CHAPTER 3

Purchasing Power Parity in Economic History

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3.1 Introduction

This essay, which draws on Officer (2006), surveys the application of purchasing power parity (PPP) to historical experiences. To be considered in the historical domain and therefore included in this essay, a study's time period must fully antedate the year 1940. This arbitrary bar means that World War II and the Bretton Woods system are "post-history." The many fixed- and floating-exchange-rate episodes before Bretton Woods enable a logical ordering of the essay. The literature is surveyed according to historical periods, with each period delineated according to exchange-rate regime or regimes.

Section 3.2 categorizes PPP theories, while Sect. 3.3 presents applications of PPP to the premodern period. Section 3.4 outlines the various methods of testing the theory, and Sect. 3.5 discusses the all-important price concept in PPP. Tests of the theory for the modern period (eighteenth century to 1940) are covered in Sect. 3.6. PPP analysis of the United States return to the gold standard is discussed in Sect. 3.7. Section 3.8 looks at actual situations (in the interwar period)

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in which PPP was applied to determine a new exchange rate. Concluding comments are in Sect. 3.9.

3.2 Categorization of Purchasing-Power-Parity Theories

This essay interprets PPP theory broadly.[1] Consider the variables P (domestic price index), P* (foreign price index), E (nominal exchange rate), R (PPP), and Q (real exchange rate), where $R = P^*/P$ and $Q = E \cdot R$. E is defined as the number of units of domestic currency per unit of foreign currency, but may alternatively be expressed as an index number; R may be re expressed as an index number; and Q is always dimensionless.

Any PPP theory can be represented by the implicit function G(E, P, P*, X), where X is a vector of variables that can include (i) E, P, P* in earlier periods and (ii) additional variables in the current period and in earlier periods. For a specific G function to be considered a PPP theory, it is necessary that certain minimum requirements be satisfied. First, the G equation must be solvable in terms of E: $E = g(P, P^*, X)$. The E that results from solving the G function may be the actual exchange rate in the current period, the equilibrium exchange rate in the current period, or the long-run equilibrium exchange rate. Second, partial derivatives must have sign consistent with PPP theory: $\partial E/\partial P > 0$, $\partial E/\partial P^* < 0$.

Inclusion of (ii) variables other than E, P, and P* in G results in an "augmented PPP theory"' (the term suggested in Officer, 1982, p. 188). Is an augmented PPP theory legitimately classified within the domain of PPP? Reasonable scholars may differ on this point, but a sensible statement is as follows: The greater the importance of R (or P and P^* individually) relative to the other determinants of E, the more clearly the augmented theory is in the PPP rubric.

The variables E, P, and P* may enter in several ways. The general G function involves a trivariable theory: E, P, and P* entering as separate variables. A bivariable theory combines two of these variables; generally, R replaces P and P* in G. The theory is univariable if Q then replaces R and E. A theory has the property of "symmetry" if there are identical magnitude effects of the domestic and foreign price levels on the exchange rate ($\partial E/\partial P/\partial E/\partial P^* = -1$) and "proportionality" if that identical magnitude is unity. The theory in terms of the real exchange rate is proportional if $\partial Q/\partial R$ is a constant. Linear or log-linear G functions can yield these properties.

Univariable, bivariable, and trivariable theories may or may not have the property of "exclusiveness" (the term coined by Edison, 1987, p. 378). The G function involves exclusivity (perhaps a better term) if the X vector does not include any variables other than lagged E or lagged R (or lagged P and P*). Define "superexclusivity" as the absence even of the latter variables; under symmetry, the G function reduces to G(E, R) = 0. If PPP theory is univariable and super-exclusive, the G function becomes G(Q) = 0. If the G function is linear, it reduces to Q = c, where c is a constant.

The modern literature considers the R-E direction of causation irrelevant and PPP theory simply describes an equilibrium relationship among the nominal exchange rate and price levels. However, traditionally and in the historical literature, PPP theory had a causal component, implicit or explicit: prices determine the exchange rate (say, R determines E). In terms of the real exchange rate: if Q is shocked out of equilibrium, R (rather than E) changes to restore equilibrium.

What modern economists cannot legitimately deny is that PPP is a monetarist theory and, as such, asserts that, at least in the long run, the nominal exchange rate (E—a monetary variable) can be affected only by monetary variables, such as PPP (R). In contrast, the real exchange rate (Q) is a real variable; correspondingly, in the long run only real variables can affect it.

3.3 Historical Application of PPP: Premodern Periods

The "premodern" period denotes human history before the eighteenth century. For the premodern period, the only use of PPP is to assess the extent of the integration of the domestic economy with foreign economies. The closer PPP is to fulfillment, the greater the integration. The best way of using PPP to determine the amount of integration of economies is to test PPP theory statistically; but this method is not possible for premodern economies, because of the lack of data. Alternatively, one could observe either individual-commodity price differences, in domestic currency, at home and abroad, or exchange rates and domestic prices. This technique is usable, even in the absence of recorded price series; for (i) contemporary authors may have written of the price differences, or (ii) inferences on price differences may be made by modern scholars on the basis of other information.

Premodern economies are characterized by monetary systems in the realm of a coin standard. Except in China, paper standards were unknown until the eighteenth century. In fact, again except in China, paper money did not even exist until toward the end of the premodern period. Exchange rates were "fixed" at mint parities. According to Einzig (1970, p. 71), foreign-exchange transactions were almost entirely coin-for-coin until the thirteenth century, when bills of exchange became dominant. The "fixity" of exchange rates was not absolute, in two respects. First, mint parities were responsive to depreciation and debasement of coins. Second, specie-point spreads were much wider than in modern times.

3.3.1 Ancient Period

The few scholars who have examined the issue are unanimous that there was not even a tendency for PPP theory to be fulfilled in ancient times.[2] In particular, there are four reasons why PPP theory did not apply to the Roman Empire. First, Roman imports were luxuries, such as valuable furs, amber, carpets, silk, precious stones, and aromatics, which were purchased only by the rich. They were income, rather than price, determined. The own-price elasticity of demand for imports was effectively zero. Second, imports were not produced in the Empire, and had no close domestic substitutes. The cross-price elasticity of demand for imports with respect to domestic commodities was also zero, or close to it.

Third, there were tremendous price differences between Rome and its trading partners.[3] Such price differences are suggestive of arbitrage imperfections, which took two forms: high transportation and commission charges, inherent in the state of transportation and communication technology; high profit margins and risk premiums. Fourth, trade in nonmonetary commodities between the Roman Empire and Asia was largely one-sided. Rome imported luxury goods; but exported nonmonetary commodities to the Far East only in small amounts, because Far Eastern countries had little demand for wine, oils, wool manufactures, and leather manufactures—which were the Empire's principal exportables. Rome did have an abundant exportable that was in demand in the East: silver. To the extent that silver exports were in the form of coin, Rome thereby financed its "balance-of-payments deficit on commodity account." To the extent that the silver was bullion, it can be considered a normal commodity export, reducing the one-sided character of Roman-Eastern trade.

In sum, the economy of the Roman Empire may have been well integrated within itself, but certainly not with the outside world.

3.3.2 Medieval Period

Einzig (1970, p. 99) states that "in the Middle Ages…exports and imports were largely inelastic and unresponsive to changes in prices or exchanges." Officer (1982, p. 28) suggests reasons for this inelasticity. First, the feudal economy, with its self-sufficiency nature and structured society, had purely luxury imports, as in Roman times. Second, general contraction of trade occurred, both within Europe (the former Roman Empire) and between Europe and Asia. The result was again inapplicability of PPP and the lack of integration between economies, even within Europe.

Over time, trade expanded and parts of Europe coalesced into sovereign regions. Trade among these entities took place, and foreign-exchange markets developed. What used to be intra-Empire trade became foreign trade, with distances and risks less than they had been for Empire-Asian trade. It is reasonable to presume that commodity arbitrage gradually became less imperfect over time, and that there was an increasing tendency toward PPP, as economies became more integrated.

3.3.3 Sixteenth-Century Spain

Spanish scholars of the Salamanca School originated the PPP theory. In their environment, PPP was an indicator not only of integration of the Spanish and outside economies but also of the importance of monetary influences on the exchange rate. The Salamancans made the following empirical observations: (i) Spain had received large inflows of gold and silver from the New World; (ii) the Spanish money stock increased; (iii) the Spanish price level also increased; and (iv) exchange rates had become unfavorable to Spain. Spain (along with England and the rest of Europe) was on a metallic standard. Therefore, what an unfavorable movement in exchange rates meant was a movement in current exchange rates away from mint parities in the direction of specie-export points. This was a lower exchange value for Spanish coin. Thus PPP as an equilibrium theory was fulfilled, at least in an approximate sense. The causal PPP theory was also satisfied, with the obvious causal chain (i) → (ii) → (iii) → (iv).

3.4 Techniques of Testing PPP Theory in Economic-History Literature

3.4.1 Comparative-Static Computation

Let E_0 denote E in period 0. An obvious test of PPP theory is to measure P and P* as index numbers with value unity in base period 0 and compute $V = (P/P^*) \cdot E_0$ for either one period, a few discontinuous periods, or a continuous sequence of periods. The computed V are then compared with the corresponding values of E, in a table or graph. Alternatively, $(E/E_0)/(P/P^*)$ is compared with unity. In either case, the closer the computed value to the norm, PPP-predicted, value, the closer is PPP theory to fulfillment. Any noticeable divergences are then explained in terms of non-PPP influences on the exchange rate (augmented PPP theory). One can allow for a lagged effect of R on E. Further, investigations of lead-lag relationships are used to test the PPP-postulated direction of causality, from prices to the exchange rate. This entire approach has the "advantage" of lying outside formal statistical analysis.

3.4.2 Regression Analysis

The use of regression analysis was a natural development in testing PPP theory. For example (using lower-case letters to denote logarithms), e is regressed on p and p* or on r^{-1}; q is regressed on a constant. Properties such as symmetry and. proportionality can be readily tested in terms of elasticities.

3.4.3 Testing for Causality

The PPP relationship tested can either be an equilibrium relationship or a causal relationship, each being tested directly. A hybrid test involves an equilibrium relationship tested via an imposed causal relationship. The causal direction isindicated by the direction of minimization of the sum of squared errors in regression. Generally, minimization is in the direction of the exchange rate. Some scholars believe that this direction of minimization is applicable only to a floating exchange rate. Under a fixed exchange rate, the "dependent variable" is p and the "independent variable" $e \cdot p^*$: the domestic price index is determined by the foreign price index

expressed in domestic currency, the "world" price index governing the domestic price. However, Gustav Cassel and other traditionalists considered PPP as the principal determinant of the exchange rate under both a floating exchange rate and the gold standard.[4]

In modern work, testing for causality involves a peculiar definition of causality: Granger causality, a forecasting concept. If r^{-1} aids in the forecasting of e beyond lagged values of e, then r^{-1} is said to Granger-cause e. Only preceding values of r^{-1} can assist in the forecast; and they can only assist: lagged values of e are also in the forecast equation.

3.4.4 Nonstationarity and Spurious Regression

It came to be realized that regression analysis ignored crucial time-series properties of variables, so that the results and conclusions could be meaningless or spurious. The comparative-static and regression studies of PPP implicitly assume stationarity of the PPP, nominal-exchange-rate, and real-exchange-rate series that are utilized. A stationary series has a constant and finite mean, a constant and finite variance, and covariances that are constant for a given time interval between the observations.

A stationary series has several desirable properties. (i) Computation of the parameters (mean, variance, autocorrelations) of the series is readily accomplished from sample data. (ii) The series exhibits "mean reversion": at least in the long run, the series returns to its mean, the equilibrium value of the series. Deviations of the series from its mean are only temporary. Shocks to the series have only temporary effect. (iii) There is the possibility (although not the necessity) of "short memory," implying a relatively fast reversion to the mean, after any disturbance. (iv) There is no statistical reason why regressions or correlations involving only stationary series would be spurious. The legitimacy of standardized tests for significance stands.

If d is an integer (the usual assumption), the "order of integration" (d) of a series is the minimum number of times that the series must be differenced to achieve stationarity. Traditionally, economists have an either-or viewpoint of stationarity: a series is stationary as it stands ($d = 0$) or needs to be differenced once to achieve stationarity ($d = 1$). And the conventional wisdom has been that most economic series are in the latter category. Nonstationary series ($d \geqq 1$) have disadvantages. (i) They lack a constant mean; or, if they have such a mean, have a nonconstant or even infinite variance. Estimation of parameters of the series cannot be readily

effected. (ii) Mean reversion is not present. There is no mean to which to revert; or deviations from a mean persist. (iii) Memory is infinitely long; the "stochastic trend" emanating from disturbances adds new terms without reducing the impact of existing terms. (iv) Regressions and correlations can be spurious with even one of the variables nonstationary, and standard tests of significance give misleading results.

It is now realized that a series can be "fractionally integrated" ($0 < d < 1$). Such series are mean reverting, but have long memory. It takes a long time for the effects of disturbances to die out. The critical value for d is $1/2$. For $d < 1/2$, the series is stationary; for $1/2 \leqq d < 1$, the series is nonstationary, because the variance of the series is infinite. In the latter case, stationarity is obtained by first-differencing the series. For correlations or regressions involving two fractionally integrated variables, say of orders d_1 and d_2, spurious results occur for $d_1 + d_2 \geqq 1/2$. Of course, if the variables are fractionally cointegrated, then the results would not be spurious.

3.4.5 Testing for Stationarity

Modern univariate testing of PPP involves testing for the stationarity (order of integration) of the real exchange rate (q) as distinct from testing for a constant mean of q (as was formerly done). Only if the series is stationary is there an equilibrium value of the real exchange rate to which the actual value reverts in the long run. Deviations of the actual from the equilibrium (mean) real rate do occur, but they eventually disappear. "Eventually" is not necessarily good enough. For the stationary series, a PPP-shock half-life (the length of time needed for the original deviation of actual q from equilibrium q to be halved) is a crucial statistic. The longer this half-life, the less is PPP theory supported. These tests of PPP are pleasing, because they treat the theory as applicable only to the long run; but the tests are also displeasing, because (i) a PPP-determined mean value is not imposed and (ii) symmetry and proportionality are ignored. In other words, an extremely weak interpretation of PPP is tested.

While a series can be made stationary by first-differencing, it is also possible that a transformation short of first-differencing might work, for example, taking logarithms of the variables. Also, including the lagged dependent variable as an explanatory variable might be sufficient. While early studies of PPP paid no attention to stationarity (and, as seen in

Sect. 3.6, these are the bulk of the studies in the economic-history vein), some did make an adjustment—perhaps inadvertently or for some other reason (usually hypothesis specification).

3.4.6 Cointegration Analysis

Even if variables are tested and nonstationarity is found, one should not proceed with correcting for spurious correlation; for the variables might be cointegrated, that is, a linear combination of the variables is stationary. Cointegration analysis is admirably suited for PPP bivariate or trivariate testing. The cointegration model involves the PPP relationship with zero error, as holding in the long run: it is the long-run equilibrium. Deviations from that relationship occur in the short run, and an error-correction process returns the variables to the long-run relationship: there is mean reversion. Differing speed of adjustment for the exchange rate and for price (or price ratio) is embedded in the error-correction process. Symmetry and proportionality are not imposed, and can be tested. General-to-specific modeling, in which restrictive models are nested within more-general models, can be used here, as with conventional regression analysis. The causal aspect of PPP can also be tested, via the speed-of-adjustment coefficients. Fractional cointegration, involving fractionally integrated variables, is also possible, although rarely performed in the PPP literature.

3.5 Price Variable in PPP Computations

Crucial to empirical use and testing of PPP is the price concept, and many price concepts have been used in PPP computations. Ranging from most justifiable to least justifiable, they are as follows (with symbols): GDP deflator (PGDP), GNP deflator (PGNP), consumption deflator (PCONS), retail price index [incorporating consumer price index and cost-of-living index] (RPI), wholesale price index (WPI), export price index (XPI), wage-rate index (WI), component indexes or subindexes of WPI or RPI, and prices of individual commodities.

The bar separating PPP-legitimate price measures is drawn between WPI and XPI. So only results based on PGDP, PGNP, PCONS, RPI, and WPI are included in the survey. PGDP and PGNP have three justifications. First, as stated by Cassel (1928, p. 33), PPP relates to the internal value of currencies, and therefore should be "measured only by general

index figures representing as far as possible the whole mass of commodities marketed in the country." PGDP and PGNP fit this criterion better than any other price index. Second, PPP is a macroeconomic theory, and therefore necessitates the usual macro-price concept, PGDP or PGNP, with the former marginally preferred, because it measures the price of production within the country. Third, to the extent that PPP is justified by arbitrage and substitutability of commodities in production and consumption (broadly construed), the price concept underlying PPP should be as broad as possible, again leading to PGDP or PGNP.

Other things being equal, one would like to place WPI below the separation bar while leaving RPI above the bar for two reasons. First, a PPP computed from traded-goods prices alone is close to a truism.[5] Because (i) in any given country, the WPI is heavily weighted with tradables and, in particular, excludes all services and (ii) across countries, arbitrage directly equates prices of tradables (up to transactions costs, including tariffs and transportation charges), a PPP computed from WPIs comes close to making PPP theory a truism. Therefore, WPI biases result in favor of the hypothesis that PPP theory holds, and therefore that the domestic economy is well integrated with the foreign economy. In contrast, the RPI consists of nontradables (services) as well as tradables. Also, the weighting pattern of the WPI need not bear a close relationship with the production-weighted (i.e., GDP weighting pattern) of the economy. The WPI incorporates considerable, but unknown, double-counting and even multiple-counting. In contrast, the RPI has a logical weighting pattern. Yet, unfortunately the most widely used price measure in PPP studies is the WPI. For many historical periods, the WPI is the only, or at least the most comprehensive, price index available. Even when alternative indexes exist, researchers often select the WPI. So, on grounds of expediency the WPI just makes the bar.

The XPI is totally composed of tradables. After the joyless decision to include the WPI above the bar, it gives one a certain pleasure to place the XPI below the bar. Also, price measures of individual commodities are excluded, because of their lack of comprehensiveness. WIs are excluded, primarily because PPP theory (and its justifications) pertains to prices of commodities rather than of factors of production. A second reason to exclude WI is the opposite justification for excluding XPI (and only reluctantly including WPI). In contrast to measures heavily weighted with

tradables, that can move almost automatically in correspondence with the exchange rate, WI is typically the price of an entity heavily nontradable, and can move *too slowly* relative to the exchange rate.

3.6 Modern Period: Testing of PPP

The principal use of PPP in historical research of the modern period (eighteenth century onward) is testing the validity of the theory. Although almost all investigators test the theory for its own sake, in effect, the degree of integration of the domestic with the foreign economy is assessed. Most, but not all, studies pertain to periods of a floating as distinct from fixed exchange rate.

3.6.1 Early North America

The earliest date of any PPP testing in this survey is the U.S. colonial period, and all authors paid attention to the stationarity issue. Bordo and Marcotte (1987) found that PPP holds under the South Carolina adjustably fixed exchange rate and proportionality could not be rejected. Choudhry and Luintel (2001) examined Pennsylvania under a floating exchange rate, and PPP results are mixed.

Bernholz (2003) examined the period of the 13 colonies in rebellion, during.which Congress issued Continental currency. During this paper standard and floating exchange rate, the price of specie (silver coin—representing the exchange rate) did not increase as much as the price index. Bernholz's explanation is the war-inflicted damage on production (supply) of goods and the British blockade,which reduced the value of specie (the currency used in payment for imports).

Grubb (2003, 2005, 2010) compared properties of the real exchange rate for six American colonies (later U.S. states) and Lower Canada in 1748–1775 (colonial period) versus 1796–1811 (Constitution period), with Lower Canada serving as a control. In the colonial period, only Massachusetts and Lower Canada were clearly on specie standards and fixed exchange rates. In the Constitution period, all U.S. states were on a fixed exchange rate—that of the U.S. dollar—by default. Lower Canada was now on a floating exchange rate, by virtue of Britain abandoning the gold standard in 1797. In general, PPP held; but half-lives

to shocks were lower in the colonial than Constitution period. As Grubb (2010, p. 141) stated: "Market integration as measured by PPP during 1796–1811 was not superior to market integration during the 1748–1755 colonial period."

3.6.2 Bullionist Periods

A "bullionist period" in economic history has both an empirical and an intellectual characteristic. Empirically, a bullionist period involved a paper standard and floating exchange rate that temporarily interrupted a specie standard and fixed exchange rate. Intellectually, a bullionist period carried with it a "bullionist controversy" regarding the ruling macroeconomic model of the economy. In modern terminology, the competing models are monetarist and nonmonetarist. In particular, "bullionists" were monetarists, and generally exposited a PPP theory of the exchange rate.

Two bullionist experiences that have been subject to PPP testing are the Swedish bullionist period (1745–1776) and the Engish bullionist period (1797–1821). The latter is customarily called the Bank Restriction Period, because the Bank of England's obligation to pay cash (gold) for its note issues was restricted. It may be noted that, while paper money originated in China, banknotes were first issued in Sweden. The Swedish bullionist period began with the paper daler made inconvertible into copper bullion.

Three authors investigated PPP for both episodes. Eagly (1968, 1971) noted increases in the price level and exchange rate in terms of banknotes. Myhrman used growth rates and found positive evidence for PPP. Bernholz, Gärtner, and Heri [hereafter Bernholz et al.] (1985) applied a univariate technique to various floating-rate episodes and found that PPP was violated in the short run but held in the long run; however, they paid no attention to stationarity. Bernholz's (1982, 2003) results for Sweden are consistent with those of Bernholz et al.

Turning to authors who examined the Bank Restriction Period exclusively, Angell (1926, p. 484) found no relationship between the British price index and exchange rate. Nachane and Hatekar (1995) rejected cointegration of the British price index and exchange rate. Also, they could not reject that price does not Granger-cause the exchange rate. Their use of the exchange rate on Paris is contrary to other researchers;

economic historians generally view the Hamburg exchange as more representative than Paris during the French Revolutionary and Napoleonic Wars. The Nachane and Hatekar observation period extends to 1838, which, with annual data, increases the sample size. However, the effect is a mixture of a "paper standard, floating exchange rate" with a "gold standard, fixed exchange rate."

In contrast, Officer (2000) used quarterly data and limited the sample to the Bank Restriction Period. Another difference is that Officer engaged in multivariate testing, with Bank of England notes, the price of wheat, and external military expenditure as variables in addition to the general price index and exchange rate. While Nachane and Hatekar also employed multiple variables, their testing was entirely bivariate. However, Officer's results regarding PPP were negative, and essentially the same as those of Nachane and Hatekar.

3.6.3 Floating Rates—Second-Half of Nineteenth Century

The greenback-period episode of a paper standard and floating exchange rate encompasses the full years 1862–1878, and has received considerable attention in the literature. Graham (1922) did not mention PPP, and in fact made no formal judgment on the validity of the theory. He stated that the principal determinants of the exchange rate were (i) expectations regarding a Northern victory, during the Civil War, and (ii) net capital inflow, in the postbellum period. However, it is clear from his computations and the context that these influences were secondary, and came into play given the effect of commodity prices on the exchange rate. This was the position also of later authors who offered an augmented PPP theory for the greenback period: Kindahl (1961) and Friedman and Schwartz (1963). None of these authors paid attention to nonstationarity; nor did Farag and Ott (1964) and Thompson (1972). Therefore, the generally positive results of all these early writers were questionable; and the regression analyses of Farag and Ott (1964) and Thompson (1972) could be particularly misleading, as the estimation technique is ordinary least-squares.

Officer (1981) provided some innovations to PPP investigation of the greenback period. Instead of representing the dollar-sterling exchange rate by the price of gold, he constructed a "true" exchange-rate series (the inverse of the dollar-sterling rate) as the ratio of the gold-dollar price of the greenback to the gold-dollar price of the pound; and his price

concept is the GNP deflator rather than the WPI. Also, Officer, in effect, corrected for nonstationarity in his regressions. So his positive results for PPP lend credibility to the results of the earlier studies.

Bernholz et al. (1985) obtained their usual qualitative result of short-run PPP violated, long-run return to PPP. Enders (1989) is the only author other than Officer to have addressed nonstationarity, and he trumped Officer because his attention is deliberate rather than inadvertent. However, Enders' results were mixed. Nonstationarity ($d = 1$) could not be rejected for the real exchange rate, while the U.S. and British price indexes (the latter expressed in dollars) were found to be cointegrated. The former result is unfavorable to PPP, the latter is supportive.

Austria was on a paper standard and floating exchange rate from the mid-nineteenth century, when it left the silver standard, until 1892, when. Austria-Hungary joined the gold standard. Especially interesting is the subperiod 1879–1892, during which the paper gulden was worth more than its legal metallic content. The PPP aspect of the Austrian experience was investigated by Yeager (1969) and Myhrman (1976), who reprinted Yeager's graph of the exchange rate and PPP. Yeager (1969) computed correlation coefficients of the exchange rate and PPP, for the variables in percentage-change form, which could produce stationarity, and the results can reasonably be construed as positive evidence for PPP. Myhrman (1976, p. 190) commented that "both prices and the exchange rate were rather stable but with a rising trend." This remark is suggestive of a possible trend-stationarity characteristic of the variables.

3.6.4 Classic Metallic Standards

With the United States back on the gold standard in 1879 and Britain on gold since the end of the Bank Restriction Period in 1821, it is natural to examine PPP for these two countries in the context of the fixed exchange rate of the gold standard. Enders (1989) offered an identical analysis as for the greenback period. For this period, not only was there cointegration in a bivariate model, but also now nonstationarity of the real exchange rate was rejected—supportive of PPP. In contrast, Grilli and Kaminsky (1991) could not reject nonstationarity in the real exchange rate, destructive of PPP.

Catão and Solomou (2005) investigated real-effective exchange rates for three groups of countries: the gold-standard core group, countries on a silver standard for at least part of their time period (1871–1913),

and countries on an inconvertible paper standard for a substantial part of the period. They did not formally test for nonstationarity of the real exchange rate of the countries; rather they accepted stationarity, based on estimated autoregressive coefficients uniformly below unity. Nevertheless, their results are unfavorable to PPP; for they found "large and protracted real exchange rate fluctuations" (Catão and Solomou, 2005, p. 1265).

Considering both the gold standard (1880–1914) and interwar period (1921–1940) for the United Kingdom and Canada versus the United States, McCloskey and Zecher (1984) found that PPP regression forecast errors were not related to U.S. money-market disequilibria—supportive of PPP. Their use of the GNP deflator is to be commended. Hasan (2004) examined PPP for silver-standard India. Among other techniques, he applied fractional-integration modeling. The hypothesis of nonstationarity of the real exchange rate was rejected.

Hegwood and Papell (2002) studied Belgium, France, Germany, and the United States over 1793–1913, which encompassed episodes of the gold standard, silver standard, and paper standard. Impressive is their concept of "quasi-PPP": reversion to mean q that exhibits structural shifts rather than to a constant mean q; and half-lives of PPP deviations were short. Structural breaks were associated with economic and political events: the U.S. Civil War, dissolution of the German Confederation, coup d'état in France, and the 1840s decade of political unrest in Europe.

3.6.5 World War I

Investigations of PPP for World War I were undertaken by Cassel (1916, 1918, 1919), Heckscher (1930), Keynes (1919), and Bresciani-Turroni (1937). Gustav Cassel, the greatest expositor and propagator of PPP, naturally tested the theory first for his own country. All these studies were comparative-static in nature.

Findings were mixed, and, because there was no attention to nonstationarity, must be viewed with caution.

3.6.6 Floating Rates—1920s

A tremendous number of PPP studies pertains to the 1920s, especially the first part of that decade. There are several reasons for this concentration. First, all countries on the classical gold standard left gold during World War, resulting in floating exchange rates. During the war, there was

exchange-market intervention on the part of some countries, in particular, France and the United Kingdom. However, shortly after the end of the war, almost all exchange rates became freely floating, and remained so for a substantial part of the decade. PPP theory is typically of greater interest to researchers when exchange rates are floating rather than fixed. Second, the United States, which had effectively adopted a paper standard extralegally in April 1917, returned to gold in March 1922. The dollar thus provided an anchor to other countries for a return to a fixed-rate system and for assessing the level and volatility of the exchange rate while their currencies were floating. In particular, the United States was a natural base country for PPP computations. Third, even though World War I marked the end of the nominal international economic supremacy of the United Kingdom and even though that country did not readopt the gold standard until April 1925, its traditional importance as the center country of the classical gold standard made it a natural alternative base country for floating exchange rates of other countries. Fourth, the very fact that the once central country of a metallic standard and fixed-rate system (the gold standard) was now floating made the United Kingdom a most interesting subject of PPP analysis, with the United States (the upstart other center country) as base country. Fifth, for researchers in the final quarter of the twentieth century and beyond, it was natural to compare the floating rates of the post-Bretton Woods period with the floating rates of the 1920s, in particular, from the standpoint of PPP analysis.

The U.K. floating rate of 1919–1925 has been studied by many authors.[6] While there is no consensus, the preponderance of the evidence suggests that the pound sterling in the 1920s floated in the dollar-pound exchange market in a manner consistent with the PPP theory. France had a floating exchange rate in 1919–1926, and this experience has been investigated by various authors.[7] PPP aspects of the German floating rate of 1914–1923 were considered by Bresciani-Turroni (1937), Frenkel (1976), Haberler (1936), Rogers (1929), and Bernholz et al. (1985). For each episode, results have quite different implications regarding the validity of PPP, and no general assessment of the validity of PPP can be made. Other individual-country PPP studies of the 1920s concerned the floating and fixed exchange rate of Sweden, and the floating rates of Switzerland and Greece.[8] Generally, results were negative for Sweden, mixed for Switzerland, and positive for Greece.

An impressive, two-volume, assemblage of studies of the post-World-War I monetary and exchange-rate experience of European countries is

that of Young (1925a). Papers were contributed by a large number of government officials and academic economists, and many of the writers in effect test the PPP approach to the exchange rate.[9] Almost all the authors adopted a common comparative-static methodology, plotting and tabulating the exchange rate versus the PPP, with the United States as the base country. The following general findings can be discerned: (i) the exchange rate and PPP moved more or less in correspondence; (ii) there was persistent directional deviation of one of these variables from the other; (iii) the usual pattern was that the domestic currency depreciated more than indicated by PPP, that is, the currency was undervalued in the foreign-exchange market; (iv) there was closer correspondence of the exchange rate and PPP in recent years than previously, especially if exchange-rate stabilization had occurred.

Bernholz et al. (1985) applied their model to three countries in the 1920s. The usual results (PPP violated in short run, validated in long run) pertained to Hungary and Poland. Austria was an outlying case, with PPP not holding in the long run.

Many studies tested PPP in the 1920s for multiple domestic countries with the United States as the base country. They fit into two groups: those that ignored stationarity and those that addressed the issue (even if via another route).[10] Distinctive in the first group is the conclusion of Keynes (1923, pp. 101, 106), who later became a critic of PPP, that "even under such abnormal conditions as have existed since the Armistice… the Purchasing Power Parity Theory, even in its crude form, has worked passably well"; and Flux's (1924) early use of logarithms in PPP computation. In the studies that addressed stationarity, overall results are more positive than negative for PPP. There are also 1920s studies with the United Kingdom as the base country.[11] No author addressed stationarity, and yet the only positive results are those of Thomas (1972).

Finally, there are 1920s studies which do not have a base country as such. A set of "equal status" countries was selected, and the PPP between pairs of these countries was investigated. One country group consists of the United States, United Kingdom, and France; another group adds Germany to these countries.[12] All studies were conducted using modern time-series analysis, with explicit attention paid to stationarity. For the first group, results were largely mixed; for the second group, they were mostly positive. Very impressive is Michael et al. (1997), who specified a nonlinear adjustment process. They concluded that, for country pairs

excluding Germany: "Despite the high degree of persistence in PPP deviations, our framework provides strong evidence of mean-reverting behavior for the real exchange rate" (Michael et al., 1997, pp. 876, 877).

3.6.7 1930s

In September 1931 the United Kingdom abandoned the gold standard for a managed float, while the United States did not leave gold until March 1933. Broadberry (1987), Whitaker and Hudgins (1977), and Grilli and Kaminsky (1991) performed PPP testing for the United Kingdom during the 1930s, with the United States as the base country. Overall, the results were negative. Graham (1935), White (1935), and Broadberry and Taylor (1992) dealt with the 1930s PPP experience of multiple countries. Overall, again results were not generally positive. The Broadberry-Taylor study is instructive. They examined all pairs in the country-group United States, United Kingdom, France, Germany, and could not reject that the real exchange rate is nonstationary ($d = 1$), a failure of PPP. Cointegration results, which pertain to equilibrium PPP, were mixed. Granger-causality tests, which address causal PPP, were also mixed. For full samples, prices never Granger-caused exchange rates, but the reverse was sometimes found. Only for subperiods of freely floating rates was there some evidence of prices Granger-causing the exchange rate.

McCloskey and Zecher (1984) found a close weekly relationship between the dollar-pound exchange rate and the U.S. WPI or RPI in 1933, with foreign prices relatively constant. The finding is associated with the depreciation of the dollar, the United States leaving the gold standard. McCloskey and Zecher (1984, p. 143) concluded: "Purchasing power parity is not a failure. On the contrary, by the standards we have examined, it is a great success."

3.6.8 Interwar Period

Some studies treated the interwar period as a broad expanse, incorporating fixed and floating exchange rates in the same sample. Young (1938) found that there were subperiods defined by PPP and the exchange rate alternately moving together (during one subperiod) and diverging (during the next subperiod). This is not good evidence for PPP. Bunting (1939) graphed the exchange rate against PPP, with the latter alternatively

lagged zero, one, two, and three periods. This is a logical way of assessing causal PPP, even though it is defective for the lack of attention to nonstationarity. Even with the lags, there were substantial deviations between the PPP and the exchange rate, and in opposite directions for France and the United Kingdom. Bunting (1939, p. 299) judged: "This is damaging statistical evidence against the purchasing power parity theory." Katano (1956, 1957) computed a number of correlation coefficients; but these are largely devoid of meaning, because of the small number of observations and the danger of spurious correlation. His most interesting result is that deviation from PPP was related to divergence from pure inflation in the countries. Bernholz et al. (1985) exhibited the usual result of PPP validated in the long run while violated in the short run.

3.6.9 Spain—Long Term

Spain was on a floating exchange rate for most of the 1870–1935 period, moving from a free to a managed float in 1931. For 1914–1920, Delaplane (1934, p. 41) used comparative-static computation to note "the wide divergence of purchasing power parity from the [exchange] rate." For the entire 1914–1933 period, his assessment of PPP was, at best, mixed: "In the light of Spanish monetary experience since 1913, one could not attribute more than a rough correspondence between purchasing power parity and exchange" (Delaplane, 1934, p. 211). Using Delaplane's data for the subperiod 1920–1929, Yeager (1976, p. 220) took a more-sanguine view of PPP: "The actual rate kept within the range of 12.5% below to 12.5% above purchasing-power parity in 82.5% of the months."

Sort et al. (2005), following Sabaté et al. (2003), examined the Spanish experience over the full 1870–1935 period. They considered q for the peseta against the British pound, French franc, and U.S. dollar. In the Hedgwood-Papell tradition, allowing for structural breaks in q enables rejection of nonstationarity. These breaks were explained via rumors of restoration of gold convertibility of the peseta in 1927, the pound abandoning the gold standard in 1931, stabilization of the peseta in 1931, and the financial instability of France after World War I. The authors concluded: "one can accept the PPP hypothesis as *a good approximation* of the behaviour of the peseta exchange rate against its main traders and investors between 1870 and 1935."

3.6.10 Guatelmala—Long Term

Schweigert (2002) investigated PPP for Guatemala for 1897–1922, during which time the country was on a floating exchange rate. The United States was the base country. The money stock was used to proxy the Guatemalan price index, for which a direct series does not exist. This representation had been adopted by Cassel and Keynes for their World War I studies, absent price data. Results were excellent for PPP. The exchange rate, U.S. price, and Guatemalan money stock were found to be cointegrated. With the coefficient of the exchange rate normalized to unity, one could not reject the hypotheses of symmetry and proportionality (coefficients of U.S. price and Guatemalan money, one and minus one, respectively).

3.7 Analysis of U.S. Return to Gold Standard in 1879

The successful PPP testing for the greenback period, on the part of Kindahl (1961) and Officer (1981), was based (wholly, for Kindahl; in part, for Officer) on real-exchange-rate computations. These authors put their computations to work to determine (i) the range of real appreciation of the greenback for successful return to the gold standard and (ii) the first year in which a successful return could occur. For (i), the technique was simply to observe the range of the real exchange rate in the postbellum period but excluding 1877–1879, which were years of unusual capital outflow. The resulting range for Kindahl was 9–27% or 8–18%; for Officer, −3 to 18%—all assuming no capital movements. If resumption was to occur at the prewar parity (as in fact did happen), then the U.S. price index could exceed the U.K. price index by a value within the specified range (with both indexes relative to base-year 1860). With capital inflow, the real exchange rate (or PPP, with no change in the nominal exchange rate) could exceed the upper limit. With capital outflow, it might have to fall below the lower limit.

To answer (ii), one approach is to find the earliest year in which the real exchange rate falls within the estimated range; but the range might be considered too broad for a confident return and maintenance of the gold standard. Consider, rather, a stronger criterion: the earliest year at which the real exchange rate reached (or almost reaches) 100—the same value as in 1860. For Kindahl, that year was 1879, when his real exchange

rate was 101 and the return to gold in fact occurred. For Officer, the year was 1875, when his real exchange rate was 100 and the Resumption Act was passed. That Act specified a return to the gold standard on January 1, 1879—which in fact happened. To some historians of the period, Officer's answer would be too optimistic. For example, Friedman and Schwartz (1963, p. 48) wrote that "the act was little more than the expression of a pious hope." However, they went on to state: "Resumption might well have been successful a year or more earlier than the date set and certainly could have occurred later"—Friedman and Schwartz (1963, p. 85).

3.8 Establishment and Assessment of a Fixed Exchange Rate in Interwar Period

This section discusses the use of PPP by government in connection with the setting of a new exchange rate. In the interwar period, there were two interesting cases of PPP computations by the government in order to establish a new, or return to a former, exchange rate: United Kingdom (1925) and France (1926).

3.8.1 United Kingdom

The U.K. return to gold on April 28, 1925 was the (sole) case of a government predetermining the exchange rate—in this case the prewar gold parity—and using PPP to measure the amount of price-level adjustment at home or abroad required to maintain the rate. France, Czechoslovakia, and Belgium applied PPP to compute the new exchange rate, although less so in France than in the other two countries.

No doubt the U.K. experience is the most famous of all governmental applications of PPP. The floating pound had appreciated from 10% to less than 2% below parity—caused by anticipation of a return to parity, whereupon the prewar exchange value of the pound ($4.86656 per pound) was restored. There was never a question that return to the gold standard would take place, and at the prewar rate. As Sayers (1960, p. 314) commented: "The restoration of the gold standard, at a tacitly assumed rate of 4.86, was government policy throughout". Moggridge (1969, p. 14) agreed: "The Authorities had as their primary aim a return to gold…a return to the pre-war parity." There was never any choice as to the fact of return and the rate. According to Sayers (1960, p. 317), one of the advisers of Winston Churchill, Chancellor of the Exchequer, told him:

"There's no escape; you have to go back [to gold at the prewar parity]; but it will be hell."

For the authorities, the only question was timing: *when* the gold standard would be reestablished. Churchill's advisers used the WPI in their PPP computation, which Keynes criticized for virtually validating the existing exchange rate. "This led them to think that the gap to be bridged was perhaps 2 or 3 per cent"—Keynes (1931 [originally published in 1925], p. 250). So the return to gold occurred on April 28, 1925.

Both contemporary and later economists used PPP to determine the overvaluation of the pound upon re-adoption of the gold standard.[13] The earliest such computation was apparently made by Keynes himself. He contrasted the government WPI-based estimated overvaluation of 2–3%, with his own RPI-based figure of 10–12%. The former estimate was considered biased downward, the latter (in conjunction with PPP based on wages and prices of manufactures) "a much better rough-and-ready guide for this purpose…than are the index numbers of wholesale prices" (Keynes, 1931 [originally published in 1925], p. 250). However, as first pointed out by Gregory (1926), Keynes used RPI figures from the state of Massachusetts rather than the national U.S. data of the Bureau of Labor. The presumed reason, according to Gregory, was that only the former series at the time was published on a regular basis. Using the national figures, Gregory obtained results in accord with those of Churchill's advisors. Cassel (1925b, 1926) offered a WPI-based estimate slightly above that ascribed by Keynes to Churchill's advisors.

The computations of later writers used a broader array of indexes and base countries. Moggridge (1972) was the first author to employ the GNP deflator—a superior price index than the WPI and RPI—and found overvaluation to be 11%, consistent with Keynes. Moggridge (1972, p. 105) wrote: "An exchange rate at least 10 per cent lower than $4.86 would probably have been somewhat more appropriate for sterling." Dimsdale's (1981) estimates were between 1 and 14%, depending on the price index. In addition, he computed a real effective-exchange-rate for sterling versus 11 currencies, but only from 1920 and on a 1929 rather than prewar base. The work of Redmond (1984) is impressive for a wide array of alternative base countries as well as for effective-exchange-rate computations; however, as might be expected, estimates are all over the place. Matthews (1986) offered estimates based on the work of Redmond and Moggridge. Taylor's (1992) estimate of 5% overvaluation was based

on an error-correction model, and is mentioned because the model is within the PPP rubric.

Certainly, the estimates of overvaluation of the authors have considerable variation. Perhaps most trustworthy are Redmond's figures based on RPI and the effective-exchange-rate concept. These estimates suggest substantial overvaluation, which is consistent with the U.K. post-return experience of balance-of-payments deficits, deflation, and unemployment. Keynes predicted this in 1925, and he was right![14].

3.8.2 France

France re-adopted the gold standard on June 25, 1928, with a par value of 124.21 francs per pound sterling. This emanated from a gold par of exchange only slightly greater than one-fifth the prewar value, when mint parity was 25.225 francs per pound. The genesis of the new par value occurred in 1926, when several French officials made PPP computations yielding ranges of a stabilized rate. The best source of this history is Mouré (1996). In August, Pierre Quesnay's calculations, using WPI and Germany as the base country, yielded appropriate stabilization of 160–170 francs per pound. In November, Jacques Rueff's PPP computations employed both WPI and RPI price indexes, again with Germany as base country. He found the desired stabilization rate to be 120–145. In the same month, Charles Rist recommended the range 140–160.

In fact, the franc was appreciating in the foreign-exchange market. To stem this appreciation, at least temporarily, on December 20, 1926, Prime Minister Raymond Poincaré authorized the Bank of France to stabilize the rate via exchange-market intervention. This was a decision based on fear that appreciation would result in recession and unemployment and reduce Poincaré's political support within a coalition government. "PPP calculations did not decide the stabilization in December 1926" (Mouré, 1996, p. 144). However, as Mouré further comments, 'the economists' arguments were not without effect." Stabilization was at about 122 francs per pound and the return to the gold standard in 1928 at 124.21. These figures are close to the lower bound of Rueff's PPP computations. Mouré (1996, p. 148) writes: "With regard to choosing a rate of stabilization, PPP calculations offered evidence that was of interest but not decisive…"

Keynes (1930) [originally published in 1928], Cassel (1936), Walter (1951), and Sicsic (1992) provided estimates of undervaluation of the franc with respect to the British pound. The extent, not the direction, of

deviation from PPP was the only issue. There is no doubt that undervaluation of the franc worsened the situation of the British, who overvalued the pound. At first, Keynes (1930, p. 114) judged that "the franc…fixed…at about one-fifth of its pre-war gold value…The figure finally chosen seems about right." Yet Keynes (1930, pp. 114–115) went on to state that a PPP computation would involve "a gold value of the franc nearer to one quarter (100 francs to the £) than to one-fifth of the pre-war value." This suggests about a 20% undervaluation (although Keynes did not state which price index he was applying). However, Keynes provided reasons—crudeness of French price indexes, room for domestic prices to rise, effect on export industry, budgetary implications, and avoidance of capital loss on foreign-exchange reserves of the Bank of France—why the French authorities were wise not to follow his computed PPP.

Using the WPI, Cassel, Walter, and Sicsic provided estimates of the undervaluation of the franc in the 6–12% range, the figure depending on the currency of comparison and the price index. These estimates are substantially below Keynes' figure of 20%.[15] Only Sicsic's RPI estimate, 28%, based on a nine-country effective exchange rate, exceeded that of Keynes.

It is not clear whether the French authorities *deliberately* undervalued the franc. According to Mouré, the concern was domestic macroeconomic stability, which explains why (i) the de facto stabilization rate in 1926 was undertaken to keep the franc from appreciating further, and (ii) the de jure stabilization rate in 1928 was close to the de facto rate established in 1926.

3.9 Conclusions

Why has PPP endured through the centuries and under the rubric of various and varying exchange-rate experiences and monetary standards? This survey of the application of PPP to historical experiences illustrates the controversial nature of PPP—and that nature is one reason for the durability and endurance of PPP. The second reason is that PPP is fundamentally a simple and intuitively appealing theory. The third reason is that it has an inherent concreteness that other exchange-rate theories lack.

Clearly, this survey shows that there is mixed empirical evidence for the applicability of PPP, whether in explaining exchange-rate behavior or in establishing new exchange-rate levels. Yet that result gives rise to a fourth reason for the robustness of PPP: *Whether or not PPP is deemed to hold*

empirically, it is useful to know the extent to which the theory is valid. Measurement of *deviations* from PPP is important both for macroeconomic historians and for economic policy-makers. As Houthakker (1962, pp. 296–297) wrote: "All in all, it would be most unwise to ignore the unique insight which PPP calculations can afford."

Notes

1. However, the essay discusses only relative PPP, a reflection of "the PPP literature with a historical bent," itself a result of a paucity of data on absolute price levels in the pre-1940 period.
2. See Burns (1927, p. 417), Einzig (1970, p. 44), and Officer (1982, p. 27).
3. Citing the Roman historian Pliny, Einzig (1970, p. 45) reports that "merchants importing Indian goods sold them in Rome at a hundred-fold of what they had paid for them…the margin between the price of luxuries in their countries of origin and in their countries of destination was [some]thing like 10,000 per cent."
4. See the references in Officer, (1982, p. 194, n. 22).
5. This was pointed out originally by Keynes (1930, pp. 72–74; 1931, pp. 249–250 [originally published in 1925]).
6. Ahking (1990), Angell (1926), Cassel (1925a), Crump (1925), Farag and Ott (1964), Grilli and Kaminsky (1991), Hodgson (1972), MacDonald (1985a), Myhrman (1976), Stolper (1948), Taylor (1992), and Michael et al. (1996).
7. Aliber (1970), Angell (1926), Dulles (1929), Farag and Ott (1964), Myhrman (1976), Pippenger (1973), Rogers (1929), Wasserman (1936), and Sicsic (1992).
8. For Sweden, Anonymous (1921), Flux (1924), and Cassel (1925a, b); for Switzerland, Junge (1984) and Bleaney (1998); for Greece, Phylaktis (1990, 1992) and Georgoutsos and Kouretas (1992).
9. The relevant papers are those of Bachi (1925), Jacobson (1925a), Jacobson and Jaeger (1925), Wight (1925a, 1925b, 1925c), Wood (1925b, 1925c, 1925d1925a), Young (1925b, 1925c, 1925d, 1925e, 1925f, 1925g), and Jacobson et al. (1925).
10. The first group consists of Flux (1924), Furniss (1922), Graham (1930), Gregory (1925), Keynes (1923), Lester (1939), Robertson (1922), Tsiang (1959), U.S. Tariff Commission (1922), and Aliber (1962); the second, Hodgson and Phelps (1975), Hakkio (1984), Krugman (1978), Rogalski and Vinso (1977), Thomas (1973a, 1973b), and De Grauwe et al. (1985).
11. Bachi (1925), Copland (1930), Flux (1924), Gregory (1925), Katzenellenbaum (1925), and Thomas (1972).

12. Studies of the first group are Edison (1985), Frenkel (1978), Georgoutsos and Kouretas (2000), MacDonald (1985b); studies of the second group are Ardeni and Lubian (1989), Frenkel (1980), Michael et al. (1997), Taylor and McMahon (1988).
13. Excluded from the discussion are computations based on wages or export price indexes, as well as estimates emanating from more-general models of exchange-rate determination.
14. In February 1934, Czechoslovakia devalued the crown by 16 2/3%, with the devaluation rate based on a WPI PPP computation. Haberler (1961, p. 49, n. 37) comments that "exactly the same mistake was made [as in the United Kingdom in 1925]." The interpretation of Nurkse (1944, p. 128) was that the rate left no margin for economic expansion, putting downward pressure on the exchange value of the domestic currency. In any event, Czechoslovakia had to devalue a second time, in October 1936. In contrast, Belgium successfully devalued its franc in 1935. The devaluation rate of 28% was decided on the basis of PPP computations, with RPI as the decisive price concept. Further discussion of the Czech experience is in League of Nations (1936, pp. 49–52). The Belgian experience is discussed in League of Nations (1936, pp. 49–50), Nurkse (1944, p. 128), Garnsey (1945), Triffin (1937), and Officer (1982, pp. 143–144).
15. The estimates for Walter were computed by this author from Walter's data.

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