Golden Fetters and the Causal Effects of Countercyclical Monetary Policy

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Abstract

We estimate the causal impact of countercyclical monetary policy on macroeconomic outcomes for open economies subject to external demand shocks. To identify exogenous monetary-policy and external-demand shocks, we construct a new database of short-term interest rates, principal exports, and international commodity prices for 30 economies between 1870-1913, an era when capital flowed unencumbered and economies followed a nominal anchor but were subjected to the "commodity lottery." We use this quasi-natural experiment from history to identify causal, positive, effects of exogenous commodity-export prices on real GDP and on domestic prices (external-demand shocks); and causal negative effects from exogenous changes in short-term rates (monetary-policy shocks). We further show that countercyclical monetary policy stabilized output and domestic prices following external-demand shocks. Stabilization policy is more effective for prices than output, and stronger for output following positive external-demand shocks.

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Introduction

Credible monetary policy is particularly challenging for policy makers working in open economies as they are often faced with balancing conflicting objectives. On the one hand, policy makers may prioritize stabilizing real and nominal variables following domestic and external shocks. On the other, they may want to maintain currency values and domestic prices using fixed-exchange rate regimes. However, following external-demand shocks, these objectives are at times incompatible with each other. For example, after a positive shock to the international price of a country's exports, stabilization policy may prescribe monetary tightening, but this may be inconsistent with a pegged currency under capital mobility. These issues are particularly relevant for commodity exporters, which often peg their currencies and have experienced a recent increase in the volatility of commodity prices (Frankel, 2010).

Should monetary policy be countercyclical with respect to external shocks? To answer this question, it is crucial to quantify the economic gains from performing aggregate-demand stabilization following external shocks. Despite the large literature on optimal monetary policy for open economies, it is hard to make causal inferences with macroeconomic data as both demand shocks and policy responses are often endogenous to underlying economic conditions. Hence, research has largely focused on theoretical models and calibration exercises.[1]

We aim to fill this empirical lacuna by providing causal empirical estimates of the effects of countercyclical monetary policy. By employing data from a unique era in macroeconomic policymaking, 1870-1913 – a period when exogenous external-demand shocks as well as exogenous policies can be identified – we provide causal estimates that arise from a historical, quasi-natural experiment. We first construct a new database of short-term interest rates, principal exports, and international export prices between 1870 and 1913 for 30 economies. We use these data to identify external-demand shocks, defined as exogenous fluctuations in

[1] See Corsetti et. al. (2010) for a review of this approach.

countries' principal export prices, and monetary-policy shocks, which arise from fluctuations in interest rates in core or base-rate countries under currency pegs.[2]

We first estimate the causal impact of external demand shocks on output and domestic prices, taking monetary policy as given. We find that positive export-price shocks increase real GDP and inflation, Further, prices respond with lags relatively to real GDP. A one-standard-deviation increase in the price of a country's principal export causes real GDP to be 1.3 percent larger, and the price level 2 percent higher, after three years. These findings relate to the large literature estimating the impact of trade-related and commodity price shocks in open economies.

Theoretically, Mendoza (1995), Kose (2002) and Drechsel and Tenreyro (2017) show how commodity booms and busts can have large impacts on output, consumption, and investment. Empirically, Fernández et al (2017) show that fluctuations in commodity prices account for significant fluctuations in output, while Schmitt-Grohe and Uribe (2017) document smaller effects. Gelos and Ustyugova (2017) study inflation responses to commodity price shocks. Benguria et al (2018) show that higher commodity prices increase domestic demand through a wealth channel and induce wage increases.

Our results also speak to understanding short-run macroeconomic effects during the first global monetary system. Previous research for the classical gold standard period has focused on the long-run effects of the commodity lottery on GDP (Blattman et al, 2007), or the short-run effects of commodity-price shocks on currency risk (Mitchener and Pina, 2016). We show that during the classical gold standard era, principal export-price shocks, mostly commodities, were an important driver of output and prices.

[2] Several papers have employed similar strategies to extract exogenous monetary policy shocks. See, for example, di Giovanni and Shambaugh (2008), di Giovanni et al (2009), Jorda et al (2015) and Jorda et al (2017). Our approach is closest to Jorda et al (2017), who also use instrumental variables and local projection methods to study the impact of monetary policy shocks for a set of advanced economies by employing the policy trilemma. However, our historical laboratory permits us to identify two sources of exogenous variation, allowing us to focus on a different set of questions – policy evaluation of *countercyclical* monetary policy – and our data set allows us to consider these effects on *developing* and *advanced* economies. Specifically, we collect data on interest rates for a panel of 30 economies, a superset of the previous work including many emerging economies, but focus on a shorter period than their research, 1870-1913, so that we can analyze countercyclical monetary policy.

We then estimate the causal impact of interest rates on output and prices. That is, we assess the quantitative effects of monetary policy shocks, taking as given real export price shocks. Our results show large negative effects of monetary policy rate increases on output and prices (di Giovanni and Shambaugh 2008, di Giovanni et al 2009, and Jorda et al 2015, 2017). whereas monetary policy shocks reduce real GDP and domestic prices. As was the case with external demand shocks, domestic prices respond with lags relatively to real GDP. A one-standard-deviation increase in policy rates causes real GDP to be 7 percent lower, and the price level 4 percent lower, after three years.

We then investigate the economic effects of monetary policy that is countercyclical with respect to export-price shocks. Specifically, we provide estimates of the local average treatment effect from exogenous combinations of exogenous external demand shocks and monetary policy shocks. A major contribution of our paper is to provide policy evaluation of different monetary policies following external shocks, complementing existing structural work on monetary policy for open economies and commodity exporters (Gali and Monacelli 2005, Catão and Chang 2013, Catão and Chang 2015 and Vogel et al 2015).

During our sample period, these shocks are not perfectly correlated with each other, allowing us to estimate the causal impact of different combinations of shocks. Given that countercyclical monetary policy is of particular interest to policy makers, we analyze two scenarios for countercyclical interest rates: (1) how prices and output respond when interest rates and export prices both increase and (2) how prices and output react when interest rates and export prices both decline. Our results establish that countercyclical monetary policy can undo the effects of external-demand shocks on real GDP per capita and on domestic prices. The effect of principal-export prices on real GDP when interest rates are countercyclical is about half of the effect when interest rates are either procyclical or acyclical. This stabilization effect is even stronger for prices: domestic prices are virtually unchanged following an increase in export prices when interest rates increase. However, prices increase substantially when rates are either unchanged or decrease. We show also that these effects are asymmetric and driven

by the ability of policy to stabilize positive external-demand shocks, but not negative external-demand shocks.

Because we provide causal estimates of countercyclical monetary policy shocks in open economies under pegs that, we are able to evaluate proposals that have advocated pegging to product-oriented price indices (Frankel, 2017). We show that, between 1870-1913, pegging to the export-price would have stabilized output and prices in emerging economies, but only following positive export-price shocks.[3]

I. Data and Empirical Framework

To estimate causal average treatment effects of joint monetary policy and real shocks, it is necessary to identify both exogenous real shocks and exogenous monetary policy shocks. In this section, we introduce the data used in this paper and explain why our historical setting and data provide reasonable sources for exogenous variation. The sample period, 1870-1913, is crucial to our identification strategy as several features of the global economy and policy making during this earlier era provide a near perfect laboratory for identifying exogenous sources of variation that can then be used to evaluate the causal effects of monetary policy of commodity exporters. First, declining trade barriers in the middle of the 19th century and rapidly falling transportation costs throughout the century led to an explosion in global trade and a free flow of goods across borders (O'Rourke and Williamson 1994, 1999). This feature of the first era of globalization allows us to examine economies dependent on trade. Second, it was an era when countries pegged to metallic standards (primarily and increasingly fixing their currencies to gold), thus exposing them to monetary shocks emanating from "base" countries, like the United Kingdom (UK). And unlike the interwar period or the rest of the twentieth century capital flowed without restriction: economies maintained pegged exchange rates without the use of capital controls (Obstfeld and Taylor, 2001). According to the

[3] Our paper is also related to the literature studying the role of pegs and exchange-rate regimes on macroeconomic adjustment following terms of trade shocks. For example, Levy-Yeyati and Sturzenegger (2003) and Broda (2004) provide some empirical evidence that terms of trade shocks have a larger effect on economic performance in countries with more rigid exchange-rate regimes than in countries with a flexible exchange rate regime.

macroeconomic policy trilemma, a country cannot simultaneously achieve fixed exchange rates, capital mobility, and monetary policy independence. Given that countries in this period were pegging to gold and permitted the free movement of capital, interest-rate movements in the UK, the largest economy at the time, provide a source of exogenous variation in monetary policy, what some have termed the "trilemma instrument." (Obstfeld et al, 2005 and Jorda et al, 2017). Third, many countries were exposed to external demand shocks that were plausibly exogenous. Export prices were largely determined in global markets and given that goods markets were highly integrated in this period, countries are likely price-takers and we can therefore take the prices for these goods that are recorded in the United Kingdom (our source) to be exogenous to the country producing them (Williamson, 2013). Fourth, most economies produced goods that were "pre-determined" in the sense that they specialized in goods and commodities based on factor endowments (geography and climate) and were thus subjected to what economic historians refer to as the "commodity lottery" (Blattman et. al. (2007, Findlay, 2003; O'Rourke and Williamson, 1994). Because these products represented a large share of production and trade, shocks to their international prices significantly influenced the behavior of these economies.

A. Data

We construct a new data set spanning 1870-1913 to analyze the causal effects of external demand shocks and foreign interest-rate shocks on macroeconomic performance during the international monetary system known as the classical gold standard. To measure exogenous real shocks to economies, we collected data on economies' principal export prices. For most economies in our sample, the principal export is a commodity, so we are examining changes in commodity prices. That is, during our sample period, many economies, especially developing economies, specialized in exporting products based on pre-determined factor endowments, with prices of these products determined in world markets. Hence, fluctuations in commodity prices of an economy's principal exports provide a plausibly exogenous source of variation for measuring external demand shocks. We identify the principal exports for each

economy between 1870 and 1913 by constructing export weights from primary sources (*British Board of Trade*, various years) as well as secondary sources (Jacobson 1909, Mitchell 1982 2007a, b). Appendix 1 provides detailed information on the sources and the methods used to determine the principal export for each economy. We combine these data with prices of trade goods from Blattman et al (2007).

To measure interest-rate shocks, we employ data on short-term interest rates from Neal and Weidenmier (2003), Mitchener and Weidenmier (2015) and Accominotti et. al. (2011). These rates represent either the country's open market rate or discount rate, are denominated in domestic currency, are highly liquid, and are not subject to default risk. They are therefore a crucial determinant of credit conditions in domestic markets and a good proxy for the effects of monetary policy. For countries lacking interest rates from these sources, we use interest rates on government bonds from Jorda et. al. (2015) as well as country-specific sources described in Appendix 2. To measure economic performance, we utilize estimates of annual real per capita GDP from Barro and Ursua (2010) and inflation rates from Reinhart and Rogoff (2011). Additional data for our two macroeconomic outcomes comes from Maddison (2013) and Pisha et al. (2015).[4] We construct indices for domestic prices using the inflation rate data, and indices for real GDP per capita for countries for cases in which we only have data on real GDP per capita in percentage changes.

Our unbalanced panel of 1564 observations includes 30 economies, both developing and more developed, primarily Western European nations in the late 19th and early-20th centuries. Table 1 displays summary statistics of our main variables of interest; Appendix Table 4 provides information on data availability for different economies and variables including the principal export for each economy.

[4] We use per capita nominal GDP for Romania due to data limitations; however, the results shown later in the paper are robust to excluding Romania. We also drop Greece and Bulgaria from the sample in 1913 to correct for the large increase in population following the annexation of territories as part of the First Balkan War.

TABLE 1: SUMMARY STATISTICS, 1870-1913

	Observations	Mean	Std. Dev.	Min	Max
Percentage change in real GDP per capita	1,513	1.44	5.86	-29.1	44.9
Annual inflation rate	1,376	1.23	8.71	-51.1	114
Percentage change in principal-export prices	1,425	0.62	15.2	-32	74
Annual interest rate (in basis points)	1,148	520	3.42	106	581

B. Identifying Real and Monetary Shocks

Our analysis relies on identifying plausibly exogenous sources of variation in external demand shocks and monetary policy. As explained in the previous section, most economies during our sample period were subjected to the "commodity lottery" and exported goods whose prices were determined in global markets. Appendix Table 4 illustrates the wide variation in types of commodities exported. Since a few economies were known to be (near) monopoly producers of particular commodities, we consider these exceptions to our "price-taker" assumption in robustness checks. considered later in the paper. We use variation in global commodity prices to extract country-specific, external, demand-shocks based on each country's principal export(s). We define the external shock as the annual percentage change in real principal-export price. To identify meaningful external shocks that are country-specific, the price data need to exhibit cross-sectional variation. Figure 1 displays kernel density functions of the annual percentage change in commodity prices for five years in our sample period: 1870, 1880, 1890, 1900 and 1910. The yearly plots show substantial cross-sectional and time-series variation in real export prices. For example, in 1890, as represented by the dotted line, real export-price shocks range from -20% and 10%, with higher densities around 0%.

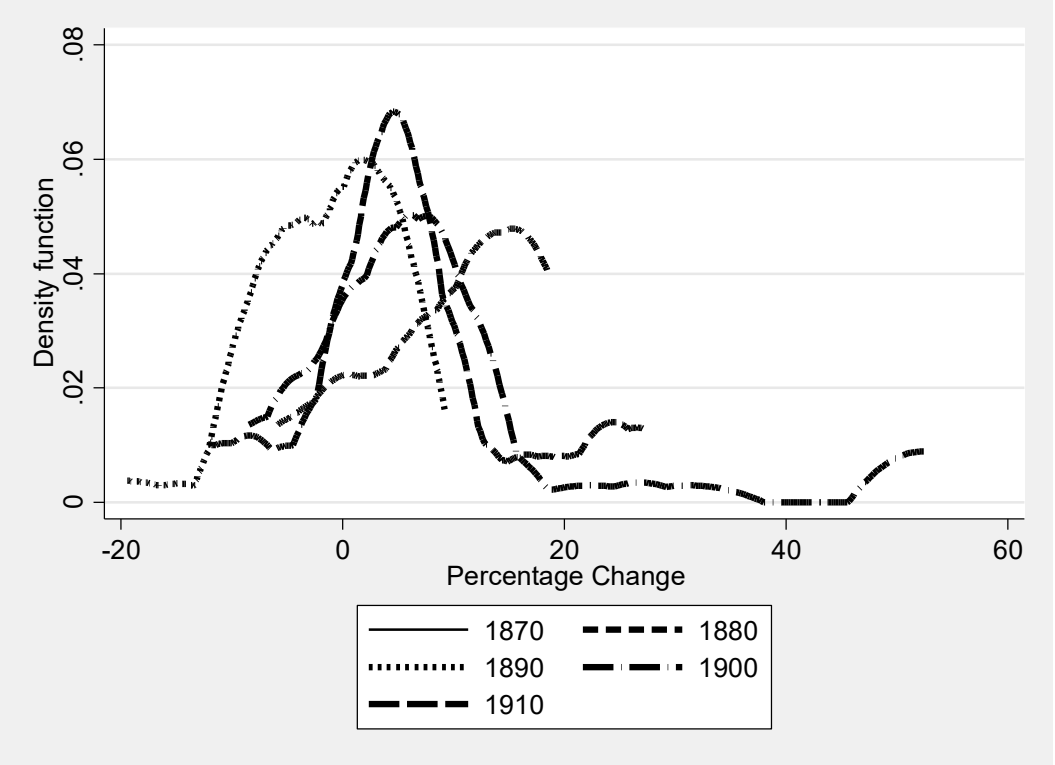


FIGURE 1: KERNEL DENSITY OF EXPORT PRICE SHOCKS, DEFINED AS PERCENTAGE CHANGE IN REAL EXPORT PRICE

We turn now to identifying an exogenous source of variation for monetary policy shocks. Given no restrictions on the movement of capital (i.e. no capital controls) and the existence of fixed exchange rates during the classical gold standard era, the international policy trilemma implies that when a base country's interest rate changes, to maintain their pegs, other countries must respond by altering their interest rates, either formally through a policy rate controlled by a central bank (in countries where they existed), or in their absence, through a no-arbitrage condition in financial markets. We use this insight to formulate a second identifying assumption – that from 1870-1913, interest rates in in the UK influenced interest rates in economies formally on the gold standard, and potentially those also using other types

of fixed exchange-rate arrangements, such as countries on silver, bimetallism, or "shadowing" the gold standard.[5]

We define an interst rate shock as:

(1) $$Z_{i,t} = \left(\Delta i_{UK,t} - \Delta i^{*}_{UK,t}\right) \times Peg_{i,t-1} \times Peg_{i,t}$$

where $\Delta i_{UK,t}$ is the change in the interest rate in the UK and $\Delta i^{*}_{UK,t}$ is the change in the interest rate in the UK predicted by observable domestic variables. Peg takes on a value of 1 if a country formally adheres to the gold standard and zero otherwise. We interact $Peg_{i,t-1}$ with $Peg_{i,t}$ in order to include only countries that adhered to the gold standard at least for one year, i.e. to eliminate bias coming from new adopters of gold. Intuitively, the instrument captures changes in the interest rate of the base country, the United Kingdom, which are not explained by that country's observable economic conditions (UK control variables).[6]

It is worth pointing out several key differences in our samples, central questions, and identifying assumptions relative to Jorda et al (2017), which employ a several approach for identifying monetary policy shocks. First, our primary objective is to provide credible estimates of *countercyclical* monetary policy, a question not addressed in their research and that may be especially important for emerging market economies who are often quite reliant on exports for growth (Mendoza, 1997 and Blattman et al, 2007). Because we collect data and estimate external-demand shocks, we can estimate countercyclical monetary policy. Second, we collected data on interest rates for a panel of 30 economies; this is a superset of their analysis for 17 developed countries. Our sample includes many more emerging-market economies, permitting us to test hypotheses that may be of particular importance to developing

[5] A classic reference is Bloomfield (1959). For more recent treatments, see also Obstfeld, Shambaugh, Taylor (2005) and references therein.

[6] We follow Jorda et al (2017) and include two lags of the first difference in log real GDP, log real consumption, investment to GDP ratio, short and long-term government rates, log real house prices, log real stock prices, and CPI inflation. We do not include credit to GDP ratios due to missing data in the 1870s. Given the absence of capital controls in the classical gold standard period (Bordo 1997, Obstfeld, Shambaugh, Taylor 2005), we do not interact this instrument with capital controls as Jorda et al (2017).

economies.[7] Third, we primarily use discount rates (the policy rate used by gold standard economies in the classical gold standard era) and market short-term interest rates to measure monetary policy instead of rates obtained from short-term government bonds. Finally, we focus exclusively on the classical gold standard era, a period that provides clean identification.

In principle, it would be possible to use our identification strategy to examine other historical eras or more recent periods; however, there are limitations to examining more recent periods – at least if the researcher's goal is to generate causal estimates of countercyclical monetary policy. First, it is worth emphasizing a point we made earlier: the first era of globalization is particularly well suited to the identification of exogenous demand shocks. Second, including the interwar period, the Bretton Woods era, or the period beginning in the early 1970s would require that we incorporate capital controls into the analysis, given their widespread usage in these eras. Because we are interested in explaining short-term macroeconomic responses, doing so would require careful measurement of annual changes in capital controls such that the researcher could discern when barriers on the flow of the capital were being used to offset or counteract interest-rate changes in a base country's rate. It is far easier (and hence more common in the literature) to define capital controls in terms of "regimes," using indicator variables that indicate de jure or de facto existence of then, then to measure precisely *changes* in them once they exist, making the IV approach used here quite challenging. Second, because policy makers in the late 19th and early-20th centuries were strongly committed to maintaining the gold standard and external balance (Bordo and Kydland, 1995), we can focus on measuring the effects of countercyclical monetary policy without being concerned about the simultaneous use of fiscal policy. In a simple Mundell-Flemming model, fiscal policy can be quite effective for a small, open economy with a fixed exchange rate and no capital controls. After World War I, policymakers became more responsive to internal balance domestic political considerations and when fiscal policy became a more widespread tool for demand management after World War I (Eichengreen, 1998); hence, any empirical estimation

[7] There is a tradeoff, however, to including emerging market economies: we lack some of the domestic control variables used in Jorda et al (2017). That said, we include a variety of country-specific controls (including institutional variables) that are not included in Jorda et. al., and that may be more important for estimating the effects in developing countries.

in later eras would need a strategy to account for their use of these and a way to identify fiscal policy.

Table 2 displays relationship between the instrumental variable and the 30 economies for which we have data on short-term interest rates. The coefficient of the relationship on the base rate is positive and highly significant: a one-percentage-point increase in the UK interest rate translates to a contemporaneous increase in domestic rates of about 0.3 percentage points.

TABLE 2 THE RELATIONSHIP BETWEEN THE INSTRUMENTAL VARIABLE AND DOMESTIC INTEREST RATES

	(1)	(2)	(3)
	No controls	Country FE	Country FE + controls
Constant	-0.009	-0.009***	1.436***
	(0.011)	(0.000)	(0.173)
Base Rate	0.315***	0.318***	0.228***
	(0.089)	(0.089)	(0.067)
Observations	1,055	1,055	1,019
Adjusted R-squared	0.006	0.006	0.220
Number of countries		30	30

Notes: The dependent variable is the nominal interest rate for country i, at time t. Trilemma instrument defined in equation (1). Controls: country specific time-trends and two lags for international financial crisis dummy, domestic financial crisis dummy, international war, intra-national war, central bank dummy, stock market dummy. Robust standard errors, clustered at the country level, are in parentheses: *** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level.

Because we have two sources for exogenous shocks, we can combine them to explore different combinations of real and policy shocks. In other words, we obtain a 2x2 matrix of different combinations for the direction of real shocks and policy shocks. In our baseline

specifications we distinguish events between positive (+) and negative (-) commodity-price shocks together with similar categorizations for interest-rate shocks. Moving from the direction of shocks and turning to their values, if real and policy shocks are exogenous, then the joint distribution of shocks is determined by a process that resembles random assignment, and hence our empirical design is one of a quasi-natural experiment. Because we are interested in identifying the independent influence of interest-rate and real shocks, for a given country, the two types of shocks should not be highly correlated. In other words, we need substantial exogenous variation in the joint distribution of real and interest rate shocks to identify their independent effects. Figure 2 shows that the correlation between commodity price shocks and changes in UK interest rates when countries formally adhere to the gold standard is relatively low. The unconditional correlation coefficient between the instrument $Z_{i,t}$ and the percentage change in the principal export prices is 0.2. More importantly, there is substantial variation in the joint distribution of shocks. Note that the instrument, the base rate change conditional on UK domestic factors, is a common shock. Take for example the largest estimate for the $Z_{i,t}$, which is close to 1. This represents a monetary policy tightening, which according to our results from Table 1, would translate to an average rate increase of about 30 basis points. The values for the real shock are between -25% and 25%. Therefore, we can see that there is substantial variation in the percentage change in real principal export prices, including some countries with positive real shocks and negative real shocks.

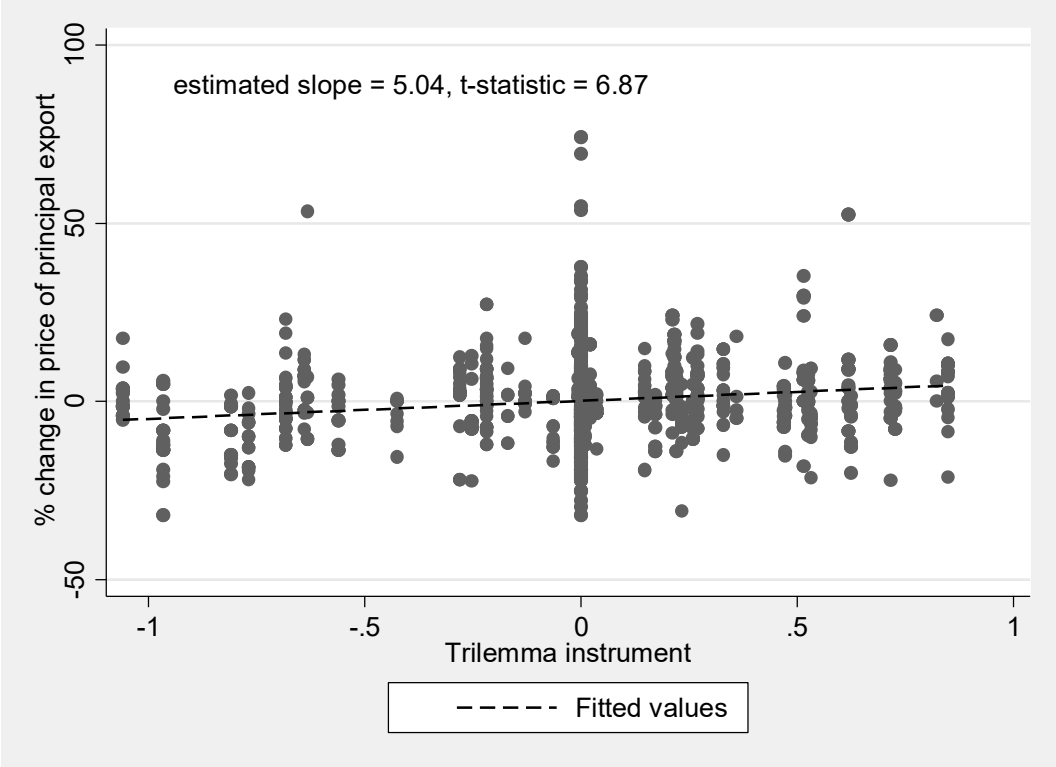


FIGURE 2: CORRELATION BETWEEN REAL AND POLICY SHOCKS.

C. Estimation

We first examine the effects of real export price and monetary policy shocks on real GDP and domestic prices using Jordà's (2005) local projections method, allowing for continuous instruments as in Jordà et al (2017). We estimate the following equations:

(2) $$\delta_{i,t} = \alpha_i + x_{i,t} g_h + \mu_{i,t} b + \varepsilon_{i,t},$$

where $\delta_{i,t}$ is the domestic change in the interest rate in country i at time t, α_i is the country-fixed effect, $x_{i,t}$ captures time-varying, country controls, including the external demand shock and $\mu_{i,t}$ is the trilemma instrument. From equation (2), we obtain our policy shock, $\delta_{i,t}^{*}$, the predicted value of the domestic change in the interest rate, which we then use to estimate the causal impact of real and policy shocks on real GDP or CPI prices at different horizons ($y_{i,t+h}$):

(3) $$y_{i,t+h} = \alpha_{i,h} + x_{i,t}\gamma_h + \delta_{i,t}^{*}\beta_h + y_{UK,t}\omega + \vartheta_{i,t+h}.$$

$y_{UK,t}$ represents either real GDP growth or CPI inflation rate for the UK.

II. Estimating the Independent Effects of Real and Monetary Shocks

We begin by estimating equation (3), the effect of external demand shocks and monetary policy shocks on output and prices. In the baseline, we include country-fixed effects and the corresponding UK variable as a control for world economic conditions. Because we are estimating both shocks jointly, our sample is restricted for the economy-year pairs for which we have data on the domestic, short-term interest rates.[9] We show results for all economies for which data exist, including some that are non-commodity exporters. Although the exogeneity of real shocks is more likely to hold for commodity exporters that are price takers in global markets, shocks to the price of manufactures can still be exogenous at the yearly frequency or when they are driven by world demand conditions. That said, our results also hold just for the sub-sample of commodity exporters.

Table 2 displays the results for two sets of regressions, one for real GDP per capita and one for prices. Domestic interest rates are instrumented using the monetary policy shock described above, while real principal-export prices enter directly into the estimation. The first two columns display show that output and prices respond positively to external demand shocks as measured by changes in principal-export prices. Output responds immediately, while the response of prices is delayed. Columns (3) and (4) show that the response to the interest-rate shock is negative: higher (exogenous) domestic interest rates lead to a reduction in output after one year, and to a reduction in prices after three years.

To illustrate the short-run response of the macroeconomy to shocks, Figures 4 and 5 display one-standard-deviation changes to export prices and short-term interest rates, respectively, with confidence intervals. Panel A of figure 4 shows that a one-standard-deviation increase in the real principal export prices (or 11%) causes real GDP per capita to increase by about 1 percent after 3 years, before reverting. Panel B of figure 4 shows that a one-standard-

[9] We further restrict the sample to observations for which countries are on gold. This is done to be consistent with the main results for countercyclical monetary policy presented later in the paper, where the identification of policy shocks relies on adherence to gold.

deviation increase in the short-term interest rate (approximately 150 basis points) causes real GDP per capita to decrease by a little more than 5 percent over 4 years.

Figure 5 displays the response of prices to these same two types of shocks. Panel A of figure 5 shows that a one-standard-deviation increase in the economy's principal export price causes the domestic price level to increase by 2 percent over 4 years. On the other hand, domestic prices are less responsive immediately after the monetary policy shock. Panel B of Figure 5 shows that it takes until the third year after the exogenous increase in interest rates for prices to decline. In all four cases, the effects appear statistically significantly different from zero at traditional significance levels.

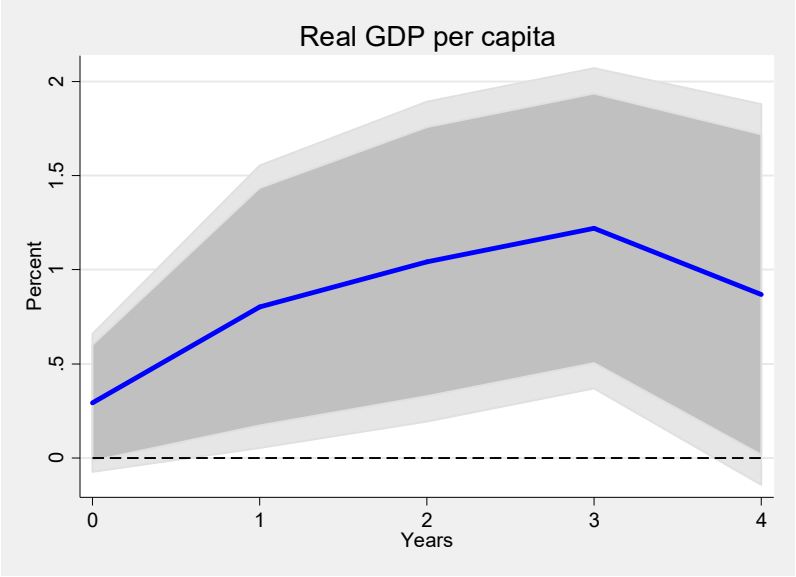


FIGURE 4, PANEL A: REAL GDP PER CAPITA RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN REAL PRINCIPAL-EXPORT PRICE. NOTES: LP-IV ESTIMATES DISPLAYED WITH A SOLID BLUE LINE AND 95% AND 90% CONFIDENCE BANDS IN GRAY.

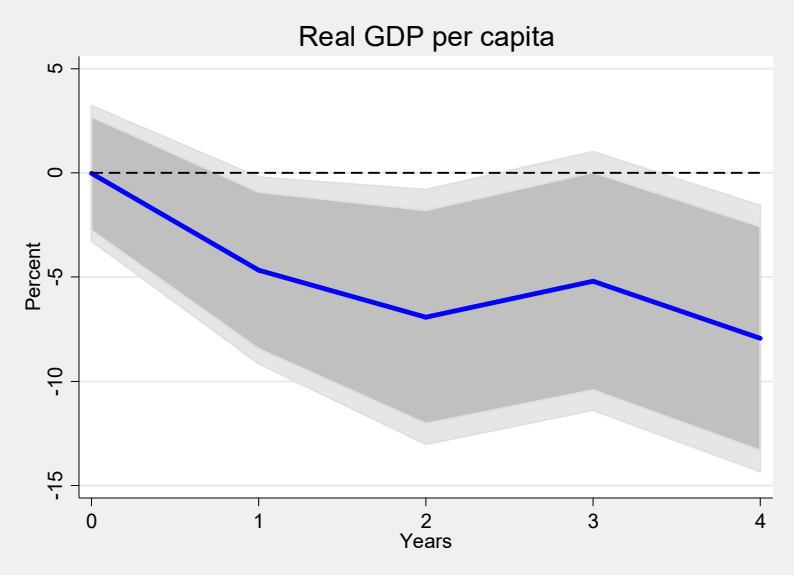


FIGURE 4, PANEL B: REAL GDP PER CAPITA RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN DOMESTIC SHORT-TERM INTEREST RATE. NOTES: LP-IV ESTIMATES DISPLAYED WITH A SOLID BLUE LINE AND 95% AND 90% CONFIDENCE BANDS IN GRAY.

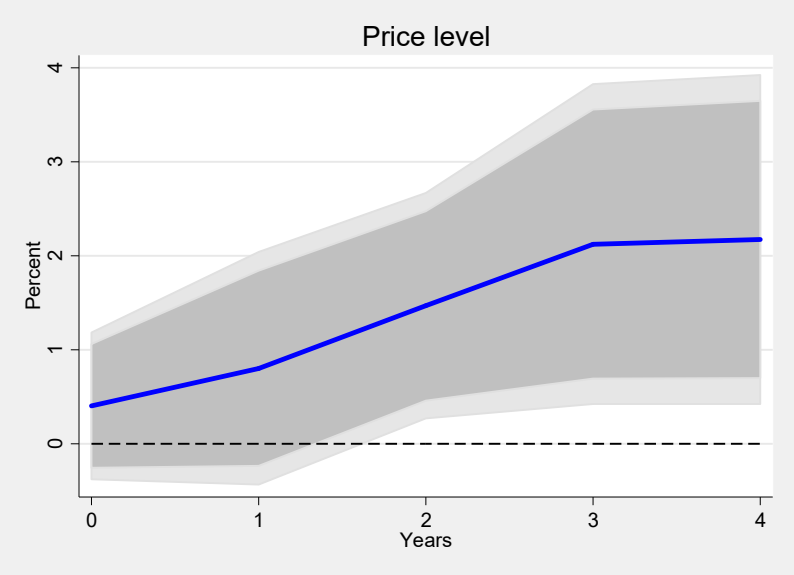


FIGURE 5, PANEL A: PRICE LEVEL RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN REAL PRINCIPAL-EXPORT PRICE. NOTES: LP-IV ESTIMATES DISPLAYED WITH A SOLID BLUE LINE AND 95% AND 90% CONFIDENCE BANDS IN GRAY.

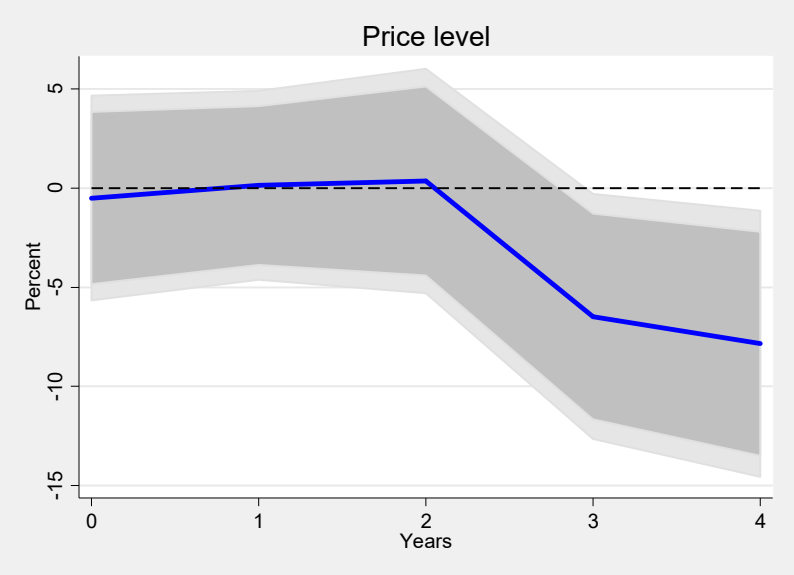


FIGURE 5, PANEL B: PRICE LEVEL RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN DOMESTIC SHORT-TERM INTEREST RATE. NOTES: LP-IV ESTIMATES DISPLAYED WITH A SOLID BLUE LINE AND 95% AND 90% CONFIDENCE BANDS IN GRAY.

TABLE 2: LP-IV ESTIMATES FOR REAL GDP PER CAPITA AND CPI PRICE RESPONSES TO CHANGES IN REAL PRINCIPAL-EXPORT PRICES AND INTEREST RATES

Responses at years 0 to 4 (100 x log change from year 0 baseline)

	Export-price shock		Interest-rate shock	
Year	Real GDP	Price Level	Real GDP	Price Level
h=0	0.034**	0.033	-0.270	-0.234
	(0.017)	(0.036)	(1.105)	(1.678)
h=1	0.081**	0.071	-3.420**	-0.046
	(0.035)	(0.056)	(1.642)	(1.561)
h=2	0.099**	0.124**	-4.799**	0.218
	(0.042)	(.0540)	(2.145)	(1.939)
h=3	0.109**	0.192**	-3.333	-4.438**
	(0.041)	(0.078)	(2.190)	(2.076)
h=4	0.072	0.198**	-4.798**	-5.418**
	(0.046)	0.079	(2.157)	(2.341)
First-stage F, h=0	n/a	n/a	9.07	7.58
Observations, h=0	678	650	678	650

Notes: The dependent variables is defined as either real GDP per capita or the price Level (100 x log change from year 0 baseline). LP-IV estimates obtained using equation (3). All regressions include country fixed-effects and UK control for the corresponding dependent variable. *** p<0.01, ** p<0.05, * p<0.1. Robust, clustered standard errors are shown in parentheses.

IV. Estimating the Effects of Countercylical Monetary Policy

We now turn to analyzing the macroeconomic effects of countercyclical monetary policy. We do so by estimating the following equation:

(4)

$$\mathbf{y}_{i,t+h} = \alpha_{i,h} + I(Countercyc_{i,t})\mathbf{x}_{i,t}\gamma_h^c + \left(1 - I(Countercyc_{i,t})\right)\mathbf{x}_{i,t}\gamma_h^p + \mathbf{y}_{UK,t}\omega + \boldsymbol{\delta}_{i,t}^{*}\beta_h + \vartheta_{i,t+h}$$

,

where $I(Countercyc)$ takes on the value of one when the percentage change in the real export price is positive (negative), and the instrumental variable takes on a positive value (negative), and 0 when the percentage change in the real export price is positive or zero (negative or zero), and the instrumental variable takes on a negative or zero value (positive or zero). The coefficient γ_h^c captures the effect of external demand shocks when policy is countercyclical, while γ_h^p captures the effect of external demand shocks when policy is procyclical or acyclical.

We turn now to estimating the causal impact of countercyclical monetary policy over a four-year horizon, defined as when: (1) the external demand shock and monetary policy shocks are both negative or (2) the external demand shock monetary policy shock are both positive. We compare these episodes to all others, including procyclical and acyclical policy periods. The first two columns of table 3 display the results related to countercyclical interest rates. As the estimated coefficients show, following a principal-export price shock, changes in output and prices are dampened when UK interest rates are countercyclical. By contrast, changes in output and prices are large for the procyclical or acyclical cases. For example, when interest rates are countercyclical, the impact on output is about half of the estimated effect in comparison to procyclical and acyclical periods. When interest rates in countercyclical periods are compared to other periods, the differences are even larger for prices.

To better illustrate these results, figure 6 plots the responsiveness of output and prices to interest rates in countercyclical and other periods. The solid black line indicates the path of the outcome variable in countercyclical episodes whereas the red, dashed line indicates all

other cases. Panel A displays the results for real GDP, while Panel B shows the results for prices. Panel A shows that the point estimates of real GDP per capita are much larger when policy is procyclical or acyclical, relative to counterclycical policy, for up to two years, after which they are virtually indistinguishable. Panel B shows that countercyclical policy is successful in keeping domestic prices under control. Domestic price levels are virtually unchanged following an external demand shock, whereas in procyclical and acyclical periods, there are large increases in domestic prices. The effects remain statistically significantly different from each other at the 10% level after three years.

TABLE 3: LP-IV ESTIMATES FOR REAL GDP PER CAPITA AND CPI PRICE RESPONSES TO REAL PRINCIPAL-EXPORT PRICES FOR COUNTERCYCLICAL INTEREST RATES OR FOR PROCYCLICA/ACYCLICAL INTEREST RATES

Responses at years 0 to 4 (100 x log change from year 0 baseline)

	Export-price shock			
	Countercyclical		Procyclical/Acyclical	
Year	Real GDP	Price Level	Real GDP	Price Level
h=0	0.027	0.024	0.041	0.044
	(0.021)	(0.033)	(0.036)	(0.057)
h=1	0.059	-0.001	0.105**	0.164*
	(0.040)	(0.067)	(0.050)	(0.090)
h=2	0.063	0.029	0.134**	0.238**
	(0.048)	(0.067)	(0.058)	(0 .104)
h=3	0.125**	0.002	0.092	0.415***
	(0.059)	(0.073)	(0.080)	(0.130)
h=4	0.081	-0.009	0.061	0.490***
	(0.059)	(0.087)	(0.092)	(0.138)
First-stage F, h=0	34.9	36.9	34.9	36.9
Observations h=0	678	650	678	650

Notes: Dependent variables either Real GDP per capita or Price Level (100 x log change from year 0 baseline). LP-IV estimates obtained using equation (4). All regressions include country fixed-effects and UK control for the corresponding dependent variable. Effect following interest-rate shock estimated but not reported in the table. *** p<0.01, ** p<0.05, * p<0.1. Robust, clustered standard errors in parentheses.

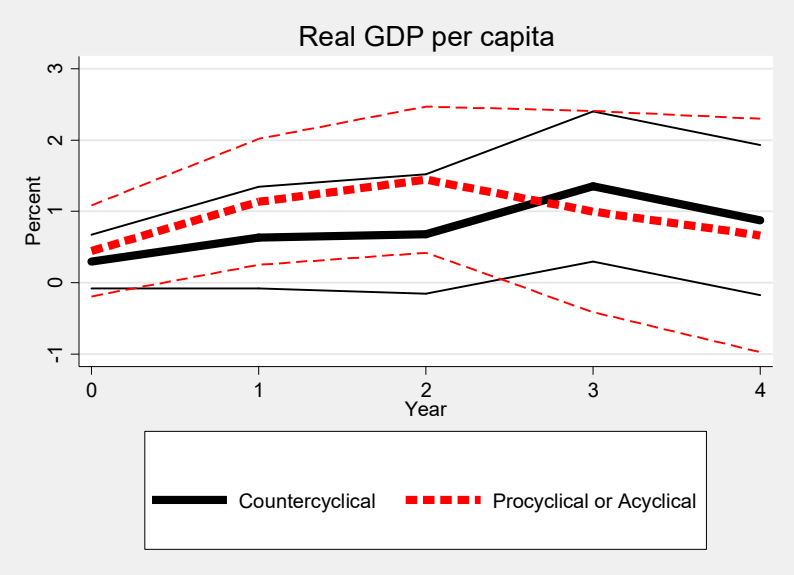


FIGURE 6, PANEL A: REAL GDP PER CAPITA RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN PRINCIPAL EXPORT PRICE, CONDITIONAL ON COUNTERCYCLICAL OR PROCYCLICAL/ACYCLICAL INTEREST RATE SHOCK. LP-IV ESTIMATES FOR COUNTERCYCLICAL EXPERIMENT DISPLAYED WITH A THICK SOLID BLACK LINE, AND 90% CONFIDENCE BANDS IN SOLID BLACK LINES. LP-IV ESTIMATES FOR PROCYCLICAL/ACYCLICAL EXPERIMENT DISPLAYED WITH THICK DASHED RED LINE, AND 90% CONFIDENCE BANDS IN DASHED RED LINES.

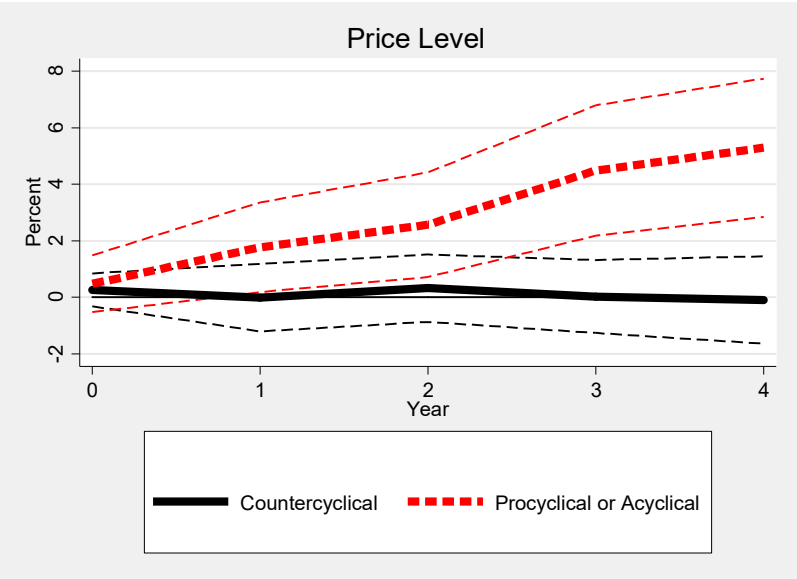


FIGURE 6, PANEL B: PRICE LEVEL RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN PRINCIPAL EXPORT PRICE CONDITIONAL ON COUNTERCYCLICAL INTEREST RATE SHOCK. NOTES: LP-IV ESTIMATES FOR COUNTERCYCLICAL EXPERIMENT DISPLAYED WITH A THICK SOLID BLACK LINE, AND 90% CONFIDENCE BANDS IN SOLID BLACK LINES. LP-IV ESTIMATES FOR PROCYCLICAL/ACYCLICAL EXPERIMENT DISPLAYED WITH THICK DASHED RED LINE, AND 90% CONFIDENCE BANDS IN DASHED RED LINES.

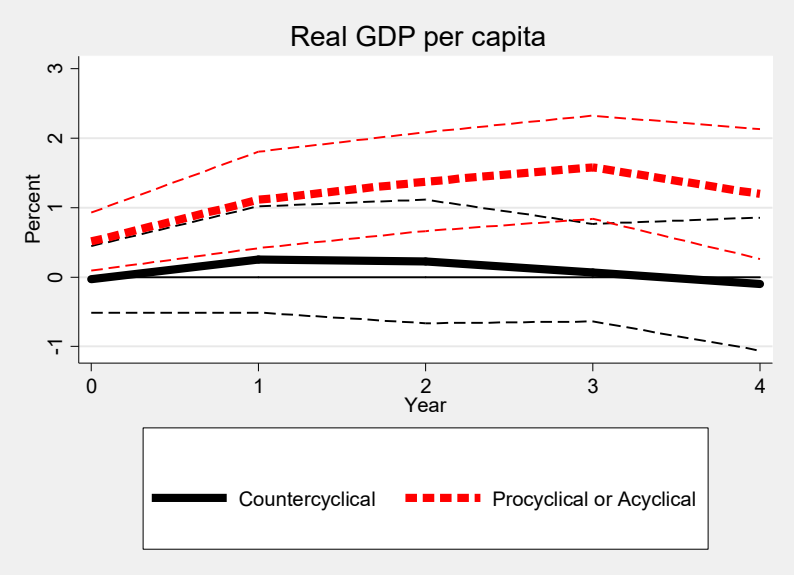
In the baseline specification, we considered all changes in the value of the trilemma instrument when constructing our countercyclical policy experiments. However, this may include small changes in interest rates that are insufficient in size to stabilize the economy following a one-standard-deviation increase in the price of a principal export. Therefore, we now limit our analysis to cases for which the change in the trilemma instrument is equal or above a one standard deviation, either positive or negative. That is, instead of constructing $I(Countercyc)$ as taking the value of 1 when the percentage change in the real export price is positive (negative), and the instrumental variable takes on a positive value (negative), we focus on values of the instrumental variable that are larger than one standard deviation, 0.4, (or less than -0.4 for the negative case). We classify all other cases, including changes in the value of the instrument within the -0.4 and 0.4 ranges, as procyclical/acyclical. Note that the contemporaneous pass-through to domestic rates estimated in Table 2 is about 0.3, such that we are imposing a band of 0.12 around zero for a domestic interest-rate shock to be potentially classified as countercyclical.

Panel A of Figure 7 shows that, for the countercyclical case, real GDP per capita does not respond to a large increase in the principal export price. However, when monetary policy is procyclical or acyclical, real GDP per capita experiences a large increase, up to 3 percent after four years. Although the 90% confidence bands overlap for the first three years, we can see that by year four, the differences in the response of output are statistically significant. These results suggest that countercyclical monetary policy with respect to external shocks can stabilize output. Panel B shows the effects on the price level. Again, when countercyclical policy is in place, domestic prices do not respond. However, they respond when monetary policy is procyclical or acyclical. These differences are statistically significant after four years.

We also considered asymmetric effects with respect to external demand shocks. Specifically, we analyzed whether countercyclical policy has the same effect under positive or negative demand shocks. To do so, we constructed two new dummy variables. The first, called "positive," takes on the value of 1 if real export-prices increase and the instrumental variable is

positive at time t and zero otherwise. The second, “negative,” takes on the value of 1 if real export-prices decrease and the instrumental variable is negative at time t and zero otherwise. Again, we employ the bands around zero given by the standard deviation of the trilemma instrument to avoid considering very small interest rate changes as part of the countercyclical experiments.

The solid black line in Panel A of Figure 8 shows that countercyclical policy is effective following a positive principal-export price shock. The estimated response of real GDP per capita is close to zero. However, the red dashed line shows that a negative principal-export price shock is not compensated by countercyclical policy. The estimated effect of real GDP per capita is negative and significantly different from zero at the 10% significance level. Panel B shows that countercyclical policy can stabilize prices in the short-run in response to either negative or positive export-price shocks. However, after 3 and 4 years, there is some evidence that, with countercyclical policy, positive export-price shocks increase domestic prices.



o.

FIGURE 7, PANEL A: REAL GDP PER CAPITA RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN PRINCIPAL EXPORT PRICE CONDITIONAL ON (LARGER) COUNTERCYCLICAL OR PROCYCLICAL/ACYCLICAL INTEREST RATE SHOCK. COUNTERCYCLICAL EXPERIMENT CONSIDERS ONLY VALUES OF THE TRILEMMA INSTRUMENT LARGER THAN ONE-STANDARD DEVIATIONS. NOTES: LP-IV ESTIMATES FOR COUNTERCYCLICAL EXPERIMENT DISPLAYED WITH A THICK SOLID BLACK LINE, AND 90% CONFIDENCE BANDS IN SOLID BLACK LINES. LP-IV ESTIMATES FOR PROCYCLICAL/ACYCLICAL EXPERIMENT DISPLAYED WITH THICK DASHED RED LINE, AND 90% CONFIDENCE BANDS IN DASHED RED LINES.

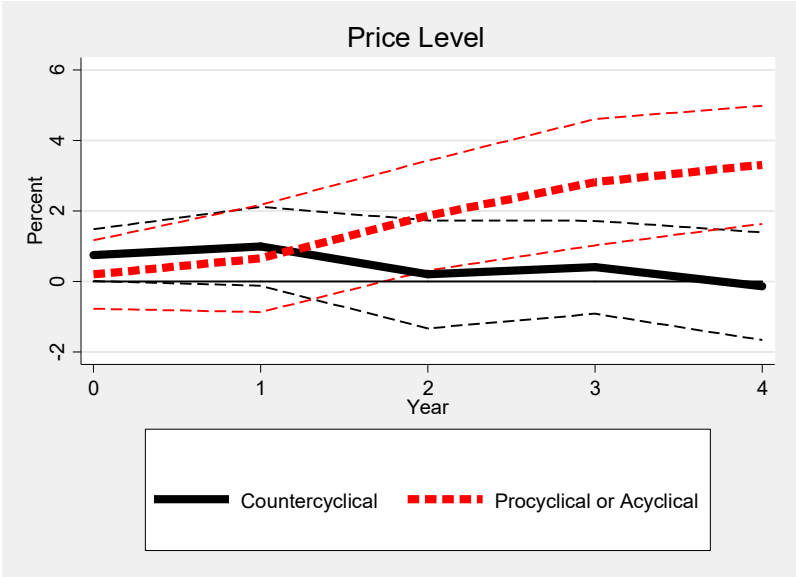


FIGURE 7, PANEL B: PRICE LEVEL RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN PRINCIPAL EXPORT PRICE CONDITIONAL ON (LARGER) COUNTERCYCLICAL OR PROCYCLICAL/ACYCLICAL INTEREST RATE SHOCK. COUNTERCYCLICAL EXPERIMENT CONSIDERS ONLY VALUES OF THE TRILEMMA INSTRUMENT LARGER THAN ONE-STANDARD DEVIATIONS. NOTES: LP-IV ESTIMATES FOR COUNTERCYCLICAL EXPERIMENT DISPLAYED WITH A THICK SOLID BLACK LINE, AND 90% CONFIDENCE BANDS IN SOLID BLACK LINES. LP-IV ESTIMATES FOR PROCYCLICAL/ACYCLICAL EXPERIMENT DISPLAYED WITH THICK DASHED RED LINE, AND 90% CONFIDENCE BANDS IN DASHED RED LINES.

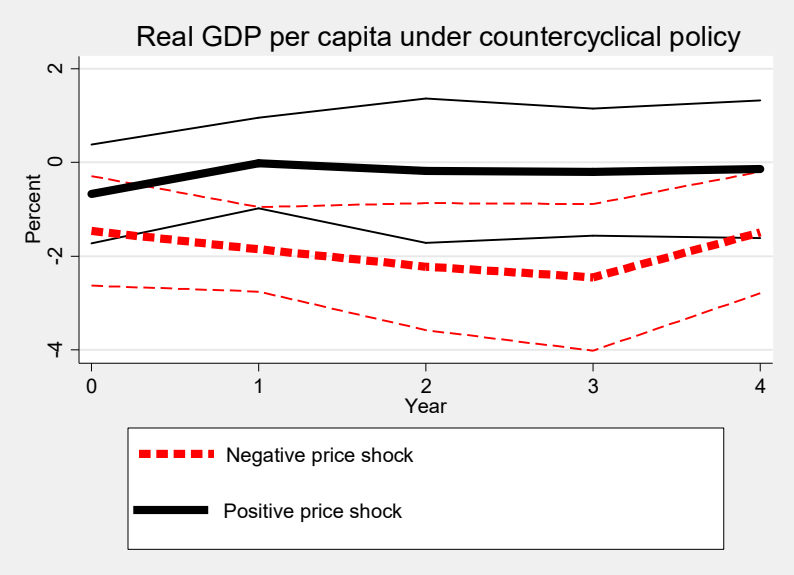


FIGURE 8, PANEL A: REAL GDP PER CAPITA RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN PRINCIPAL EXPORT PRICE CONDITIONAL ON COUNTERCYCLICAL INTEREST RATE SHOCK. NOTES: LP-IV ESTIMATES DISPLAYED WITH A THICK SOLID BLACK LINE AND 90% CONFIDENCE BANDS IN SOLID BLACK LINES. THICK DASHED RED LINE PLOTS RESPONSE FROM PROCYCLICAL OR ACYCLICAL INTEREST RATE POLICY, 90% CONFIDENCE BANDS IN DASHED RED LINES.

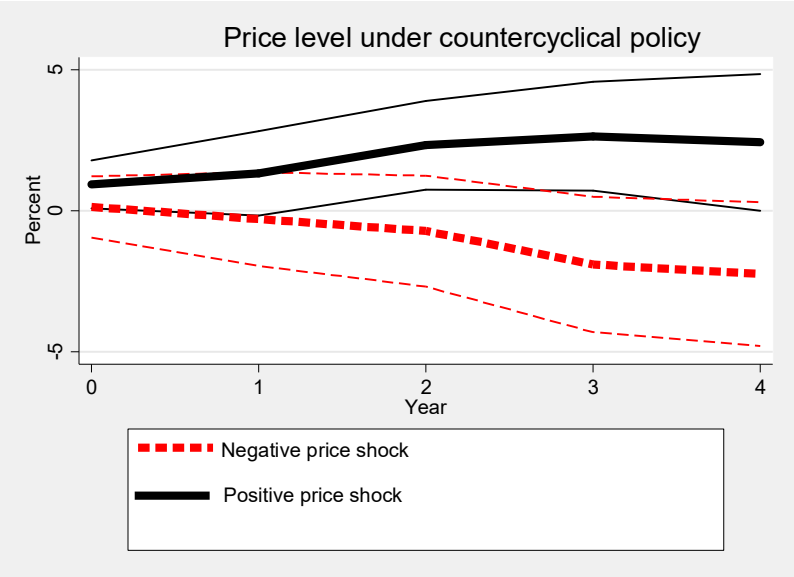


FIGURE 8, PANEL B: PRICE LEVEL RESPONSE TO A ONE-STANDARD-DEVIATION INCREASE IN PRINCIPAL EXPORT PRICE CONDITIONAL ON COUNTERCYCLICAL INTEREST RATE SHOCK. NOTES: LP-IV ESTIMATES DISPLAYED WITH A THICK SOLID BLACK LINE AND 90% CONFIDENCE BANDS IN SOLID BLACK LINES. THICK DASHED RED LINE PLOTS RESPONSE FROM PROCYCLICAL OR ACYCLICAL INTEREST RATE POLICY, 90% CONFIDENCE BANDS IN DASHED RED LINES.

III. Conclusion

We use quasi-experimental evidence from the first era of globalization to empirically estimate how monetary policy can stabilize an economy following external shocks. Focusing on the this earlier historical era allows us to estimate the causal effect of exogenous combinations of real and policy shocks for a panel of economies and to obtain plausible empirical identification of different monetary policy stances by countries adhering to pegs. As we emphasize, in this case, history has its advantages: due to the emergence of trade and capital controls, which are not easily measured over time, it is more challenging to obtain exogenous combinations of real and policy shocks using data from more recent periods.

Our results suggest that countercyclical monetary policy can indeed stabilize the economy following real, external shocks. However, the analysis also points to several caveats. We find that the casual impact of countercyclical policy has stronger effects for domestic prices than for output. Importantly, the effect on output is asymmetric. Monetary policy can counteract positive shocks to principal-export prices, but not negative shocks. Although our setting is historical, external demand and monetary policy shocks, the focus of our analysis remains relevant for policy makers today.

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IV. Appendix

Appendix 1:

Principal exports sources, methods and prices: To be completed

TABLE 4: DATA SUMMARY

Economy	Real GDP	Inflation rates	Principal Export	Domestic Interest Rate	Gold Standard dates
Argentina	1875-1913	1870-1913	Wool	1880-1913	1870-1876, 1883-1884, 1900-1913
Australia	1870-1913	1870-1913	Wool	1870-1913	1870-1913
Austria-Hungary	1870-1913	1870-1913	Timber	1870-1913	1893-1913
Belgium	1870-1913	1870-1913	Cotton mf.	1870-1913	1879-1913
Brazil	1870-1913	1870-1913	Coffee	1870-1913 (LT bonds)	1888-89, 1906-1913
Bulgaria	1887-1913	1888-1913	Wheat	1879-1913	1906-1913
Canada	1870-1913	1870-1913	Timber	1871-1897 (Call rates) and 1902-1913	1870-1913
Chile	1870-1913	1870-1913	Nitrate	1870-1913	1895-1898
China	1890-1913	1870-1913	Silk	-	-
Colombia	1905-1913	1870-1913	Coffee	-	-
Denmark	1870-1913	1870-1913	Butter	1870-1913	1872-1913
Egypt	1894-1913	1870-1913	Cotton	1883-1913	1885-1913
Finland	1870-1913	1870-1913	Timber	1870-1913	1877-1913
France	1870-1913	1870-1913	Wool mf.	1870-1913	1878-1913
Germany	1870-1913	1870-1913	Cotton mf.	1870-1913	1871-1913
Greece	1870-1913	1870-1913	Fruits and	1880-1913	1885, 1910-1913

			nuts		
Iceland	1870-1913	1901-1913	Fish	1903-1913 (Interbank rates)	1872-1913
India	1872-1913	1870-1913	Cotton	1879-1913	1898-1913
Indonesia	1880-1913	1870-1913	Sugar	-	1875-1913
Italy	1870-1913	1870-1913	Silk	1870-1913	1884-1894
Japan	1870-1913	1870-1913	Silk	1879-1913	1897-1917
Malaysia	1900-1913	-	Tin	-	1906-1913
Mexico	1870-1913	1878-1913	Silver	1900-1913	1905-1913
Netherlands	1870-1913	1870-1913	Iron prod.	1870-1913	1875-1913
New Zealand	1870-1913	1870-1913	Wool	-	1870-1913
Norway	1870-1913	1870-1913	Timber	1870-1913	1875-1913
Peru	1896-1913	1870-73 & 1901-13	Sugar	1870-74 & 1883-1913	1901-1913
Philippines	1902-1913	-	Hemp	-	1903-1913
Portugal	1870-1913	1870-1913	Wine	1880-1913	1854-1891
Romania	1880-1913	-	Wheat	1870-1913	1890-1913
Russia	1870-1913	1870-1913	Wheat	1870-1913	1897-1913
Spain	1870-1913	1870-1913	Iron	1880-1913	
Sri Lanka	1870-1913	-	Tea	-	1898-1913
Sweden	1870-1913	1870-1913	Timber	1870-1913	1873-1913
Switzerland	1870-1913	1870-1913	Silk mf.	1870-1913	1878-1913

Taiwan	1901-1913	1898-1913	Rice	-	1897-1917
Turkey	1875-1913	1870-1913	Silk	1870-1913 LT BONDS	1881 or 83-1913
UK	1870-1913	1870-1913	-	1870-1913	1870-1913
USA	1870-1913	1870-1913	Cotton	1870-1913	1879-1913
Uruguay	1870-1913	1871-1913	Wool	-	1876-1913
Venezuela	1883-1913	1870-1913	Petroleum	-	-

TABLE 5: SOURCES FOR REAL GDP AND PRICE LEVEL

Economy	Real GDP	Data Source and Notes for Real GDP	Inflation	Data Source and Notes for Inflation
Argentina	1875-1913	Ferreres, Orlando J. (director), Dos siglos de economía argentina (1810-2004): Historia argentina en cifras, Fundación Norte y Sur, Buenos Aires, 2005.	1870-1913	CPI, Williamson, Jeffrey, (1999), "Real Wages, Factor Price, and Globalization in Latin America before 1940," Revista de Historia Economica 17, 101-142.
Australia	1870-1913	Maddison	1870-1913	CPI, Mitchell, Brian R. (2003). International Historical Statistics: Africa, Asia, and Oceania, 1750–2000.London: Palgrave Macmillan.
Austria-Hungary	1870-1913	Butschek, Felix, "The Austrian Economy in World War II", in: Mills, Geofrey T. and Hugh Rockoff (eds.), The Sinews of War: Essays on the Economic History of World War II, Iowa State University Press, Ames, U.S.A., 1993.	1870-1913	CPI, Flandreau, Marc and Frederic Zumer (2004), The Making of Global Finance: 1880-1913, (Paris:OECD).
Belgium	1870-1913	Maddison	1870-1913	CPI, Allen, Robert,n.d., Consumer Price Indices, Nominal/Real Wages of Building Craftsmen and Laborers, 1260-1913, Oxford: Oxford University. At http://www.iisg.nl/hpw/data.php#netherlands.
Brazil	1870-1913	Goldsmith, Raymond, Brasil 1850-1984: Desenvolvimento Financiero sob um Sécolo de Inflaçao, São Paulo, Harper and Row do Brazil, 1986.	1870-1913	CPI, Williamson, Jeffrey, (1999), "Real Wages, Factor Price, and Globalization in Latin America before 1940," Revista de Historia Economica 17, 101-142.
Bulgaria	1887-1913	Pisha, Arta, Besa Vorpsi, Neraida Hoxhaj, Clemens Jobst, Thomas Scheiber, Kalina Dimitrova, Martin Ivanov, Sophia Lazaretou, George Virgil Stoenescu et al., "South-Eastern European Monetary and Economic Statistics from the Nineteenth Century to World War II," Publications, 2015.	1888-1913	Pisha, Arta, Besa Vorpsi, Neraida Hoxhaj, Clemens Jobst, Thomas Scheiber, Kalina Dimitrova, Martin Ivanov, Sophia Lazaretou, George Virgil Stoenescu et al., "South-Eastern European Monetary and Economic Statistics from the Nineteenth Century to World War II," Publications, 2015.
Canada	1870-1913	Maddison	1870-1913	CPI, Diaz, Jose B., Rolf Luders, and Gert Wagner (2005),"Chile: 1810-2000, La Republica en Cifras," Instituto de Economia, Pontificia Universidad Catolica de Chile, May.
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Uruguay	1870-1913	Facultad de Ciencias Sociales, "Banco de Datos de Economía e Historia Económica", Programa de Historia Económica, Uruguay (available at: http://www.fcs.edu.uy/bd/banec/productohist.htm)	1871-1913	CPI, Williamson, Jeffrey, (1999), "Real Wages, Factor Price, and Globalization in Latin America before 1940," Revista de Historia Economica 17, 101-142
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Appendix 2

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Notes: