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STABILITY OF MONETARY UNIT AND INFORMATIVENESS OF CORPORATE FINANCIAL REPORTING

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Abstract

Monetary unit is a basic element of accounting used to manage, report, govern and tax organizations in all sectors of the economy. Instability of monetary unit introduces noise, weakening the effectiveness of accounting in performing its important economic roles in society. We model the impact of monetary instability on the accuracy of accounting valuation and consequently on the economics of managing organizations. We also examine some empirically testable implications of the theory. Though the magnitude of this effect remains to be estimated, it may be significant enough to deserve explicit consideration in selection of monetary policy.

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Stability of Monetary Unit and Informativeness of Corporate Financial Reporting
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When its value is stable, money is the best, although hardly a perfect unit of accounting measurement. When the real value of money becomes uncertain or unstable, the rationale for keeping accounts in units of money fades. In a monetized and commercialized society, rates of exchange between most resources and money are available. Such opportunities for exchange yield estimates of opportunity costs of the resources. In such environments, it is possible to easily, transparently, and usefully represent bundles of disparate resources in terms of money (see Vatter, 1971, pp.4-5). Consequently most accounting is done in units of money (see Dobija and Sliwa, 2001, for a history). Many accounting textbooks list money unit as a basic element of accounting.

While money is often the best unit of accounting, it is, for all its functions, not perfect. The deviation from perfection increases with instability in the value of money. Instability may take several statistical forms. The prevailing rates of exchange between real resources and money may change for individual resources, change on average, or become hard-to-observe in thin markets. The composition of resource bundles sought to be valued may also change, making money more or less useful as a unit of accounts. When money becomes less stable in one or more of these senses, effectiveness of agents to use accounting numbers as information in decision-making and control is also reduced. These decisions and their welfare consequences pervade the economy.

In most societies, sovereign power controls monetary policy. Much thought has been given to this policy in relation to its direct consequences for inflation, employment, output, and investment, etc. Hayami (2000) writes:

> The market economy is a structure within which firms and households make decisions regarding consumption and investment based on prices of individual goods and services. … [T]he levels of individual prices can be evaluated against the general price level as a yardstick. In this framework, price stability means that this yardstick is reliable. If so, changes in consumer preferences and the progress of technological innovation will be efficiently translated into changes in individual prices. Thus, firms will be able to use changes in relative prices as a signal for their future business strategy. From a macroeconomic viewpoint, when the economic environment is continuously changing, stable prices facilitate the smooth reallocation of such resources as labor and capital and also technological innovation in response to, for example, consumer trends, thereby ensuring sound economic growth over the long run.
>
> If prices fluctuate considerably and the yardstick becomes unreliable, then the signaling function of individual prices will be greatly weakened. In this case, labor and capital will not be easily transferred to growth industries, and the inefficient allocation of resources will ensue. In addition, an economy with unstable prices will likely experience unstable business cycles. This, in turn, will make it difficult for firms and households to formulate prospects regarding profits and income, which obstructs sound investment activity. Thus, if price stability is impaired, the long-term growth rate will decline.

Beaudry, Caglayan and Schiantarelli (1996) model the impact of price instability on breadth of investment, and empirically test their model with U.K. panel data. They conclude:

> The overall evidence is supportive of the framework we propose to explain the relationship between nominal uncertainty, the informational content of prices, and the time variation in the cross-sectional distribution of investment. Hence, we conclude that the data is consistent with the view that monetary instability may affect the process of investment allocation through its effect on the predictability of prices. The theoretical and empirical emphasis on the effect of the informational content of market signals on the distribution of investment is the distinguishing and unique feature of our paper. However, its general objective is related to that of numerous contributions that have studied the effects of inflation on relative price volatility and on the optimality of resource allocation. Although we do not provide an analysis of the welfare consequences of uncertainty in this paper, it is clear that the link we outline between nominal uncertainty and the allocation of investment may be one of the important elements in such an analysis.

We explore the effects of monetary policy on economic efficiency and allocations via the role of money as the unit of accounts. The overall effect of monetary instability is to increase the noise in data produced by accounting systems, and thus reduce the efficiency of decision-making in the economy. Though we cannot yet estimate the magnitude of this effect, it is reasonable to suggest that such effect may deserve attention in choosing monetary policy.

Section 1 examines the role of monetary unit in accounting. Section 2 explores the various forms of monetary instability relevant to accounting. Sections 3 and 4 examine the effects of these forms of instability on accounting reports. Section 5 looks at the empirically testable implications of the theory developed here. Section 6 has the concluding remarks.

1. Money as the Unit of Account

Contrary to appearances, money or any other single resource as a unit is not necessary for preparation of accounts. It is possible, and sometimes desirable, to keep accounts of resource flows and stocks in units appropriate to each. Table 1 shows an example of such a balance sheet and income statement. Cash, fruit, fertilizer and buildings are shown on the balance sheet in their own appropriate units. Total assets are an awkward collection of incommensurate items. The same is true of the flow of resources reported in the income statement. To readers unfamiliar with the specific resources, these statements do not convey much information. On the other hand, readers who are intimately familiar with the resources, such statements may actually carry more information than accounts drawn up in units of money.

Conversion of these *original-unit* accounts into the more familiar *common-unit* accounts requires choosing a common unit and multiplying the quantity of each resource by an appropriate exchange rate. In commercialized societies, money is the only practical unit of account because the exchange rates for more resources are available in terms of money than in terms of any other unit. Table 2, with commensurate magnitudes, is simpler than Table 1. However this simplicity and commensurability have diverse consequences for agents depending on their state of knowledge. For a farmer familiar with these resources, 500 bushels of apples and 35 tons of fertilizer in his stock is more informative than $5,000 in apples and $3,500 in fertilizer. For those without such direct knowledge of these resources, Table 2 carries more information. For most people, the conversion rate of real resources to units of money is subject to well-known ambiguities and controversies, even under the best of circumstances. And circumstances are not always at their best. Table 2 helps such readers by presenting a resolution of these ambiguities, though not without introducing an agency problem due to motivations of those who use their judgment to resolve the ambiguities. Even for a farmer who intends to sell his apples in the market, the money price of apples is more useful than their quantity.

It is not surprising that managerial and control accounting, frequently used by people with intimate knowledge of the resources, makes liberal use of *original-unit* accounts. Financial reports, used mostly by agents who have little knowledge or contact with the real resources, invariably take the *common-unit* form. Effects of monetary instability are confined to the latter. We focus our attention on financial reports.

2. Forms of Monetary Instability Relevant to Accounting

Monetary instability relevant to accounting can take several forms. Changes in the price of one or more goods over time render accounts sensitive to the timing of prices used in their preparation, and to the time when the information in this accounts is used. Uncertainty of any such changes in the future makes it more difficult to project the results of continuing operations and assess their present value.

Changes in prices of all goods can be decomposed into price changes averaged across all goods—also called general price level change—and changes specific to individual goods. The latter component is the difference between total change in price of a good and average price change for all goods. Usually, a reference to price instability is confined to changes in general price level (Federal Reserve Board 2000, for example). We need a more detailed treatment here.

Statistically, the general and specific price changes over a given interval of time can be measured by their means and variances. While means measure the magnitude of price changes on average, variances measure the magnitude of variation relative to the means. The two measures independently capture different aspects of monetary instability. Small or large mean price changes could be accompanied by small or large variances of prices of changes.

Two other aspects of prices, not necessarily counted as monetary instability, affect accounting reports. One of these is the error or imprecision in measurement of price changes. As a theoretical construct, price is defined for perfect markets, and markets for most goods are far from perfect. The actual price observations can at best be regarded as samples with error, of the theoretical construct of price. For some goods, markets hardly exist and their prices must be estimated with the help of various surrogates. In either case, the measured prices and price changes differ from the actual but unobservable prices by an error term. It may be possible to adjust our measurement methods to reduce the mean of this error to zero. However, as long as markets remain imperfect or incomplete, it is not possible to reduce the variance of this measurement error to zero. While not an element of monetary instability itself, this error variance can be closely related to monetary instability. We include it in our analysis in the following section.

The composition of resource bundles of firms which are valued by accounting is also subject to changes over time, making money more or less useful as a unit of accounts. This is not considered in the following analysis.

3. A Framework for Accounting Consequences of Monetary Instability

We use Sunder (1978) and Lim and Sunder (1991) framework to assess the consequences of various aspects of monetary instability for informativeness of accounting valuation. We use the mean squared error between the accounting estimate of changes in the value of a firm's basket of assets, and the actual but unobservable price changes, as an inverse measure of informativeness of valuation. This is consistent with the standard econometric practice of using mean squared error as an inverse metric of precision of estimation.

Briefly, the analysis shows that the informativeness of historical price valuation decreases monotonically with all three forms of monetary instability (increase in price of a single good, increase in general inflation, and increase in variances and covariances of changes in prices of individual goods). Informativeness of historical valuation is not affected by variance-covariance of measurements errors in relative price changes. Increases in variances of relative price changes, and of measurement errors in relative price changes, cause a decrease in informativeness of price index valuation rules (current valuation, general price valuation, etc.). Increases in covariance of measurement errors also cause decrease in informativeness of valuation. Only increases in covariances of relative price changes increase informativeness of valuation. The analysis is summarized in Table 3; the following paragraphs provide the details.

This framework postulates an economy with *n* goods, and two dates, 0 and 1. Let n-vectors $\boldsymbol{p_0}$ and $\boldsymbol{p_1}$ be the unit prices of the goods at the two dates and let $\boldsymbol{q_0^*}$ and $\boldsymbol{q_1^*}$ be the total quantities of the goods in the economy at the two dates. Then the relative weights of the *n* goods in the economy on date 0 are given by vector $\boldsymbol{\omega}$, where $\omega_i = p_{0i}q_{0i}^*/\boldsymbol{p_0}'\boldsymbol{q_0^*}$.

Let the economy consist of a large number of firms of equal size. The asset portfolio of each firm, indicated by the vector of relative weights of assets in its portfolio, $\boldsymbol{w}$, is assumed to be created by ρ multinomial draws with replacement from the economy's asset portfolio $\boldsymbol{\omega}$.

Let $\boldsymbol{r}$ be the vector of relative price changes for the *n* goods between dates 0 and 1, so $r_i = (p_{1i} - p_{0i})/\ p_{0i}$. Let $\boldsymbol{\mu}$ be the vector of expected price changes and $\boldsymbol{\Sigma}$ be the variance-covariance matrix of price changes, so $E(\boldsymbol{r}) = \boldsymbol{\mu}$ and $E(\boldsymbol{r}-E(\boldsymbol{r}))(\boldsymbol{r}-E(\boldsymbol{r}))' = \boldsymbol{\Sigma}$. Let $\tilde{\boldsymbol{r}}$ be the vector of observed relative price changes, the sum of actual relative price changes $\boldsymbol{r}$ and a vector of errors $\boldsymbol{\varepsilon}$ so $\tilde{\boldsymbol{r}} = \boldsymbol{r} + \boldsymbol{\varepsilon}$, where $E(\boldsymbol{\varepsilon}) = \boldsymbol{0}$ and $E(\boldsymbol{\varepsilon}\,\boldsymbol{\varepsilon}') = \boldsymbol{\Delta}$.

In this framework, different linear valuation rules can be represented as different price index systems at various levels of aggregation. Current valuation of assets can be thought of as a system of valuation in which the historical price of each good *i* in the asset portfolio of the firm is adjusted by the observed relative price change for that good, $\tilde{r}_i$. In effect, it amounts to using the price change in each good as its own price index for adjusting historical price to current price. Current valuation uses the most disaggregated system of price indexes to adjust historical prices. Under this system, the asset portfolio of a firm, $\boldsymbol{w}$ is valued at $\boldsymbol{w}'\tilde{\boldsymbol{r}}$. Actual price change for this firm is $\boldsymbol{w}'\boldsymbol{r}$. Lim and Sunder (1991) showed that, averaged across the distribution of current valuation of the asset portfolio of a firm and the distribution of firm-specific asset portfolios, the mean squared error of valuation is given by

MSE(Current Valuation) =

$$E(\mathbf{w}'\tilde{r} - \mathbf{w}'r)^2 = (1 - 1/\rho)\omega'\Delta\omega + (1/\rho)\omega'\delta \qquad (1)$$

where $\boldsymbol{\delta}$ is *n*-vector of diagonal elements of matrix $\boldsymbol{\Delta}$.

General price level valuation uses a single price index to adjust the historical prices of all assets to current levels. Return on the general price level index, created by using economy-wide relative weights $\boldsymbol{\omega}$ is given by $\boldsymbol{\omega}'\tilde{\boldsymbol{r}}$. The mean squared error associated with this method of valuation is given by

MSE(General Price Level Valuation) =

$$E(\omega'\tilde{r} - \mathbf{w}'r)^2 = \omega'\Delta\omega + (\omega'(\sigma + \dot{\mu}) - \omega'(\Sigma + \mu\mu')\omega)/\rho \qquad (2)$$

where $\boldsymbol{\sigma}$ is *n*-vector of diagonal elements of matrix $\boldsymbol{\Sigma}$.

Historical price valuation does not adjust historical prices to current prices at all. Estimated return (relative price change) under historical valuation is zero, and its MSE is given by

MSE (Historical Valuation) =

$$E(0-\mathbf{w}'r)^2 = \omega'(\sigma+\dot{\mu})/\rho + (1-1/\rho)\omega'(\Sigma+\mu\mu')\omega) \qquad (3).$$

More generally, we can partition *n* goods into *k* non-empty, mutually exclusive subsets, and construct one price index for each subset, using normalized elements of $\boldsymbol{\omega}$ as relative weights. With *k* =1, we get the unique general price index valuation rule given in (2) above. With *k* =*n*, we get the unique current valuation rule given in (1) above. With *k* =0, we get the unique historical valuation rule given in (3) above. For each of other values of *k*, there are multiple specific price index valuation rules. The general expression for their mean squared error is given by

MSE(Specific Index Valuation Rule with k-price indexes) =

$$\begin{aligned}&(1-1/\rho)\omega'\Delta\omega + (1/\rho)\sum_{u=1}^{k}\frac{\omega_u'\Delta_{uu}\omega_u}{\omega_u'e} + (1/\rho)\omega'(\sigma+\dot{\mu})\\ &-(1/\rho)\sum_{u=1}^{k}\frac{\omega_u'(\Sigma_{uu}+\mu\mu')\omega_u}{\omega_u'e}\end{aligned} \qquad (4).$$

These prior results for the mean squared error of estimation associated with various accounting valuation rules, express these errors as functions of parameters that define the statistical properties of price changes. The primary question of interest here is how monetary instability affects valuation errors.

4. Accounting Consequences of Monetary Instability

We can define monetary instability in terms of these parameters in three different ways. First, elements of vector $\boldsymbol{\mu}$ are expected values of relative price changes of individual goods. We can ask how the mean squared error of valuation changes with changes in each element of $\boldsymbol{\mu}$, and with respect to the overall expected rate of inflation given by $\boldsymbol{\omega}'\boldsymbol{\mu}$.

Sensitivity of Valuation Errors to Expected Price Changes

We partially differentiate the right hand expression in (4) with respect to μ_i, the expected rate of price change for good *i*, where good *i* is included in u[th] price index:

$$\partial MSE(Specific\ Index Valuation\ Rule\ with\ k\ \Pr ice\ Indexes)/\partial\mu_i = 2\omega_i(\mu_i - \frac{\omega'_u\ \mu_u}{\omega'_u\ e})/\rho \quad (5).$$

The first term in the parentheses is the expected rate of relative price change for good *i*. The second term is the expected rate of relative price change for the goods included in the price index in which good *i* is included. If the expected rate of price change for a good is higher than the corresponding average rate for all goods in its price index, valuation error increases with increases in μ_i and decreases with decreases. On the other hand, if the expected rate of price change for an individual good is lower than the average for its index, the sign of the derivative becomes negative. In general, for index-based systems, an increase in expected rate of price change for a single good does not necessarily increase the mean squared error of valuation. For symmetric distributions, this error will increase for about half of all good and decrease for the others.

For current valuation, each good is in an index of its own, and expression (5) is always zero; changing the expected rate of relative price change for any good has no effect on mean squared error. For general price level valuation, the right hand side of (5) becomes expression $2\omega_i(\mu_i - \omega'\mu)/\rho$, which means that the effect of changing the expected rate of relative price change of a single good on mean squared depends on whether this rate is higher or lower than the expected rate of general inflation.

Finally, we partially differentiate the right hand expression in (3) with respect to μ_i, the expected rate of price change for good *i*:

$$\partial MSE(HistoricalValuation)/\partial\mu_i = 2(\omega_i(\mu_i - \omega'\mu)/\rho + \omega_i\omega'\mu) \qquad (6)$$

For a significantly large value of ρ, this expression is approximately equal to the last term, $2\omega_i$ $\boldsymbol{\omega'\mu}$, or the expected rate of general inflation, which is proportional to relative weights ω_i across all goods i. Mean squared error of historical valuation increases at this rate with the change in expected rate of price change for any good.

Sensitivity of Valuation Errors to Variance and Covariance of Price Changes

To examine the sensitivity of mean squared error to variance-covariance terms in $\boldsymbol{\Sigma}$, we partially differentiate the right hand side of (4) with respect to σ_{ij} to get

$$\begin{aligned}&\partial MSE(Specific\ Index Valuation\ Rule\ with\ k\ \mathrm{Pr}ice\ Indexes)/\partial\sigma_{ij} = \\ &\quad(-2/\rho)\omega_i\omega_j/\omega_u'e \quad if \quad i \neq j \\ &(1/\rho)\omega_i(1-\omega_i/\omega_u'e) \quad if \quad i = j\end{aligned} \qquad (7)$$

Elements of matrix $\boldsymbol{\Sigma}$ are variances (diagonal terms, $i = j$) and covariances (off-diagonal terms, $i \neq j$) of price changes. Since $\boldsymbol{\omega_u'e}$ is the sum of relative weights of goods included in the u[th] price index which includes ω_i as well as other non-negative terms, $\omega_i / \boldsymbol{\omega_u'e}$ is necessarily less than 1. Therefore, the effect of an increase in the variance of any good on MSE of any specific index valuation rule is positive. For covariance terms of $\boldsymbol{\Sigma}$, the partial derivative is always negative. Thus, expression (7) shows that the effect of increase in variance of price changes makes all index valuation rules less accurate, and an increase in covariance makes them more accurate.

For current valuation, each good is in an index by itself, making the partial derivative of covariance terms negative, and of variance terms zero. For general price level valuation, (7) is simplified to

$$\partial MSE(General\ \Pr ice\ Index Valuation)/\partial\sigma_{ij} = \begin{cases} (-2/\rho)\omega_i\omega_j & if \quad i \neq j \\ (1/\rho)\omega_i(1-\omega_i) & if \quad i = j \end{cases} \tag{8}$$

The effect of change in variance of price changes on the mean squared error of historical valuation can be examined by taking the partial derivative of the right hand side of expression (3) with respect to σ_{ij} to get

$$\partial MSE(Historical\ \Pr ice\ Valuation)/\partial\sigma_{ij} = \begin{cases} (1-1/\rho)2\omega_i\omega_j & if \quad i \neq j \\ \omega_i/\rho + (1-1/\rho)\omega_i^2 & if \quad i = j \end{cases} \tag{9}$$

This partial derivative is always positive and, for large values of ρ, it is approximated by $2\omega_i\omega_j$ if for covariance terms and by ω_i^2 for variance terms. While the effect of increases in covariances on MSE of specific index valuation systems is negative, this effect on the MSE of historical valuation is positive for both variances as well as covariances.

<u>Sensitivity of Valuation Errors to Variance and Covariance of Measurement Errors in Price Changes</u>

To examine the sensitivity of mean squared error to variance-covariance terms in $\boldsymbol{\Delta}$**,** we partially differentiate the right hand side of (4) with respect to δ_{ij} to get

$$\partial MSE(Specific\ Index Valuation\ Rule\ with\ k\ \Pr ice\ Indexes)/\partial\delta_{ij} = \begin{cases} 2\omega_i\omega_j(1-1/\rho+1/\rho\omega_u'e) & if \quad i \neq j \\ (1-1/\rho+1/\rho\omega_u'e)\omega^2{}_i & if \quad i = j \end{cases} \tag{10}$$

Elements of matrix $\boldsymbol{\Delta}$ are variances (diagonal terms, $i = j$) and covariances (off-diagonal terms, $i \neq j$) of price changes. Since the value of ρ is always equal to or more than 1, this partial derivative is always non-negative. This means that any increase in variance or covariance of measurement errors necessarily increases the mean squared error of valuation for all specific price index valuation rules, and makes them less informative.

For current valuation, each good is in an index by itself, making the partial derivative (10), always nonnegative, takes a simpler form (11):

$$\partial MSE(Current\,Valuation)/\partial\delta_{ij} = \begin{cases} 2\omega_i\omega_j(1-1/\rho) & if \quad i \neq j \\ (1-1/\rho)\omega^2{}_i + \omega_i/\rho & if \quad i = j \end{cases} \tag{11}$$

For general price level or single-index valuation rule, derivative (10) is further simplified to

$$\partial MSE(General\,\mathrm{Pr}\,ice\,Index Valuation)/\partial\delta_{ij} = \begin{cases} 2\omega_i\omega_j & if \quad i \neq j \\ \omega^2{}_i & if \quad i = j \end{cases} \tag{12}$$

The effect of change in variance of price measurement errors on the mean squared error of historical valuation is necessarily zero because historical valuation rule does not use the data on price changes.

$$\partial MSE(Historical\,\mathrm{Pr}\,ice\ Valuation)/\partial\delta_{ij} = 0 \qquad (12).$$

5. Empirical Implications of the Model

Provision of information for investor decision-making and confirmation is recognized as an important function of financial reporting. Investors use multiple imperfect sources of information to support their decisions. Financial reports are one of these important sources. We can expect an increase in the noisiness of financial reports to cause a decrease in the association between such reports and stock prices; first because of the increase in the noisiness of the reports per se, and second because of the shift of investor decisions away from dependence on noisier sources of information.

The model developed in the preceding sections shows that instability of monetary unit (whether in the form of greater variance of price changes of individual resources, or of measurement errors in the price changes) causes financial reports to be noisier. It is an empirical implication of this theory is that monetary instability should be associated with weaker association between financial reports and stock prices (returns or levels). All three classes of these variables are observable in the field (monetary instability, financial reports, and stock prices) and monetary instability varies greatly over time and across countries. It should be possible for us to test this theory by estimating these relationships from the data.

In accounting literature the question of time trends in the association of financial reports and stock prices have received much attention. However, to the best of our knowledge, theorizing and testing about the possible effects of monetary instability on this association have not yet been attended to. The model presented here suggests one way of doing so.

6. Policy Implications and Concluding Remarks

An increase in instability of monetary unit introduces more noise into financial reports for several reasons. Many aspects of financial reports are based on historical costs, which deviate more from the opportunity cost of resources in presence of price instability. Second, even if the financial reports are adjusted for changes in general price level, they are difficult to adjust for the increase in variance of price changes for various resources, again introducing additional noise in the reports.

Increases in variances of price changes and measurement errors in price changes accompany monetary instability. The above analysis shows that the statistical gap between actual and accounting estimates of value of a bundle of assets grows with such increases. Many agents, including managers and shareholders of the firm, use accounting data for making decisions. As the statistical gap grows with monetary instability, so does the imprecision of these decisions. Noisier decisions are less efficient decisions.

As monetary instability renders accounting data less efficient bases for making decisions, agents should be expected to look for alternative sources of information. Accounting data prepared and verified by the firm under well-known standards is reliable and freely available. Alternative sources of information are costly, not free to agents.

These findings have policy implications for accounting as well as monetary policy. At the turn of the century, price instability in the U.S. is low, and the accounting standards do not require adjustment of financial reports for monetary instability. However, as a matter of general policy, such adjustments become desirable when monetary instability rises in relation to the measurement errors in price changes. Lim and Sunder (1991) provided an analysis of this trade off. For makers of monetary policy, the efficiency consequences of monetary instability are worth consideration, in addition to the other well-known consequences for output, employment, and inflation.

In his famous work, von Mises (1949) warned that a stable standard of value is not the same thing as a stable price level, nor does it mean "zero inflation." Under such a standard, consequences of productivity surprises should appear as rising or falling purchasing power of money (also see Selgin, 1997). In other words, there are “goods induced” or justifiable changes in prices that result from shifts in demand, supply, productivity, etc. In measuring price instability and its consequences, we need to isolate these “supply side” price changes from the “cash-induced” changes in prices. Analysis presented in this paper does not attempt this isolation.

Table 1: *Original-Unit* Balance Sheet and Income Statement

Balance Sheet			
Assets		**Equities**	
Cash	$4,500	Wages Payable	$1,600
Inventory of Apples	500 bushels	Bank Loan Payable	$2,000
Inventory of Fertilizer	25 tons	Proprietor's Equity	$ 900 + 500 bushels of apples + 25 tons of fertilizer + 4,000 sq. ft. warehouse, 4 years old
Warehouse	4,000 square feet, 4 years old		
Total Assets	**$4,500 + 500 bushels of apples + 25 tons of fertilizer + 4,000 sq. ft. warehouse, 4 years old**	**Total Equities**	**$4,500 + 500 bushels of apples + 25 tons of fertilizer + 4,000 sq. ft. warehouse, 4 years old**

Income Statement	
Revenues	
Sale of Apples (1,000 bushels)	$10,000
Expenses	
Wages	$2,000
Fertilizer	35 tons
Bank Interest	$350
Depreciation	Aging of 4,000 sq.ft. Warehouse from 4 to 5 years
Total Expenses	$2,350 + 35 tons of fertilizer + aging of 4,000 sq.ft. warehouse from 4 to 5 years
Net Income	**$7,650 – 35 tons of fertilizer – aging of 4,000 sq.ft. warehouse from 4 to 5 years**

Table 2: *Single-Unit* Balance Sheet and Income Statement
(in units of money)

Balance Sheet			
Assets		**Equities**	
Cash	$ 4,500	Wages Payable	$ 1,600
Inventory of Apples (500 bushels @$10/bushel)	$ 5,000	Bank Loan Payable	$ 2,000
Inventory of Fertilizer (25 tons @$100 per ton)	$ 2,500	Proprietor’s Equity	$20,400
Warehouse (4,000 sq. ft, 4 years old @$3 per sq.ft.)	$12,000		
Total Assets	**$24,000**	**Total Equities**	**$24,000**

Income Statement	
Revenues	
Sale of Apples (1,000 bushels @ $10/bushel)	$10,000
Expenses	
Wages	$2,000
Fertilizer (35 tons at $100 per ton)	$3,500
Bank Interest	$350
Depreciation (4,000 sq.ft. warehouse aging from 4 to 5 years @$0.50 per sq. ft.	$2,000
Total Expenses	$7,850
Net Income	**$2,150**

Table 3
Partial Derivatives of Mean Squared Error of Valuation Rules with respect to Monetary Instability Parameters

	Monetary Instability Parameters			
Valuation Rule	Expected Relative Price Change for Good *i* (μ_i)	Expected Rate of General Inflation ($\boldsymbol{\omega'\mu}$)	Variance-Covariance of Relative Price Changes (σ_{ij})	Variance-Covariance of Measurement Errors in Relative Price Changes (δ_{ij})
Generic Specific Price Index Valuation Rules	$2\omega_i(\mu_i - \dfrac{\omega'_u \mu_u}{\omega'_u e})/\rho$ (positive for some goods, negative for others)	$2(\mu_i - \dfrac{\omega'_u \mu_u}{\omega'_u e})/\rho$ (positive for some goods, negative for others)	$(-2/\rho)\omega_i\omega_j/\omega_u'e \quad if \quad i \neq j$ $(1/\rho)\omega_i(1-\omega_i/\omega_u'e) \quad if \quad i = j$ (always nonpositive for *i* ≠*j*, always nonnegative for *i* =*j*)	$2\omega_i\omega_j(1-1/\rho+1/\rho\omega_u'e) \quad if \quad i \neq j$ $(1-1/\rho+1/\rho\omega_u'e)\omega^2{}_i \quad if \quad i = j$ (always nonnegative)
Current Valuation Rule	0	0	0	$2\omega_i\omega_j(1-1/\rho) \quad if \quad i \neq j$ $(1-1/\rho)\omega^2{}_i + \omega_i/\rho \quad if \quad i = j$ (always nonnegative)
General Price Level Rule	$2\omega_i(\mu_i - \omega'\mu)/\rho$ (positive for some goods, negative for others)	$2(\mu_i - \omega'\mu)/\rho$ (positive for some goods, negative for others)	$(-2/\rho)\omega_i\omega_j \quad if \quad i \neq j$ $(1/\rho)\omega_i(1-\omega_i) \quad if \quad i = j$ (always nonpositive for *i* ≠*j*, always nonnegative for *i* =*j*)	$2\omega_i\omega_j \quad if \quad i \neq j$ $\omega^2{}_i \quad if \quad i = j$ (always nonnegative)
Historical Valuation	$2(\omega_i(\mu_i - \omega'\mu)/\rho + \omega_i\omega'\mu$ (almost always positive when inflation is positive)	$2((\mu_i - \omega'\mu)/\rho + \omega_i\omega'\mu$ (almost always positive when inflation is positive)	$(1-1/\rho)2\omega_i\omega_j \quad if \quad i \neq j$ $\omega_i/\rho + (1-1/\rho)\omega_i^2 \quad if \quad i = j$ (always nonnegative)	0

	Monetary Instability Parameters			
Valuation Rule	Expected Relative Price Change for Good *i* (μ_i)	Expected Rate of General Inflation ($\boldsymbol{\omega'\mu}$)	Variance-Covariance of Relative Price Changes (σ_{ij})	Variance-Covariance of Measurement Errors in Relative Price Changes (δ_{ij})
Generic Specific Price Index Valuation Rules	Positive or Negative	Positive or Negative	Nonpositive for covariances Nonnegative for variance	Nonnegative
Current Valuation Rule	0	0	0	Nonnegative
General Price Level Rule	Positive or Negative	Positive or Negative	Nonpositive for covariances Nonnegative for variance	Nonnegative
Historical Valuation	Positive under inflation	Positive under inflation	Nonnegative	0

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