

A New World Order: Explaining the Emergence of the Classical Gold Standard

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Abstract

It is rarely recognized that the classical gold standard only gradually became an international monetary regime, and to date, there has been no cross-country econometric analysis of the issue. I use duration analysis to show that *network externalities* explain the pattern of diffusion of the gold standard. Countries adopted the gold standard sooner when they had a large share of trade with other gold countries relative to GDP. Also, countries with sound financial systems and the institutional capabilities to maintain a convertible currency adopted sooner. I find no evidence that exchange rate volatility or concerns about deflation mattered for the timing of adoption. The paper is relevant to research on why countries join currency unions today, and how monetary regimes and transaction costs affect trade.

Keywords: gold standard; network externalities; financial institutions; currency union; inconvertibility; duration; hazard; gravity.

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1 Introduction

In the waning decades of the nineteenth century, the world economy came to have the first truly global monetary system. In 1870, the only major nations using a gold standard were Great Britain, Australia, Canada and Portugal. However, by 1910, most nations had come to adopt the gold standard.

This paper investigates the nearly universal adoption of the gold standard prior to 1913. In particular I ask why some countries adopted the gold standard earlier than others. The diffusion of the classical gold standard, while eventually nearly universal, was gradual. For this reason, the years between 1870 and 1913 provide evidence on the cross-sectional and time series determinants of why countries prefer one monetary regime to another or why countries forego monetary autonomy for a system of uniform currency and fixed exchange rates.

By joining the gold standard, countries pledged to trade a fixed quantity of gold for a certain amount of domestic currency units. Consequently, the classical gold standard unleashed a global regime of fixed exchange rates and *monetary uniformity*. This system reduced the transaction costs of trade between all gold standard countries. Hence, the rise of this system may have substantially affected global integration in the nineteenth century.¹

Rose (2000) finds that when two countries joined a currency union between 1970 and 1990 they could expect to increase their trade by about 300 percent. The effect comes purely from having a monetary union and not from the omission of factors such as exchange rate volatility, political or geographic factors or unobserved variables that might drive both trade and monetary coordination. Similarly, López-Córdova and Meissner (2000) find that, between 1870 and 1910, the gold standard seems to have increased trade between two countries by nearly 60 percent.² In other words, coordination in monetary

¹Obstfeld and Rogoff (2000) show how small costs to trade can significantly affect the home-bias in trade.

²López-Córdova and Meissner (2000) also find that joining a monetary union in the late nineteenth century increased trade by nearly 200 percent. Flandreau and Maurel (2000) use a gravity model during the late 1800s for Europe. They find that monetary unions increase integration.

regimes may have a surprisingly large impact on economic outcomes. Moreover, the trade-offs nations faced when joining the nineteenth century gold standard parallel those which countries face today when deciding to join a currency union.

To explain why some countries adopted the gold standard earlier than others, I develop a model of monetary regime choice. The model generates testable predictions which I examine using duration analysis. Throughout the paper, I make reference to the historical record and the statements of policy makers and economists of the nineteenth century.³

I find substantial evidence that *network externalities* matter for explaining the timing of the adoption of the gold standard. As I discuss below, joining the gold standard decreased the cost of trade with other gold standard countries. Consequently, countries adopted gold sooner the more they traded with other gold standard countries. Conversely, for bimetallic or silver countries, heavy trade links with others in the bimetallic or silver blocs, respectively, led to a later adoption of the gold standard.

Some evidence also shows that nations needed *institutional capability* to join the gold club quickly. Loosely regulated banking systems or relatively backward financial systems delayed adoption of the gold standard. Additionally, the level of output per capita accelerated the move to the gold standard. On the other hand, higher deficit to GDP ratios are associated with earlier adoptions of the gold standard.

I also find that many other factors *cannot* explain the timing of the move to gold convertibility. Econometric results show the gold standard was not a defense against exchange rate volatility nor did the creditor class foist the gold standard upon agricultural debtors. Also, the desire to decrease the cost of capital inflows cannot explain the timing of the implementation of the gold standard. All of these issues may have entered the political debates of the time or might have mattered in individual cases, but the cross-country analysis suggests they played no universal role in the decision to join the classical gold standard.

³Though this is the first econometric study of the issue to my knowledge, many of the hypotheses I test have already been put forward in the modern literature (see for example Gallarotti (1995) and Eichengreen and Flandreau (1998)). In part, this paper is a test of these narrative-based hypotheses.

I begin my study by briefly outlining the history of the international monetary system from the 1860s up to 1913. In Section 3, I sketch a framework that analyzes the trade-offs nations faced when choosing whether or not to adopt the gold standard. The logic of that framework is formally analyzed in Appendix A. In the following section, I present a number of other hypotheses I wish to test. In the final section, I describe my econometric approach and present the results. I follow up with a sensitivity analysis of my conclusions. When necessary, I make reference to the historical record.

2 A Brief History of the International Monetary System, 1850 to 1913

Prior to 1870, few countries had currencies which were convertible exclusively into gold. The notable exception was Great Britain which chose a gold standard in 1816.⁴ Later in the 1850s, Australia and Canada joined their mother country in adopting a gold standard. Portugal, adopting the gold standard in 1854, was the only other European country to go on gold before 1870.⁵

During the 1850s and 1860s, many bimetallic states became de facto gold standard countries. Gold discoveries shifted the market ratio of gold and silver, setting Gresham's law into motion (Russell (1898)).⁶ But until 1871, when Germany embarked on national monetary reform and changed its standard from silver to gold, few countries explicitly made their currencies convertible only into gold.

A sea change in national monetary strategies was evident at the International Monetary Conference of 1867. Delegates, representing 20 nations from Europe along with the United States, discussed the worldwide adoption of a monometallic (i.e., either gold or silver) globally uniform system of coinage. At the conclusion of the conference, most

⁴Eichengreen (1996) cites Sir Isaac Newton's overvaluation of gold in 1717 as the historical accident that led to England's preference for a gold standard. A detailed history can be found in Seyd (1868).

⁵This nation had extensive commerce with England and a powerful debtor class that preferred an inflationary standard—as gold was deemed to be in the 1850s (Reis (1998)).

⁶Russell (1898) claims that this was the case in general. Flandreau (1996), however, argues that bimetallicism in France continued to function normally throughout the period.

delegates supported a worldwide monetary union based on gold.⁷

The conference record shows that Scandinavian countries were strong advocates of gold as were the delegates from the German states. At the other end of the spectrum, Russia and Holland—a nation with a vast silver-using empire in southeast Asia—strongly opposed a monometallic gold standard. Nevertheless, Holland conceded it would admit a gold standard if its trading partners in Europe moved to gold. Thus, many countries had already contemplated the shift to gold prior to 1871. Over the course of the next two decades, nations put action to words.

Table 1 lists the dates of adoption of gold convertibility for a number of countries.⁸ In 1872 Germany abandoned silver for gold setting off a domino effect. Norway, Sweden and Denmark followed suit and adopted the gold standard in 1873. In the meantime, bimetallic France suspended silver coinage in late 1873. Flandreau (1996) argues that policy-makers acted defensively hoping to stop the invasion of German silver and halt the flight of gold. In 1878, France, along with Belgium and Switzerland chose gold convertibility and abandoned bimetallism.⁹ The United States regained free convertibility of the dollar into gold in 1879.¹⁰

Nations in the less-developed periphery, with a propensity to over-issue paper currency, relatively backward financial systems and less connection to international commerce, waited to adopt.¹¹ In the late 1890s and early 1900s, the gold standard diffused

⁷See Russell (1898) for an authoritative study of the conference. See Reti (1998) for a modern analysis of these events.

⁸In the literature, there are discrepancies regarding the exact dates of adoption of the gold standard. Some notable cases include Austria-Hungary, Argentina, and Norway. I have tried to use the dates that correspond most closely to what country experts have said is the date of adoption. In any case, discrepancies in dating alter none of the conclusions of this paper.

⁹Flandreau (1996) cites a French survey from the 1860s which tellingly reveals the origin of national preferences over monetary regimes. Merchants engaged in trade with England plumped for a gold standard. The east and south of France apparently preferred a silver regime because of the greater amount of trade with silver countries like Germany, Austria-Hungary, Russia and Asia.

¹⁰The United States, by legally demonetizing silver, in the infamous “crime of 1873,” had already expressed its intentions to move to gold. The country had to wait to clear the hangover from the Greenback period of the 1860s.

¹¹Less developed nations, close to the expanding gold bloc in Europe, like Italy, Spain and Greece wobbled on the edge of adopting gold. Italy hesitated but made the leap in 1884. Spain never adopted, but Martín-Acena (2000) argues that it could have easily made the transition in the 1880s. Greece also tried adopting the gold standard in 1885 only to be pushed off in the same year due to a financial

Table 1: Year in which Countries Adopted the Gold Standard

| <i>Country</i> | <i>Year of adoption of gold convertibility</i> | <i>Country (cont.)</i> | <i>Year of adoption of gold convertibility (cont.)</i> |
|----------------|--|------------------------|--|
| Australia | 1852 | India | 1899 |
| Canada | 1853 | Costa Rica | 1900 |
| Portugal | 1854 | Ecuador | 1900 |
| Argentina | 1863, 1883, 1903 | Philippines | 1903 |
| Uruguay | 1863 | Straits Settlements | 1903 |
| Colombia | 1871 | Siam | 1903 |
| Germany | 1872 | Mexico | 1905 |
| Sweden | 1873 | Brazil | 1906 |
| Denmark | 1873 | Bolivia | 1908 |
| Norway | 1873 | Greece | 1910 |
| Netherlands | 1875 | Nicaragua | 1912 |
| Finland | 1877 | Austria-Hungary | --- |
| Belgium | 1878 | Santo Domingo | --- |
| France | 1878 | Haiti | --- |
| Switzerland | 1878 | Bulgaria | --- |
| United States | 1879 | China | --- |
| Turkey | 1880 | Guatemala | --- |
| Italy | 1884 | Honduras | --- |
| Egypt | 1885 | Indonesia | --- |
| Chile | 1887 & 1895 | Paraguay | --- |
| Romania | 1890 | Persia | --- |
| Salvador | 1892 | Peru | --- |
| Japan | 1897 | Spain | --- |
| Russia | 1897 | Venezuela | --- |

Note: This table uses the date of adoption of the free convertibility of a currency exclusively into gold. The entry "---" means that the country did not adopt gold convertibility before 1913.

to the southern cone of Latin America and most of Asia. Ultimately, on the eve of World War I, much of the world had managed to adopt the gold standard.

3 Benefits and Costs

In this section, I argue that the trade-offs a nation faced when joining the gold standard very much resembled those involved in deciding whether to join a currency union.¹² In Appendix A, I develop a formal model of trade and strategic interaction that verifies the logic of this section. The main argument is that nations chose the gold standard to economize on the costs of trade. The larger the gold bloc was the greater the cost savings; monetary regimes exhibit network externalities or *strategic complementarities*.

3.1 Decreasing Transaction Costs

As in a currency union, sharing a commodity money regime appears to have lowered the cost of trade. If this is the case, such homogenization should have fomented trade.¹³ López-Córdova and Meissner (2000) use a gravity model to examine this issue.¹⁴ Our baseline results show that trade increased by 60 percent when both countries joined the gold standard.¹⁵

Contemporary observers also thought monetary harmonization lowered the cost of trade. Importers from the U.S., testifying to the Silver Commission of 1876, declared

crisis—a crisis emblematic of its weak financial position. Eventually Greece adopted gold in 1910 after a series of reforms that began in 1897 (see Lazaretou (1995)). Austria-Hungary never adopted gold convertibility mainly because of the inability to sustain fiscal discipline (see Flandreau, Le-Cacheux, and Zumer (1998)).

¹²Alesina and Barro (2000) present a theoretical model where a nation’s benefit to joining a monetary union depends on the level of trade with countries already using the currency up for adoption, the ability to commit to price stability and the co-movements of relative prices and shocks to output.

¹³Obstfeld and Rogoff (2000) show, in a formal setup, how such costs can have non-linear effects on the home bias in trade. The effects of even small costs to trade can have enormous effects on the degree of integration.

¹⁴A gravity model of trade asserts that bilateral trade is a function of the distance and size of trading partners. We use a log-linear, OLS approach to estimate the effects of various explanatory variables on bilateral trade.

¹⁵Results are robust to specification and data problems and the potential endogeneity of the gold standard dummy.

their support for the gold standard. A.A. Low, an American importer of Chinese merchandise, advocated the gold standard because his purchases were made through London in the gold-backed pound sterling. For merchants like A.A. Low, sharing a common metallic standard with London saved broker's commissions (Meyer (1878) and United States Monetary Commission (1879)). Also, J.S. Moore, a U.S. Treasury official testified as follows:

Q. 118. Do you not think that the use of a common standard of value has a tendency to promote a free commercial interchange between the various countries using it?

A. . . . and if two countries, be they ever so distant from each other should have the same standard of money . . . there would be no greater harmonizer than such an exchange. If our silver dollar were to pass current in Mexico and South America, or if we had a union dollar, we should have much more of their trade and intercourse . . . (United States Monetary Commission (1879))

It is also important to remember that for silver nations and bimetallic nations, the status quo might have conferred network externalities as well. One example of this comes from Scandinavia. Denmark, Sweden and Norway, all silver countries prior to 1873, met at the Nordic economic meetings in 1872 to make a joint decision about monetary regime choice (Henriksen and Koergard (1995)). By making a multilateral decision with principal trading partners, no country had to forego the benefits from being on silver in a unilateral deviation to gold.

3.2 Institutional Capability

However, the decision differed from the choice to join a monetary union. In a currency union, control of the money supply is delegated to an anchor nation. Under the gold standard, no mechanism existed to tie the hands of note issuing institutions and spend-thrift governments. By joining the gold standard, countries had to unilaterally pledge

convertibility of domestic liabilities into specie at a fixed price. Speculative capital was sure to put a country to the test sooner rather than later.¹⁶ In this respect, adopting the gold standard appears more comparable to the implementation of a currency board or a pegged exchange rate.

Paper countries could not switch to gold convertibility without building institutional capability, a politically difficult reform to eliminate fiscal deficiencies or a protracted debate on the method of transition to convertibility.¹⁷ By institutional capability, I mean the existence of a legal framework that limited over-extension in the banking sector and/or political mechanisms that prevented the monetization of debt or the entrenchment of spendthrift interest groups. But often, simply re-establishing convertibility proved to be a political quagmire.

The American experience points out how difficult it was for paper countries to negotiate the precise method by which resumption of convertibility would be financed and carried out (Unger (1964) and U.S. Commission on International Exchange (1904)). A large portion of the U.S. Silver Commission's hearings were devoted to gleaning opinions on the best method of financing the retirement of outstanding U.S. government liabilities—"Greenbacks." Political debates throughout the postbellum period were sharply divided over the currency issue. Also, Russia and Argentina underwent a severe and prolonged depression in the 1890s in attempts to restore convertibility.

Many financially undeveloped and fiscally imprudent countries like the Philippines, Mexico, and Brazil waited until the first decade of the twentieth century to adopt

¹⁶Keynes (cited in Eichengreen and Flandreau-(eds.) (1997)) was the first to point out that the gold standard worked like a *target zone*; in the short-run, nations had some monetary autonomy and did not have to play by the rules of the game. What mattered was the *ultimate commitment* to convertibility. Nations were put to the test often enough as each decade from the 1870s to 1913 witnessed at least one global financial crisis (Bordo and Eichengreen (1999)).

¹⁷This notion does not argue that the social benefits to adopting gold would not be very large if a nation could delegate the responsibility for the money supply to another more stable nation. In fact, if they could do so, the marginal benefit to linking to such a system might be larger than for convertible countries. But, since the gold standard differed from a currency union in that entry, exit and, to the extent nations had fiduciary issues, control of the money supply was controlled domestically, such nations could not *easily* capitalize on those benefits. Also, a large literature in macro-political economy discusses the difficulty controlling structural deficits once they have taken root.

gold. Scandinavia, France and Germany, with well-developed financial systems, adopted quickly. The United States, Italy and Argentina, all adopting convertibility between 1879 and 1885, sat in the middle of these ranks with their fragmented, loosely regulated banking systems.¹⁸

Peripheral countries like Austria-Hungary, Greece, Russia and Spain had fiscal problems to resolve before they could go to gold.¹⁹ Persistent government deficits may have made sustained gold convertibility more difficult. Fiscal imprudence appears to have contributed to delayed adoptions in these countries.

In conclusion, sharing a commodity regime lowered the transaction costs of trade. The size of the cost savings were directly related to the amount of trade with gold standard countries. As more countries joined the gold standard, integration with the gold standard increased. Hence, the benefit to adopting the gold standard was larger the greater the number of countries adhering to gold. In short, there was a network externality associated with the gold standard.

Despite this benefit, nations had to achieve the institutional capability to maintain convertibility. Countries with weak financial systems would have effect institutional innovation or at least wait for a settled international financial environment so that they could join the gold standard.²⁰

The next section explores the implications of these hypotheses. I provide a way to test this monetary homogenization hypothesis with the historical data. I also examine

¹⁸Of course the United States was making rapid advances after the Civil War but also suffered the legacy of the Greenback era. Argentina, an important recipient of British capital, had a relatively well developed banking system as of the mid-1880s. That system imploded culminating in the Barings Crisis of 1890 (see Cuccorese (1972) and Conant (1927)). Italy had a consortium of large regional banks that, until the early 1890s when a series of crises hit, provided a relatively sound financial foundation (Fratanni and Spinelli (1997)).

¹⁹Many of the costs and difficulties that the move to gold implied for paper regimes have been extensively discussed in the national histories. For the countries in my econometric sample, see Flandreau, Le-Cacheux, and Zumer (1998) on Austria-Hungary, Lazaretou (1995) on Greece, García-Iglesias Soto (1998) and Martín-Acena (2000) on Spain, Fritsch and Franco (2000), pp. 154-157, on Brazil and Barkai (1973) on Russia.

²⁰Even if such a country managed to gather the resources to join the gold standard it was likely to soon exit from the gold standard in the face of a generalized crisis. Examples are Greece in 1885, Italy in 1893, Argentina in 1884 and Chile in 1898.

other hypotheses from the literature.

4 Hypotheses and Variable Definitions

The primary goal of this paper is to estimate the effects of various explanatory variables on the timing of the adoption of gold convertibility. In this section, I explore a number of other hypotheses from the literature. First I address why the focus is strictly on the timing of the implementation of the gold standard. I then describe the mechanics of adopting the gold standard.

4.1 A Note about Monetary Regime Options: 1870-1913

Up to 1870, countries had a range of monetary systems available to them. Bimetallism, silver, gold and inconvertible paper currencies (i.e., fiat regimes) were the usual types of monetary regimes.

However, no nation in my sample moved to adopt any other regime besides gold or a fiat currency. While some nations started out with silver or bimetallic currencies, eventually these became gold countries. Russia, Japan and Spain were silver or bimetallic countries in 1870, but moved onto a fiat regime soon after 1870.

Finally, many countries already had a fiat regime beginning in 1870.²¹ Paper currencies often plagued nations that had been rocked by financial crises or had governments with extensive fiscal needs.²² After 1870, a return to convertibility, to which most countries aspired, meant adopting the gold standard.

²¹Nearly all commentators of the time viewed inflation and price fluctuations to be the hallmark of a fiat regime while metallic convertibility provided price stability. However, countries like Chile and Brazil did have advocates of inflation. Subercaseaux (1922) refers to the “papeleras” of Chile. These were staunch opponents of convertible currencies which were thought to restrict commerce.

²²Countries like Greece, Chile and Argentina often aspired to return to convertibility as soon as possible after having lost convertibility. Frequently, one sees emergency declarations of suspension of convertibility, especially in Chile and Argentina, accompanied by governmental declarations that convertibility would be restored quickly (see for instance Subercaseaux (1915) and Cuccorese (1972)). See Flandreau, Le-Cacheux, and Zumer (1998) for more on the endogeneity of the ability to commit to fiscal propriety.

4.2 Mechanics of Transition

To join the gold standard, a country established a law fixing the price of gold in terms of domestic currency units and allowed for an unfettered market for gold. Additionally, national authorities or legislatures usually declared a ratio (which varied by country) of gold reserves and/or foreign assets to outstanding liabilities which had to be maintained by note-issuing institutions. To obtain these reserves, most countries either sold silver reserves or borrowed the necessary funds on international capital markets.

For more developed countries in Europe, the transition to gold meant simply redefining the national currency strictly in terms of gold and finding or buying adequate gold reserves. For already convertible currencies, the particular amount of gold chosen per currency unit usually resulted in the amount that maintained the historical level of the exchange rate vis-à-vis a gold currency like England.

Paper countries faced a different scenario. The United States retired some outstanding paper currency in the 1860s, while in the 1870s the country disinflated by restricting Greenback growth. In 1879 the United States recovered the pre-Greenback era nominal exchange rate against the pound sterling. On the other hand, countries like Russia in 1897 and Argentina in 1899 took a shortcut. After suffering an inflationary fiat regime, these countries adjusted their par values downward and resumed convertibility with a nominally depreciated currency.²³

Finally, less developed countries often packaged the initiation of the gold standard with the creation of a national currency system. Countries like Argentina in 1884 and the Philippines in 1903 radically revamped their historically chaotic monetary systems as commerce reached a level necessitating an organized system of intermediation and payments (Cuccorese (1972) and U.S. Commission on International Exchange (1904)).

²³In Argentina and the United States, the debate over the par value was often protracted and controversial (Cuccorese (1972) and Unger (1964)).

4.3 Hypotheses

The arguments I sketch in Section 3 and formally verify in Appendix A have four testable predictions. I discuss each in turn.

Monetary Homogenization

The monetary homogenization hypothesis argues that nations would adopt gold sooner the larger their share of trade with gold standard countries (scaled by a measure of national income).²⁴ Nations would wait longer to adopt gold if they already belonged to the silver or bimetallic bloc and traded heavily with the other countries of that regime. Such nations, by adopting gold, would be foregoing the lower costs of trade they experienced with members of the status quo regime.²⁵

Financial Prudence/Institutional Capabilities

Countries with strong gold reserve ratios, convertible currencies and low average budget deficits might have made the transition to gold much faster than countries with a fiat currency regime. As discussed above and in Appendix A, moving to convertibility imposed a cost on paper countries. No paper country in my sample adopted gold before 1879. The median date of adoption for paper countries in my sample is 1896. On the other hand, for convertible countries in the sample, the median date of adoption was 1875.

Level of Development

Ceteris paribus, higher output per capita should have led to earlier adoption of gold convertibility. Redish (1990) argues that developed countries with transactions of greater

²⁴Gallarotti (1995) argues that countries preferred the commodity standards of the majority of their trading partners, but the literature appears to give no economic rationale for this preference for homogeneity. Eichengreen (1996) writes that network externalities operated to make the gold standard an attractive monetary regime but gives no indication of the origin of the benefits to being on the network. Neither is the hypothesis tested econometrically.

²⁵I am implicitly arguing that nations would find gold more valuable the greater the symmetry of relative price shocks and output shocks to the rest of the gold bloc. Essentially I follow Alesina and Barro (2000) and assume that symmetry is greater the more integrated a nation is with a country on the gold standard. An example of how shocks mattered in the nineteenth century is from the Netherlands. Holland went onto silver in 1847 after having been on the gold standard. It declared that being on gold was difficult when in close proximity to Great Britain. Each financial crisis in Britain evidently initiated an unsupportable drain of gold from Holland (United States Monetary Commission (1879)).

value than less developed countries could save on carrying costs by transacting in a gram-for-gram more valuable metal like gold. Eichengreen and Flandreau (1998) note that development coincided with a number of favorable conditions including having an orderly financial system and access to gold reserves. Finally, the model from Appendix A points out that more “productive” countries may simply have a higher demand for traded goods causing their integration with gold countries to be higher.

4.4 Other Hypotheses

Besides the arguments I put forward in Section 3, many other hypotheses exist in the literature. All have implications for the timing of the adoption of the gold standard. Here I discuss the main factors economic historians identify as driving the emergence of the gold standard.

Terms of Trade Effects

Beginning in the mid-1870s, gold experienced a continuous appreciation relative to silver. By 1900 gold had appreciated by more than 100 percent relative to its level in 1870. Assuming some form of short-run nominal rigidities, gold currencies would have experienced an appreciating real exchange rate vis-à-vis silver regimes. The appreciation would likely grow larger as more countries transitioned to the gold standard and demand for gold outpaced supply.²⁶

Thus, in nations where importers and consumers of imported goods had political clout, the adoption of gold should have come earlier. Policy-makers in France worried that being off gold would increase the price of English products while the English would obtain French products at a low price (De-Lavaley (1877), p. 612).

²⁶This logic applies under certain conditions. The main assumptions behind this logic are the following: precious metals are in limited or fixed supply, there are short-run nominal rigidities, and the monetary policy maker does not alter the amount of gold per unit of domestic currency too radically as to offset price differentials (see Bordo and Kydland (1997) on why this last assumption is valid in most cases). Meissner (2000) studies a theoretical model where industrialized nations prefer to adopt an appreciating gold standard while the periphery (exporting raw materials) waits to adopt gold standard. The model is based on Corsetti, Pesenti, Roubini, and Tille (2000) who show that in cases when goods are relatively poor substitutes for each other, depreciations can actually be beggar-thyself rather than beggar-thy-neighbor. That being so appreciations can also be welfare enhancing.

Conversely, Frieden (1997) studies the American congressional record of the 1890s and shows that as agricultural exporters made up a larger proportion of a district's output congressmen were more likely to vote for a depreciating silver currency. Cuccorese (1972) and Ford (1962) cite the same phenomenon in Argentina. There, exporters of agricultural goods preferred staying off the gold standard in the 1880s and the 1890s. When such interests are present, a country would be expected to delay joining the gold standard.

Gold Reserves

Eichengreen and Flandreau (1998) emphasize that nations required an adequate amount of gold relative to domestic liabilities in order to make a quick transition to the gold standard.²⁷ Gauging the effect of this variable turns out to be complicated by its endogeneity. Nevertheless, it would appear to be an important control variable.

Silver Reserves

Gallarotti (1995) and Eichengreen and Flandreau (1998), along with many contemporaries, thought that it would take longer to switch to gold if a country had large amounts of silver reserves. Quickly exchanging silver reserves for gold on world markets had the potential to depress the price of silver bringing losses on such asset sales. Observers argued that Scandinavia and Holland were able to switch rapidly to gold because of their relatively small silver holdings. France, with its elephantine silver reserves, had to reflect more carefully on the impact of such a regime change. This delayed a rapid move to gold convertibility.²⁸

Debtors versus Creditors

Often, researchers and contemporaries claimed that regime choice was a political power struggle between an urban, creditor class and a rural, debtor class (de Cecco (1974)). The gold standard represented deflation thus increasing the real value of nominally indexed debt contracts. In testimony from the U.S. Monetary Commission, the argument that re-instating a silver standard would have been benefitted debtors is ubiq-

²⁷Of course this assumes that nations do not alter the par values of their currencies too radically. This seems to be the case historically. The only countries in my sample that altered the par value of currency were Argentina, Austria-Hungary (which never went back to convertibility), Chile and Russia.

²⁸See Flandreau (1996) for an examination of French policy makers' decision process in the 1870s.

uitous. The prediction is that nations with a large proportion of rural interests in the economy would wait longer to adopt the gold standard.

The search for stability

Some of the current theoretical literature on exchange rates argues that merchants eschew exchange rate volatility. Exchange rate volatility increases risk and uncertainty and increases the costs of carrying out foreign transactions.²⁹ By adopting the gold standard, nations could limit volatility against a group of important commercial nations already on gold. In the 1900s, volatility appears to have been of paramount concern for the silver-using nations of southeast Asia (U.S. Commission on International Exchange (1904)). All else equal, nations should have adopted the gold standard sooner the higher their exchange rate volatility.

On the other hand, a survey by Moreno (2000) notes that the effect of exchange rate volatility may be ambiguous, or, counter-intuitively, that volatility is beneficial to the traded-goods sector. In this case, the expected effect of volatility is uncertain. In the extreme, exchange rate volatility *may actually delay* adoption of the gold standard.

The “Good Housekeeping Seal of Approval”

Recent work by Bordo and Rockoff (1996) suggests that adopting the gold standard lowered the costs of borrowing on international capital markets. Countries with large demands for capital inflows (appropriately scaled) should have incurred a relatively large gain by adopting the gold standard and should have adopted earlier.

Many ideas have been put forward as to why countries adopted the gold standard when they did. Many relate adoption to open-economy factors like the cost savings from trade, the level or the variability of the exchange rate or the incentive to save on the costs of external borrowing. Others focus on domestic structural issues such as the degree of financial responsibility, the level of development, the struggle between creditors

²⁹The majority of empirical studies in the twentieth century have found that exchange rate volatility matters little for international trade flows. See Obstfeld (1997) and Wyplosz (1997) for summaries. López-Córdova and Meissner (2000) find no statistical evidence that exchange rate volatility reduced bilateral trade between 1870 and 1910 (see Table 2). Rose (2000), studying the period 1970 to 1990 finds some evidence that exchange rate volatility decreases trade.

Table 2: Summary Statistics of Variables

| <i>Variable</i> | <i>Observations</i> | <i>Mean</i> | <i>Standard Deviation</i> | <i>Minimum</i> | <i>Maximum</i> |
|--|---------------------|-------------|---------------------------|----------------|----------------|
| Ratio of trade with gold standard countries to GDP | 351 | 17.80 | 11.63 | 0.57 | 61.30 |
| Ratio of imports from non-gold countries to GDP | 267 | 7.92 | 7.01 | 0.65 | 49.87 |
| Ratio of trade with countries on same standard to GDP | 85 | 9.15 | 9.88 | 0.00 | 49.52 |
| Paper Dummy | 402 | 0.75 | 0.44 | 0.00 | 1.00 |
| Silver Standard Dummy | 402 | 0.14 | 0.34 | 0.00 | 1.00 |
| Bimetallic Dummy | 402 | 0.13 | 0.33 | 0.00 | 1.00 |
| Ratio of gold reserves to notes outstanding | 249 | 24.79 | 19.50 | 0.00 | 138.10 |
| Silver Reserves (millions of pounds sterling) | 220 | 6.25 | 6.75 | 0.00 | 42.05 |
| ln (real per capita GDP) | 204 | 7.23 | 0.58 | 6.03 | 8.24 |
| ln (real GDP in m 1990 US \$) | 204 | 9.92 | 1.06 | 7.57 | 11.88 |
| ln (nominal GDP in m pounds) | 362 | 2.54 | 0.58 | 1.03 | 3.67 |
| Ratio of Agricultural output to GDP | 327 | 46.26 | 14.01 | 19.00 | 78.28 |
| Weighted exchange rate volatility vis-à-vis gold standard countries | 394 | 1.22 | 1.58 | 0.00 | 7.25 |
| Trade Weighted exchange rate volatility | 333 | 1.90 | 1.70 | 0.15 | 8.00 |
| ln (population) | 402 | 2.39 | 1.28 | 0.03 | 4.84 |
| Average distance from the country to gold standard countries at time t | 402 | 8.00 | 0.63 | 6.85 | 8.96 |
| Border dummy (one if at least one gold country on border) | 402 | 0.68 | 0.47 | 0.00 | 1.00 |

and debtors or the composition and quantity of reserves. I now present empirical tests of these competing hypotheses.

5 Data and Sources

The data set I use is an unbalanced panel of macroeconomic variables for 19 countries from 1870 to 1913. I compiled the data from a number of historical and contemporary sources.³⁰ Table 2 presents summary statistics for each of my explanatory variables.

The dependent variable is the number of years after 1870 it took for a country to adopt gold convertibility. The median date of adoption in my sample is 1879. Table 1 gives a set of countries and the dates on which they adopted the gold standard. I have

³⁰The full data set and notes on country specific sources are available from the author upon request. Appendix B gives references for various series. Table A2 presents the countries and variables in my sample.

three censored observations in the sample—Spain, Austria-Hungary and Italy—which were not on gold when my sample ends. Observations in a given year are not used when there is a missing value for one of the covariates.

To test the first part of the monetary homogenization hypothesis (i.e., a common regime was likely to decrease the costs of trade), I used the ratio of the nominal value of exports and imports with all gold standard countries relative to nominal GDP as an explanatory variable. I also control for the benefits to the status quo commodity money regime. For silver and bimetallic countries I use the level of trade to GDP with countries on a similar commodity money standard. Paper countries receive a zero for this variable.

To measure the degree of financial prudence, I control for the level of the national deficit to output and the ratio of gold reserves to notes in circulation as Eichengreen and Flandreau (1998) suggest. As an alternative, I use an indicator variable equal to one if a country had a fiat money regime in a given year and zero otherwise. Essentially a zero is a rough proxy for good financial responsibility. However, moving to convertibility required all of the following characteristics be present: prudent expansion and/or regulation of the banking system; restraining excessive fiscal demands; convincing capital markets of the willingness to maintain convertibility in the face of global financial crises; organized cooperation among financial institutions and the government which might avoid systemic liquidity problems in times of panic; and finally the avoidance of costly wars. So, this dummy variable picks up the effect of not having one, some or all of the previous characteristics. I justify using an indicator variable here because most of these traits are hard to measure accurately or difficult to control for in the small sample.

I measure the level of development by using the natural logarithm of real output per capita. The figures are in 1990 PPP-adjusted U.S. dollars. In some specifications, I use the nominal value of per capita output converted to pounds sterling with the annual average exchange rate. This expands the sample size. The cost is that time-series variation will be less dependable as a measure of actual changes in the level of development.

To test for terms of trade effects, I suggest we measure the ratio of imports from countries not-on-gold to GDP. Choosing the gold standard, if it truly brought a real appreciation, would lower the costs of imports from these countries. The larger this measure, the sooner a nation should have become part of the gold bloc.

I also use information on the absolute size of silver reserves which I convert to pounds sterling at the current annual average exchange rate. This tests the notion that large silver reserves impeded adoption of the gold standard.

I measure the rural, debtor interests in the economy by using the ratio of agricultural output to total GDP. The larger this measure, the longer a country would delay adoption of the gold standard.

In addition I use a measure of weighted exchange rate volatility.³¹ For the weighting scheme, I used a three-year moving-average of the weight of trading partners on the gold standard in total trade.

Finally, I control for the “good housekeeping” effect with a proxy for capital inflows. Roughly speaking, capital inflows should be positively related or nearly equal to the average current account deficit. I use the average of the previous three year current account deficit as a proxy for the demand for external finance. I scale this variable by GDP. The larger the value of this measure, the larger the potential savings to joining the gold standard, and the sooner a country should move to the gold standard.

6 Empirical Approach and Results

In this section, I outline the duration analysis approach. I then discuss the estimated effects of the explanatory variables. The next sub-section tests the robustness of the results for a variety of potential problems.

³¹The raw measure of bilateral exchange rate volatility is the standard deviation of the difference $\ln(e_{ijt}) - \ln(e_{ijt-1})$ (where e_{ijt} is the bilateral exchange rate between country i and j at month t) for the previous three years.

6.1 Duration Analysis.

Duration models estimate the effect of explanatory variables on the time conditional probability (i.e., the hazard rate) of making a transition from one state to another.³² Using these models, one can easily account for censored observations. Slightly recasting these models provides an estimate of how covariates affect the length of time until adoption of gold convertibility.

Figure 1 plots a non-parametric estimator of the hazard rate for the full sample of countries reported in Table 1. Figure 1 shows the time-conditional probability of switching to gold convertibility may have increased slightly over time. This suggests the use of a parametric model which allows an increasing or a constant hazard rate.³³

One example of a parameterization of the hazard rate that approximates the non-parametric hazard from Figure 1 is the Weibull.³⁴ Its hazard rate can be written

$$h(t) = pt^{p-1} [\exp(x(t)'\beta)]. \quad (1)$$

The parameter p is a parameter to be estimated. If $p > 1$ the hazard rate increases over time. If $p < 1$ the hazard decreases over time, and if $p = 1$ the hazard rate is constant over time. The latter case is when the Weibull distribution becomes an exponential distribution with parameter 1. Also, $x(t)$ is a vector of time-varying covariates; β is a vector of parameters describing the magnitude of the effect of covariates on the hazard; t is the time at observation. I first assume that the number of years a country waited

³²The hazard rate is the probability of transitioning from one state to another given that no transition has previously been made. If T is a non-negative random variable denoting the time of an event, then the time-specific probability (hazard) of an event is defined as $h(t) = \lim_{\Delta \rightarrow 0^+} \frac{\text{pr}(t < T < t + \Delta | t < T)}{\Delta}$

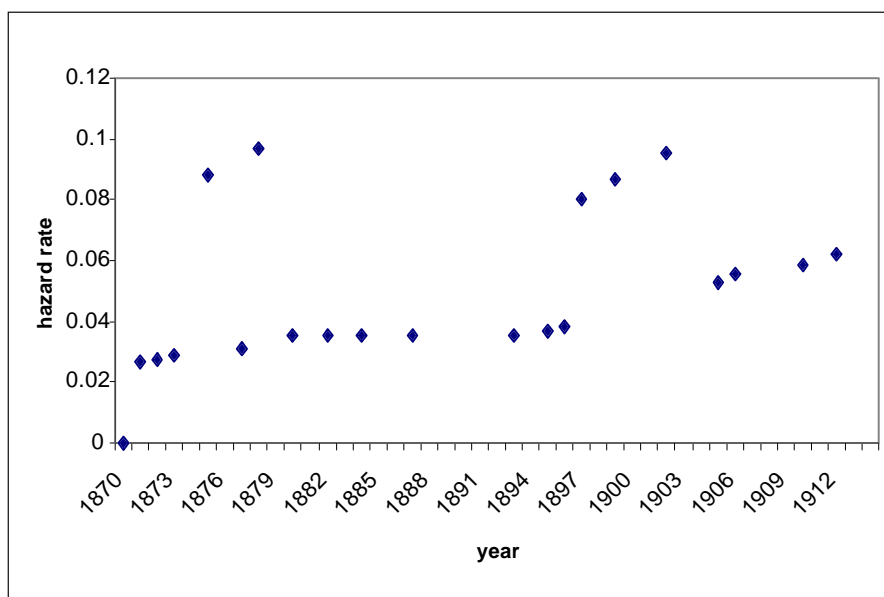
³³The non-parametric hazard function was estimated simply as

$$\hat{h}(t) = \frac{a_t}{R_t}$$

where a_t is the number of countries adopting gold convertibility at year t and R_t is the number of countries adopting at year t together with those *not adopting* in that year.

³⁴My baseline results use a simple constant hazard specification—an exponential model. It is in reality a constrained Weibull model with the restriction that the hazard rate be constant over time. The next section shows that the effects of covariates on the timing of adoption are not sensitive to using a Weibull, exponential or a semi-parametric Cox estimator.

Figure 1: Non-Parametric Hazard Rate, 1870 to 1913



to join the gold standard had no impact on the instantaneous probability of adoption of the gold standard (i.e., a constant hazard rate) and use the exponential model as my baseline.³⁵

The duration model above can be estimated by maximum likelihood. The log-likelihood function consists of two parts—the contribution to the probability of an adoption by those that adopt in any year t and the contribution to the likelihood of all those who adopt gold after or are censored in year t . I maximize the likelihood function

$$l = \sum_n \delta_i \ln h(t_i, x_i(t), \beta) - \sum_n \int_0^{t_i} h(\tau_i, x_i(\tau), \beta) d\tau \quad (2)$$

where n is the set of countries in the sample between 1870 and 1913, each indexed by their time of adoption of the gold standard, δ is an indicator equal to one if country i adopted the gold standard at time t and zero if it was censored in a given year (i.e.,

³⁵The validity of this restriction can easily be checked by means of a likelihood ratio test. Throughout the empirical section I use robust standard errors of the estimators to take into account the dependence among country-observations in the sample.

did not adopt the gold standard) and h is the hazard function of the random variable of adopting the gold standard.

One can transform equation (2) into a more intuitive estimation model called the accelerated failure time (AFT) model. This model can be written

$$\ln t_i = x_i(t)' \beta + \varepsilon_i(t) \quad (3)$$

where $x_i(t)$ is a vector of covariates for country i in year t , β is the effect of the covariates on the log survival time and $\varepsilon_i(t)$ is a country specific-error term independent of $x_i(t)$.³⁶

6.2 Baseline Results

The basic theoretical framework from Appendix A suggests three factors matter for the timing of adoption of the gold standard. These are the ratio of trade with gold standard countries to GDP, the ratio of trade with countries on a similar metallic regime to GDP, and real GDP per capita.³⁷ The results are as follows:

$$\begin{aligned} \ln t_i = & 10.03 - 0.036 \text{ (trade with gold countries}_{it}/\text{GDP}_{it}) \\ & (4.88) \quad (0.01) \\ & + 0.09 \text{ (trade with countries on same standard}_{it}/\text{GDP}_{it}) - 0.95 \text{ (RGDP}_{it}/\text{Population}_{it}) \\ & (0.06) \quad (0.67) \end{aligned}$$

where RGDP is real GDP and robust standard errors correcting for dependence among same country observations are below the coefficients. All variables have the expected effect on the time until adoption of the gold standard, and all are statistically significant at greater than the 15 percent level of confidence. The coefficient on the ratio of trade

³⁶The error term can take on any number of distributions depending on how the econometrician believes the hazard function is shaped over time. If the true model of the data has a constant hazard rate or an exponential hazard, ε has an extreme value distribution.

³⁷Below I explore the tricky issue of testing the institutional capability hypothesis. Leaving this issue aside does not change my key results. Also, as I discuss later, none of the other factors outlined in Section 4.2 appear to play a statistical role in explaining the timing of the adoption. For this reason, I present the most parsimonious specification first.

with gold standard countries to GDP is significant at the one percent level of confidence.³⁸

A one standard deviation increase in the ratio of trade with gold standard countries to GDP decreases the time until adoption after 1870 by nearly 42 ($\approx 12 \cdot 100 (\exp(-.036) - 1)$) percent. This drops the median expected time to adoption from 1879 to about mid-1875. On the other hand, adding ten percentage points (i.e., one standard deviation) to the ratio of trade with countries on the same standard to GDP increases the median time until adoption by about eight and a half years. For a silver country like Holland, or the countries in Scandinavia, these two factors worked in sync; as trade with the silver bloc declined, trade with the gold bloc increased almost one-for-one. For these countries, each percentage point change in their trade shares caused by defection from silver to gold decreased expected waiting time until adoption by about 12 percent.

Finally there is evidence that the level of development accelerated the move to the gold standard. A one standard deviation increase in real per capita output—an increase of roughly 50 percent—decreases the median expected adoption time by about four and a half years.

Columns two through four of Table 3 explore the possibility that countries with weak financial systems took longer to adopt. Column 2 extends the baseline to include the ratio of gold reserves to domestic liabilities and the level of the deficit to output. Both of these may measure the ability to maintain convertibility. The coefficient on gold reserves implies that a higher ratio accelerates adoption. One should be cautious because the level of gold reserves to notes outstanding is quite obviously endogenous to the desire or ability to go onto gold. The estimated coefficient may be exaggerating the impact of financial prudence. The coefficient on the deficit ratio also suggests that a deficit led to earlier adoption. The effect appears to be strong. An improvement of the deficit ratio of 3 percentage points (i.e., a standard deviation) would approximately triple the median

³⁸The explanatory variable *trade with gold standard countries* is actually a summation with two components. The variable is the sum over the product of an indicator variable (which is one if a trading partner is on the gold standard) and the level of trade with a trading partner. The baseline regression assumes that there is no correlation between the error term in each country's decision to join the gold standard and the current observation's error.

Table 3: Baseline Regressions

| <i>Explanatory Variable</i> | <i>Baseline</i> | <i>Baseline with Financial Capabilities</i> | <i>Paper Regimes</i> | <i>Paper Regimes & nominal GDP</i> |
|--|------------------|---|--------------------------|--|
| Ratio of trade with gold standard countries to GDP | -0.036 (.009) | -0.08 (0.00) | -0.001 (0.953) | -0.025 (0.068) |
| Ratio of trade with countries on same standard to GDP | 0.091 (.121) | 0.15 (0.197) | 0.404 (0.000) | 0.29 (0.014) |
| ln (real per capita output) | -0.946 (.156) | -2.41 (0.037) | -0.608 (0.370) | --- |
| ln (nominal per capita output) | --- | --- | --- | -0.15 (0.748) |
| Ratio of gold reserves to notes outstanding | --- | -0.067 (0.012) | --- | --- |
| Ratio of deficit to output | | -0.61 (0.001) | | |
| Paper dummy | --- | --- | 3.327 (0.000) | 2.57 (0.00) |
| Constant | 10.03 (.040) | 25.6 (0.006) | 4.327 (0.376) | 1.69 (0.272) |
| Observations | 180 | 148 | 180 | 310 |
| Log likelihood | -14.28 | -4.37 | -6.22 | -15.32 |

Notes: The p-values for the null hypothesis that the coefficient's effect is zero based on robust standard errors are in parentheses. The dependent variable is the natural logarithm of the time until adoption of gold convertibility after 1870. Here a one unit change in the explanatory variable has a $[(\exp(\beta)-1)*100]$ percent change in the time until adoption of the gold standard.

waiting time to adoption of the gold standard. This result is a bit mysterious given the anecdotal evidence. It could support the idea that the gold standard was adopted by countries which desired to tie the hands of spendthrift government.³⁹

The benefit from adding gold reserves is the improved fit of the model. Gold reserves are a very good predictor of timing. However, leaving that ratio out, either in the baseline or when including the deficit ratio, does not bias the qualitative results of the baseline and avoids taking too seriously the coefficient on this strongly endogenous variable.

Simply adding the paper regime indicator variable to the baseline regression shows paper countries waited longer to adopt the gold standard. However, this eliminates the statistical significance of the effect of trade with gold standard countries and that of per capita output. This is likely because the paper dummy provides a nearly perfect prediction of monetary status. Nearly all observations when the paper dummy is equal to one are years in which a country did not adopt. This is the case for 128 of 132 observations in the baseline sample.

Running the baseline with a paper dummy and nominal GDP per capita doubles the number of observations available. In this specification, the paper dummy suggests that the time until adoption increased 13 times when a country suffered a paper regime relative to countries with a convertible currency. More importantly, this specification also leaves the network externalities coefficients in tact both in magnitude and in terms of statistical significance. However, the effect of per capita output comes out statistically insignificant.

Columns 1 and 2 of Table 4 present variations on the baseline regression. Column 1 substitutes nominal per capita output for real output which expands the sample size. While the coefficient on output per capita becomes statistically insignificant, the coefficients on trade with gold standard countries and trade with countries on the same standard remain similar in both magnitude and statistical significance.

³⁹On the other hand, this variable is a very noisy measure. Data collection on government finance and nominal GDP is far from perfect even in relatively recent data. This problem might bias the estimated coefficient.

Table 4: Other Specifications

| <i>Explanatory Variable</i> | <i>Alternative Measure of GDP</i> | <i>Long Specification</i> | <i>Terms of Trade Effects</i> |
|---|-----------------------------------|---------------------------|-------------------------------|
| Ratio Trade with gold Standard countries to GDP | -0.037 (0.001) | -0.035 (0.784) | |
| Ratio of trade with countries on same standard to GDP | 0.063 (0.214) | 0.079 (0.676) | 0.099 (0.082) |
| Ratio of imports from non-gold Countries to GDP | | 0.028 (0.835) | -0.045 (0.102) |
| Ratio of gold reserves to notes outstanding | | -0.043 (0.302) | |
| ln (real per capita output) | | -1.511 (0.373) | -0.539 (0.441) |
| Average current account deficit | | -0.132 (0.751) | |
| Exchange rate volatility | | -0.541 (0.552) | |
| ln (Nominal GDP per capita) | -0.861 (0.077) | | |
| Agricultural output to GDP | | 0.002 (0.975) | |
| Silver reserves (m of pounds sterling) | | -0.026 (0.757) | |
| Constant | 5.892 (0.000) | 16.983 (0.242) | 6.721 (0.191) |
| Observations | 310 | 126 | 153 |
| Log likelihood | -21.53 | -7.00 | -13.07 |

Notes: The p-values for the null hypothesis that the coefficient's effect is zero based on robust standard errors are in parentheses. The dependent variable is the natural logarithm of the time until adoption of gold convertibility after 1870. Here a one unit change in the explanatory variable has a $[\exp(\beta)-1]*100$ percent change in the time until adoption of the gold standard.

In column 2, I present one test of the hypotheses of Section 4.2. While the extended model provides a better log-likelihood, the reduced sample size makes inference difficult. Given the theoretical support and the historical evidence that network externalities were important, there is no reason to discount the baseline specification.⁴⁰

Regarding the role of exchange rate appreciations and depreciations, column 3 shows that imports from non-gold countries decreased the time to adoption of gold convertibility and is statistically significant at the eight percent level of significance. However, in the longer model from column 2, it has a sign contrary to the hypothesis and is statistically insignificant. The two variables are highly correlated ($\rho = .49$). This collinearity can mask the true terms of trade effects. Given the historical record, I am inclined to accept the results from column 3 as weak evidence for such a story.

The conclusion here is that the creditors versus debtors story, and the silver reserves story find little support in the data. I also reject, at standard levels of confidence, the idea that the gold standard was about the desire to maintain a system of fixed exchange rates or an urge to lower the costs of borrowing on capital markets.⁴¹

What explains all of these negative results? The creditors versus debtors story may only be applicable at certain points in time. In the early 1870s, few imagined that gold would be deflationary. In the late 1890s, new gold discoveries and the substitution of foreign assets for gold reserves (i.e., the “gold exchange standard”) made deflationary risk less of an issue. The price level was a live political issue in the U.S. and other countries between the late 1870s and the early 1890s. William Jennings Bryan’s defeat in the presidential election of 1896 effectively closed the door on the struggle for “soft

⁴⁰Un-reported regressions find that these variables have little explanatory power in any specification. In any case, a likelihood ratio test cannot statistically distinguish between the long model and the baseline model. This is true of course when restricting the sample to only those observations used in the long specification.

⁴¹As an alternative measure of exchange rate volatility, I used the trade-weighted difference between volatility under the current regime and the volatility England had against other countries. A large positive difference would imply a lower trade-weighted volatility under the gold standard. This measure performs no better than the others. The assumption that a prospective new-comer to the gold standard would have roughly the same volatility as England is valid. The gold standard implied very limited exchange rate fluctuation given convertibility was maintained.

money”. The same argument can be made regarding the level of the exchange rate.

The statistical insignificance of exchange rate volatility seems to square with the results from López-Córdova and Meissner (2000) and Flandreau and Maurel (2000). Both studies find that exchange rate volatility had no statistically significant effect on trade in the late nineteenth century. Perhaps the costs of a fluctuating exchange rate were easily covered. Testimony from A.A. Low suggests that fluctuations in the exchange rate were of little importance for his importing business (U.S. Commission on International Exchange (1904)). Finally, the silver argument seems to be logically consistent, but few countries actually had large holdings. The variation in the data is too large to get a precise estimate of the coefficient. Certainly this issue loomed large in the minds of Bank of France officials (Flandreau (1996)).

The positive results from Table 3 and 4 are clear. A monetary homogenization story, as outlined in Appendix A and in Section 3, provides a reasonable explanation for the variation in the timing of the adoption of the gold standard. As the world went to gold, trade with gold standard countries began to make up a larger portion of GDP and it came to be ever-more irresistible to adopt the gold standard. Network externalities defined the shape of the international monetary regime of the late nineteenth century. A certain level of development was also necessary to adopt gold early. Financially backward countries delayed adoption, but strangely, countries with budgetary problems adopted earlier. Paper countries were in a class apart from already convertible countries, and they could not rapidly establish gold convertibility. The following section tests the robustness of the baseline results.

6.3 Sensitivity Analysis

Alternative Specifications

In Table 3, I used the exponential model which imposes a constant hazard rate over time on the data. Table 5 uses other parameterizations of the hazard rate and the semi-parametric Cox estimator. If the results are comparable, my general conclusions

are not being swayed by the particular parameterizations.⁴² Column 4 reports a probit estimate of the probability of adoption of the gold standard. This assumes that the time-conditional probability of adoption is constant over time. In each parameterization, the coefficients of interest maintain a level of statistical significance similar to the baseline, their anticipated signs and their relative magnitudes.⁴³ Interestingly, the probit model fits well.⁴⁴

Linear Probability Specification

The next tables use a linear probability model (i.e., OLS where the dependent variable is a zero in years of non-adoption and one in the year of adoption).⁴⁵ The motivation for using this model is, in part, to facilitate the attempt to deal with a potential endogeneity problem. I tackle that issue in the next sub-section, but I present these results for comparison to both the previous and the following tables.⁴⁶ Column 1 of Table 6 presents a straightforward application of the linear probability model to the pooled sample. Results are virtually identical to the probit estimates and qualitatively support the baseline exponential model.

⁴²The Cox model assumes that the hazard of adoption is proportional for all subjects. This modification eliminates common environmental factors affecting all countries in a given year and estimates the change in the relative hazard rate for a change in the explanatory variables. One cannot compute the change in expected time until adoption using this model. Additionally, not imposing structure on the baseline hazard, adds noise to the calculation of the marginal effects of the explanatory variable. The benefit of this estimator is that it does not impose structure on the shape of the baseline hazard which might bias the magnitude of the coefficients. As results show, the magnitude of the coefficients are similar in the Cox, Weibull and exponential models. Imposing a particular parameterization does not seem to bias my results.

⁴³Standard errors are robust and account for the dependence among country observations.

⁴⁴The fit of the model is extremely good. The pseudo R-squared is 0.49, and the mean of the predicted probability in actual years of adoption is 0.54 while in years of non-adoption the mean is 0.07. Also, adding in the gold cover ratio as an explanatory variable makes the network effects significant without greatly altering the magnitude of the coefficients.

⁴⁵The use of this model uses the duality between the hazard approach and the AFT approach. If something increases the time-conditional probability of adoption (i.e., the hazard rate) then it also influences the expected time until adoption conditional on joining the sample in the given year. Here I am also estimating a conditional probability of adoption. This specification, if it works similarly to the duration approach, validates the use of the simple two-stage least squares approach I take in the next sub-section

⁴⁶One drawback of this model, compared to the duration analysis, is the difficulty of treating the censored observations. I do not correct for this problem here because the potential bias would appear to be small.

Table 5: Alternative Parameterizations

| <i>Explanatory Variable</i> | <i>Weibull</i> | <i>Cox Semi- Parametric Model</i> | <i>Log-Logistic</i> | <i>Probit</i> |
|---|-------------------|---------------------------------------|---------------------|-------------------|
| Ratio of trade with gold standard countries to GDP | -0.046 (0.063) | .025 (0.140) | -0.096 (0.063) | 0.003 (0.011) |
| Ratio of trade with countries on same standard to GDP | 0.153 (0.112) | -0.104 (0.114) | 0.13 (0.057) | -0.004 (0.162) |
| ln (real per capita output) | -1.111 (0.172) | 0.634 (0.342) | -0.554 (0.835) | 0.039 (0.329) |
| Constant | 11.087 (0.065) | | 7.227 (0.731) | |
| Weibull parameter p | 0.803 (0.162) | | | |
| Observations | 180 | 180 | 180 | 180 |
| Log likelihood | -13.9 | -19.84 | -11.6 | -40.1 |
| Pseudo R-squared | | | | .09 |
| Observed probability | | | | 0.066 |
| Predicted probability at x-bar | | | | 0.052 |

Notes: The p-values for the null hypothesis that the coefficient's effect is zero based on robust standard errors are in brackets. The dependent variable in column one and three is the natural logarithm of the time until adoption of gold convertibility after 1870. In column two the dependent variable is the natural logarithm of the hazard rate of adoption. The dependent variable in column four, for the Probit estimation, is one if a country adopted gold in the given year of observation and zero if it did not adopt gold. In column two, the effect of a one unit change in the explanatory variable is a $(\beta)^*100$ percent change in the relative hazard (i.e., probability) of adoption of gold convertibility. The coefficients in column one and three report that a one unit increase in the explanatory variable has a $[\exp(\beta)-1]^*100$ percent change in the time until adoption of the gold standard. The coefficients in column four report dF/dx —the change in the probability of adoption given a one unit change in the regressor.

Table 6: Linear Probability and Panel Models

| <i>Explanatory Variable</i> | <i>Pooled OLS</i> | <i>"Within" Estimator</i> | <i>"Between" Estimator</i> | <i>Random Effects</i> | <i>Probit with city Dummies</i> | <i>OLS with Time Dummies</i> |
|---|-------------------|---------------------------|----------------------------|-----------------------|---------------------------------|------------------------------|
| Ratio of trade with gold standard countries to GDP | 0.005 (0.002) | 0.001 (0.004) | -0.002 (0.003) | 0.005 (0.002) | 0.0002 (.001) | 0.006 (0.002) |
| Ratio of trade with countries on same standard to GDP | -0.004 (0.003) | -0.031 (0.006) | 0.011 (0.005) | -0.005 (0.003) | -0.001 (0.007) | -0.008 (0.004) |
| ln (real per capita output) | 0.039 (0.038) | 0.073 (0.167) | -0.012 (0.054) | 0.039 (0.034) | -0.0003 (0.006) | 0.027 (0.039) |
| Constant | -0.28 (0.25) | -0.384 (1.161) | 0.182 (0.384) | -0.281 (0.236) | --- | -0.188 (0.282) |
| Observations | 180 | 180 | 180 | 180 | 116 | 180 |
| R-squared | 0.05 | 0.196 | 0.304 | | 0.49 | 0.297 |
| Root MSE | 0.245 | | | | | 0.243 |

Notes: Robust standard errors are reported in parentheses. The dependent variable is one if a country adopted gold in the given year of observation and zero if it did not adopt gold in that year. Country specific indicators are omitted from column five. Year specific indicators are omitted from column six.

The next columns use panel estimation techniques. I present a panel “within” estimator, a panel “between” estimator, a random effects technique and pooled sample probit estimates with country-fixed effects.⁴⁷ The within estimator checks if the baseline results are being driven by variance across time in the covariates. The between method uses cross-sectional variance in country-based means to identify the coefficients of interest.

In the within model, the coefficient on trade with gold standard countries becomes insignificant though it keeps its expected sign and has a similar magnitude to the probit estimates. In the between model, both network effects have flipped sign. On the other hand, the random effects coefficients backup the results from the duration analysis and the pooled linear probability model.⁴⁸ It would appear that *variation over time* in the explanatory variables, rather than cross-sectional variance, is responsible for explaining the timing of the adoption of the gold standard.⁴⁹

Column 6 of Table 6 pools the sample and runs OLS using year dummies to purge the data of time specific factors. This method uses cross section and time series variance but does not assume that the probability of adoption in any given year is un-affected by the year of observation. Here the estimates on the network externalities coefficients qualitatively support the baseline model, but their statistical significance is somewhat diminished (with the exception of the coefficient on trade with gold standard countries which is significant at the five percent level of confidence).

Omitted Variable Bias/Endogeneity

Finally, I address the potential problem of unobserved heterogeneity and simultaneity bias. López-Córdova and Meissner (2000) show that bilateral trade may increase dramatically when two countries are on the gold standard. This paper argues that a country would be more likely to be on gold the more it traded with other gold standard countries. Nothing rules out the possibility that the coefficient on the ratio of trade with

⁴⁷The standard errors in the pooled sample are robust standard errors.

⁴⁸A Hausman exogeneity test suggests that this model is not a good specification however.

⁴⁹However, given the data, we cannot soundly reject the idea that unobservables at the country level are driving the results on the network effects. Nevertheless one should not be too demanding in these specifications as the degrees of freedom drop precipitously putting strain on the data. The point estimates are still suggestive of the original results.

gold standard countries to GDP is biased due to the presence of a simultaneity bias or omitted variables that are correlated with trade networks and monetary regime choice.

To resolve this issue, I take two different approaches. The first method simply uses the fitted values from a regression of the ratio of trade with gold standard countries to GDP on its lagged value in the baseline AFT model. Table 7 shows this does not affect the results from Table 3 in any significant way. The second method uses an instrumental variables technique.

To find instruments for the ratio of trade with gold standard countries to GDP, I use an approach that follows closely Frankel and Romer (1999) and Frankel and Rose (2000). I run two-stage least squares using the fitted values from the following first-stage regression

$$\text{trade with gold countries}_{it}/\text{GDP}_{it} = \beta_0 + \beta_1 \ln(\text{population}_{it}) + \quad (4)$$

$$\beta_2 \ln(\text{mean distance to gold countries}_{it}) + \beta_3 (\text{border}_{it}) + \nu_{it}$$

where mean distance to gold countries is the average great circle distance from all gold standard countries to country i and “border” is an indicator equal to one if country i has at least one border country on the gold standard in year t .⁵⁰

Following the gravity approach, the ratio of trade with gold standard countries to GDP is inversely correlated to the size of the country but there is no reason why population levels should be correlated to the decision to adopt the gold standard.⁵¹ The gravity approach also asserts that distance from a country (sharing a border) is inversely (directly) related to the level of trade with a country. As Frankel and Romer (1999) argue, there is no reason to believe that the geographic characteristics of countries are

⁵⁰The distance measure is taken from Rose (2000) and is for the modern definition of boundaries. Given my sample this is unlikely to skew the results.

⁵¹Rather than using the natural logarithm of population, I also tried real GDP. Results do not change using this variable. Also, this approach is a shortcut from Frankel and Romer’s approach. There, the method is to predict bilateral trade and then to aggregate across country pairs. However, Frankel and Rose (2000) discuss and successfully employ this sort of a shortcut. Leaving out the ratio of trade with countries on the same standard to GDP does not change the results.

Table 7: Instrumental Variables Specifications

| Explanatory Variables | Exponential Duration | Exponential Duration | 2SLS | 2SLS w/ Fixed Effects | 2SLS w/ Year controls | 1st Stage Regression | |
|--|-------------------------|-------------------------|-------------------|-----------------------------|-----------------------------|--|-------------------|
| | | | | | | Instruments | |
| Ratio of trade with gold standard countries to GDP | | -0.132 (0.013) | 0.012 (0.008) | 0.022 (0.009) | 0.012 (0.009) | ln (population) | -5.84 (0.386) |
| Lagged ratio trade with gold standard countries to GDP | -0.03 (0.014) | | | | | Average distance to gold standard countries | -0.571 (0.997) |
| Ratio of trade with countries on same standard to GDP | 0.075 (0.193) | 0.144 (0.064) | -0.006 (0.004) | -0.019 (0.01) | -0.011 (0.007) | | |
| ln (real per capita output) | -0.95 (0.163) | -0.929 (0.122) | 0.015 (0.04) | -0.563 (0.26) | 0.011 (0.05) | Border dummy (one if at least one gold standard ctry. on the border) | 5.79 (1.31) |
| Constant | 9.907 (0.047) | 11.542 (0.015) | -0.211 (0.28) | 4.234 (2.053) | -0.093 (0.349) | | 33.34 (8.47) |
| Observations | 167 | 183 | 180 | 180 | 180 | | 351 |
| R-squared | | | | 0.24 | 0.27 | | 0.42 |
| Log Likelihood | -13.92 | -12.12 | | | | | |
| Root MSE | | | 0.253 | 0.24 | 0.247 | | 8.87 |

Notes: The p-values for the null hypothesis that the coefficient's effect is zero based on robust standard errors are in brackets in column one and two. Standard errors corrected for the instrumental variables approach are reported in column three through five. Standard errors are reported in brackets in column seven. In column one and two, the dependent variable is the natural logarithm of the time of adoption. The dependent variable in columns three through five is one if a country adopted gold convertibility in a given year and zero if it did not adopt gold. The dependent variable in the final column is trade with gold standard countries relative to GDP. In column one and two a one unit change in the explanatory variable has a $(\exp(\beta)-1)*100$ percent change in the time until adoption of the gold standard. The coefficients in column three through five report the change in the probability of adoption given a one unit change in the regressor.

correlated with possible omitted variables that drive countries to adopt the gold standard earlier or later. Casual observation suggests as many countries near to, or on the border of, gold standard countries did not adopt gold as those that did. On the other hand, the current trade literature shows that these variables strongly influence the level of trade.

Column 7 of Table 7 reports the first-stage regression of trade with gold standard countries to GDP on the instruments; the model fits well, has an R -squared of 0.42, the F-test for zero slopes soundly rejects the null hypothesis (F-value = 76.26) and the correlation between the predicted values and the dependent variable is 0.65.⁵² Column 2 simply uses the fitted values from the first-stage regression in the baseline duration model. Though I have not corrected the standard errors, the magnitude of the coefficient on the ratio of trade with gold standard countries increases in this specification.

⁵²A regression of the dependent variable on the predicted values gives a coefficient of one which is statistically significant at less than the one percent level of confidence.

The other columns use the linear probability model on the pooled data, the pooled data with country indicators and the pooled data with time dummies. In each case, I use the fitted values from equation (4) as instruments for the ratio of trade with gold standard countries to GDP. The statistical significance varies, but the magnitude and direction of the effect of trade with gold standard countries increases relative to the results in Table 3. In the pooled specification, we cannot reject at the 86 percent level of confidence that the effect of trade with gold standard countries is zero. The conclusion is that unobserved heterogeneity or simultaneity bias is not seriously affecting the results.⁵³

Finally, unreported regressions tested the sensitivity of the baseline exponential results to possible outliers and disputes in the date of adoption of gold convertibility. I dropped each country, one at a time. In none of the cases were the baseline results altered. Similarly, changing the dates of adoption to coincide with other authors' dating of the adoption of the gold standard makes no significant difference to the results.⁵⁴

7 Conclusions

Countries found it more valuable to join the gold standard when trade with other gold standard countries made up a large proportion of GDP and when they traded relatively little with countries on other commodity standards. The emergence of the classical gold standard is about international strategic interdependencies. The actions of other nations strongly influenced domestic regime choice. It also appears that more developed countries adopted gold sooner. Some evidence suggests that countries that were not financially prudent delayed adoption of the gold standard.

Some weak evidence in the initial specifications also supports the hypothesis that

⁵³Tests for the exogeneity of trade with gold standard countries relative to GDP give mixed results. A Durbin-Wu-Hausman test, suggested by Davidson and MacKinnon (1993), cannot reject the null hypothesis of exogeneity. A Hausman test for exogeneity shows we can reject the null hypothesis of exogeneity at the 90 percent level of confidence.

⁵⁴I changed the date of adoption for Norway to 1875 from 1873; I allowed Austria-Hungary to adopt gold in 1902 as in Flandreau, Le-Cacheux, and Zumer (1998); finally, as Italy had a relatively stable currency between 1893 and 1913 I dropped it from the sample in that period, in effect treating it as if it were actually on gold.

importers of products from non-gold areas tried to take advantage of the depreciating currencies in the periphery by adopting gold early on. I find little evidence that opposition by debtor interests delayed adoption of the gold standard, that the gold standard was about a search for stability in exchange rates or that countries with large silver reserves had difficulty making an early switch to gold.

If countries adopted similar monetary regimes in expectation of savings in the cost of trade, this squares with what we know about the homogenization of monetary regimes and the level of trade. López-Córdova and Meissner (2000) and Rose (2000) find monetary regimes have a large influence on trade. If this is the case, then monetary regimes may play a key role in explaining the integration of the world economy in the late nineteenth century and even today. Moreover, if trade brings about large welfare gains and enhances growth, the emergence of the classical gold standard may have substantially contributed to rapidly advancing living standards between 1870 and 1913. Finally, this paper provides a partial answer to the question of “Did it have to be gold?” The empirical and theoretical results illustrate that the gold standard was only one of several equilibria that might have occurred. Silver or bimetallism might have been the global standard if a large enough mass of countries adhered to them.

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Appendix A

8 A Model of International Trade and Monetary Regime Choice

This model describes the interactions between trade, development and monetary regime choice. The model predicts that countries adopt the gold standard sooner the greater the level of trade with gold standard countries relative to total output and the higher the level of “productivity”.

The model closely follows the setup of Alesina and Barro (2000), but simplifies the issues and the possible equilibria considerably by restricting the strategy space for countries. Whereas their model allows countries to form currency unions based on any extant monetary unit, I only allow each nation to be part of a gold bloc, silver bloc, bimetallic bloc or a fiat currency regime. I also point out and make central to the analysis the feature of network externalities that arise when policy options lower the costs to trade. Finally I adapt the model to a stochastic environment allowing me to generate testable predictions regarding the evolution of the international monetary system.⁵⁵

For the most part, this model attempts to explain how the world could move from an international monetary landscape like that of 1870 to one similar to 1910. How could the world consist of four blocs—one for each monetary regime above—circa 1870 but come to consist mainly of gold countries by 1910? My model can explain these outcomes as different equilibria of the same model. It turns out that when there are large players in the global economy, like for instance the United Kingdom, Germany and France, fractionalization can be ruled out and homogenization of monetary standards can appear.

8.1 A General Setup

The world is made up of J countries. Each country has a population N_j , $j \in \{1, \dots, J\}$. Each individual in the world has a label $v \in \{1, \dots, W_t\}$. The total world population is W_t . I assume first that $\frac{N_j}{W_t}$ is small and equal for all j . Each country in the world belongs to one of four distinct monetary blocs. Countries have a gold, silver or bimetallic standard, or they have an inconvertible currency or a fiat regime. The “population” at time t of each monetary bloc is given by G_t for the gold bloc, S_t for the silver bloc, B_t for the bimetallic bloc and F_t for the fiat countries.⁵⁶ Each country is inhabited by consumer-producers who maximize per-period consumption. Each individual r uses the production function

$$Y_r = A_j \left(\sum_{v=1}^W X_{vr}^\alpha \right) L^{1-\alpha} \quad (5)$$

⁵⁵One other difference is that I neglect a micro-founded Barro-Gordon analysis of monetary independence. In a world of commodity regimes, monetary policy is, for the most part, passive and, hence, an irrelevant consideration. Fiat regimes may have been worried about the loss of the exchange rate tool of adjustment. I model this simply as a cost of giving up floating rather than micro-founding the loss function of a monetary policy maker. The qualitative results would change little if I had followed this approach.

⁵⁶The word population is in quotes here because we should not literally interpret this as the number of people in a country. It will become apparent that the population corresponds to the number of producers of intermediates in each country or bloc.

where $A_j > 0$ is a productivity parameter that may vary across countries, X_{vr} is the quantity of non-durable input v that person r uses, $0 < \alpha < 1$ and L is a fixed endowment of labor. Output of individual r , Y_r , can be traded for consumption one-for-one or to produce input X_r . Prices of the homogeneous consumer good are equalized the world over at one. Each individual produces a unique intermediate input.

I assume that every producer monopolistically supplies her intermediate input good X_r . The price for this input is set domestically at $P_r > 1$. Domestic trade in intermediates and all trade in consumer goods occur without transaction costs, but I assume that international trade in intermediates is subject to transaction costs. Specifically I assume an iceberg cost on the purchase of each unit of foreign inputs such that $1 - b$ units arrive for every unit ordered where $0 \leq b \leq 1$. This effectively increases the foreign price on one unit of input to $\frac{P_r}{1-b}$.

We can write $b_R^{R'}$ for the cost of trade where the subscript is the domestic monetary regime while the superscript is the foreign regime, and $R, R' \in \left\{ \begin{array}{l} G \text{ (gold)}, S \text{ (silver)}, \\ B \text{ (bimetallism)}, F \text{ (fiat)} \end{array} \right\}$.

I will assume that monetary homogenization reduces the transaction costs of trade. Specifically let $b_G^G \leq b_S^S \leq b_B^B < b_F^F = b_R^{R'}, \forall R \neq R'$. The assumption here is that similarity in commodity standards reduces the transaction costs of trade. For instance sharing a commodity regime eliminates brokers fees. Transactions can be settled in one sort of precious metal rather than having to make a trade between separate precious metals that are backing national currencies. Also, pegging the price of a precious metal, when a trading partner does so, eliminates most exchange rate volatility. In general the cost could depend on each country pair.

Also, as in Alesina and Barro (2000), I add in another trading cost b_{1ji} so that total trading costs between countries j and i are $b_{ji} = b_{1ji} + b_{jR}^R$. The first part of the trading costs could be thought of as the cost that distance imposes on trade or the barriers to trade created by political or cultural dissimilarity.⁵⁷ For the rest of this section I will assume $b_{1ji} = 0$.⁵⁸

Let us first abstract away from regime choice to study the patterns of trade and the optimal level of consumption and production. Each producer-consumer chooses X_{vr} for $v = 1, \dots, W_t, (v \neq r)$. This is the quantity of inputs to purchase at time t from domestic and foreign producers. The optimal choice of inputs takes as given other producers' prices. The producer of each type of input takes demand as given and sets the optimal price.

First let us focus on a one-period model. The consumer producer then maximizes consumption subject to the following budget constraint

$$C_t = Y_{rt} - X_{rrt} + (P_{rt} - 1)(X_{rt} - X_{rr}) - \sum_{v=1}^{N_{it}} P_v X_{vr} - \left(\frac{1}{1 - b_R^G} \right) \sum_{v=N_{it}+1}^{G_t} P_v X_{vr} - \quad (6)$$

$$\left(\frac{1}{1 - b_R^S} \right) \sum_{v=G_t+1}^{S_t} P_v X_{vr} - \left(\frac{1}{1 - b_R^F} \right) \sum_{v=S_t+1}^{F_t} P_v X_{vr}.$$

⁵⁷The gravity literature on trade finds that these factors play a large role in explaining the level of bilateral trade. See Table 2 for evidence on how being in a political union, distance and borders affect bilateral trade.

⁵⁸None of the conclusions are altered by this assumption.

The first order conditions for maximizing U for all t give a relation between the inputs chosen and the market prices. They can be written as

$$A\alpha L^{1-\alpha} X_{rr}^{\alpha-1} = 1 \quad (7)$$

$$A\alpha L^{1-\alpha} X_{vr}^{\alpha-1} = P_v, v = 1, \dots, N_j$$

$$A\alpha L^{1-\alpha} X_{vr}^{\alpha-1} = \frac{P_v}{1 - b_R^R}, \forall v \in R'_t$$

For a monopolist, the first order condition for P_r is

$$\frac{(P_r - 1)}{P_r} = \frac{-1}{\epsilon(X_r - X_{rr})}, \quad (8)$$

where $\epsilon(X_r - X_{rr})$ is the price elasticity of demand for net sales of r 's own good. The nature of the production function implies constant price elasticities equal to $\frac{-1}{1-\alpha}$. Using equation (8) this means that all intermediate goods have an equal price

$$P_r = \frac{1}{\alpha}. \quad (9)$$

Substituting this result into the first-order conditions for consumption, we find the final demands for intermediates by individual r in country j as

$$X_{rr} = (A\alpha)^{\frac{1}{1-\alpha}} L \quad (10)$$

$$X_{vr} = (A\alpha^2)^{\frac{1}{1-\alpha}} L, v = 1, \dots, N_j$$

$$X_{vr} = (1 - b_R^R)^{\frac{1}{1-\alpha}} (A\alpha^2)^{\frac{1}{1-\alpha}} L, \text{ for } v \in G, S, B, F, v \notin N_j \text{ and } \forall R$$

Plugging these values into the production function we get gross output

$$Y_r = \tilde{A} \left\{ 1 + \alpha^{\frac{\alpha}{1-\alpha}} \left[(N_j - 1) + \sum_{i \in R_t} (1 - b_R^i)^{\frac{\alpha}{1-\alpha}} i_t \right] \right\} \quad (11)$$

where the reader recalls that, for all regime types, R_t is the population of all nations pertaining to that regime. Also, let $\tilde{A} = LA^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}}$.

Likewise we can use the results to find C_t . We find that

$$C_t = \tilde{A} \cdot (1 - \alpha) \left\{ 1 + \alpha^{\frac{\alpha}{1-\alpha}} \cdot (1 + \alpha) \left[(N_j - 1) + \sum_{i \in R} (1 - b_R^i)^{\frac{\alpha}{1-\alpha}} i_t \right] \right\} \quad (12)$$

Total trade of country j with foreign nationals can be found by using the demands from equation (10) and multiplying by P_r . Total purchases from the producers of each regime R can be shown to equal

$$\tilde{A} \alpha^{\frac{1}{1-\alpha}} \left[(1 - b_R^R)^{\frac{\alpha}{1-\alpha}} R_t N_j \right]. \quad (13)$$

In this model it can be shown that all trade balances. It will also be useful to note, for the empirical section, that the value of trade with regime R , relative to total output of country j , can be written

$$\frac{\text{Ratio of trade with gold}}{\text{standard countries to GDP}} = \frac{\alpha^{\frac{1}{1-\alpha}} \left[(1 - b_R^R)^{\frac{\alpha}{1-\alpha}} R_t \right]}{1 + \alpha^{\frac{\alpha}{1-\alpha}} \left[(N_j - 1) + \sum_{i \in R} (1 - b_R^i)^{\frac{\alpha}{1-\alpha}} i_t \right]} \quad (14)$$

From expression (13), as the number of producers of intermediates in a given bloc increases, the level of trade with that particular bloc increases. One can also verify that, as trade with a certain regime increases, the ratio of trade with that regime to total output also increases.

8.2 Regime Choice

I now turn to the question of monetary regime choice. The model above can easily illuminate the fact that trade patterns determine regime choice. First, countries choose a regime based on the “population” sizes of each bloc and having planned for the level of trade. After having chosen the optimal monetary regime and optimal output plans, trade occurs and the game ends.

Supposing that actors are infinitesimal, each nation chooses a regime in which to participate and takes other nations’ regime choices as given. The calculus countries undertake when deciding on their regime is to see which regime provides a higher level of consumption at time t .⁵⁹ The choice of regime depends on the inequality

$$\Pi = C_t(R) - C_t(R') \geq 0,$$

where $C_t(R)$ is the value of current consumption when the country is on regime R given the size of all other monetary blocs. Nations choose regime R over R' if the expression is positive or equal to zero. To see which regime a country chooses, we need to examine trade’s contribution to consumption. For country j , the contribution to national consumption from trade with a certain bloc is given by

$$\tilde{A} \alpha^{\frac{1}{1-\alpha}} (1 - \alpha^2) \left[(1 - b_R^R)^{\frac{\alpha}{1-\alpha}} R_t \cdot N_j \right].$$

So, for example, if a country contemplated adopting either a silver standard or the gold standard, the net impact on consumption, scaled by the size of country j , is

$$\tilde{A} \alpha^{\frac{1}{1-\alpha}} (1 - \alpha^2) \left\{ G_t \left[(1 - b_{jG}^G)^{\frac{\alpha}{1-\alpha}} - (1 - b_{jS}^G)^{\frac{\alpha}{1-\alpha}} \right] + S_t \left[(1 - b_{jG}^S)^{\frac{\alpha}{1-\alpha}} - (1 - b_{jS}^S)^{\frac{\alpha}{1-\alpha}} \right] \right\} \geq 0 \quad (15)$$

The calculation is similar for a country contemplating moving from bimetallism to gold. The net benefit is increasing as \tilde{A} and G_t (the “population” of the gold bloc) become larger. The net benefit declines as S_t (the “population” of the gold bloc) increases.⁶⁰

⁵⁹I leave the time subscripts because they are important when the game becomes dynamic. For now the reader can ignore the time subscripts as I focus on a one-period game.

⁶⁰I have left aside for simplicity the matter of monetary independence. While monetary independence is not an issue for currencies that are convertible into a precious metal it may be natural to suppose that similarity in commodity regimes increases the exposure of each country to foreign shocks from the same currency bloc. For example a gold drain to a neighboring gold country because of foreign financial stringency may spillover into the home country. Had the home country been on silver, it would likely have avoided such a spillover. I follow Alesina and Barro (2000) and argue that as two countries become more integrated in trade, shocks are less asymmetric. Ultimately, the benefit to joining a particular regime increases as trade with that regime increases.

Summarizing, the above setup shows that the incentive to move to one regime from another commodity regime depends positively on the number of transactions undertaken with the candidate regime and negatively on the level of connections with the current regime.⁶¹

8.3 Paper Money Regimes

The calculus undertaken by paper money regimes brings a slight modification of the model above. I assume that paper countries must pay cost w to join a commodity regime. Without assuming this cost, all paper countries have a strictly dominant strategy in joining the monetary regime that yields the largest decrease in trading costs.

One can think of w as the opportunity cost of seignorage revenue and/or fiscal flexibility that a paper country loses by making its currency convertible. The loss of such flexibility translates into a cost since the country might have chosen a fiat regime to free itself from the reigns of convertibility clauses.⁶² Alternatively, under a system of free capital mobility, these types of countries might be likely to fall victim to a speculative attack if they attempt to move from a fiat regime to a regime of currency convertibility. Often, former paper regimes attempting a move to gold did come under attack. Some countries in this situation include Greece (1885), Argentina in the mid-1880s and in 1890 and Chile in the mid-1880s. This would impose a cost of real output losses or reputational losses in the capital markets.⁶³

Formally, the benefit to joining the gold standard for a fiat currency country is proportional to the following expression

$$\tilde{A}\alpha^{\frac{1}{1-\alpha}}(1-\alpha^2)\left\{G_t\left[(1-b_{iG}^G)^{\frac{\alpha}{1-\alpha}}-(1-b_{iF}^G)^{\frac{\alpha}{1-\alpha}}\right]\right\}-w\geq 0. \quad (16)$$

The larger is the amount of transactions with the gold bloc, the larger the net benefit to giving up the fiat regime. If the transition costs are high, a country with a fiat regime would avoid adoption. The next section analyzes why some countries left a particular bloc sooner than others, and how, if the scales are tipped far enough, all nations would be likely to adopt gold.

8.4 Evolution of the International Monetary System

8.4.1 A Repeated Stochastic Framework

Here I turn to an infinitely repeated version of the period problem from above. Each nation is small and has no effect on other nations' payoffs. I assume a simple myopic maximization problem on the production/consumption side. I focus on the comparative statics of regime choice for a *fixed level* of fundamental trade patterns and parameters. I study a specific case where nations only contemplate the possibility of moving from an

⁶¹Also note that the net benefit to adopting gold increases if and only if trade with the gold bloc relative to output increases. This fact will be used in the empirical section. I will use trade with each standard as the explanatory variables that test for the presence of network externalities in regime choice.

⁶²This assumes the par value of a currency is not malleable. As I mention in the body of the paper, historically this seems to be the case. Either countries were ideologically opposed to par value switches or countries could not change the par value of a currency without paying a penalty.

⁶³I will restrict attention to explaining the choice of the gold standard over paper. But in general the choice of regime might be complicated by the fact that paper countries had trade with bimetallic and silver countries too. As the size of these two blocs decreased rapidly after 1873 this does not seem to present a problem for the empirical side of this paper.

initial regime into the gold standard. I also focus only on the *time until the first adoption of the gold regime* rather than dealing with other theoretically possible transitions.⁶⁴

While the above has assumed that all nations with the same trade levels and cost parameters will choose similar regimes, there may be an idiosyncratic component to expression (15). For example some countries could be gripped by an ideology that gold is the money of advanced or “civilized” nations, silver reserves could be discovered fortuitously pushing countries away from gold or, as Gallarotti (1995) mentions, market structure and the liquidity of capital markets may alter the contemporary benefits. Countries with high idiosyncratic benefits to adopting gold relative to their current regime would be more likely to adopt gold and would be more likely to adopt gold sooner than other countries.

To study the effects of such idiosyncratic benefits on the probability of adoption of gold, define $\nu_i = \bar{\Pi} - \Pi_i$. Here $\bar{\Pi}$ is the average net gain to adopting gold from any commodity money regime given the observed variables. Π is the gain for country i from switching to gold. The larger is ν_i the smaller the likelihood that a country adopts the gold standard relative to similar countries.

Redefining expression (15) we see that a country adopts gold in place of another commodity money regime if

$$\bar{\Pi} = \Gamma \left\{ G \left[(1 - b_{iG}^G)^{\frac{\alpha}{1-\alpha}} - (1 - b_{iG}^S)^{\frac{\alpha}{1-\alpha}} \right] + S \left[(1 - b_{iS}^G)^{\frac{\alpha}{1-\alpha}} - (1 - b_{iS}^S)^{\frac{\alpha}{1-\alpha}} \right] \right\} \geq \nu_i \quad (17)$$

where $\Gamma = \tilde{A}\alpha^{\frac{1}{1-\alpha}}(1-\alpha^2)$. Here we see that if the idiosyncratic benefits are large i.e., ν_i is small, a country is *more likely* to adopt. In general the propensity to adopt could change over time in response to changing fundamentals and depending on how ν is distributed. The following assumes that the propensity to adopt depends only on a fixed set of fundamentals. In this case, we can show that a country that is just indifferent between the two regimes has a value of $\nu = \nu^*$ such that

$$\nu_i^*(G, S, T) = \Gamma \left\{ G \left[(1 - b_{iG}^G)^{\frac{\alpha}{1-\alpha}} - (1 - b_{iG}^S)^{\frac{\alpha}{1-\alpha}} \right] + S \left[(1 - b_{iS}^G)^{\frac{\alpha}{1-\alpha}} - (1 - b_{iS}^S)^{\frac{\alpha}{1-\alpha}} \right] \right\} \quad (18)$$

The probability of this event at any time T , given that a country has not adopted in the previous periods, is simply the hazard rate of the random variable ν . If ν has the cumulative distribution function F , then the hazard rate is

$$h(T) = \frac{F \left[\nu^* \left(G, S, \tilde{A}, T + 1 \right) \right] - F \left[\nu^* \left(G, S, \tilde{A}, T \right) \right]}{1 - F \left[\nu^* \left(G, S, \tilde{A}, T \right) \right]} \quad (19)$$

If idiosyncratic benefits are distributed exponentially then the hazard rate of gold adoption is constant over time for fixed fundamentals.⁶⁵

⁶⁴The interest in this event is mainly to generate empirical predictions consonant with the historical record. A more general model would study steady-state regime transition probabilities for general paths of the underlying trade patterns and fundamentals.

⁶⁵More generally, the distribution of ν and the rate of change over time of ν will determine the time pattern of adoption for fixed parameters of the payoff function. If ν were distributed normally, the hazard rate might rise in early periods. If it were distributed Weibull, the hazard of adoption of gold could either rise or fall over time. Also, by focusing on the hazard rate, one can re-interpret the results with a regression-like framework where the log of time until adoption depends on a linear combination of covariates and an error term with an extreme value distribution (Kalbfleisch and Prentice (1980)).

The appropriate hazard rate for an exponential random variable is simply $\exp\{\nu_i(G, S, t)\}$. The hazard rate of adoption of gold is increasing in G (i.e., the number of transactions with gold countries) and decreasing in S . To see this simply take the derivative of the hazard rate with respect to G . Moreover, in my framework it can be shown that the time until adoption is decreasing as G becomes larger or as S is smaller.

The benefit to adopting gold is also increasing in the size of the productivity parameter \tilde{A} . If per capita output is a proxy for the technology parameter, then the probability of adoption increases in the per capita output level of each country.

To implement estimation, I also remind the reader that *trade with gold standard countries relative to GDP* increases with the number of transactions with gold countries equal to G . I use the former as a covariate in the regressions so I can scale the value of trade by a measure of the number of transactions generated by the size of the domestic economy.

Summarizing, this model is simply one of regime choice. The model makes the prediction that nations would be more likely to adopt the gold standard (and would adopt sooner) the larger their trade with gold standard countries and the smaller the trade with members of their current commodity money regime. The model identifies a network externality in regime choice because the benefit to a given regime increases as the number of trading partners using a particular regime increases. It also illustrates that paper countries have a different calculus to undertake. If the costs to adopting the gold standard are high, this could delay the adoption of the gold standard by paper countries. As a multitude of nations defect from a given bloc to gold, the adoption of the gold standard becomes more likely for any country and the waiting time until adoption decreases.

8.4.2 A One-Shot Example—Defection from the Silver Bloc to Gold

Now I will consider the “evolution” of the international monetary system. I focus on a world where countries can have either a silver or a gold standard.⁶⁶ I will study four sets of hypothetical countries named Germany, Great Britain, Scandinavia and the British colonies/dominions/commonwealth. The example illustrates how when a large player moves to the gold standard other standards become inviable as equilibrium outcomes. Alternatively this example shows that when a small nation on silver faces the disappearance of nearly all silver trading partners choosing gold is the best response.

With the first part of the trading costs we can easily make an equilibrium such that initially Germany and Scandinavia are in the silver bloc while England and the commonwealth are on gold.

Specifically, let the cost to trade between any two monetary regimes $b_{jR}^{R'} = .2$, the cost to trade between a similar standard $b_{jR}^R = .1$, and let the following hold for the first part of the trading costs b_1 : for trade between Scandinavia and Germany or between UK and colonies, $b_1 = .01$; for trade between Scandinavia and UK or Germany and UK and colonies and Germany $b_1 = .1$; for trade between the colonies and Scandinavia $b_1 = 1$ (i.e., no trade between them).

These trade costs imply that Scandinavia and Germany have a natural trading relationship say due to geography, distance and/or cultural heritage. The effect is similar between Great Britain and her colonies. Other nations have moderate costs when trading outside of the bloc and the smaller parts of each bloc do not trade with each other.

⁶⁶In principle we could analyze the game when bimetallic countries and paper countries are present. To keep things tidy I do not. Essentially I am assuming that the bimetallic countries have little trade with silver countries—a situation that is certainly the case in my sample after about 1873 when the European silver bloc disintegrated. The same caveat applies to paper countries.

Figure 2: Regime Coordination Game

| | | Scandinavia | |
|---------|--------|---|---|
| | | silver | gold |
| Germany | silver | $(0.79 + 0.49 \textit{gold}),$ $(0.79^* D + 0.49 \textit{gold})$ | $(0.62 + 0.49 \textit{gold}),$ $(0.79^* D + 0.64 \textit{gold})$ |
| | gold | $(0.62 + 0.64 \textit{gold}),$ $(0.62^* D + 0.49 \textit{gold})$ | $(0.79 + 0.64 \textit{gold}),$ $(0.79^* D + 0.64 \textit{gold})$ |

Further, for simplicity I set the “population” of Scandinavia and the colonies to 1 while the population of Germany is D and that of the Great Britain is UK both of which can be larger than one. Also I assume that A is constant across countries and discard the leading coefficient of expression (16). Finally, let $\alpha = 2/3$.⁶⁷

To study the transformation and configuration of the international monetary system at any given year, I define an equilibrium concept.

Definition: An equilibrium is when all countries belong to a regime R , taking its trade pattern as given such that no nation can earn a strictly higher level of consumption by switching to another regime.

One can calculate the benefits to each regime using expression (13) and the definition of trading costs. To keep things neat, I discard the leading coefficient of $\tilde{A}\alpha^{\frac{1}{1-\alpha}}$, and to make payoffs comparable internationally I divide the benefit by the size of the domestic country N_j . The strategic form of the game can then be written as

where *gold* is the “population” of the UK and the colonies and payoffs are listed for Germany and then for Scandinavia. I have omitted the payoffs for England and the

⁶⁷A subtlety arises with α . The size of the net benefit from linking up to a similar regime as trading partners with whom a country has a natural relationship (i.e., low b_1) is larger only if α is greater than $1/2$. This holds if goods are relatively close substitutes for each other. I restrict α to be greater than $1/2$ for this exercise.

colonies for simplicity. Given that England and the colonies are both playing gold we may either have as equilibria $\{S, S, G, G\}$, $\{G, G, G, G\}$, where S is being on silver, G is being on gold and the actions of players are listed in the following order: Germany, Scandinavia, UK, the commonwealth and colonies.

For the first profile to be an equilibrium, one can verify that, for Germany, the ratio of inputs made in the gold bloc relative to those imported from Scandinavia (i.e., other silver countries) must be less than or equal to 1.12. If the ratio is higher, Germany will always strictly prefer gold. In a comparative statics framework, this implies that if we start from the first profile we might rule it out in the future. If the gold bloc's trade with Germany becomes sufficiently large, Germany would automatically defect to gold. When this is the case, the first profile can never be an equilibrium. Also, to ensure the existence of the first equilibrium we need, for Scandinavia, that the ratio of inputs from Germany compared to the gold bloc be greater than .92. If it were less, Scandinavia would always want to be on the gold standard.

To prevent England from switching to silver we also need that the "population" of the commonwealth makes up more than 92 percent of the total volume of transactions with Germany.⁶⁸ I am assuming this is the case. The colonies would only want to switch to silver under two circumstances. The first is when trade with Germany was sufficiently high which I will assume is not the case. The second scenario is if England were to play S .

With atomistic players, we can still see changes in country by country regime choice while still retaining a landscape similar to that of the first equilibrium profile. In other words, any equilibrium is possible. A special case of this atomistic world arises either when players are large, the purchases of inputs from one bloc drops to zero or both. That is to say, if all of the small silver trading partners of a small-open economy on silver *all* defect to gold the last country would have to defect to gold as well. Both of these things happened as the gold standard became an increasingly popular monetary regime in the nineteenth century and major players like Germany and France left their respective blocs. This caused the near disintegration of the bimetallic and silver bloc in Europe. The first profile became a less viable equilibrium.

In this parameterization, there are two other possible pure strategy equilibria. They are $\{S, S, S, S\}$ and $\{G, G, S, S\}$. One might rule out these equilibria based on a more casual argument. Suppose that the British had a strictly dominant strategy in gold. Perhaps this was due to an ideological zeal or preference for gold, or perhaps it was because of a fear that the value of its (large) gold reserves would drop if England were to sell gold for silver on world markets. Given the importance of England, the colonies would have to play gold thus ruling out the last two profiles as equilibria.

The English delegate to the International Monetary Conference of Paris in 1867, referring to the alteration of par values and coinage systems in preparation for a hypothetical global monetary union, stated, "The English nation is in a position much more independent upon this question than most continental nations." Admittedly, this is not in reference to the metallic standard per se but is indicative of the immutability of British policy on the monetary system. Also, Seyd (1868) recounts how England was a steadfast advocate of the gold standard.

Removing these two equilibria then leads us to try to explain the switch from the first to the second equilibrium. The first equilibrium, with two blocs—one silver and one gold—could have been eliminated because trade with gold countries became large enough to tip the balance in favor of gold.

⁶⁸The calculation is similar to whether Scandinavia switches to gold given Germany's actions since the cost parameters are symmetric.

8.4.3 Repeated Game Framework

One could turn this into an infinitely repeated game. Without inserting storage technologies and capital accumulation into the model, the per-period maximization holds. The only complication arises because of the explosion in the set of equilibria. The folk theorem applies if countries are patient enough and we may see any sort of equilibrium that assures the minimum of all best response payoffs for each country. Essentially, any international monetary landscape can happen, and roughly it did. From the 1840s until 1913 many countries bobbed in and out of the gold standard while others maintained silver or paper regimes. For now, however I will note that the equilibria defined before are also perfect equilibria of the infinitely repeated game where each stage is the game from above.

Appendix B

Data Notes

Real GDP: Figures are from Maddison (1995). They are in real, 1990 PPP U.S. dollars.

Volatility: I use monthly exchange rate data from the Global Financial Database and Schneider, Schwarzer, and Zellfelder (1991). Some series are for “sight” transactions on foreign exchange while others are for “three-month” or “six month” exchange rates. I operate under the assumption these series never diverge significantly. We observe that in some cases, when all series are available, this is in fact the case. Countries for which we use data from Schneider, Schwarzer, and Zellfelder (1991) are France, Netherlands, Germany, Italy, Switzerland, the United States, Norway, Sweden, Finland (before 1900), Portugal, Austria, and Belgium. To construct the volatility measure, I then take the standard deviation of $\ln(e_{ijt}) - \ln(e_{ijt-1})$ multiplied by 100. Where e_{ijt} is the bilateral exchange rate between country i and j in month t . I use cross rates when necessary.

Distance and Borders: Distance is taken from Rose (2000). The data were downloaded from <http://haas.berkeley.edu/~arose>. He in turn lifted the data from the CIA’s website. The data on borders comes from López-Córdova and Meissner (2000).

Regime Dating: Many sources were used to establish the first year of gold convertibility of a currency. Sources include Llona-Rodríguez (2000) Bordo and Schwartz (1995) Carbo (1954) Calogeras (1960) de Cecco (1974) Eichengreen and Flandreau (1998) Flandreau, Le-Cacheux, and Zumer (1998) Fratianni and Spinelli (1997) Kemmerer (1916) Lazaretou (1995) Martín-Acena (2000) Masayoshi (1899) Muhleman (1895) Quintero-Ramos (1965) House of Commons (1876) Torres-Garcia (1945) Williams (1920) Yeager (1969) Young (1925).

Trade Data: I have two main sources for trade data. Mitchell (1992) provided most of the data. Trade data were expressed in millions of current pounds sterling. Most often data was transformed from national currency units into pounds sterling. I complemented this data with series from Barbieri (1996) when necessary. I also used a pure series from Barbieri supplementing these series with Mitchell’s data in the case of missing values. Barbieri’s data was transformed from current U.S. dollars into pounds sterling at the annual average exchange rate.

The data covers trade from most of the important trading partners though there is no universal cut-off value for being included in Mitchell’s series. Barbieri’s data are more comprehensive in general, but only independent countries are included in the data.

Gold, Specie and Notes in Circulation: This series includes all notes outstanding in the nation of question. Usually this meant using the notes in circulation of the central bank and possibly the government if these notes were convertible. For countries without central banks the notes in circulation are at all banks of issue. Only gold reserves and silver reserves held in banks were used for calculating the amount of specie in a country. See the particular country notes for the sources used.

Government deficits: I use the average of the ratio of current and the previous two year’s deficit (i.e., the difference between expenditure and revenue) to nominal output.

Table 8: Countries and variables

| Country | Trade with Gold Standard Countries to GDP | Gold to Notes in Circulation | Trade with Countries on the Same Standard to GDP | Agriculture to GDP | Non-Gold Standard Countries Trade With | Average Distance to Gold Countries | Volatility | Silver Reserves | In (Real GDP) | In (Real per capita GDP) | In (nominal per capita GDP) | Average Current Account Deficit to GDP |
|-------------|---|------------------------------|--|--------------------|--|------------------------------------|------------|-----------------|---------------|--------------------------|-----------------------------|--|
| France | X | X | X | X | X | X | X | X | X | X | X | X |
| US | X | | X | X | X | X | X | X | X | X | X | X |
| Belgium | X | X | X | X | X | X | X | X | X | X | X | X |
| Switzerland | | | X | X | | X | X | | 1870 | 1870 | X | |
| Italy | X | X | X | X | X | X | X | X | X | X | X | X |
| Germany | X | | X | X | X | X | X | | X | X | X | X |
| Holland | X | X | X | X | X | X | X | X | X | X | X | X |
| Denmark | X | X | X | X | | X | X | X | X | X | X | |
| Norway | X | X | X | X | X | X | | X | X | X | X | X |
| Sweden | X | X | X | X | X | X | X | X | X | X | X | X |
| Finland | X | X | X | X | X | X | | | X | X | X | X |
| Austria | X | X | X | X | | X | X | X | X | X | X | X |
| Russia | X | X | X | 1885-1897 | X | X | X | X | | | 1885-1897 | 1888-189 |
| Spain | X | X | X | X | X | X | X | X | 1901-1901- | X | X | X |
| Greece | X | | X | X | 1887- | X | 1902- | | | | X | X |
| Japan | X | X | X | X | X | X | X | X | 1886-1886- | 1875- | 1878- | |
| Brazil | X | | X | X | | X | X | | | | X | |
| Chile | 1880-1893- | 1895 | X | | | X | 1879- | | 1900 | 1900 | 1880-1894 | 1883-189 |
| Argentina | 1886- | 1886- | X | | 1886- | X | 1886-1890- | 1891 | 1900-1900- | 1886- | 1889- | |