Pegxit:

Evidence from the Classical Gold Standard

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Preliminary

Abstract

We develop a simple model that highlights the costs and benefits of fixed exchange rates as they relate to trade, and show that negative terms-of-trade shocks reduce fiscal revenue and increase the likelihood of an expected currency devaluation. Using a new high frequency data set on commodity-price movements from the classical gold standard era, we then show that the model's main prediction holds even for hard pegs. We identify a negative causal relationship between export-price shocks and currency-risk premia in emerging market economies, indicating that negative commodity-price shocks increase the likelihood of abandoning their hard pegs.

Keywords: currency risk, exchange rate devaluation, terms of trade shocks

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1 Introduction

A recurrent feature of the international monetary system over the past 150 years has been the use of fixed exchange rates to anchor currency values and prices. Fixed exchange rates have some macroeconomic benefits (Edwards et al. (2003), López-Córdova and Meissner (2003) and Husain et al. (2005)), but abandoning a fixed-exchange rate regime is one of the most frequently observed policy decisions in open-economy macroeconomics (Obstfeld and Rogoff (1995) and Reinhart and Rogoff (2009)). This decision is followed by a currency devaluation, which can result in significant reductions in employment and output (Kaminsky and Reinhart (1999) and Gupta et al. (2007)). Given the fragility of fixed exchange rates, countries often turn to hard pegs and currency unions. But as shown by Schmukler and Servén (2002) and Mitchener and Weidenmier (2009), even hard pegs have rarely been viewed as credible arrangements by financial markets.

In this paper, we provide one mechanism for why countries abandon pegs and devalue their currencies: shocks to the value of their output. In particular, we study whether export-price shocks affect the expectation of currency devaluation. We take the perspective that fixed exchange rates are often adopted to facilitate external trade, and explore how exogenous fluctuations in export prices affect the probability of leaving a peg. To do so, we first solve a long-run model with flexible prices, where a government chooses an optimal policy weighing the costs and benefits of abandoning a fixed exchange rate. The cost of floating is that trade is lower outside of a fixed exchange rate regime, which reduces government tax revenues and increases fiscal pressure. The benefit of floating is that, in real terms, the government faces lower domestic currency debt payments following devaluation, reducing the real debt burden and easing fiscal pressure. Optimal policy balances these two effects for a fixed level of debt and a fixed devaluation.[1]

The main result of the model is that the probability of leaving the peg depends on the price of a country's exports. When export prices are high, the costs of a reduction in trade after leaving the peg are large and are not offset by the fixed benefit from lower real debt payments. However, when export prices are low, these costs are also low and thus compensated by reduced *real* debt payments. In our framework, the trigger behind the decision to abandon a fixed exchange rate are exogenous fluctuations in the international prices of exports. We solve this structural model of abandoning a peg to show how negative (positive) shocks to the price of a country's exports increase (decrease) the probability of leaving a peg and devaluing its currency.[2]

We then show empirically that this mechanism helps explain *pegxits* using currency risk, a closely followed indicator of expected currency devaluation by economic agents, policy makers, and market participants. We employ a novel high-frequency dataset that includes measures of world commodity prices, countries' principal exports, and currency risk for more than 30 years to test whether export price shocks influence currency risk. The identification of the causal impact of

[1]In the model, we assume that abandoning a fixed exchange rate is followed by a devaluation of the currency and that this decision is irreversible. This assumption captures the view that countries can not easily hop on and off from a fixed exchange rate mechanism. Consistent with this long-run perspective, we assume flexible prices and that purchasing power parity holds. Our mechanism is therefore driven by long-run considerations related to trade, and not short-term considerations associated with competitive devaluations or currency wars. There are different reasons why trade may be larger under a peg, for example, lower exchange rate volatility and transaction costs. The empirical literature on the classical gold standard suggests that trade was larger under pegs due to transactions costs (See López-Córdova and Meissner (2003)).

[2]Although we focus on a reduction of real debt payments, it should be noted that there are at least two additional sources of inflation-related revenues that would matter for the government: seigniorage and the reduction of real payments of nominal government contracts, for example, public wages.

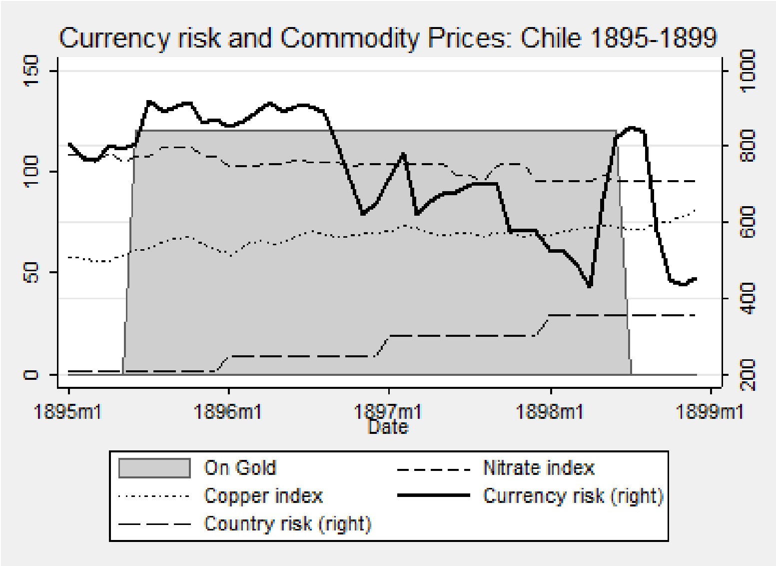

Figure 1: Currency risk (solid line on right axis), Nitrate price index (left, average 1913 = 100) Copper price index (left, average 1913 = 100) for Chile. Adherence to gold (shaded area), and country risk (from Ferguson and Schularick (2006) is also plotted (right).

export prices shocks on currency risk is possible due to the exogeneity of export prices that are determined in global markets and the presence of fixed exchange rates, which allow for exogenous price shocks to impact expected devaluation.

Chile's experience in the 1890s illustrates our finding that export prices contribute to the breaking of hard pegs and that this is captured by currency risk. Chile rejoined the gold standard on June 1, 1895 only to abandon it three years later in July 1898 (Bordo and Kydland (1995)). Chile suffered a number of negative shocks in this period, including a border dispute with Argentina that resulted in an arms race and an increased defense budget; however, Collier and Sater (1996) stress the role of export price shocks in making a bad situation worse. Figure 1 plots our measure of currency risk (solid line) together with the price indices for nitrate and copper, Chile's two most important exports by value. Chile's adherence to the gold standard and a measure of country risk are also plotted. Between 1895 and 1898, we can see that the price of nitrate fell, while the price of copper began to decrease just before currency risk spiked in June 1898. Unsurprisingly, currency risk peaked just before Chile abandoned gold.[3]

We investigate the main testable hypothesis from the model using a monthly panel data set spanning 21 countries between 1870-1913. The first era of globalization, the late 19th and early 20th centuries, are a particularly well-suited laboratory for understanding why countries abandon hard pegs for several reasons. First, many countries pegged to gold to facilitate trade (Eichengreen (1998), López-Córdova and Meissner (2003), Mitchener and Weidenmier (2008), Mitchener et al. (2010), Mitchener and Voth (2011)). Second, both capital and goods markets were unfettered and integrated. Finally, many countries, particularly those in the periphery, had relatively unspecialized production structures which exposed them to external trade shocks that were plausibly exogenous (Williamson (2013)). Trade in this early era of globalization is well described by the Heckscher-Ohlin model of comparative advantage in factor endowments (See Blattman et al. (2007), Findlay and O'Rourke (2003), Mitchener and Yan (2014) and O'Rourke and Williamson (1994).). Since many countries specialized in exports of raw materials and minerals, we are able to exploit this *commodity lottery* in our identification strategy: that is, commodity prices provide a reasonably exogenous source of variation in the benefits of fixed exchange rates as different countries specialize in different exports which are determined by pre-determined factor endowments.

Our empirical results uncover a negative and statistically significant causal re-

[3] The monthly price indices for nitrate and copper are constructed from *The Economist*. The measure of currency risk is obtained from Mitchener and Weidenmier (2009), while the measure for country risk comes from Ferguson and Schularick (2006).

lationship between the price of exports and currency risk, where our identifying assumption is that export prices are determined in world markets and therefore are exogenous to price taking countries. This result is robust to alternative specifications, including those with country and year fixed effects that account for omitted covariates. Furthermore, we show that the effects appear to be driven by countries in the periphery rather than the core European countries of the gold standard.

Our model and empirical findings relate to several existing strands of literature, including the large literature on how unsustainable pegs collapse. First generation models such as Krugman (1979), Flood and Garber (1984), Calvo (1987) and Broner (2008) study the dynamics and timing of currency crises as a consequence of macroeconomic fundamentals.[4] These models assume that a fixed exchange rate is abandoned once reserves hit a critical threshold level following unsustainable fiscal policy. One related study is Rebelo and Végh (2008) which solves for optimal policy when there are output costs from abandoning a peg. This study finds that, for large government expenditure shocks, it is optimal to abandon the peg immediately. This literature highlights a fiscal mechanism as to why pegs collapse: government expenditures need to be financed with inflation-related revenues (for example, seigniorage), but inflation is incompatible with fixed exchange rates under capital mobility. However, government expenditure shocks are frequently endogenous or coincide with other shocks such as wars, natural disasters, policy and political shifts, making it challenging to identify empirically how important

[4]Another class of models, called second generation models, show that crises can be unpredictable and caused by self-fulfilling expectations, often independently of fundamentals (see for example, Obstfeld (1986) Angeletos et al. (2007)). A third class of models, called third generation models explore how the financial sector interacts with currency crises and how these crises propagate into the real economy. Examples include Corsetti et al. (1999), Krugman (1999) and Aghion et al. (2004).

this fiscal mechanism is in driving currency risk. To address this identification issue, we focus on a model and an estimation strategy that turns to fiscal shocks emanating from the revenue side of the ledger. Doing so allows us to identify a plausibly exogenous source of variation in revenues (i.e., global commodity price shocks) that can be causally tested to see whether they influence the decision to abandon a peg.

A related literature studies the optimality of exchange rate regimes in response to real and nominal shocks (see for example Chernyshoff et al. (2009)) and as a commitment device (see Bordo and Rockoff (1996) and Obstfeld and Taylor (2003)). We take a public finance view on currency risk similar to Rigobon (2002) and Pina (2015). In this sense, our approach is close to the literature on the "Twin D's": default and devaluation, which argues that inflation acts as default in the sense that it reduces the real value of debt payments of the government (Calvo (1988), Aguiar et al. (2013), Corsetti and Dedola (2013) and Na et al. (2014)). However, we abstract from sovereign default to focus on currency risk, and use continuous time methods as in Leland (1994) to obtain a closed form solution for the relationship between expected devaluation and exogenous export prices.

Our study also contributes to understanding of the operation and performance of the classical gold standard in the periphery. Although economic historians have noted how the gold standard influenced trade flows and how terms-of-trade shocks influenced the pace and pattern of economic development, to our knowledge, this paper is the first to analyze and account for how these trade shocks affected the durability of the gold standard on the periphery. That said, our focus on terms-of-trade shocks is related to earlier work including Blattman et al. (2007), Williamson (2008) and **?**, and our contribution is to relate the effects of terms-of-trade shocks to currency risk. In addition, by modeling the benefits of hard pegs as accruing from trade, our paper relates to research showing how countries on the gold standard traded more with each other (López-Córdova and Meissner (2003), Estevadeordal et al. (2003), Flandreau and Maurel (2005), Mitchener and Weidenmier (2008) and Mitchener et al. (2010)). Further, the role of domestic denominated debt is related to the work of Bordo and Meissner (2006), which documents that an important share of public debt was denominated in domestic currency. The mechanism in our model works through the reduction of real payments of foreign and domestic debt denominated in domestic currency but, more generally, it applies also to any source of inflation-related revenues, including seigniorage and the reduction of real payments on nominal government contracts and wages. Flandreau et al. (1998) document how debt put a strain on existing institutions during the gold standard, and how fluctuations in real interest services affected the stability of the European gold standard. We study a similar mechanism, but focus on country-specific export price shocks. Finally, our results are also related to the literature on the trilemma (see Obstfeld et al. (2005) for an historical overview of this literature.). In an environment of perfect capital mobility, we document that country-specific external shocks that change the relative value of monetary autonomy affect the probability of exchange-rate instability.

The next section of the paper presents a simple model of currency risk. Section 3 presents the data set and tests the predictions of the model, while the final section discusses our findings and suggests areas for future research.

2 Model

This section derives a simple, long-run model of endogenous currency risk with flexible prices. Capital markets are assumed to be frictionless and all agents have perfect information and are risk neutral. All variables are measured in terms of the numeraire, and to relate it later to the empirical setting, we assume that issued currency is backed by gold in order to fix exchange rates.

2.1 Production and prices

Consider a small open economy producing an amount y of a tradable good with a price, P_t, that is exogenous to the economy and determined in international markets. For simplicity, we abstract from output growth and focus on the production of a single tradable good.[5] We further assume that PPP holds. The price of the tradable good fluctuates according to the following process:

$$dP_t = \mu P_t dt + \sigma P_t dZ_t, P_0 > 0. \tag{1}$$

where μ and σ represent constant mean and volatility of the commodity price growth rate, and Z_t is a wiener process. In other words, P_t follows a geometric Brownian motion with percentage drift μ and volatility σ. The first term controls the trend of the price trajectory while the second the random noise effect in the trajectory. Solving this differential equation, we find:

[5]More generally, we could have included non-tradable goods and other tradable goods at the expense of notational simplicity. In the model presentation we will refer to output and exports interchangeably, but the crucial assumption for our results is that the price of output P_t is exogenously determined in world markets, independently of whether it is ultimately traded.

$$P_t = P_0 e^{\left(\mu - \frac{\sigma^2}{2}\right)t + \sigma Z_t}.$$

We can see that P_t follows a log-normal distribution:

$$ln\left(\frac{P_t}{P_0}\right) \sim N\left(\left(\mu - \frac{\sigma^2}{2}\right)t, \sigma^2 t\right).$$

Note that $E(P_t) = P_0 e^{\mu t}$. The value $P_t y_t$ represents the value of output of this country at period t. Then, the expected present value, discounted at rate ρ, of a constant level of output for the country is:

$$E\left(\int_0^\infty P_t y e^{-\rho t}\right) dt = \frac{P_0 y}{\rho - \mu}. \tag{2}$$

2.2 Government

The government issues debt at $t = 0$ to finance a public investment that generates a return of r_g per unit of time. The discounted benefit of issuing debt equals

$$E\left[\int_0^\infty r_g e^{-\rho t} dt\right] = \frac{r_g}{\rho}. \tag{3}$$

This debt is not subject to default, but it is denominated in domestic currency and thus subject to currency risk.[6] At $t = 0$, the government sets a rule whereby the amount of currency issued is directly tied to the numeraire good, gold. That

[6] We focus our analysis on currency risk, rather than country or political risk. In the empirical section of the paper, we argue that our measure of risk premia does not include sovereign risk.

is, the government promises to keep the price level equal to the international price level of 1. However, the government can not commit to this policy. In fact, there exists a threshold P^F at which it is optimal for the government to float the currency, which happens at time $T^F = inf\left\{t \geq 0 | P_t \leq P^F\right\}$ when the international price first falls to P^F. This policy is determined endogenously based on the trade-off between costs and benefits derived from leaving the gold standard. We assume that once the government leaves the hard peg it does not return.[7]

Further assume the government issues long-term debt in the form of a perpetuity of amount D with debt service C, both denominated in local currency.[8] If the country floats, the real value of the debt service goes down to $\frac{C}{S_t}$, where $S_t = Se^{\pi t}$ and $S > 1$ is the price level after the government floats.[9] This reduction in debt payments gives the government the incentive to float. However, by increasing exchange rate volatility and transaction costs (Rose (2011)), it also negatively affects international trade, which reduces taxable output by a fraction $\lambda \in [0, 1]$. This is the cost of floating.[10]

The government appropriates a constant fraction τ of tradable output as tax

[7]The assumption of lack of commitment follows Bordo and Kydland (1995). We abstract from escape clauses as our export price shocks are arguably not indicative of the emergencies discussed in Bordo and Kydland (1995), e.g., wars. Instead, we focus on the strategic decision of the government to abandon the peg.

[8]Although there is a large empirical literature indicating the existence of original sin (i.e., inability to issue foreign debt denominated in home currency), most all economies in the late 19th century, including those on the periphery, funded their public debt by issuing long-term bonds in domestic currency in the home market, if not in London. See Accominotti et al. (2011) for data on the the share of public debt issued in home currency.

[9]We motivate the assumption that the currency would depreciate after leaving gold with the positive and persistent currency risk premia found for this period by Mitchener and Weidenmier (2015).

[10]One common government tax instrument during the gold standard was import tariffs. In the model tax revenues fluctuate with export prices. Under the assumption of balanced trade, imports are equal to exports. More generally, our assumptions capture that the government obtains tax revenues from economic activity that depends on whether the country fixes its exchange rate.

revenues. The discounted value of fiscal revenue from potential output is then $\tau\frac{P_0 y}{\rho-\mu}$. For simplicity, we assume the government is running a balanced budget. In particular, we assume that the government can raise lump-sum taxes or give back subsidies to firms (Ψ) such that it does not accumulate assets or issue new debt over time:[11]

$$\dot{a}_t = \rho a_t + \tau P_t y_t + \Psi_t - C = 0, fixed;$$
$$\dot{a}_t = \rho a_t + \tau P_t y_t \left(1-\lambda\right) + \Psi_t - \frac{C}{S} = 0, floating.$$

Before providing the mathematical details to solve the model, we develop the intuition for our main result: that an exogenous decline in the price of exports increases the probability of leaving the peg and devaluing currency, while an increase in the price of exports leads to a decline in the probability of leaving the peg and devaluation. In other words, we show how exogenous fiscal revenue shocks affect currency risk. The benefit of devaluation is that the government faces lower domestic currency debt payments in terms of gold. The cost is that abandoning a fixed exchange rate negatively impacts external trade. Optimal policy balances these two effects for a pre-determined level of domestically denominated debt payment, C, and a fixed devaluation following the abandonment of the peg. This pre-determined debt and fixed devaluation play an important role in our model. Together, they imply that the benefit of abandoning a currency peg is pre-

[11]Note that any payments in gold-denominated debt are included in Ψ_t. We focus on domestic currency public debt since the government can not affect the real payments on gold-denominated debt through devaluation. The assumption that the government has access to lump-sum taxes and is running a balanced budget is done for simplicity and would not change the results in this paper.

determined and independent of current economic conditions. This contrasts with the costs of leaving a peg which fluctuate with the international price of exports. As a consequence, if the government leaves the peg when the price of exports is high, it loses valuable tax revenues. These costs do not compensate the fixed benefit of abandoning the peg. On the other hand, when the price of exports declines substantially, the cost of leaving the peg is small and is more than compensated by the fixed benefit in the reduction of real debt payments.

Importantly, although we focus on a reduction of real debt payments, it should be noted that there are at least two additional sources of inflation-related revenues: seigniorage and the reduction of real payments of nominal government contracts (e.g., public wages).[12]

2.3 Pricing sovereign debt and Currency Risk Premia

In this section we solve for the economy's currency risk premia. Using Ito's lemma, the value of public debt D satisfies:

$$\rho D = C + \mu P D_P + \frac{1}{2}\sigma^2 P^2 D_{PP}, \tag{4}$$

this in turn can be written as:

$$D(P) = A_0 + A_1 P + A_2 P^X, \tag{5}$$

where X is the negative root to the equation $\frac{\sigma^2}{2}X(X-1) + \mu X - \rho = 0$. $X = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2\rho}{\sigma^2}} < 0$ (See Shreve (2004) and Leland (1994)).

[12]See Burnside et al. (2001) and Burnside et al. (2006) for theoretical and empirical analysis of these alternative mechanisms in the late 1990s Asian Crisis.

To determine the constants A_0, A_1 and A_2 we make use of boundary conditions. To obtain A_0 and A_1 note that when P goes to infinity, the country does not leave the peg and it's domestic price level is fixed at 1. Therefore, the credit risk premium is zero and the value of debt is just the discounted value of present value of real payments C:

$$limD\left(P\right)_{P\rightarrow\infty}=\frac{C}{\rho}. \tag{6}$$

From this boundary condition we can see that $A_0=\frac{C}{\rho}$ and $A_1=0$. When the country floats the currency, we assumed that the domestic price level jumps to $S>1$, and that the country does not return to the peg. Then, the debt payments following a peg are permanently reduced in real terms to $\frac{C}{S}$, which implies that:

$$limD\left(P\right)_{P\rightarrow P^F}=\frac{C}{\rho S}. \tag{7}$$

From these two boundary conditions we obtain that $A_2=\frac{C}{\rho}\frac{1-S}{S}\left(P^F\right)^{-X}$. Using these results we can rewrite the value of the debt as:

$$\begin{aligned}D_t\left(P\right)&=E\left[\int_t^{T^F}Ce^{-\rho(u-t)}du\right]+E\left[\int_{T^F}^{\infty}\frac{C}{S}e^{-\rho(u-t)}du\right]\\&=\frac{C}{\rho}\left[1-\frac{S-1}{S}\left(\frac{P_t}{P^F}\right)^X\right],\end{aligned}$$

where $E_t\left[e^{-\rho\left(T^F-t\right)}\right]=\left(\frac{P_t}{P^F}\right)^X$. The term $\frac{S-1}{S}\left(\frac{P_t}{P^F}\right)^X$ corresponds to the currency risk premium. The market value of debt denominated in domestic currency is then equal to a risk-less perpetual bond, minus the currency risk premium associated with devaluation. Note that P^F is constant and does not depend on current macroeconomic conditions.

For a given C, the currency risk spread is given by $CRS_t\left(P\right) = \frac{C}{D_t(P)} - \rho$:

$$CRS_t\left(P_t\right) = \rho\left[\frac{1}{1 - \frac{S-1}{S}\left(\frac{P_t}{P^F}\right)^X} - 1\right], \tag{8}$$

where $\frac{\partial CRS}{\partial P_t} < 0$. In words, lower international prices are associated with higher risk of a country leaving the currency peg and devaluing the currency, which is reflected in risk-neutral risk premia.[13]

2.4 Decision to float currency

In the previous section, we have priced domestically denominated debt under the assumption that the country floats its currency if export prices are too low. We now solve for the optimal decision when to float and, in particular, for the threshold level of international prices that induces a pegxit. First, note that the sovereign government's wealth can be written as:

$$\begin{aligned} W_t(P) = & E\left[\int_t^\infty \tau P_t y e^{-\rho(u-t)} du\right] - D_t\left(P\right) + \\ & E\left[\int_t^\infty r_g D_t\left(P_t\right) e^{-\rho(u-t)} du\right] - E\left[\int_{T^F}^\infty \lambda\tau y P_t e^{-\rho(u-t)} du\right] \\ & = \tau\frac{P_t y}{\rho-\mu} - \frac{\tau\lambda y P^F}{\rho-\mu}\left(\frac{P_t}{P^F}\right)^X + \frac{C}{\rho}\left(\frac{r_g}{\rho} - 1\right)\left[1 - \frac{S-1}{S}\left(\frac{P_t}{P^F}\right)^X\right], \end{aligned}$$

[13]Given that $X = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2\rho}{\sigma^2}} < 0$, we can see that $\frac{\partial X}{\partial \mu} < 0$ and $\frac{\partial X}{\partial \sigma} > 0$. Furthermore, $\frac{\partial CR}{\partial X} > 0$. Therefore, the higher the volatility of the international price, the larger the spread and the lower the growth rate of the international price, the lower the currency risk.

where $E_t\left[\int_{T^F}^{\infty} P_t e^{-\rho(u-t)} du\right] = E_t\left[P^F e^{-\rho\left(T^F-t\right)}\right] = P^F\left(\frac{P_t}{P^F}\right)^X$.

Government wealth depends positively on tax revenues, the public investment returns, the reduction in debt payments from devaluation, and negatively on the costs of devaluation and debt payments. The floating policy will be defined by a boundary level for the international price such that the government floats the currency that maximizes sovereign wealth. We assume that the government wishes to maximize its wealth and can take first order conditions with respect to the international price:

$$\frac{\partial W}{\partial P} = \tau \frac{y}{\rho - \mu} - \frac{X\tau\lambda y}{\rho - \mu}\left(\frac{P_t}{P^F}\right)^{X-1} - \frac{C}{\rho}\frac{S-1}{S}\left(\frac{r_g}{\rho} - 1\right)\frac{X}{P^F}\left(\frac{P_t}{P^F}\right)^{X-1}.$$

Together with the smooth pasting condition:[14]

$$\frac{\partial W}{\partial P}_{P=P^F} = \frac{\tau y}{\rho - \mu}\left(1 - \lambda\right),$$

obtain:

$$P^F = C\frac{\frac{S-1}{S}\left(\frac{r_g}{\rho} - 1\right)X\left(\rho - \mu\right)}{\lambda\tau y\rho\left(1 - X\right)}. \tag{9}$$

Note that P^F depends only on parameters. In Figure 2, we show that the export price lower bound before a country floats its currency P^F depends posi-

[14] The smooth pasting condition ensures continuity in the value of wealth at the time of devaluation. If value functions don't smooth paste at T^F, then floating at T^F can not be optimal: better to float an instant earlier or later. If there is a (convex) kink the gain from waiting is smaller than the cost (symmetric argument for concave kink). This is like a boundary condition, Dumas (1991) shows it's an optimality condition.

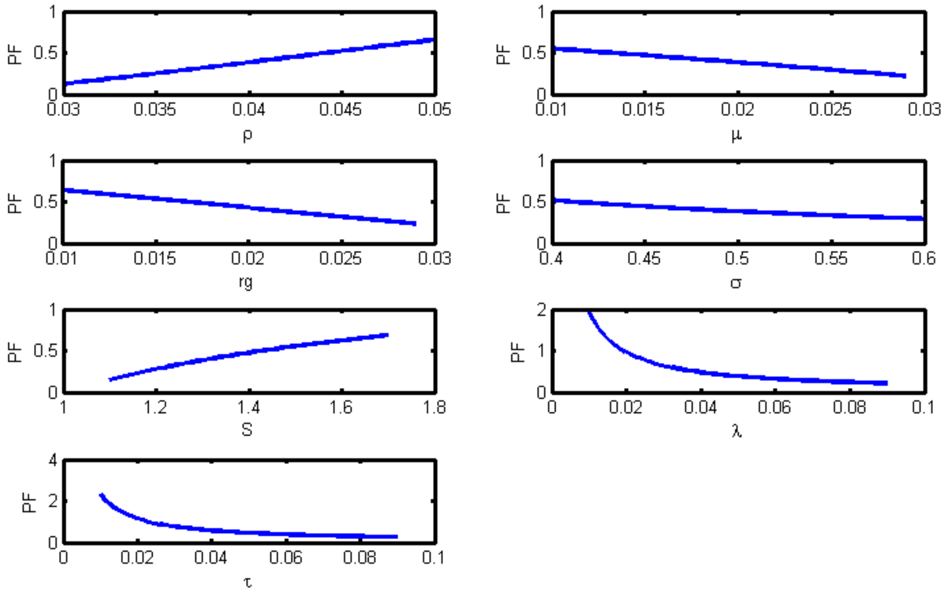

Figure 2: Comparative Statics for export price lower bound: ρ is risk free rate, r_g is return on public spending financed with debt, S is post-float currency devaluation, τ is tax rate, μ is the growth rate in principal commodity price, σ is volatility of principal commodity price and λ is the reduction in exports after devaluation.

tively on the risk free rate ρ and the currency devaluation S but negatively on the return to public debt r_g, the tax rate τ, the growth rate of export prices μ, the volatility of the export price σ and, finally, the output cost after leaving the peg λ. Intuitively, anything that makes the post-devaluation worse, for example, higher output costs, is associated with lower P^F and lower probability of devaluing. Anything that improves the government's situation following devaluation, for example higher devaluation rate S, increases P^F and implies a higher probability of devaluing.

3 Empirical Analysis

In this section, we test the model's predictions for currency risk using a new high-frequency data set on commodity price movements from the period of the classical gold standard.

3.1 Data

We use high-frequency data to study the impact of commodity price fluctuations on currency risk. We use weekly data on short-term interest rates for 21 countries to obtain monthly currency spreads as in Mitchener and Weidenmier (2015) and combine it with newly constructed monthly data for traded goods prices from *The Economist*, together with principal exports and imports for each of the countries in our sample.[15]

Currency risk spreads are defined as a country's short-term bank rate minus the UK's short term bank rate. These short-term open market rates are very liquid and not subject to default-risk (Mitchener and Weidenmier (2015) and Schmukler and Servén (2002)). To identify the principal exports for each economy, we first collect export weights from the British Board of Trade (various years), Jacobson (1909), Mitchell (1982), Mitchell (2007a), and Mitchell (2007b). The first two publications provide detailed information on exports and imports by product for most of the countries in our sample between 1870 and 1909. Appendix A collects the sources and the method used to determine the principal export for each country.[16]

[15] We use end of the month observations for all variables. When the end of the month observation is missing, we opt to use the first weekly observation of the following month (769 observations). If that is also not available, we use the average of the current month (13 observations).

[16] Although one of our economies is a colony (India), and another a Grandy-Duchy (Finland),

Our sample includes 21 economies, and 9073 observations between January 1870 and December 1913. Table 1 summarizes the data while Table 2 reports the principal exports for the economies in our sample by order of importance. Table 2 also denotes whether an economy is designated as part of the core or the periphery.[17]

Variable	Obs	Mean	Std. Dev.	Min	Max
Month-year	8901			1870m1	1913m12
Currency risk	8901	1.96%	2.18%	-3.12%	13%
Export Price index	8901	92.6	24.3	44.4	211.2
Export Price index 1 year growth	8748	1.07%	14.7%	-50%	150%

Table 1: Summary Statistics for monthly data

Empirically testing the effects of export price shocks on currency risk requires some further consideration of some of the modeling assumptions made above, in particular as they relate to what is exported and who exports it. First, there is substantial variation in the principal export in different countries, but some exports are manufactured goods, not commodities. Second, commodities are more important for countries in the periphery. Economies in the core have more diversified production, including substantial shares of many different manufactured or semi-manufactures products. These two facts suggest that the proposed mechanism identified in the model may operate more strongly in the periphery. Exogeneity of export price movements is also more plausible in the periphery since specialization

we will use the words country and economy interchangeably to facilitate exposition.

[17] For a few economies, we could not obtain monthly price data for their principal exports for the full sample, and we approximate the monthly price of their principal export using data for the product that is most correlated with the principal export we identified. For example, cotton manufactures are proxied using the price index for cotton before 1880 (the monthly correlation between the cotton index and the monthly index for textile products price index is 0.76, results are robust to dropping the observations being proxied.). The monthly correlation between the price of wool and the price of textile products is 0.78.

Country	Principal Exports	Max %	Core	Periphery
Argentina	**Wool**, Wheat, Beef	50		X
Austria-Hungary	**Timber**, Sugar, Flour	23		X
Belgium	**Flour**, Coal, Iron	15	X	
Bulgaria	**Wheat**, Barley, Animals	82		X
Chile	**Nitrate**, Copper, Coal	81		X
Denmark	**Butter**, Flour, Beef	65		X
Finland	**Timber**, Tar, Pitch	N/A		X
France	**Wool** mf., Silk mf., Cotton mf.	15	X	
Germany	**Iron** prod., Wool mf., Flour	15	X	
Greece	**Iron**, Olive oil, lead	30		X
India	**Cotton**, Rice, Tea	49		X
Italy	**Silk**, Olive oil, Hemp	49		X
Japan	**Silk**, Tea, Rice	60		X
Mexico	**Silver**, Coffee, Copper	84		X
Netherlands	Drugs, **Flour**, Iron prod.	22	X	
Norway	**Timber**, Iron, Oats	52		X
Romania	**Wheat**, Barley, Flax	59		X
Russia	**Wheat**, Flax, Barley	31		X
Sweden	**Timber**, Iron, Oats	49		X
Switzerland	**Cotton mf.**, Silk, Timber	24	X	
United States of America	**Cotton**, Wheat, Beef	34	X	

Table 2: Table of countries and principal exports. Notes: Max weight between 1880 - 1913. Principal exports used in baseline specifications identified in bold. For some economies the price of the exogenous export is not available at a monthly level. Appendix A collects the sources used and the method used to determine the principal exogenous export.

is largely determined by endowments, and there are in turn driven by exogenous factors such as climate and geography. In our specifications, we allow for the coefficient to be different if a country belongs to the core or to the periphery. Finally, note that a few countries were effectively monopolists. Two noteworthy cases are Chile for nitrate and the Netherlands for quinine (Peruvian bark grown in Java.).[18]

3.2 Descriptive Analysis

Figure 3 provides a graphical representation for the relationship between currency risk and export prices between 1870 and 1913 as an example of the mechanism we study in this paper. It plots our measure of currency risk (solid line) against the growth rate in the price of one of Chile's principal exports, copper (dashed line). We can see from this figure that Chile's currency risk is negatively correlated with the growth rate of the international price of copper. The correlation coefficient between is -0.165, and significantly different from zero at the 1% level. In other words, when the price of copper increases, currency risk decreases, a result consistent with our model.[19] Turning to the full sample of economies, the correlation between currency risk and the yearly growth in the price of the principal export is -0.0438 (significant at the 1% level), while for the second main export is -0.0432 (significant at the 1% level). The correlation between the growth

[18]The Netherlands are part of the core, and therefore less relevant for our empirical analysis. We do not have monthly prices for Peruvian bark, and use their second largest export instead. Note that the Netherlands pose an additional challenge related to the fact that most of their exports are also imports going through its harbors. We will address this in a specification where we replace nitrate with copper for Chile, and where we drop the Netherlands from our sample of countries.

[19]Although copper is not Chile's principal export, it is more exogenous than Chile's most important commodity export at the time, Nitrate. The unconditional correlation coefficient between currency risk and the growth rate of the price of nitrate is 0.001, and not significantly different from zero between 1870 and 1913.

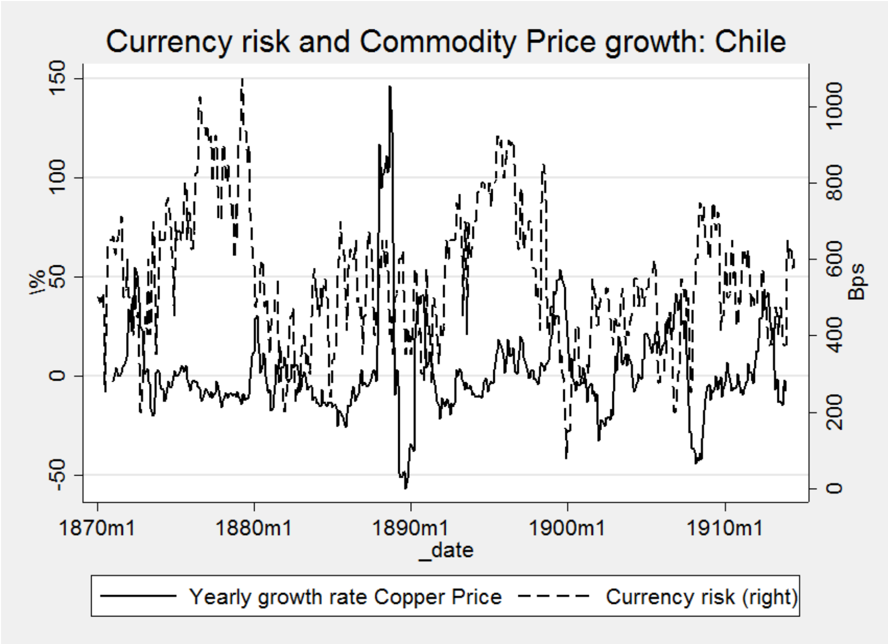

Figure 3: Currency risk (solid line on right axis) and year-on-year export price growth for copper (dashed line on right axis) for Chile.

in the two prices is positive: 0.10 (significant at the 1% level).

3.3 Panel Data Specifications

In this section we investigate if currency risk is related to the price of exports using our panel of 21 economies. Our model established that, everything else equal, permanent negative price shocks increase currency risk, while permanent positive price shocks decrease currency risk. Note that in our theoretical model we assume that export prices follow a random walk, which has a unit root. We discuss this and other issues associated with non-stationary of our data in Section 3.5. In this section, we show how to derive a structural interpretation from our theoretical model using the level of prices, and present also a reduced-form specification using growth rates. Our empirical model can be specified according to the following equation:

$$CRS_{c,t} = \alpha + \phi_t + \mu_c + \beta X_{c,t} + \gamma Z_{c,t} + \epsilon_{c,t}, \tag{10}$$

where $CRS_{c,t}$ represents currency risk spreads, c corresponds to country, t stands for month-year, ϕ_t captures time fixed effects, μ_c summarizes country fixed effects, $X_{c,t}$ refers to measures of the price of the principal export, and finally $Z_{c,t}$ contains country controls that vary monthly or annually. We are interested in testing if β is smaller than zero, which according to the model would suggest a negative relationship between fiscal shocks and currency risk. Before presenting the results, we discuss some issues with identifying this coefficient and how we address them.

The main differences between the structural and reduced-form specifications is the way we introduce export prices $X_{c,t}$ - log of levels or year-on-year growth rates - and currency risk spreads - log of spreads or levels of spreads. The structural form specification can be obtained by applying logs to both sides of equation (8):

$$CRS_t\left(P_t\right) = \frac{\rho \frac{S-1}{S}\left(\frac{P_t}{P^F}\right)^X}{1-\frac{S-1}{S}\left(\frac{P_t}{P^F}\right)^X} \approx \rho \frac{S-1}{S}\left(\frac{P_t}{P^F}\right)^X, \tag{11}$$

$$log\left(CRS_{c,t}\right) \approx log\left(\rho\right) + log\left(\frac{S_c-1}{S_c}\right) + X_c log\left(P_t\right) - X_c log\left(P_c^F\right). \tag{12}$$

when CRS is relatively small.[20] Assuming that ρ, X and P^F are time invariant as in the model, this equation can be estimated as:[21]

[20]Let $x = \frac{S-1}{S}\left(\frac{P_t}{P^F}\right)^X$, then $\frac{x}{1-x} = x + x^2 + x^3 + ... \approx x$ if $x \approx 0$.

[21]For some countries, currency risk is occasionally negative, and applying logs would yield in a number of missing observations (1677 of 9029). To avoid these missing observations, we re-base currency risk in the regressions.

$$log\,(CRS_{c,t}) = \alpha + \gamma_c + \beta log\,(P_t) + \epsilon_{c,t}, \qquad (13)$$

where the country fixed effect γ_c captures all the time-invariant country and product-specific factors.[22]

In our reduced form specifications, we regress currency risk on the annual growth rate in the price of the principal export. Using the yearly growth rate of export prices has been used in applied research using exogenous commodity prices (see, for example, Bazzi and Blattman (2014) and Caselli and Tesei (2011)). Furthermore, it makes less restrictive assumptions on the permanent nature of export price shocks. One month fluctuations in the level of export prices may not be sufficient to affect currency risk in the market, perhaps because they are the consequence of other temporary shocks, and one-year growth rates are more likely to capture permanent changes in prices. In the robustness section, we include up to 12 lags of monthly growth rates in prices.

We present the results of the structural and reduced form approaches outlined above on the raw data instead of extracting permanent shocks. This approach is conservative in the sense that any bias goes against finding a relationship between export price shocks and currency risk. Moreover, it is relatively more transparent than transforming the data. All regressions include country and year fixed effects and have standard errors clustered at the country level.

[22]Note that a strict interpretation of our model would imply that β is country specific, in other words, that our slopes are country specific. Wooldridge (2005) shows that traditional country fixed effects methods can be used to estimate the population-averaged β, even if slopes are country specific and correlated with covariates.

3.4 Panel Data Results

3.4.1 Reduced form analysis

We first explore yearly variation, controlling for year and country fixed effects, which control for unobservables affecting all countries at the yearly level, and unobservable constant country-specific effects. Table 3 reports the coefficients of a regression of the yearly average of currency risk at year y (measured in basis points) on the growth rate of the yearly average export price at the same year y in columns (1)-(2). We also consider lagged growth rate in the average prices in columns (3)-(5). Column (1) shows that the coefficient is negative but small. In column (2), we consider whether the level of development matters by letting the coefficient β be different if a country belongs to the core or the periphery. This distinction is important because the mechanism studied in this paper should be particularly relevant for the periphery, where countries have less diversified production structures and are more likely to be price-takers. We interact the price of principal export with a dummy variable that takes the value of 1 if the country is in the core, such that the coefficient on the export price alone captures our coefficient of interest. Core countries are identified in Table 2. This columns demonstrates the importance of controlling for core and periphery. We find that a price decrease of 10% in the principal export of a country in the periphery is associated with an increase of average currency risk of about 10 basis points. This effect is magnified when controlling for past growth in export prices as demonstraded in columns (4) and (5).[23]

[23]If we do not control for year fixed effects, the effect size is even larger, up to 24 basis points following a 10% price decrease. Note that our measure of currency risk is relative to the UK short-term bank rate, so any common shocks affecting the UK and the countries in our sample are already captured without year fixed effects.

	(1)	(2)	(3)	(4)	(5)
Export price growth	-0.33	-0.96***		-1.04***	-1.16***
	(0.32)	(0.30)		(0.30)	(0.28)
Export price growth # Core		1.83***		1.91***	2.24***
		(0.50)		(0.51)	(0.44)
Export price growth$_{y-1}$			-0.85**	-0.86**	-1.00**
			(0.32)	(0.32)	(0.40)
Export price growth$_{y-1}\#Core$			1.07**	1.03**	1.53***
			(0.51)	(0.47)	(0.41)
Export price growth$_{y-2}$					-0.45
					(0.44)
Export price growth$_{y-2}\#Core$					0.99*
					(0.55)
Export price growth$_{y-3}$					-0.33
					(0.32)
Export price growth$_{y-3}\#Core$					1.69**
					(0.67)
Year fixed effects	X	X	X	X	X
Constant	106.59***	98.90***	353.65***	358.48***	364.74***
	(31.86)	(31.74)	(33.74)	(32.89)	(31.51)
Observations	741	741	729	729	704
Adjusted R-squared	0.44	0.45	0.45	0.46	0.46
Number of countries	21	21	21	21	21

Table 3: Regression of yearly average currency risk at year y (measured in basis points) on the growth rate of the yearly average export price at year y. Core takes on a value of 1 for the core countries, O otherwise. # represents interaction. *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses clustered at the country level.

We now turn to richer monthly data. We regress the level of currency risk on the yearly month-on-month price growth, both measured at the end of the month. Column (1) of Table 4 reports coefficients without year fixed effects, all other regressions include them. The coefficient in columns (1) and (2) remain negative, but smaller than for yearly averages. The model studied currency risk from the perspective of abandoning a peg. A similar mechanism to the one we study may be present even outside of a currency peg, if there are some benefits to smooth exchange rates. Using our panel data we can check if the mechanism is stronger with or without a currency peg. In columns (3) - (5) of Table 4, we interact export prices with dummy variables that captures if a country is formally on gold.[24] In column (3), we allow for interactions between gold, core and the price of export. For the periphery, it is possible to see that being on gold makes the causal impact of prices on currency risk stronger as the coefficient on export prices is negative. Summing the coefficients for price growth in the periphery and price growth interacted with gold we obtain a coefficient of -0.68, which is different from zero and significanlty different from zero at the 1% level. In column (4) and (5) we perform our regression on two sub-samples, in and out of gold. In column (4) we include only observations for which a country is formally on gold. Column (5) includes only observations for which a country is not on gold. We can see that the effect is stronger while on gold, which is consistent with the model.

[24] Note that countries can shadow the gold standard even if they do not explicitly adopt it. The gold dates used are collected in Table 9.

	(1)	(2)	(3)	(4)	(5)
				On Gold	Not on Gold
Export price growth	-0.80**	-0.44*	-0.19	-0.54***	-0.08
	(0.38)	(0.24)	(0.40)	(0.19)	(0.41)
Export price growth # Core	0.52	1.03**	0.78	1.05***	0.31
	(0.44)	(0.39)	(0.63)	(0.34)	(0.72)
Gold			-1.68		
			(21.31)		
Export price growth # Gold			-0.49		
			(0.38)		
Core # Gold			22.98		
			(31.15)		
Export price growth # Core # Gold			0.48		
			(0.56)		
Year fixed effects		X	X	X	X
Constant	197.20***	88.18***	81.05***	114.27***	326.71***
	(0.31)	(26.96)	(26.44)	(3.75)	(10.22)
Observations	8,748	8,748	8,748	5,878	2,870
Adjusted R-squared	0.01	0.27	0.27	0.23	0.31
# of countries	21	21	21	21	16

Table 4: Regression of the level of currency risk (measured in basis points) on the year-on-year growth rate of the principal export price. Core takes on a value of 1 for the core countries, O otherwise. Gold takes on a value of 1 if the country has a formal gold commitment in place, 0 otherwise. # represents interaction. *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses clustered at the country level.

3.4.2 Structural analysis

We now estimate the structural interpretation using equation (13). To maximize data coverage, we estimate the first monthly observation of our weekly currency risk data on the one-month lag export price level (both logged).[25] Column (1) of Table 5 shows the coefficients of the regression of currency risk on export prices, when we absorb exclusively time invariant country fixed effects. Looking at column (1) of Table 5, we can calculate the effect size of the structural interpretation of the model as a 10% monthly decrease in the one month lagged price of the principal export causally increasing currency risk by 1.9%. This effect is significantly different from zero at the 1% level. This structural analysis confirms the results for the reduced form specification. They highlight the results is stronger in the periphery, particularly when these countries have a formal commitment to gold in place.

To summarize our findings for panel data, we uncover a negative and significant relationship between the price of exports and currency risk using structural and reduced form interpretations for our model, that we argue is causal. This relationship is robust to omitted variables that are country and year specific. We can use our preferred specification to comment on the economic significance of the results. Looking at the structural form regressions with country and year fixed effects for countries in the Periphery (Column (3) of Table 5), we document that a 10% decrease in the price index of the principal export in the periphery, causes an increase of 1.2% in currency risk spreads. Considering the yearly reduced form

[25]Results are qualitatively similar using the end of the month counterparts, or choosing a particular month within the year, although the level of statistical significance varies depending on which month is used.

	(1)	(2)	(3)	(4)	(5)	(6)
					On Gold	Not on Gold
Log Export Price	-0.23***	-0.05	-0.12*	-0.12	-0.13*	-0.13
	(0.07)	(0.05)	(0.06)	(0.08)	(0.06)	(0.08)
Log Export Price # Core			0.27***	0.56***	0.29**	0.51***
			(0.09)	(0.11)	(0.11)	(0.16)
Gold				0.01		
				(0.30)		
Log Export Price # Gold				0.01		
				(0.07)		
Core # Gold				1.34**		
				(0.52)		
Log Export Price # Core # Gold				-0.28**		
				(0.11)		
Year fixed effects		X	X	X	X	X
Constant	2.68***	1.60***	1.55***	1.19***	1.52***	2.22***
	(0.29)	(0.30)	(0.30)	(0.38)	(0.28)	(0.33)
Observations	8,901	8,901	8,901	8,901	5,926	2,975
Adjusted R-squared	0.03	0.23	0.24	0.24	0.22	0.28
# of countries	21	21	21	21	21	16

Table 5: Regression of the log of currency risk on the log of principal export price. Core takes on a value of 1 for the core countries, O otherwise. Gold takes on a value of 1 if the country has a formal gold commitment in place, 0 otherwise. # represents interaction. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses clustered at the country level.

specification, we obtain that a 10% decrease in the price index of the principal export in the periphery increases currency risk by approximately 10 basis points.

In this section we uncover a causal mechanism through which exogenous fluctuations of export prices affect currency risk. Our effect sizes are statistically significantly different from zero, but are quantitatively small. There are two reasons why one might expect to see small economic effects as we do. First, our results capture the effect of the principal export on currency risk, but countries often specialize in a number of products. Second, we are not attempting to explain the cross-sectional variation of currency risk, but instead identify a causal impact of export prices for each country. Note that expected volatility of export prices is already priced-in and absorbed by our country and year fixed effects. We take a conservative approach but find that the principal export price causes currency risk, particularly for the periphery, and while countries have a formal gold commitment.

3.5 Robustness

In this section, we perform a battery of robustness checks. We use deseasonalized price data, investigate the role of lagged effects, and augment the estimation of the model with a larger number of exports, imports, as well as a number of additional covariates.

3.5.1 Deseasonalized data

Some of the monthly variation in commodity prices may reflect seasonality. Looking at Table 2 it is not surprising that many of these exports face either supply and/or demand seasonality. Supply seasonality is associated with the natural growth or extraction calendar, while demand seasonality comes from general economic activity. This seasonality in international supply and demand may affect the price of exports for our countries at the monthly frequency but is not necessarily associated with the terms of trade shocks we considered in our theoretical model, and therefore may not be causing currency risk. In the model, we assume that price growth follows a random walk and shocks are permanent while changes in prices associated with seasonality are by nature temporary. As a consequence, using seasonally unadjusted data can bias the β coefficient. Table 6 reproduces the analysis from Table 5 but uses deseasonalized price data. It shows that results are relatively unchanged.

3.5.2 More exports, more exogenous exports, imports

In Table 3.5.2 we investigate the robustness of the reduced form results. In Column (1) we replace some of the main exports in 2 by main exogenous exports. To be exact, we replace nitrate with copper for Chile and remove the Netherlands from our sample. We can see that the effect size for the periphery is robust to using more exogenous exports. In Column (2) we add the second largest export to the principal export identified in Table 2, while in Column (3) we add the main import together with the principal export. Finally, in Column (4) we include the 3 main exports and the 3 main imports. The coefficient on the primary export is negative throughout. In general, only export price growth coefficients are significantly different from zero, which is consistent with our results.

	(1)	(2)	(3)	(4)	(5)	(6)
					On Gold	Not on Go
Log Export Price	-0.24***	-0.05	-0.11*	-0.11	-0.12**	-0.13*
	(0.06)	(0.05)	(0.06)	(0.07)	(0.06)	(0.06)
Log Export Price # Core			0.26**	0.55***	0.28**	0.50***
			(0.10)	(0.10)	(0.11)	(0.14)
Gold				0.03		
				(0.29)		
Log Export Price # Gold				-0.00		
				(0.06)		
Core # Gold				1.34**		
				(0.49)		
Log Export Price # Core # Gold				-0.28**		
				(0.11)		
Year fixed effects		X	X	X	X	X
Constant	2.69***	1.62***	1.56***	1.18***	1.53***	2.37***
	(0.27)	(0.30)	(0.30)	(0.37)	(0.26)	(0.28)
Observations	8,901	8,901	8,901	8,901	5,926	2,975
Adjusted R-squared	0.03	0.23	0.24	0.24	0.22	0.28
# of countries	21	21	21	21	21	16

Table 6: Regression of the log of currency risk on the log of principal export price (deseasonalized). Core takes on a value of 1 for the core countries, O otherwise. Gold takes on a value of 1 if the country has a formal gold commitment in place, 0 otherwise. # represents interaction. *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses clustered at the country level.

	Exogeneity				
Export 1 price growth	-0.50**	-0.39	-0.41	-0.44*	-0.75**
	(0.19)	(0.24)	(0.26)	(0.25)	(0.29)
Export 1 price growth# Core	1.22***	0.82*	0.92**	0.79*	1.15**
	(0.35)	(0.40)	(0.40)	(0.39)	(0.44)
Import 1 price growth			-0.09	0.03	0.01
			(0.12)	(0.12)	(0.13)
Import 1 price growth# Core			0.52***	0.23	0.27
			(0.16)	(0.18)	(0.33)
Export 2 price growth		-0.24*		-0.16	-0.10
		(0.13)		(0.10)	(0.09)
Export 2 price growth# Core		0.73**		0.44	0.21
		(0.29)		(0.27)	(0.37)
Import 2 price growth				-0.30*	-0.20
				(0.16)	(0.17)
Import 2 price growth# Core				0.58***	0.39*
				(0.20)	(0.22)
Export 2 price growth		-0.24*		-0.16	-0.10
		(0.13)		(0.10)	(0.09)
Export 2 price growth# Core		0.73**		0.44	0.21
		(0.29)		(0.27)	(0.37)
Import 2 price growth				-0.30*	-0.20
				(0.16)	(0.17)
Import 2 price growth# Core				0.58***	0.39*
				(0.20)	(0.22)
Year fixed effects	X	X	X	X	X
Constant	197.20***	88.18***	81.05***	114.27***	326.71***
	(0.31)	(26.96)	(26.44)	(3.75)	(10.22)
Observations	8,748	8,748	8,748	5,878	2,870
Adjusted R-squared	0.01	0.27	0.27	0.23	0.31
# of countries	21	21	21	21	16

3.5.3 Covariates

In this section we check the robustness of our results to a number of important covariates. We do not take a stance whether these events are endogenous or exogenous. Crucially, if export prices are exogenous, these variables should not affect our coefficient of interest. Table 7 includes monthly dummies that domestic and foreign wars, whether a country has a central bank or a stock market, is experiencing default or whether it is under the gold standard. These dummies capture institutions and events that may be relevant for the market perception of currency risk. The coefficient of our variable of interest is relatively unchanged and borderline significant.[26]

[26] One potential issue with this dummy regression is that we are over controlling. Regressions without year fixed effects increase the size and the significance of the coefficent.

Export price growth	-0.44*	-0.44*	-0.44*	-0.42	-0.72*	-0.42
	(0.24)	(0.25)	(0.24)	(0.25)	(0.38)	(0.25)
Export price growth# Core	1.03**	1.03**	1.03**	0.99**	0.45	0.99**
	(0.39)	(0.39)	(0.39)	(0.39)	(0.44)	(0.39)
Intra state war		4.76			-8.89	3.41
		(41.51)			(43.31)	(40.35)
Inter state war		-12.99			-9.21	-13.88
		(31.97)			(34.15)	(32.29)
Central bank			0.05		-35.67**	0.06
			(18.81)		(16.86)	(18.89)
Stock market			9.34		-9.16	8.66
			(18.89)		(25.57)	(19.33)
Default				115.35	238.94***	115.88*
				(67.27)	(60.55)	(66.66)
Year fixed effects	X	X	X	X		X
Constant	88.18***	88.15***	82.41***	86.57***	224.29***	81.16***
	(26.96)	(26.88)	(27.85)	(27.08)	(26.55)	(28.00)
Observations	8,748	8,748	8,748	8,748	8,748	8,748
Adjusted R-squared	0.27	0.27	0.27	0.27	0.04	0.27
# of countries	21	21	21	21	21	21

Table 7: Notes: Regression of the level of currency risk on the year-on-year growth rate of the principal export price. The dummy variable Core takes on a value of 1 for the core countries identified in Table 2, 0 otherwise. # represents an interaction. All regressions have country fixed effects, *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses clustered at the country level.

Export price growth	-0.88**	-0.89**	-1.81***	-0.78**	-0.75*
	(0.31)	(0.35)	(0.51)	(0.35)	(0.39)
Export price growth# Core	1.62*	2.08**	1.80***	1.95**	1.16*
	(0.80)	(0.73)	(0.52)	(0.71)	(0.59)
Trade balance % of exports	-0.26		-0.41	-0.50	
	(0.25)		(0.38)	(0.29)	
Sovereign bond spread		0.00	0.19	0.01	
		(0.08)	(0.16)	(0.09)	
Reserves % of GDP					-12.90***
					(3.34)
Year fixed effects	X	X		X	X
Constant	266.19***	227.71***	216.89***	223.74***	213.41***
	(24.46)	(29.12)	(34.22)	(29.63)	(19.14)
Observations	499	417	417	417	402
Adjusted R-squared	0.45	0.45	0.07	0.46	0.61
# of countries	16	16	16	16	13

Table 8: Notes: Regression of the level of currency risk on the year-on-year growth rate of the principal export price. The dummy variable Core takes on a value of 1 for the core countries identified in Table 2, 0 otherwise. # represents an interaction. FE stands for fixed effects, *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses clustered at the country level.

Finally, we include data on the trade balance and on the government bond spread over consols. It is important to control for the trade balance as negative shocks to export prices may lead to a deteroriation of the trade balance. Under a formal commitment to gold, this may put pressure on the gold reserves and make leaving a peg more likely. Controlling for the spread of government bonds over consols is also important as it can capture whether currency risk is measuring expected devaluation or, at least in part, default risk. Table 8 collects the results. We can see that the relationship between trade balance and currency risk is negative, but the coefficient for the growth rate in the price of exports is relatively unchanged and more precisely estimated than before.

3.6 Discussion

The mechanism explored in the model works through domestic denominated debt. Although we do not have data on the proportion of debt denominated in domestic currency for all our 21 economies, Accominotti et al. (2011) reports that a substantial share of public debt was in fact denominated in domestic currency, including in some economies in the periphery.[27]

4 Conclusion

This paper identifies one important determinant of pegxits: export prices. We study theoretically and empirically whether export price shocks affect the expec-

[27] Although we focus on a reduction of real debt payments of foreign debt, it should be noted that the mechanism we study works also for reduction of real payments of domestic debt, but also through additional sources of inflation-related revenues, for example, seigniorage and the reduction of real payments of nominal government contracts and wages. Related, the ability to conduct independent monetary policy is an additional benefit when leaving a peg.

tation of currency devaluation. Using a simple model of peg exits and currency devaluation, we show that export price shocks are negatively related to the risk of currency devaluation. The intuition behind our main theoretical result is that negative export price shocks decrease government revenues, but they do not affect inflation related revenues. Given that inflation-related revenues (e.g., seigniorage obtained by printing money) are inconsistent with a currency peg, negative price shocks increase the probability that a government will raise inflation-related revenues, and therefore, leave a currency peg. In other words, negative export price shocks increase currency risk while positive export price shocks decrease it.

We test the existence of this mechanism during the classical gold standard era and find that exogenous export price shocks matter even for a period where pegs were considered relatively credible. Our identifying empirical assumption is that world prices are exogenous to price-taking countries. We find a negative causal relationship between the price of exports and currency risk that is consistent with our theoretical results. The results are driven by countries in the periphery, and are stronger in periods where countries formally adopt the gold standard as a fixed exchange rate mechanism.

From a theoretical perspective, our model can be extended in a number of interesting ways. On the production side of the model we assumed long-run flexible prices and that devaluation decreases trade. Although these two assumptions are consistent with the time period of our empirical analysis, it would be relevant to incorporate price-stickiness and to study the mechanism through which currency devaluation can affect economic activity. One interesting avenue for future research is to consider balance sheet currency mismatches that can turn a currency devaluation into a banking crises. We have also omitted default risk from our model and empirical analysis. Although our measure of currency risk does not capture default risk, these may interact, and export price shocks may also be relevant for the dynamics of default risk.

Some of these extensions lend themselves to empirical work within the classical gold standard era. We have limited our empirical analysis to the principal exogenous export for each country. Although this was motivated by our theoretical results - and the desire to identify one exogenous export and explore high-frequency data; including the full portfolio of exports and imports would allow us to assess the magnitude of the impact of trade shocks on currency risk. Finally, we have taken a partial equilibrium perspective on currency risk where countries take international prices for their exports as given. Besides participating in a global goods market for their exports, countries in the gold standard were linked also through imports, as well as immigration and capital flows. In future work, we plan to study these relationships further.

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A Data for world prices and principal exogenous export

In this Appendix we collect the data sources used in the paper. First, we collected a number of price series for different products. Second, we identify the principal exogenous exports for the countries in our sample for which we have data at the monthly level.

A.1 Price series notes

We collected a number of monthly price series for different products from *The Economist*. We select the price series that maximizes data coverage and consistency throughout our sample (1870-1913). This is important as some price series change units or definitions. We create price indices for each relevant product price series that take on the value of 100 for the average on the price in 1913. We select 1913 as our base year as the initial date for which we have data varies across series. The list below provides details on the prices used:

Beef: Inferior.

Butter: Prices series for Dutch (including Friesland) and Danish butter.

Coffee: Between 1870-1881, Jamaica Fine Ord. to Fine. Between 1881-1913, Ceylon, Plantatn. Low mid changed to Santos Good Average in 1908.

Copper: Between 1870-1881, Copper: Tough Cake. Between 1881-1913, Chili Bars changed to G.M.B in 1899, Standard in 1912.

Cotton: Between 1870-1881, Mule No 40, Fair, 2nd quality, Manchester Markets. Between 1881-1913, Yarn-40 Mule Twist.

Lead: English Pig.

Sugar: Between 1870-1881, Bengal Good Yellow and White. Between 1881-1902, West India Refining. Between 1902-1913, West India Syrups.

Wheat: Between 1870-1881, Wheat Gazette Average. Between 1881-1913, Gazette Averages (English Grain) - Wheat.

Wool: Sydney Unwashed/Changed to NS.Wles Greasy Average in 1891.

Rice: Rangoon.

Silver:

Silk: Between 1870-1881, Raw Cossimbuzar. Between 1881-1913, Cossimbuzar.

Wood: Price series for Norwegian, Swedish and Finnish timber.

A.2 Principal exports

We use a number of sources to identify a country's principal exports including: British Board of Trade (various years), Mitchell (2007b), Mitchell (1982), Hanson (1980) and Blattman et al. (2007). The summary table below captures each country's biggest export for 1870, 1880, 1890, 1900 and 1910 (when available). Our primary source is the Statistical Abstract for the Principal and other Foreign Countries from British Board of Trade (various years), henceforth, SA.

The list below summarizes our findings:

Argentina: Wool. Mitchell (2007b) reports that the average value of wool exports for Argentina between 1870 and 1914 was 40.2 million gold pesos, compared to 35.7 million gold pesos for wheat and 22.4 million gold pesos for hides and skins. According to the SA wool accounted between 49.9% of Argentina's exports (1889) and 19.9% in (1904).

Austria-Hungary: Wood. According to the SA, Wood is the largest export for Austria-Hungary in our sample (14 times the largest export). Sugar follows closely (11 times). Hanson (1980) reports that for 1900 the largest export for Austria was raw sugar (37.9 million dollars), followed by cotton manufactures (4.6 million dollars). Given that we do not have data on Austria-Hungary wood, we use the price of swedish wood as a proxy for the monthly series.

Belgium: Flour. According to the SA, Flour is the largest export for Belgium in our sample (11 the times largest export) Hanson (1980) reports that for 1900 the largest export for Belgium was raw sugar (15.3 million dollars), followed by hides and skins (9.2 million dollars).

Bulgaria: Wheat. According to the SA, Wheat is consistently the largest export for Bulgaria. Chirot (1991) reports that wheat sales represented 70% of Bulgaria's export totals around 1900. Confirmed by Lampe and Jackson (1982).

Chile: Nitrate. Mitchell (2007b) reports that the average value of copper exports between 1870 and 1914 was 29.6 million gold pesos of 18 pence, which is smaller than the value of Nitrate exports for the same period (125.4 million gold pesos of 18 pence). Results are robust to using copper as the principal export as Chile.

Denmark: Butter. According to the SA, Flour and Butter are the most representative exports for Denmark. Flour accounts for a larger share of exports earlier in our sample, while butter dominates after 1890. Blattman et al. (2007) reports that meat accounted for 32.9% of Denmark's exports between 1898 and 1902. Butter accounts for the largest percentage of exports during this period (54.7%). We use the monthly price of Dutch butter to proxy for Danish butter, for which we only have data from 1894 onwards. The correlation coefficient between Danish and Dutch butter following 1894 is 0.87.

Finland: Timber. Hjerppe (1989) report that timber and wood products accounted for 46.05% of Finnish exports between 1869-1913.

France: Textile manufactures. According to the SA, wool, silk and cotton manufactures represent the largest exports for France, followed by wine and hides. Hanson (1980) reports that for 1900 the largest export for France are silk manufactures (61.5 million dollars), followed by cotton manufactures (34.9 million dollars). Given that we do not have monthly data for silk manufactures we proxy the price of France's largest export with an index for textile products from the NBER.

Germany: Iron. According to the SA iron products are the largest export for Germany for 13 years, followed by sugar. Hanson (1980) reports that for 1900 the largest export for Germany are cotton manufactures (67.1 million dollars), followed by raw sugar (51.5 million dollars).

Greece: Iron. According to the SA the main export are dried fruits, followed by ore (as high as 30% of exports in 1895). Blattman et al. (2007) reports that fruits & nuts account for 59% of Greece's exports between 1898 and 1902. The second largest export is lead, accounting for 14.1%.

India: Cotton. Mitchell (1982) reports that the average value of cotton exports between 1870 and 1913 was 167.3 million rupees. Rice accounts for the second largest export, averaging 128.2 million rupees, followed by opium, jute, cotton manufactures, tea and jute manufactures. Blattman et al. (2007) reports that rice accounts for 21.1% of Indias's exports between 1898 and 1902. Other important exports include cotton (16.9%), cotton manufactures (13.8%), jute (13.7%), tea (12.2%), opium (11.7%) and jute manufactures (10.6%).

Italy: Silk. SA reports that silk, raw and thrown waste cocoons account for the largest share of Italy's exports, followed by silk manufactures. Hanson (1980) reports that for 1900 the largest export for Italy are silk manufactures (86.6 million dollars), followed by cotton manufactures (11.8 million dollars).

Japan: Silk. Mitchell (1982) reports that the average value of raw silk exports between 1870 and 1913 was 46.15 million yen, followed by cotton yarn & fabrics (25.9%) and silk fabrics (19%). Confirmed by SA.

Mexico: Silver. Mitchell (2007b) reports that the average value of silver exports between 1870 and 1913 was 52.5 million pesos, much larger than the second largest export, coffee (6.7 million pesos).

Netherlands: Wheat. SA reports that drugs are the largest export for the Netherlands, followed by Wheat. Hanson (1980) reports that for 1900 the largest export for Netherlands are cotton manufactures (16.2 million dollars), followed by Dyes and Dyestuffs (9.1 million dollars). Given that the Netherlands are monopolists in the market for Peruvian Bark we select wheat, for which we have monthly prices.

Norway: Wood. SA reports that wood and fish are the largest exports for Norway. Blattman et al. (2007) reports that wood and products accounted for 44.2% of Norway's exports between 1898 and 1902. Fish accounts for the largest percentage of exports during this period (50.1%), but we do not have monthly data for norwegian fish.

Romania: Wheat. SA reports that wheat is the largest export for Romania, followed by maize and barley. Chirot (1991) reports that wheat sales represented 80% of Romania's export totals around 1900. Confirmed by Lampe and Jackson (1982).

Russia: Wheat. SA reports that wheat is the largest export for Russia, followed by flax and wood. Blattman et al. (2007) reports that grain accounted for 63.0% of Russia's exports between 1898 and 1902, 65.0% between 1878 and 1882.

Sweden: Wood. SA reports that wood is the largest export for Sweden, followed by iron products, oats and butter. Johansson (1967) reports that between 1891 and 1895 wood products accounted for 28% of Sweden's exports.

Switzerland: Textile manufactures. SA reports that silk and cotton manufactures represent the largest exports for. Hanson (1980) reports that for 1900 the largest export for Switzerland are silk manufactures (40.7 million dollars), closely followed by cotton manufactures (32.9 million dollars).

United States of America: Cotton. SA reports that cotton is the largest export for the USA, followed by wheat and meat and sausages. Mitchell (2007b) reports that the average value of cotton exports between 1870 and 1913 was 250 million dollars, larger than the second largest export, wheat (108 million dollars).

Gold dates

Country	Gold dates
Argentina	1870m1 - 1876m5, 1883m7 -1885m1 , 1899m11 - 1914m6
Austria-Hungary	1892m8 - 1914m6
Belgium	1878m11 - 1914m6
Bulgaria	1902m11 - 1912m10
Chile	1895m6 - 1898m7
Denmark	1873m5 - 1914m6
Finland	1877m12 - 1914m6
France	1878m11 - 1914m6
Germany	1871m10 - 1914m6
Greece	1885m1 - 1885m8, 1910m3 - 1914m6
India	1898m1 - 1914m6
Italy	1883m2 - 1894m12
Japan	1897m9 - 1914m6
Mexico	1905m4 - 1913m12
Netherlands	1875m6 - 1914m6
Norway	1873m5 - 1914m6
Romania	1890m4 - 1914m6
Russia	1897m1 - 1914m6
Sweden	1873m5 - 1914m6
Switzerland	1878m12 - 1914m6
United States of America	1879m1 - 1914m6

Table 9: Gold dates.

Top Exports (ordered)	1870	1880	1890	1900	1910
Argentina		Wool, Hides, Meat	Wool, Hides, Maize	Wheat, Wool, Hides	Wheat, Maize, Wool
Austria-Hungary	Flour, Animals+, Coal	Grain and Flour, Sugar*, Wood	Sugar* , Barley, Animals+	Wood, Sugar*, Eggs	
Belgium	Flax, Coal, Hides	Grain and Flour, Flax hemp and jute, Wollen yarn	Machinery, Grain and Flour, Coal	Machinery, Coal, Iron products	
Bulgaria			Wheat, Maize, Animals	Wheat, Animals, Maize	
Chile		Copper, Nitrate	Nitrate, Copper	Nitrate, Copper	Nitrate, Copper
Denmark	Wheat flour meal, Bacon and Hams, Rye meal	Wheat flour meal, Rye meal, Bacon and Hams	Butter, Animals, Meats and Sausages	Butter, Eggs, Horses	
Finland	Timber and wood products, no data by year				
France	Silk manuf, Wool manuf, Wine	Wool manuf, Wine, Silk manuf	Wool manuf, Silk manuf, Wine	Silk manuf, Wine, Wool manuf	
Germany (1872)	Grain and Flour, Coal, Animals	Silk manuf, Grain and Flour, Wool manuf	Iron products, Wool manuf, Cotton manuf		
Greece	Fruit, Lead products, Olive and palm oil		Currants and raisins, Ore, Olive and palm oil	Currants and raisins, Ore, wine	
India	Cotton, Opium, Rice	Opium, Cotton, Rice	Cotton, Rice, Cotton manuf	Rice, Cotton, Tea	Cotton, Rice, Jute manuf
Italy	Raw silk, Olive and palm oil, Grain and Flour	Raw silk, Olive and palm oil, Wine	Raw silk, Fruit, Olive and Palm oil	Raw silk, silk manuf, Fruit	
Japan (1882)	Raw silk	Raw silk, Tea, Rice	Raw silk, Tea, Copper and copper manuf	Silk, silk manuf, cotton yarn	Raw silk, cotton yarn, silk manuf
Mexico	Silver	Silver, Iron ore, Copper	Silver, Coffee, Lead	Silver, Coffee, Copper	Silver, Copper, Coffee
Netherlands	Sugar, Coffee, Raw cotton	Iron products, Graind and Flour, Drugs	Drugs, Iron products, Wheat	Drugs, Wheat, Iron products	
Norway	Beer, Wood, Trainoil	Wood, Fish and Seafood, Trainoil	Fish and sea food, wood, Trainoil	Fish and sea food, wood, Woodwares	
Romania (1882)		Wheat, Maize, Barley	Wheat, Maize, Oleaginous Seeds	Wheat, Oleaginous Seeds, Maize	
Russia	Wheat, Flax, Oleaginous Seeds	Wheat, Oleaginous Seeds, Rye	Wheat, Flax, Wood	Wheat, Rye, Wood	
Sweden	Wood, Oats, Lucifer matches	Wood, Iron products, Oats	Wood, Iron products, Butter	Wood, Iron products, Butter	
Switzerland (1871)	Wood, Cheese, Cotton manuf	Wood, Cheese, Cotton manuf	Cotton manuf, Silk manuf, Watches and Clocks	Silk manuf, Cotton manuf, Watches/clocks	
United States of America	Cotton, Wheat, Mineral refined oil	Cotton, Wheat, Indian corn	Cotton, Meat and sausages, Wheat flour meal	Meat and sausages, Cotton, Indian corn	

Sugar: raw and refined Animals: except horses