR_t^{kj}} D_t^{kj}(f)\,\mathrm{d}k\,\mathrm{d}f \\ -P_t^j\left(C_t^j + X_t^j + V_t^j\right) + \Pi_{Ft}^j,\end{aligned}$$

where X_t^j is investment (inclusive of capital-adjustment costs) and V_t^j the intermediate input. The first two terms are the revenue from selling country j's varieties — for all uses — at home and abroad; the third is total domestic absorption; the last is the net income remitted by the financial intermediaries.

To a first order, this financial income drops out, and investment and intermediate goods enter only through the cross-border component of total demand. The balance of payments reads:

$$\beta b_t^j - b_{t-1}^j + \bar{g}\Delta g_t^j = \bar{\Gamma} \int_k \left(p_t^{kj} - xr_t^{kj} - p_t^{jk}\right)\,\mathrm{d}k + \bar{\Gamma} \int_k \left(\hat{d}_t^{kj} - \hat{d}_t^{jk}\right)\,\mathrm{d}k \tag{A.29}$$

$$b_t^j = \frac{B_t^j}{P_t^j Y_t^j} \qquad \bar{g} = \frac{\mathcal{E}_t^j G_t^j}{P_t^j Y_t^j} \text{ expressed in steady state.}$$

A.3.9 Model Summary

For each country, there are 26 variables: output (y), consumption (c), domestic demand (d), intermediate input (v), investment (x), capital (k), Tobin's q (q), rental rate (r^K), marginal cost (mc), wage (w), hours worked (n), price charged in country k (p^{jk}),[1] its inflation rate (π^{jk}) and frictionless target (Ψ^{jk}), import price index (IPI, p^{j*}), consumer price index (CPI, p^j), CPI inflation (π_c^j), wage inflation (π_w^j), marginal utility (μ^j), nominal interest rate (i^j), money supply (m^j), exchange rate (xr^j), nominal gold price (ϵ^j), noise-trader shock (ψ^j), bonds owned (b^j) and gold stock (g^j). Prices are sticky *à la* Calvo, as in the Price Rigidity section: each price p_t^{jk} adjusts gradually toward its frictionless target (A.16) through a New Keynesian Phillips curve, where c denotes the currency of invoicing (the producer's under PCP, $c = k$; the destination's under LCP, $c = j$; a dominant currency under DCP, $c = d$). The endogenous state variables are p_{t-1}^{jk} (which includes the domestic price p_{t-1}^{jj}), w_{t-1}^j, k_{t-1}^j, b_{t-1}^j and g_{t-1}^j. The exogenous state variables are the nominal gold price ϵ_t^j and the noise-trader shock ψ_t^j. Other variables are controls. The flexible-price benchmark of the baseline model — in which only wages are rigid — is nested with $\xi^p \to 0$: then $\kappa^p \to \infty$ forces each price onto its target, the price indices collapse onto marginal cost, and the market-clearing condition reverts to its marginal-cost form.

The markets for gold — the world stock is constant — and bonds must clear at the world level:

$$\int_k \hat{g}_t^k \, dk = 0 \tag{A.30}$$

$$\int_k b_t^k \, dk = 0. \tag{A.31}$$

The market clearing for bonds is redundant. Indeed, it can be deduced from summing over j in equation (A.29). The right-hand side drops out, so:

$$\beta \int_j b_t^j \, dj = \int_j b_{t-1}^j \, dj - \bar{g}\Delta \int_j g_t^j \, dj.$$

The last term is 0 for all t by equation (A.30). The initial condition guarantees: $\int_j b_{-1}^j \, dj = 0$, so that: $\int_j b_0^j \, dj = 0$. Iterating over t implies equation (A.31). This redundancy verifies Walras's law: if the markets for goods and gold clear, so does the market for bonds.

To make the model stationary, I subtract the local gold price from nominal quantities (p^{kj}, p^{j*}, p^j, w^j, mc^j), ϵ^j. The exchange rate can be substituted out. I denote those transformed

[1] To be precise, p^{jk} is not a single variable, but a continuum of variables as there is a continuum of countries k. The producer price index (PPI) is its domestic member, p^{jj} (the case $k = j$).

variables with tildes. The variables introduced by capital — the rental rate $r^{K,j}$, Tobin's q (q^j), capital k^j, investment x^j, the intermediate input v^j and demand d^j — are real, hence already stationary, and need no transformation. Random walk variables can be expressed in first difference: $\Delta\epsilon_t^j = \epsilon_t^j - \epsilon_{t-1}^j$.

$$\begin{aligned}
&\text{market clearing:}\quad \hat{y}_t^j = -\rho\left[(1-\bar{\Gamma})(\hat{\tilde{p}}_t^{jj} - \hat{\tilde{p}}_t^j) + \bar{\Gamma}\int_k (\hat{\tilde{p}}_t^{k*} - \hat{\tilde{p}}_t^k)\,\mathrm{d}k\right] \\
&\qquad\quad - \theta\bar{\Gamma}\int_k (\hat{\tilde{p}}_t^{kj} - \hat{\tilde{p}}_t^{k*})\,\mathrm{d}k + (1-\bar{\Gamma})\hat{d}_t^j + \bar{\Gamma}\int_k \hat{d}_t^k\,\mathrm{d}k \qquad \text{(A.32)}
\end{aligned}$$

$$\text{domestic demand:}\quad \hat{d}_t^j = \nu\hat{v}_t^j + (1-\nu)\bar{x}\,\hat{x}_t^j + (1-\nu)(1-\bar{x})\,\hat{c}_t^j \qquad \text{(A.33)}$$

$$\text{intermediate demand:}\quad \hat{v}_t^j = \hat{\tilde{mc}}_t^j - \hat{\tilde{p}}_t^j + \hat{y}_t^j \qquad \text{(A.34)}$$

$$\text{marginal cost:}\quad \hat{\tilde{mc}}_t^j = \alpha(1-\nu)\,\hat{r}_t^{K,j} + (1-\alpha)(1-\nu)\,\hat{\tilde{w}}_t^j + [\alpha(1-\nu)+\nu]\,\hat{\tilde{p}}_t^j \qquad \text{(A.35)}$$

$$\text{rental rate:}\quad \hat{r}_t^{K,j} = \hat{\tilde{mc}}_t^j - \hat{\tilde{p}}_t^j + \hat{y}_t^j - \hat{k}_t^j \qquad \text{(A.36)}$$

$$\text{labor demand:}\quad \hat{n}_t^j = \hat{\tilde{mc}}_t^j - \hat{\tilde{w}}_t^j + \hat{y}_t^j \qquad \text{(A.37)}$$

$$\text{capital Euler:}\quad \hat{i}_t^j - E_t\pi_{c,t+1}^j + \hat{q}_t^j = \beta E_t\hat{q}_{t+1}^j + [1-\beta(1-\delta)]\,E_t\hat{r}_{t+1}^{K,j} \qquad \text{(A.38)}$$

$$\text{Tobin's q:}\quad \hat{q}_t^j = \kappa^k\left(\hat{k}_{t+1}^j - \hat{k}_t^j\right) \qquad \text{(A.39)}$$

$$\text{capital accumulation:}\quad \hat{k}_{t+1}^j = (1-\delta)\hat{k}_t^j + \delta\hat{x}_t^j \qquad \text{(A.40)}$$

$$\text{CPI:}\quad \hat{\tilde{p}}_t^j = (1-\bar{\Gamma})\hat{\tilde{p}}_t^{jj} + \bar{\Gamma}\hat{\tilde{p}}_t^{j*} \qquad \text{(A.41)}$$

$$\text{CPI inflation:}\quad \pi_{ct}^j = \hat{\tilde{p}}_t^j - \hat{\tilde{p}}_{t-1}^j + \Delta\epsilon_t^j \qquad \text{(A.42)}$$

$$\text{wage inflation:}\quad \pi_{wt}^j = \hat{\tilde{w}}_t^j - \hat{\tilde{w}}_{t-1}^j + \Delta\epsilon_t^j \qquad \text{(A.43)}$$

$$\text{marginal utility:}\quad \hat{\mu}_t^j = \frac{\sigma}{(1-\iota)(1-\beta\iota)}\left(\beta\iota E_t\hat{c}_{t+1}^j - (1+\beta\iota^2)\hat{c}_t^j + \iota\hat{c}_{t-1}^j\right) \qquad \text{(A.44)}$$

$$\text{Euler equation:}\quad \hat{\mu}_t^j = E_t\hat{\mu}_{t+1}^j + \hat{i}_t^j - E_t\pi_{c,t+1}^j \qquad \text{(A.45)}$$

$$\text{money holdings:}\quad \hat{i}_t^j = \frac{1-\beta}{\beta^2}\left(-\chi(\hat{\tilde{m}}_t^j - \hat{\tilde{p}}_t^j) - \hat{\mu}_t^j\right) \qquad \text{(A.46)}$$

$$\text{Phillips curve:}\quad \pi_{wt}^j = \beta E_t\pi_{wt+1}^j + \kappa^w\phi\hat{n}_t^j - \kappa^w\hat{\mu}_t^j - \kappa^w(\hat{\tilde{w}}_t^j - \hat{\tilde{p}}_t^j) \qquad \text{(A.47)}$$

$$\text{money supply:}\quad \hat{\tilde{m}}_t^j = \hat{\tilde{g}}_t^j \qquad \text{(A.48)}$$

$$\text{gold price:}\quad E_t\Delta\epsilon_{t+1}^j = \rho^\epsilon\Delta\epsilon_t^j \qquad \text{(A.49)}$$

$$\text{UIP deviations:}\quad \hat{i}_t^j - \hat{i}_t^k - E_t\left(\Delta\epsilon_{t+1}^j - \Delta\epsilon_{t+1}^k\right) = \upsilon_1(\psi_t^k - \psi_t^j) - \upsilon_2(b_t^j - b_t^k) \qquad \text{(A.50)}$$

$$\text{frictionless target:}\quad \hat{\tilde{\Psi}}_t^{jk} = \begin{cases} (1-\zeta_1-\zeta_2)\hat{\tilde{mc}}_t^k + \zeta_1\hat{\tilde{p}}_t^{j*} + \zeta_2\hat{\tilde{p}}_t^j & \text{if } k \neq j \\ (1-\bar{\zeta})\hat{\tilde{mc}}_t^j + \bar{\zeta}\,\hat{\tilde{p}}_t^j & \text{if } k = j \end{cases} \qquad \text{(A.51)}$$

$$\text{NKPC-P:}\quad \pi_t^{jk} + \Delta\epsilon_t^c - \Delta\epsilon_t^j = \kappa^p\left(\hat{\tilde{\Psi}}_t^{jk} - \hat{\tilde{p}}_t^{jk}\right) + \beta E_t\left(\pi_{t+1}^{jk} + \Delta\epsilon_{t+1}^c - \Delta\epsilon_{t+1}^j\right) \qquad \text{(A.52)}$$

$$\text{price inflation:}\quad \pi_t^{jk} = \hat{\tilde{p}}_t^{jk} - \hat{\tilde{p}}_{t-1}^{jk} + \Delta\epsilon_t^j \qquad \text{(A.53)}$$

$$\text{IPI:} \quad \hat{\tilde{p}}_t^{j*} = \int_k \hat{\tilde{p}}_t^{jk}\, \mathrm{d}k \tag{A.54}$$

$$\text{bop:} \quad \beta b_t^j - b_{t-1}^j + \bar{g}\left(\Delta \hat{\tilde{g}}_t^j\right) = \bar{\Gamma} \int_k \left(\hat{\tilde{p}}_t^{kj} - \hat{\tilde{p}}_t^{jk}\right) \mathrm{d}k + \bar{\Gamma} \int_k \left(\hat{d}_t^{kj} - \hat{d}_t^{jk}\right) \mathrm{d}k. \tag{A.55}$$

In the special case $\xi^p = 0$, every price is reset each period: $\kappa^p \to \infty$, so the NKPC-P drops out, replaced by the static condition $p_t^{jk} = \Psi_t^{jk}$ (and the inflation variable π_t^{jk} becomes redundant). The system then collapses to the flexible-price baseline, in which only wages are rigid, and the market-clearing condition reverts to its marginal-cost form.

A.4 Model Estimation

To estimate the model, I minimize the weighted sum of the empirical moments in two steps:

1. I estimate parameters that can be tied to a single moment without having to solve the model: those are the exchange rate process (surprises or AR(1) coefficient) and the microeconomic trade elasticity, θ, which directly maps to the results of section 5 (proposition 1). When prices are flexible, I can also recover the markup elasticity, $\bar{m}$, by targeting the pass-through coefficient (proposition 2);

2. I minimize the weighted distance between the empirical impulse response functions and the model-implied ones: $(\hat{\mathcal{B}} - \bar{\mathcal{B}})' \times \hat{V}^{-1} \times (\hat{\mathcal{B}} - \bar{\mathcal{B}})$.

$\mathcal{B}$ is a vector that contains the IRFs:

$$\mathcal{B} = \begin{pmatrix} \mathcal{B}^{ip\prime} & \mathcal{B}^{imp\prime} & \mathcal{B}^{inv\prime} & \mathcal{B}^{cons\prime} & \mathcal{B}^{wpi\prime} & \mathcal{B}^{nw\prime} & \mathcal{B}^{ipi\prime} \end{pmatrix}'.$$

Each $\mathcal{B}^y$ is itself a vector that contains the IRF of y from 1931 to 1935 in the DD case or for the 3 years that follow the shock in the HFI case. A $\hat{.}$ denotes the empirical estimate, and a $\bar{.}$ the model equivalent. Since each IRF is made of several moments, I re-weight pass-through estimates by the number of moments per IRF when prices are not flexible, so that it receives the same weight as an IRF, for a given variance. $\hat{V}$ is the diagonal matrix that contains the estimated variance of each point of each IRF. Christiano et al. (2010) argue in favour of a diagonal weight matrix as a transparent way to ensure that the model-implied IRFs lie inside a "confidence tunnel about the point estimates." That procedure is also followed by Christiano et al. (2005) or Auclert et al. (2020). When prices are rigid and the pass-through coefficient cannot be independently estimated, I include it in $\mathcal{B}$ and use as inverse weight its variance divided by 5, so that it carries the same weight as one IRF (for identical variances).

The two-step procedure is not necessary, but it is transparent. In particular, since it fixes the path of the exchange rate before solving the model, it ensures that the estimation does not implicitly use the internal structure of the model to infer the path of the exchange rate.

I use different procedures in the DD and HFI cases to construct confidence intervals. In the DD case, I take the first 200 bootstrap draws of the estimation, reestimate the model for each draw, and produce confidence intervals. Importantly, this procedure fully preserves the correlation structure within and across IRFs. In the HFI case, for which I do not bootstrap the empirical standard errors, I draw from the parametric distribution of the empirical IRFs. Estimating all of the IRFs jointly is too challenging computationally, so I estimate each IRF separately and draw from a distribution with block diagonal variance. This procedure preserves correlation within, but not across, IRFs.

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