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Commodity money and the price level

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Abstract

In an open free market economy with money based on a metallic standard, it is found that, with the exception when the currency is debased, any supply or demand shocks leave the prices unaffected both in the short run and in the long run. This stabilization property derives from the mechanism that changes in commodity prices motivate the holders of the stock of the currency to shift the latter's demand up to the point of equating the currency's cost of ownership to its purchasing power in terms of goods and services. When the country is large relative to the international market for specie, maintenance of price stability may require adjustments in the seigniorage charge, whereas in countries with closed economies such adjustments are in general imperative. In addition, through seigniorage adjustments, and at the zero bound of seigniorage charge though lowering the specie content of the currency, the price level may be held even fixed, and indeed irrespective of the magnitude and origin of shocks, the relative size of the country, and the degree of its openness. These results are consistent with the monetary experiences of Athens in classical times, France during the period 1350-1436 AD, Spain in the 16th century, the United States in 1870-1914 AD, and China in 1910-1935 AD. Additionally, since an electronic money like the Bitcoin has properties similar to gold or silver, the results may extend to a cryptocurrency standard.

Keywords: Commodity money, inflation, deflation, stabilization,

JEL Codes: E31, E42, E51, E63, N13

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Commodity money and the price level

1. Introduction

The term “commodity money” refers to products like gold and silver, which have been used in the past for exchange of goods and store of value purposes. In the 20th century, and particularly after the collapse of the Bretton Woods agreements in 1971, when the convertibility of the U.S. dollar to gold ended, with few exceptions, the interest of monetary economists in commodity standards eclipsed, and instead they focused on fiat money in conjunction with the presumed stabilizing powers of governments and central banks. Economists following the monetarist tradition cannot be absolved of their responsibility for this development. For, say, when Friedman ([1953, 209-210](#); [1960, 5](#)) wrote that,

The fundamental defect of a commodity standard, from the point of view of the society as a whole, is that it requires the use of real resources to add to the stock of money. People must work hard to dig gold out of the ground in South Africa—in order to re-bury it in Fort Knox or some similar place.”

Friedman, most likely committed to his assessments in [Friedman \(1951\)](#), missed the opportunity to throw his weight in favor of a commodity standard based entirely on futures, which would eliminate the social costs he was so concerned with the gold standard,¹ and remained unmoved even as late as [Friedman, Schwartz \(1986\)](#). Now we live in a world of fiat money, negative interest rates, and huge public and private debts, so thinking ahead of the next big crisis, research efforts to increase the pool of alternative policy options, including the return to a commodity standard, should be welcome.

Another reason for looking into this direction has to do with the state of the large specialized literature where it is claimed that silver and gold standards have proved unstable in the past, and indeed more so in the short-run, thus rendering the presence of a central bank necessary to stabilize the economy. For an excellent example in this regard, consider the study by [Bordo, Dittmar, Gavin \(2007\)](#). Using a Dynamic Stochastic General Equilibrium model with parameter values drawn from the experiences of 13 advanced economies, their objective was to assess the differential effects of

¹ The idea of a basket of commodities standard is not new. It is an extension of the concept of “symmetallism” first proposed by [Marshall \(Marshall 1887, 204-7\)](#). According to it, all money would circulate in the form of banknotes convertible into gold or silver ingots joined together in fixed proportions. The market would determine a weighted average of the prices of these metals and both would remain in the reserve base. In this way, the standard would not degenerate into monometallism. Still the problem of production and storage costs mentioned in the quotation by Friedman would continue to exist. However, these costs might be eliminated completely following the design and operation of schemes based on futures, as discussed in [Barro \(1979, 20-31\)](#) and in more detail in [Dowd \(1995, 309-339\)](#).

four monetary regimes regarding the long- and short-term stability of the price level.² Included in these four regimes was also one based on an idiosyncratic type of commodity money. Among other results, they found that:

- (a) ... a fiat regime based on a credible nominal anchor provides the price stability benefits of the gold standard with neither the resource costs nor the short-run variability associated with the gold standard; and (b) ... if a central bank wants price stability for the short-term, then stabilizing a broad price index clearly dominates the classic gold standard.

Taking these results at face value, and even without considering the thorny issues associated with central banking as expounded, say, in ..., the superiority of fiat over a commodity standard is claimed to stand on three advantages. Namely, first, that the former is free of the latter's cost of resources; second, that it can be equally price stabilizing in the long run; and thirdly, that it is characterized by lesser short-term price variability. They are highly dubious, but not isolated because similar assertions by well-known economists are widespread in this literature. Therefore, the challenge remains intact. For, if we brush aside the argument about the resource costs, which would crumble now under the progress of the advancing digital technology and the breath of available futures markets,³ the case for returning to a commodity standard hinges on establishing firmly its price stabilization properties.

Related to this quest are also the developments in the front of cryptocurrencies or cryptos. Many proponents insist that currencies like Bitcoin are indeed “digital gold”. Their claims are not without merit. The similarities of cryptos to gold or silver are not limited to the significant energy and other inputs consumed in their production. Additionally, once possessed by somebody, exactly like any commodity money, they cannot be in any way another person's liability. In other words, unlike fiat money, the value of which is based on the credibility of the issuing govern-

² Price stability has been adopted as a desirable outcome because inflation distorts the informational content of prices, thus leading to misallocation of resources; it slows down productivity and economic growth; and not the least, it biases the distribution of national income in favor of the younger and against the older that live more or less on fixed incomes. On the other hand, deflation is conceived as undesirable because it is accompanied invariably by more or less severe unemployment, national income losses, and adverse distributional effects among young and old. In macroeconomics, the root causes of inflation and deflation are associated commonly with the advent of excessive or deficient aggregate demand. Less commonly, deflation is identified and modelled with productivity growth, particularly in more recent decades. No doubt, if productivity gains were allowed to work their way through the intertemporal structure of prices, the general price level would decline. But it would be difficult to separate it econometrically from the effects of deficient aggregate demand and this important differentiation is ignored.

³ It is of particular interest to note that by the close of the 20th century the argument of the “resource cost” by Friedman (1953, 209-210; 1960, 5) and other monetary economists following his lead was already strongly rebutted by [White \(1999, 42-50\)](#).

ment, in the case of cryptos, there is no trust involved. If one holds bullion, the only way one loses ownership is by selling it or by losing it to thieves. Cryptos have the same exact property. Once in one's wallet, they cannot be cloned and they stay firmly in one's ownership. For example, the only way Bitcoin leaves one's grasp is through sale, theft, or losing in some way one's wallet. Drawing on the above specie like advantages of cryptos, experts do not preclude that an electronic currency like the Bitcoin may emerge as a world currency. Are these prognoses farfetched? The answer is in the negative. For, even though it is early to tell how the introduction of Bitcoin and numerous other cryptos will integrate into the national and international monetary system of payments, electronic commodity money in the form of cryptocurrencies, but not the digital currencies in which central banks show particular interest, may push aside fiat money as per the inverse of Gresham's law.

In view of the preceding remarks, the objective here is twofold. That is first, to investigate the stability of prices in an open free market economy with a commodity standard, and secondly, to test the findings against the historical experiences of several countries where varieties of such a standard were applied for long periods.⁴ To this effect, next section presents the model and its analysis. To anchor the presentation to a realistic case, the setting of the model is envisioned to draw on the experiences of countries like Athens in classical times or the United States (U.S.) today, that is, large relative to their trading partners. The rationale being that in the advent of sizable supply or demand shocks their effects might possibly spread internationally and influence the price of the precious metal used in their commodity standard. Section 3 highlights the equilibrium properties of the proposed model and states the findings in the form of a theorem. Then, in Section 4, the applicability of the theorem is validated by reference to certain well-researched historical country episodes, and finally in Section 5 the paper closes with a summary of the findings and the conclusions.

2. Setting of the problem and analysis

Consider an open economy with a silver standard named "drachma" and traded goods and services as depicted in the following expression.

$$(x_1, x_2, x_3, x_4, x_5, \dots, x_h, x_{h+1}, x_{h+2}, \dots, x_m). \quad (1)$$

⁴ Hence, it should be noted that there is no intention here to investigate the implications of a standard where the base commodity is a cryptocurrency. For a first attempt in this direction, see ...

Let x_1 stand for the stock of silver drachma coins, x_2 for the stock of silver bullion, x_3 for the stock of silver held in the form of silver goods for various uses, x_4 for the stock of banknotes convertible on demand into drachma coins, $(x_{h+1}, x_{h+2}, \dots, x_m)$ for a basket of consumer goods, and (x_4, x_5, \dots, x_h) for a basket of all other goods. The ratios of goods x_i , for $i = 2, 3, \dots, m$, to the drachma coins x_1 give the *relative prices*. Using these relative prices, assume that all consumer goods are aggregated into a basket of consumer goods of quantity c and price p_c^d . The latter, standing, say, for the well-known Consumer Price Index (CPI), denotes the quantity of silver drachmae or fraction thereof one needs in order to purchase one unit of c . At the same time, the inverse of p_c^d , stands for the price of the monetary unit in terms of the quantity of consumer goods it buys, that is, its real purchasing power. Therefore, by definition, it holds that:

$$p_d^c \equiv 1 / p_c^d. \quad (2)$$

This identity defines the value of the drachma as the reciprocal of the unit price of the consumer goods that it buys. Hence, it holds irrespectively of the material from which it is fabricated.

The question that arises in the above context is how to define the commodity standard in order to avoid material losses in the consistency and generality of the conclusions. The answer depends on resolving two issues. The first emanates from the realization that silver goods like household utensils, ornaments, etc., included in x_3 , and silver coins in x_1 may be close or distant substitutes, whereas the second issue has to do with the banknotes x_4 . Responding to the scarcity of precious metals, actual free market economies have made use of a great deal of money substitutes. What transpires in transactions depends on the cost for converting x_3 to x_1 . Presumably high costs for reclaiming silver from silver goods and high seigniorage and other charges at the mint would render x_3 and x_1 distant substitutes, and vice versa. In this paper it is assumed that the said conversion costs are such that only x_1 serves as hand-to-hand commodity money. Yet, this simplification is not meant to gloss over the significance of money substitutes because, depending on the circumstances, the supply of x_1 may be subjected to serious destabilizing shocks from shifts in the allocation between monetary and non-monetary uses of the base commodity. As for the second issue, it is stipulated that the quantity of banknotes x_4 is a fixed multiple of x_1 , so that from a be-

havioral perspective only the latter matters in the analysis. Again though, this should not be interpreted to imply that the structure of banking is not important. The reason being that a great deal of monetary innovation over the centuries resulted from the participation of banks in the process of reducing the required quantity of precious metals without affecting the operational efficiency of the monetary system. And, moreover, unless totally replaced by a cryptocurrency like the Bitcoin or some new technique that would render the storage of the base commodity superfluous, no matter how limited the scale of x_1 becomes, still in terms of resources a commodity standard is likely to remain more costly for society relative to these alternatives.

Having settled on x_1 as the base commodity, let us now define the “cost of ownership” of the drachma coin f_d^c . This comprises four components. The first is the cost of silver contained in the drachma coin k_1^c . The second is its fabrication cost k_2^c . The third, k_3^c , represents the regular tax that the mint collects on behalf of the issuing state;⁵ and lastly, the fourth component, k_4^c , stands for an extra tax that burdens exclusively the foreign users of the currency. In other words, we have $f_d^c = k_1^c + k_2^c + k_3^c + k_4^c$. Of the four components entering into f_d^c , k_1^c is determined in the international markets for silver which, depending on their institutional setup, may be more or less competitive.⁶ The value of k_2^c depends on the operating costs of the mint. k_3^c is a policy instrument in the sense that it is decided by the official commodity money issuing authority; and lastly k_4^c is possibly an extra tax or “currency premium”⁷, which is determined in the international markets for foreign currencies and is paid only by those traders who prefer to deal in the currency in question.

⁵ This tax is the so-called “seigniorage”. Depending on the context it is used, this term may refer only to the taxes that the government seeks to collect from coinage or just printing fiat money. As it can be ascertained, for example, from [Obstfeld \(1997\)](#), the implications for fiscal and monetary policies when this channel is used for raising public revenues have been studied extensively. But when money is used in international transactions, the meaning of the term may expand to include an extra tax that springs from the extra services that the currency offers to foreign traders. For example, in the case of the U.S. dollar, [Eichengreen \(2011, 3-4\)](#) has coined the term “Extravagant privilege” and justifies it as follows:

...It costs only a few cents for the Bureau of Engraving and Printing to produce a \$100 bill, but other countries have to pony up \$100 of actual goods and services in order to obtain one. (That difference between what it costs the government to print the note and a foreigner to procure it is known as “seigniorage” after the right of the medieval lord, or seigneur, to coin money and keep for himself some of the precious metal from which it was made).

⁶ If in the international markets operate a few large government mints, their monopsony power is bound to distort the prices of silver or gold. Prices may be less distorted if the mints are large but privately-own, and even more so if the mints are private and relatively small. In any case, these issues lie beyond the scope of the present inquiry.

⁷ In the case of a commodity standard, aside of the seigniorage charge, which burdens both domestic and foreign holders of the currency, international markets would place on it a premium, depending on how well it performs relative to

In view of their underlying determinants, f_d^c and p_d^c may differ due to various economic circumstances. Therefore, given that the wedge between them generates for the holders of the stock of drachma coins opportunities for gains and incentives for the avoidance of losses, there arise two questions. These are, first, if p_d^c changes, due to demand or supply shocks in the markets for consumer goods, would the emergence of inflation or deflation be permanent or transient? and second, if f_d^c changes due to non-compensating shifts in its determinants, how might these changes affect the price level p_d^c ? To answer these questions, we need a theory based on the rational economic behavior of economic agents who are active in the economy.

A convenient approach to such a theory is to hypothesize that the purchasing power of drachma and the cost of its ownership adjust in a way that, after some reasonable time, they converge to an equilibrium. Adopting this conceptualization, let

$$\dot{p}_d^c = -\lambda(\bar{p}_d^c - p_d^c) \quad (3)$$

where $\lambda > 0$ and a dot (bar) over a variable denotes, respectively, its time derivative and equilibrium value. Equation (3) is a stable first order differential equation which converges to $\bar{p}_d^c = p_d^c$. The idea underlying (3) is that a disturbance in p_d^c , say dp_d^c , motivates economic agents to act so that, as the disturbance dies out, $dp_d^c \rightarrow 0$, p_d^c returns gradually to its equilibrium value, $p_d^c \rightarrow \bar{p}_d^c$. At the microeconomic level there are markets which once hit by a shock release forces that lead to the establishment of a new equilibrium. Yet at the economy level equation (3) is considered by macroeconomists adequate (see e.g. [Alogoskoufis 2019, 370](#)), because shocks in the goods markets do not hit all markets at the same time and on the average the effects of negative and positive shocks phase out gradually in more or less short time.

Regarding the ownership cost of the drachma coin, it is postulated that current values converge to equilibrium as per the process:

$$\dot{f}_d^c = -\mu(f_d^c - \bar{f}_d^c), \quad (4)$$

where $\mu > 0$. Again, (4) is a stable first order differential equation that converges to $f_d^c = \bar{f}_d^c$, and

other international currencies as medium of exchange and store of value. For example, in the case of Athens in classical times there is evidence showing that foreign merchants who brought their goods to the port of Piraeus, they sold them at significant price discounts to customers who paid in Athenian currency. These discounts determined the magnitude of the “brand premium” that the markets placed on the drachma.

together with (3) yields a second order system:

$$\bar{f}_d^c = \bar{p}_d^c. \quad (5)$$

Embedded in (4) is the conceptualization that supply or demand shocks in f_d^c motivate economic agents to act such that $f_d^c \rightarrow \bar{f}_d^c$. Hence, the explanatory power of the model depends on whether (5) remains stable to shocks.⁸

3. Stability of the equilibrium

The holders of the stock of drachma coins in the economy, rationally thinking, should have an incentive to minimize losses when $\bar{f}_d^c < p_d^c$, and maximize gains when $\bar{f}_d^c > p_d^c$. By reducing (increasing) respectively their purchases of consumer goods, the price of the latter will increase (decline), the purchasing power of money will decline (increase) and eventually all adjustments will end by establishing equilibrium as per equation (5). So, let us return to the questions raised above and investigate whether this equilibrium remains stable or not upon a disturbance from various hypothetical shocks.

3.1 Shocks from productivity improvements in the supply of consumer goods

Due to keen competition among firms in the consumer goods sector, assume that all improvements in productivity are passed on to consumers in the form of price reductions. Alternatively, this implies that the firms in this sector retain no abnormal profits. The decline in the price of consumer goods increases the purchasing power of the drachma coin above its equilibrium value, and hence above its equilibrium ownership cost. The situation that arises is $\bar{f}_d^c = \bar{p}_d^c < p_d^c$. Ceteris paribus, will this shock give rise to deflation? The holders of drachma coins and assets denominated thereof are offered certain windfall gains. So, behaving rationally they may be expected to transfer silver from other non-monetary uses, including dishoarding of commodity money, and even use good substitute means of payment like gold, to expand their purchases of consumer goods.⁹ Moreover, since the economy is presumed to be open, the decline in the domestic prices

⁸ Aside of stability, under which the price level would be expected to remain trendless or without persistent inflation or deflation, the analysis will extend to the case where \bar{f}_d^c is held fixed through appropriate seigniorage policies. In the latter event, the level of prices would be expected to remain fixed.

⁹ The model presented above is in the spirit of [Senior \(1840\)](#). It focuses on the equilibrium of the supply and demand for x_1 , which is a stock variable. In the actual economy, this turns into flow through the velocity of circulation. As the latter, change the equilibrium in the flows of the supply and demand for money changes. In a full-fledged monetary

of consumer goods will render them more competitive relative to those abroad and export demand will increase. Inflows from exports will increase the commodity money supply in the domestic markets; higher profit margins and productivity gains in the silver producing domestic industry may induce further increases in the supply of the commodity money; and all these adjustments should continue until the price of consumer goods returns to $\bar{f}_d^c = \bar{p}_d^c$, thus establishing that the price of consumer goods remains stable.

In a small country with an open free market economy and commodity money this result would hold with certainty because, the self-correcting adjustments mentioned above cannot be expected to exercise any decisive influence on the international price of silver k_1^c , and \bar{f}_d^c remains fixed. But, if the economy is large relative to the world market, it cannot be precluded that a productivity shock will not stir deflation. The reason is that, due to the scale of the country, excess demand will increase the price of silver, k_1^c will move upwards, and in turn \bar{f}_d^c will shift to a new higher equilibrium such that $\bar{f}_d^c < \bar{\bar{f}}_d^c = \bar{\bar{p}}_d^c > \bar{p}_d^c$. The proposed model offers the possibility to make sure that productivity gains do not give rise to deflation. The policy is based on the seigniorage charge. In particular, given the generalization introduced by [Obstfeld \(1997\)](#), if the policy calls for raising the seigniorage to compensate for a decline in the world price of silver, state revenues can be raised at will by increasing k_3^c , in conjunction if necessary with a simultaneous reduction in other taxes to balance the budget. On the contrary, if the policy calls for reducing k_3^c to compensate for an increase in the world price of silver, the government may lower seigniorage and do so up to zero while raising other taxes to balance the budget. However, if the policy calls for a negative seigniorage charge, to avoid an influx of specie from abroad to take advantage of any subsidy, the government may revert to reducing the silver content of the currency as required. In essence, by shifting k_3^c in a compensatory manner, the government may hold \bar{f}_d^c fixed in the same ways that [Williams \(1892\)](#)¹⁰ and [Fisher \(1913\)](#) proposed long ago.

Lastly, if the country's economy is closed, the self-correcting adjustments become subdued and most likely they will fail to raise the demand for consumer goods sufficiently to push p_d^c back to

model, it would be necessary to setup conditions for equilibrium in both the stock and flow variables along the lines suggested by [White \(1999, 28-37\)](#). However, to avoid the complications that such an extension would entail, with some loss in generality, it is assumed that the velocity of circulation remains fixed, and hence that when equilibrium in the stocks obtains the same holds true for equilibrium in the flows.

¹⁰ I am indebted to Kevin Dowd for bringing this source to my attention.

the equilibrium level. Then, assuming that price stability is the objective, the suggested policy approach becomes imperative. For, shifting k_3^c appropriately upwards, increases f_d^c and, by speeding up the velocity of circulation of the commodity money, deflation ends at a new higher equilibrium such that $\bar{f}_d^c < \bar{f}_d^c = \bar{p}_d^c$. In this case though, responsible for the emergence of deflation would be the arrangements that rendered the economy closed rather than the shocks from improvements in productivity.

The analysis of shocks that enter through the aggregate demand or supply of consumer goods follows modes of thinking like the above and leads to analogous inferences. Therefore, without further ado, let us turn to the next most important issue.

3.2 Shocks through the supply side of the market for specie

Looking closer at equation (5) in conjunction with the determinants of the ownership cost of the commodity money, one cannot miss that shocks channeled through f_d^c are key to the stability of the equilibrium, and hence to the stability of the level of prices. For, if the shocks are such that the equilibrium of f_d^c shifts, say to $\bar{f}_d^c \neq \bar{f}_d^c$, then depending on whether $\bar{f}_d^c > \bar{f}_d^c$ or $\bar{f}_d^c < \bar{f}_d^c$, the price level will go into inflation or deflation, unless the disequilibrium generates incentives that motivate economic agents to undertake initiatives to bring about the convergence of f_d^c to \bar{f}_d^c . Thus, given that the nature and the implications of the shocks through the supply side of the market for specie lie at the center of the problem, their analysis is most important.

To this effect, it serves best our purpose to consider the case that transpired in Athens in 483 BC. In that year they discovered a new rich vein of silver in the nearby Laurion region; its production expanded spectacularly; and at least during the period 480-430 BC Athens was elevated to the top world supplier of silver. Consequently, the international price of silver ought to have declined, k_1^c shifted downwards, and the lowering of the drachma's ownership cost led to a disequilibrium situation $f_d^c < \bar{f}_d^c = \bar{p}_d^c$. Did they experience persistent inflation and if not why? The disequilibrium certainly motivated Athenians to bring about the following adjustments. Since the economy was open, the rise in the price of consumer goods stimulated imports. Competition from imports pushed the price of consumer goods back to \bar{p}_d^c ; Paying for the cost of imports in currency and bullion and curtailing the production of silver as well as discouraging its monetari-

zation, due to the decline in the purchasing power of the drachma, certainly reduced the excess supply of silver. Were these adjustments enough to prevent the decline of k_1^c and hence the shift of f_d^c to a lower inflationary equilibrium? For an answer, let us consider the following quotation from [Xenophon \(*Ways and Means*, IV, 3-8\)](#):

Well, so long as the maximum number of workmen was employed in them (Author: he means the mines), no one ever wanted a job; in fact, there were always more jobs than the labourers could deal with. And even at the present day no owner of slaves employed in the mines reduces the number of his men; on the contrary, every master obtains as many more as he can. The fact is, I imagine, that when there are few diggers and searchers, the amount of metal recovered is small, and when there are many, the total of ore discovered is multiplied. Hence of all the industries with which I am acquainted this is the only one in which expansion of business excites no jealousy. Further than this, every farmer can tell just how many yokes of oxen are enough for the farm and how many labourers....But an increase in the amount of the silver ore discovered and of the metal won is accompanied by an increase in the number of persons who take up this industry. Neither is silver like furniture, of which a man never buys more when once he has got enough for his house. No one ever yet possessed so much silver as to want no more; if a man finds himself with a huge amount of it, he takes as much pleasure in burying the surplus as in using it (Underlined by the author).

According to the testimony of this astute student and observer of economic developments at the time, demand for silver was practically insatiable. That was demand for one's portfolio of assets, namely wealth, comprising silver, land, houses, and other treasures, but as the price of silver declined with the abundant supply, it would be rational for Athenians to boost the silver shares in their portfolios, thus giving rise to increased demand for silver. Therefore, given that, the Athenian economy was open and there was no excess international supply of silver, in all probability the discovery of the Laurion silver mines left the equilibrium at $\bar{f}_d^c = \bar{p}_d^c$ and the level of prices stable.¹¹

3.3 Debasement of the currency

In this case, the state purposely issues new coins with lower content in silver. When the new coins appear in the market for consumer goods, their price in the new currency duly increases, so that the value of the new currency in terms of consumer goods declines, and thus a new long run equilibrium is established in which the price of consumer goods has increased permanently. Still

¹¹ Presumably, prices would remain stable under productivity improvements in the economy and particularly in the mining and processing industries of silver. In the case of classical Athens, there is evidence showing that improvements at the purification stage of silver ores resulted in significant gains in the quantity and quality of the extracted silver bullion.

there is a problem, because the old currency contains more silver and hence it commands higher value in terms of purchasing power. The circumstances are such that either the holders of the old currency proceed to remint the currency in their ownership or, driven by Gresham's law, they hoard it, or the market splits into two, the one dealing in the old currency and the other in the new currency. However, in all three cases there is another long-term equilibrium with a higher price level.

3.4 Sum up

In a country with commodity money, the stability of the level of prices depends on two conditions. These are, first, whether the country is small or large relatively to the international market for silver, and second, whether the country's economy is open or closed. Expressing more compactly the implications of these conditions, yields the following theorem.

Theorem

In a country with open free market economy and commodity money, the price level remains stable under any shock, excluding the debasement of the currency. If the country is large relative to the international market for specie, preserving price stability may require adjustments in the seigniorage charge, whereas if the country's economy is closed, regardless of its relative size in the market for specie, maintenance of price stability renders such adjustments imperative. Through seigniorage adjustments, and at the extreme by lowering the specie content of the currency, the price level may be held even fixed throughout, irrespective of the magnitude and origin of the shocks, the relative size of the country, and the degree of its openness.

What remains is to find how well this theorem applies by reference to a few historical country episodes for which we have enough information about their institutional setup, the nature of the commodity standard that was used, and the course of prices.¹² But before turning to this task a note is in order. According to the theorem, if the economy is closed, the effects of shocks are not self-correcting. Hence, all policy interventions through the ownership cost of the commodity money to confront persistent price instabilities are second best to keeping the economy and its markets as open and as competitive as possible.

4. Empirical validation of the theorem

The above theorem was deduced from the assumption that rational economic agents act to maxim-

¹² From a methodological point of view, any such sample may be suspected as an exercise in cherry-picking country episodes to bias the conclusions in favor of the tested hypotheses. This risk is mitigated here by interpreting the results as conditional upon verification or refutation through further research.

ize windfall gains or minimize windfall losses when circumstances drive a wedge between the ownership cost of the currency and its purchasing power in terms of consumer goods. As such, the theorem may be considered true. Then there arises the question: Is this theorem “true” in the same sense as those of algebra and geometry, or is it merely probable, like the propositions of literary economists? The answer is that there exists a fundamental difference. This amounts to the qualification that, while the theorem may be considered absolutely true, at the same time though the model itself and the underlying assumptions may not be applicable to any real world phenomena, and this in turn may render the theorem vacuous. Therefore, to make sure that the theorem is useful, we must supplement it with a proposition specifying the real world situation(s) to which it applies. This proposition may be called an applicability or empirical accountability theorem and as such it is highly probable but never absolutely certain. In this section the objective is to assess the applicability of the derived theorem by looking at certain historical country episodes, which have attracted attention in the literature.

4.1 Athens in classical times

In the period 480-430 BC, the Athenian economy was exposed to two huge streams of silver flows. The one emanated from the mines in the nearby Laurion region and the other from the tributes Athens received from its allies in the context of the First Athenian Alliance for leading the collective defense of Greek city-states against the Persians. A similarly huge inflow of precious metals repeated again in the 4th century, but not earlier than 330 BC, originating in the treasures of gold and silver that Alexander the Great captured from the Persians and distributed to Athenians who had followed him in his expedition to Asia and returned to Athens. As we argue elsewhere, for 300 years the currency was never debased, Gresham’s law held in reverse, and the drachma had been established in the eastern Mediterranean and beyond as the select medium of exchange and store of value. In other words, as the U.S. dollar today, it enjoyed a brand or royalty privilege.

The evidence is that the mint in Athens fabricated exquisite designs of coins, with high productivity, implying relatively low fabrication cost, and the seigniorage was kept relatively low in competition to the mints of the other city-states. These advantages, in conjunction with the plentiful supply of silver bullion, must have shifted the production, and hence the ownership cost of the drachma much lower than before. Did the shocks from the supply of silver result in a significant permanent inflation? [Figueira \(1998, 493\)](#) rates the likelihood of inflation quite high. He suggests

that the working hypothesis should be that Athenians experienced significant inflation in the 5th century, because it is unlikely that the supply of goods and services increased in proportion to the increase in the money supply. Instead, the conclusion reached in Sub-section 3.2 and the following theorem driven analysis suggests a different interpretation for whatever inflation there was.

Before silver from the Laurion mines appeared in the form of currency, bullion and bank deposits, mining and processing of silver ores expanded employment and incomes, and hence GDP. The latter's composition would have changed and with it certainly the relative prices. But the aggregate demand for goods and services should have increased pretty much in proportion with their aggregate supply. For, if the prices for foodstuffs and other household and enterprise implements increased in the short-run due to supply of silver induced excess demand, profit margins would have increased and, by stimulating in the medium run imports, paid for by the plentiful supply of silver, prices would have returned to their previous long run equilibrium. Hence, if there was significant inflation, it could not have come from the supply of domestically produced commodity money. Still, the evidence is that significant inflation may have emerged from the way in which the city-state of Athens applied the large inflows of allied tributes. Illuminating in this regard is the following quotation from [Loomis \(1998, 243\)](#):

The possible c. 50% rise in wages from c. 450 to 432 would be the natural result of enormous tribute revenues pouring into Athens year after year. With the transfer of the *treasury of the Delian League* from Delos to Athens by 453 and the elimination of the Persian military threat by the Peace of Kallias in 449, more money was available for expenditure in Athens itself, for (the raw materials for) public works, and for the wages of public officeholders, soldiers and sailors, and public construction workers. The increasing amount and circulation of this money, in the context of a (presumably) less rapidly increasing labor supply, would have been the cause of the wage increases in this period.

In other words, the state raised the wages of public magistrates, soldiers and sailors across the board; it spent lavishly in the construction of luxurious public buildings and city beautifications; it established programs of social welfare, festivals and other cultural activities, etc. In turn, rising wages in the public sector raised the wages and the cost of materials in the private sector. As the latter entered into a phase of cost-push inflation, the drachma lost purchasing power. The miners of silver lost incentives and curtailed their efforts. The supply of domestically produced commodity money declined; and, eventually, when the allied tributes declined to a trickle and Athens did not have money to prepare for the Peloponnesian War, the price level returned to its long run equilibrium.

4.2 France 1350-1436 AD

[Sussman, Zeira \(2003\)](#) have examined the effects of repeated debasements on the price of the commodity money and the level of prices in France during the so-called period of Hundred Years War, which spanned the period from 1350 to 1436 AD. They find that:

... commodity money can be inflated similarly to fiat money through repeated debasements, which act like devaluations. Furthermore, as with fiat money, demand for commodity money falls with inflation. However, at high rates of inflation demand for commodity money becomes insensitive to inflation, since commodity money has intrinsic value in addition to its transactions value.

In Sub-section 3.4, it was established that upon debasement the price level increases permanently, and that in turn the purchasing power of the debased commodity money declines to a new long run equilibrium. This prediction from the simple model in equation (3) is consistent with the first finding in the above quotation. The second empirical finding is that the demand for the inflated currency falls. Again, drawing on the rational behavior of economic agents, in Sub-section 3.4 it was argued that markets may split into those dealing in the new and those dealing in the old currency. By implication, the demand for the new debased currency may be expected to fall. Perhaps, this happened in the period under consideration each time a debasement took place. For, if on the contrary the normal was for the holders of the good currency to remind it upon debasement, the demand for the new debased currency might as well have increased. Finally, there is the finding regarding the differentiation of the demand for the debased commodity money at low and high rates of inflation. The proposed model cannot shed light on this issue because it is too simple to capture the expectations that economic agents develop in the context of repeated debasements of different size.

From the above, it turns out that the theorem is consistent with the empirical findings regarding the debasement of currency-induced inflation in this historical country episode.

4.3 Spain in the 16th century

In the Sub-section 3.4, it was established that, in the advent of a supply shock that increases the quantity of the commodity money in excess of the available goods, the price level remains stable, if and only if the economy is open. The theorem provides explicitly for this condition. Hence, its relevance may be validated by contradiction, namely, by reference to the case of a country with a closed economy where, upon a positive shock in the supply of commodity money, the price level

increased. Suitable for such a test is the case of Spain in the 16th century, also known as Spanish Price Revolution, because the coincidence in this period of a huge influx of silver into Spain from Latin America with a trend increase in the rate of inflation has attracted much research attention.

From the sizable literature in this area, it sharpens the requirements for the validation of the theorem, if we consider the findings by [Kugler, Bernholz \(2007\)](#), which have passed a particularly demanding set of statistical tests. Among other European countries to which the Spanish Price Revolution spread, the authors focus on the relationship of commodity prices to the money supply in Spain over the 1500-1600 period. In particular, they fit a structural vector autoregression model to data on commodity prices and the money supply in the Spanish regions of Old Castile and Leon and New Castile. They find that the increase in the commodity prices at rates of 1.1 and 1.4% per annum, respectively, was induced by the expansion of the money supply, due to the above-mentioned influx of silver. Based on these and similar results obtained, for example, by [Fisher \(1989\)](#), one would be compelled to conclude that the theorem did not apply in Spain at the time, since the influx of huge quantities of silver caused a secular increase in inflation at rates that were not as low as they would seem to us today. However, on closer examination one can hardly miss that the estimates from these studies derive from statistical models that do not account for institutional arrangements that might have decisive influence on the estimates. To highlight this possibility, consider the following quotation from [Lynch \(1991, 175\)](#):

Spain was already a protectionist country, barricaded with customs, and a government which theoretically controlled everything entering and leaving its frontiers was unlikely to allow the new-found treasure to escape its grasp. But the monopoly, and the attempts to preserve it, were not perfect: there were frequent complaints from the cortes that the continual exit of precious metals-'as if we were Indians'-was impoverishing the country, and it was commonly said that Spain was 'the Indies of other countries'. Yet there were many reasons why the precious metals should escape from Spain and circulate abroad. Spain was primarily an exporter of raw materials and an importer of manufactured goods; with an unfavourable trade balance, she had to settle her payments with ready cash.

From this narrative, two hypotheses come to mind. The first is that the Spanish economy during this period was relatively closed due to heavy administrative controls. If so, the theorem does retain its relevance, since its working was vitiated by the walls that Spanish governments erected to prevent the free flow of imports and exports. The second hypothesis is that, while the huge inflows of specie were re-directed abroad, mainly to settle Spanish government obligations, higher inflation

entered through the backdoor of the Spanish balance-of-payments in the form of higher priced imports. Again, this interpretation, proposed by [Flynn \(1978\)](#), is consistent with the theorem, because inflation did not emanate from the supply of the commodity money. Expectedly, had the authors of these studies been able to allow for the import-export institutional arrangements, the estimated coefficient of the money supply would not be different to zero.

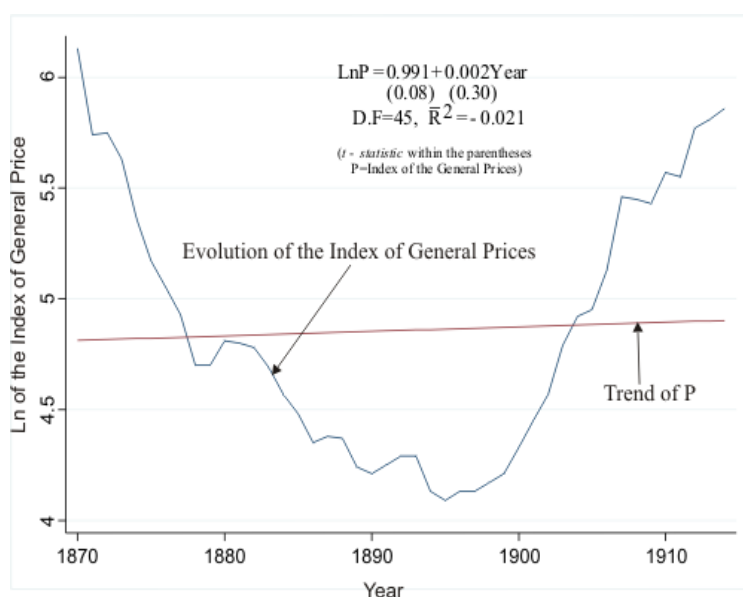
4.4 United States, 1870-1914 AD

In the period 1792-1834, the United States (U.S.) was officially on a bimetallic standard of silver and gold at the ratio of 15 to 1.¹³ Additionally, a number of foreign coins had been declared legal tender and circulated in parallel with the U.S. dollar. But not long after the first Coinage Act of 1792, the price ratio of silver to gold increased to 15½ to 1 and, as gold became more expensive and grew relatively scarce due to exports, the standard turned effectively into one of silver. With the Coinage Act of 1834, the U.S. Congress sought to remedy the problem by changing the mint ratio of silver to gold to 16 to 1. This time though, the new policy made gold cheaper relative to the world market price ratio, silver began to be exported, and after a few years the standard became one of gold. At the same time, as there emerged shortages in fractional coins, the U.S. Congress authorized in 1853 the cutting of silver coins, which were made legal tender for amounts less than \$5. Thus, in the period before the Coinage or Mint Act of 1873, the standard was bimetallic comprising large denominations from gold and small denominations from silver.

Although somewhat inadvertently, the latter Act ended bimetalism by abolishing the right of silver bullion holders to have their metal struck into silver and placed the U.S. on the gold standard. However, in the following years, as the world production of silver continued to expand relative to gold, mainly farmers in coalition with the opponents of the state's monopoly on gold reserves managed through political pressure to convince the federal government to buy repeatedly large quantities of silver and coin them into silver dollars. This period of actual bimetalism lasted until the U.S. Congress authorized the Gold Standard Act of 1900, which provided for the free coinage of gold and full convertibility of the currency into gold coins. Then, in 1914, the U.S. government suspended this regime, so that it could print enough money to pay for the expenditures of World War I; it reestablished it in 1919 upon the end of the war; and, finally, as it became the scapegoat for the great depression of 1929, in 1933 the gold standard was abandoned.

¹³ For a more detailed documentation of the history of commodity money in the U.S., see [Elwell \(2011\)](#). Moreover, note that henceforth the abbreviation AD is omitted.

Now from [Barro \(1979, 29\)](#) we know that as long as the relative prices of the two metals can adjust freely, bimetallism or symmetallism preserves the property of price stability. Hence, if the theorem were relied upon to predict the course of prices over the period 1870-1914, in the absence of inconsistent policy interventions, they ought to remain trendless in the long run and stable in the short run. Data regarding the general price level for that period are available from: a) the *Historical*



Source: Series M04051USM324NNBR, Link: <https://fred.stlouisfed.org>

Figure 1: Index of the General Prices, 1913=100

Statistics of the United States, 1789-1945, Chapter L; b) the *NBER Macrohistory database*, Chapter 4, series m04048a and m04048b; and c) the database of the *Federal Reserve Bank of St. Louis*. Figure 1 displays the evolution of the index of general prices using the series M04051USM324NNBR from the latter source. From 1870 to 1895, prices declined. From 1896 to 1914, prices increased; and if a trend were estimated over the whole period, as the horizontal straight line indicates, the level of prices would not follow any persistent tendency downwards or upwards. Moreover, it should be noted that this finding is robust to different measurements of the price level as well periods over which the test is carried out going backwards. For example, [Martin \(2017\)](#) uses the GDP deflator and the consumer price index, extending the period of testing as far as back as 1790, whereas [Alogoskoufis \(2019, 23, 24\)](#) employs the indices of consumer and retail prices going back to the first half of the 19th century. Both find that the level of prices before WWI was trendless. In the words of the latter author:

There was no systematic inflation and the price level did not display a particular trend until World War I, because for most of this period, both the United States and the United Kingdom had adopted metallic monetary systems, based on precious metals (specie), such as gold and silver. Such metallic systems constrained the rate of growth of the money supply. When they were forced to temporarily abandon such systems, as during wars, both countries sought to return to such systems as soon as possible. (*ibid*, 24)

Hence, in contrast to the experiences under the “pseudo” gold standards that were applied until 1971, and even more so, under the “pure” fiat standard since then, the general price level in the U.S. over the period of the so-called “classic” gold standard remained remarkably stable. But while this comparison leaves no doubt about the superiority of the latter in the long-run, as prices trended downwards until 1895 and then upwards until 1914, if U.S. governments adopted consistent policies, the applicability of the theorem in the short run might be contested.

From the available historical evidence, it can be easily corroborated that U.S governments introduced the following key policies:

- In the period following the Coinage Act of 1873, the price of silver was declining rapidly and certainly, silver could have been used as a good substitute to combat the increasing scarcity of gold. Yet the Act eliminated the monetary use of silver in anything but fractional currency. In Figure 1, this explains the initial phase of deflation, which rendered the Act contentious and some denounced it as the “Crime of 1873”. As for the second phase of reflation, this coincided with accelerated coinage of silver in the early 1890s, which was undertaken not in the interest of stabilizing prices but defusing the political pressures by the holders of silver.
- The U.S. Mint intervened as buyer or seller to defend at times of bimetallism a select price ratio of gold to silver and at times of monometallism a select price of gold. By doing so, it attempted to control the developments in the free markets for the two metals. But this is an impossible task, because even the most sophisticated planning bureau is short of the required divine faculties. Hence, by entering into this game, U.S. governments applied models of “adulterated” or “pseudo” commodity standards, which they changed frequently to suit the expediencies of those who were in power over the years.
- Beyond the above, U. S. governments instituted arrangements that distorted gravely free banking and turned the state into a major part of the problem instead of a means to solving it.

By implication, the variability of prices in the short run was determined by policies alien to the the-

orem and its provisions for relevance, thus leading to the question: Ignoring these inconsistent policies, was price variability at that time higher than under fiat standards more recently? The evidence discussed by [Lewis \(2016\)](#) led him to conclude that:

... on an apples-to-apples comparison, we have 14.67% volatility in commodity prices 1970-2015, and 6.74% in 1880-1913.

Therefore, a commodity standard operated under policies consistent with the theorem would offer at both the long- and the short-run superior price stability relative to fiat alternatives.

4.5 China, 1910-1935 AD

The last country episode to test the validity of the theorem is China in the period 1910-1935 AD. At a time when Western countries were on the gold standard, in 1910 AD China acceded formally to a currency standard based on silver. [Kreps \(1934, 249\)](#) and [Hu \(2013, 49\)](#) inform us that the latter's application was so much different from region to region that one might reasonably doubt whether a silver standard was applied at all. However, despite the chaotic complications introduced in everyday transactions by the plethora of coins minted following different accounting units and silver content, currency markets certainly should have established exchange rates among the various coins, so that some sort of silver standard did apply until 1935 AD, when China abandoned it and switched to fiat money.

Drawing on these brief remarks, an interesting question to start with is why did China elect to adopt silver instead of gold? The relevant literature provides various conjectures. For example, a few are that: traditionally household and enterprises had been accustomed to accumulate valuables in silver. The Chinese government at the time lacked knowledge of the international monetary system and the changes that it was undergoing, and that because China was frequently in wars, its governments did not have the time to pursue reforms in the country's monetary system. Yet, while there may be some truth in these claims, the following reasons suggest that the decision to adopt silver rather than gold was taken on solid economic analysis grounds:

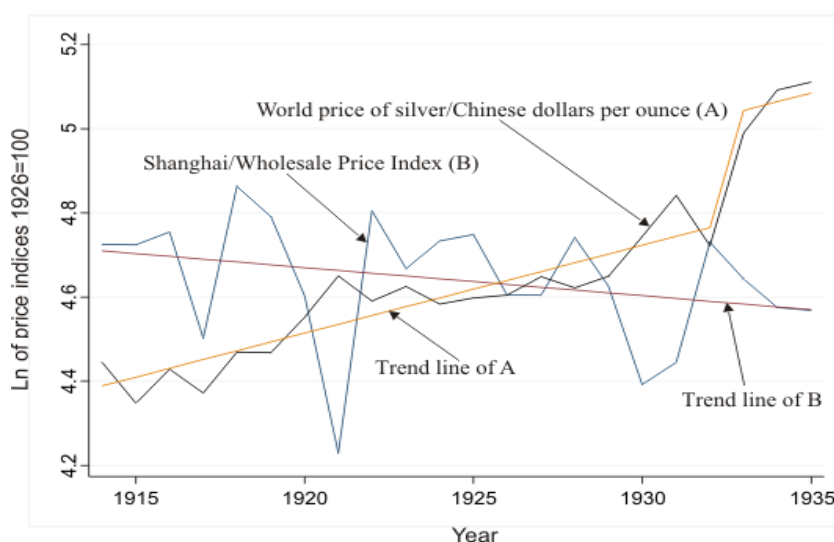
- For all practical purposes, China produced neither gold nor silver in materially significant quantities. Hence, whichever of the two precious metals was adopted, the necessary quantities would have to be imported.
- If the estimates discussed by [Kreps \(1934, 255-257\)](#) regarding the stock of silver that was held by the Chinese people in the forms of ornaments, bullion and coins were anywhere near

the actual figures, then during the period under consideration this large stock would have rendered any decision to adopt the gold standard baseless.¹⁴

- Since China was large relative to the international silver market, even small demand and supply shocks originating from China would affect significantly the price of silver, and hence the ownership cost of silver coins f_d^c .
- Lastly, given that China at that period was the only country on the silver standard, whatever demand and supply shocks for non-monetary uses of silver that emanated from the rest of the world would exercise limited influence on the international silver market. Hence, China might rest assured that it would be the sole major player in this market for monetary silver.

With the above in mind, let us now turn to the relationship of the price of silver to the price level over the said period.

Figure 2 exhibits the developments in the fronts of the price level and the international price of silver over the period in which China applied the silver standard. The price level is measured by the Wholesale Price Index (WPI) in the region of Shanghai. However, it should be noted that roughly



Data sources: 1. Data for (B) comes from the Institute of Economics, Shanghai Academy of Social Sciences, A Compilation of Price before and After Liberation in Shanghai, 1959, Shanghai People's Publishing House, 4, 126, 175.
2. (A) was obtained using the series "Price of silver in U.S. dollars per ounce," and "exchange rate of U.S. dollar to Chinese dollar" from Chang (1988),

Figure 2: The price level under the silver standard in Shanghai/China

¹⁴ According to [Chang \(1988, 87-88\)](#) the stock of silver held by China in 1933 was estimated at 2.5 billion ounces, or 22% of the world's visible stock, ranking the country second in the world after India. This stock of silver is very close to the estimates discussed by [Kreps \(1934, 255-257\)](#).

the same results would have emerged, if the available data from the region of Canton were employed. On the other hand, the international price of silver is measured in Chinese dollars per ounce of silver. The long-term trends of the corresponding variables have been computed using linear regressions. In both cases, the trend lines explain over 98% of the variance in the dependent variables and the parameter estimates meet all classical statistical tests. Observe that that the trend line of the international price of silver after 1932 jumps violently upwards. A dummy variable captures this break and reflects the impact of the silver purchasing program that was instituted late in 1933 in the United States.¹⁵

From the slopes of the two trend-lines, it follows that, as it would have been expected, the price level declined in the same period that the price of silver increased. In particular, given the large size of China relative to the international silver market, the accelerated imports of silver throughout the 1910s and 1920s were bound to put upward pressure on the international prices of silver. Hence, as per the theorem, to avoid the deflation shown by the downward trend of the Wholesale Price Index, China ought to have adopted policies to hold the ownership cost of the Chinese dollar stable. Having failed to do so in the period before 1932, when the annual increase in the price of silver was mild, it was certainly asking for too much to begin the heavy intervention that was required. For, when the international price of silver skyrocketed in the following years due to the silver purchasing program introduced in the United States, which in turn raised precipitously the exports of silver from China. In conclusion, the explanatory power of the theorem is perfectly validated by the case of the silver standard in China during the said period.

5. Summary of findings and conclusions

It was found that in an open free market economy, given any shock with the exception of debasement, a decentralized monetary regime based on a metallic standard attains stable prices both in the long and in the short run. This property derives from two effects. The first is that rising (falling) commodity prices lead to a fall (rise) in the purchasing power of the currency, thus creating windfall losses (gains) to holders of the stock of currency and other assets valued thereof. This in turn, gives rise to the second effect in that these losses (gains) motivate them to reduce (increase) the currency's demand up to the point of equating its ownership cost to its purchasing power in terms of goods and services. Also found were the following results. When a country is

¹⁵ For the politics that led to this policy in the United States and its international ramifications, particularly with regard to the regime change in China, see [Friedman, Schwartz \(1963\)](#), [Friedman \(1992\)](#), and [Brandt, Sargent \(1988\)](#).

large relative to the international market for specie, maintenance of price stability may require appropriate adjustments in the seigniorage charge. In countries with centralized management of the commodity money or closed economies, such adjustments are in general imperative. Lastly, through seigniorage policies, and at the zero bound of the seigniorage charge through lowering the specie content of the currency, the price level may be held even fixed, irrespective of the magnitude and origin of shocks, the relative size of the country, and the degree of its openness.

The above predictions, expressed compactly in the form of a theorem, were assessed for relevance in the context of the monetary experiences of Athens in classical times, France during the period 1350-1436 AD, Spain in the 16th century, the United States in 1873-1910 AD and China in 1910-1935 AD. In all cases it turned out that, the predictions were consistent with the available empirical evidence, thus validating the explanatory power of the model. Additionally, it emerged as an issue for future research that, in related econometric applications, researchers should allow for the relative size of the country under consideration in the international market for specie as well as for the degree of “openness” of its economy.

Finally, by way of closing, two remarks are in order. First, note that the validity of the above results is not tied necessarily to a metallic standard. Since technically the value of the monetary unit can be based on the share price of a portfolio of resources used in the production of GDP and valued at future prices, this would relieve the standard from any resource cost. Secondly, since a standard based on a cryptocurrency like the Bitcoin may become feasible in the coming years, looking forward, the results may be quite relevant to emerging developments in this direction.

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Department of Economics Athens University of Economics and Business

The Department is the oldest Department of Economics in Greece with a pioneering role in organising postgraduate studies in Economics since 1978. Its priority has always been to bring together highly qualified academics and top quality students. Faculty members specialize in a wide range of topics in economics, with teaching and research experience in world-class universities and publications in top academic journals.

The Department constantly strives to maintain its high level of research and teaching standards. It covers a wide range of economic studies in micro-and macroeconomic analysis, banking and finance, public and monetary economics, international and rural economics, labour economics, industrial organization and strategy, economics of the environment and natural resources, economic history and relevant quantitative tools of mathematics, statistics and econometrics.

Its undergraduate program attracts high quality students who, after successful completion of their studies, have excellent prospects for employment in the private and public sector, including areas such as business, banking, finance and advisory services. Also, graduates of the program have solid foundations in economics and related tools and are regularly admitted to top graduate programs internationally. Three specializations are offered: 1. Economic Theory and Policy, 2. Business Economics and Finance and 3. International and European Economics. The postgraduate programs of the Department (M.Sc and Ph.D) are highly regarded and attract a large number of quality candidates every year.

For more information:

<https://www.dept.aueb.gr/en/econ/>