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Replacement versus Historical Cost Profit Rates: What is the difference? When does it matter?

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Abstract

This paper explains the BEA methodology for computing historical cost and replacement cost measures of the net stock of capital in the U.S. economy. It is demonstrated that there exists a threshold rate of inflation in the price of capital goods that keeps the percentage difference between the two capital stock measures constant. Hence, over periods when average inflation in the price index for capital goods is equal to the threshold value, historical cost and replacement cost profit rates would show equal percentage changes; an example of such a period for the U.S economy is the whole postwar period 1946–2010. Moreover, trends in both replacement cost and historical cost profit rates display very similar movements over long periods, making the choice of capital stock valuation irrelevant for empirical analysis of profitability trends.
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JEL Codes: E01, B51.

1 Introduction

The Marxian tradition of political economy understands capitalism as a system driven by the needs of capital accumulation. Since profitability is the primary driver of capital accumulation, the aggregate profit rate is one of the most important variables for Marxian political economic analysis. Thus, Marxist economists pay close attention to movements in profitability to explain key macroeconomic events, including periods of structural crises, in capitalist economies.

Both because it is the leading capitalist-imperialist nation and because of easy availability of reliable macroeconomic data, numerous Marxist scholars have studied profitability trends for the

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postwar U.S. economy. A fault line that runs through this literature on profitability trends in the postwar U.S. economy is between adherents of the temporal single system interpretation (TSSI) of Marx's value theory and the rest of Marxist scholars. For the former, the aggregate profit rate has trended downwards over the whole postwar period (Kliman, 2011); for the latter, the period since the early 1980s was a period of rising or stagnant profitability (for e.g., see Duménil and Lévy (2011)).

The difference in the reading of profitability trends between the TSSI school and the rest of Marxist scholars hinges on different measures of capital stock that they respectively use. While the TSSI scholars use the historical cost (HC) valuation of capital stock, most other Marxist scholars use the replacement cost (RC) valuation of capital stock. This paper explains the differences in these alternative valuation methodologies and draws out the implications of the alternative valuation methodologies for profitability analysis.

To get the discussion started, let us recall that the profit rate is defined within Marxian political economy as the ratio of the flow of profit income (over a period) and the stock of capital advanced (or tied up) to generate that profit income. At the aggregate level, the stock of capital advanced includes productive capital (unused raw materials, unfinished commodities, undepreciated fixed assets, and unused labour power), commercial capital (the inventory of finished products) and financial capital (the stock of financial assets) of all the capitalist enterprises. Since data on commercial and financial capital is relatively more difficult to come by, most researchers focus their attention on productive capital. But data on some components of productive capital like inventories unfinished goods, unused raw materials and unused labour power, are also difficult to get. Hence, most researchers end up using a subset of the stock of productive capital, namely the stock of undepreciated fixed assets, as a measure of the "stock of capital advanced".

There are two different ways to measure the stock of undepreciated fixed assets: (a) as the *historical cost* value of the stock of fixed assets, i.e., valuing elements of the fixed capital stock at the prices at which they were originally purchased, and (b) as the *replacement (or current) cost* value of the stock of fixed assets, i.e., valuing elements of the fixed capital stock at prices at which they could be purchased in the market in the current period. As I have already pointed out, economists close to the temporal single system interpretation (TSSI) of Marx's value theory use historical cost valuation (e.g., Kliman (2011)), and most other Marxist economists use replacement cost valuation of the capital stock (e.g., Moseley (1992); Kotz (2009); Shaikh (2010); Duménil and Lévy (2011)).

When studying the U.S economy, both groups of economists use data on fixed assets from the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce, one group using the historical cost series and the other using the replacement (or current) cost series. This paper explains the differences in these two valuation methodologies adopted by the BEA.

Analyzing the relationship between the two valuation methodologies in the context of profitability trends, this paper argues that it is possible to define a "threshold" value of the rate of inflation in the price of fixed assets that keeps the percentage difference between replacement cost (RC) and historical cost (HC) values of fixed assets, constant over time. When average inflation in the price of fixed assets is above the threshold, (RC-HC)/HC tends to become larger over time; when average inflation in the price of fixed assets is below the threshold, (RC-HC)/HC becomes smaller over time. This has an interesting implication for the analysis of profitability trends.

If the average rate of inflation in the price index for capital goods between two time points is approximately equal to the threshold value just defined, *percentage changes* in replacement cost and historical cost profit rates between those two time points will be roughly equal. Over the span of such periods, the choice of capital stock valuation methodology becomes irrelevant to empirical analysis of profitability trends (or movements in the rate of profit).

This also means that the time series of HC profit rates can be understood as "rotated" versions of the corresponding RC profit rates.[1] Moreover, the direction of rotation depends on whether inflation in the aggregate price of fixed assets is above (or below) the threshold value. During periods of above-threshold inflation in the price of fixed assets, the HC profit rate series is a counter-clockwise rotated version of the RC profit rate series; during periods of below-threshold inflation, the opposite will be true.

The analysis in this paper shows that the postwar period of U.S. capitalism, 1946–2010, is an example of a period where (RC-HC)/HC remained approximately same at the two end points. This implies that over this period inflation in the price of fixed assets was approximately equal to the threshold value. Hence, for comparison of profit rates at the two ends of the period, 1946 and 2010, the choice of capital stock valuation is largely irrelevant.

On the other hand, over the period 1946-1982, (RC-HC)/HC became larger in magnitude. This means that average inflation in the price of fixed assets remained above the threshold value for the period 1946-1982. That is why replacement cost profit rates fell more, in percentage terms, than historical cost profit rates over this period. Clearly then, empirical analysis of profitability movements between 1946 and 1982 would depend on which valuation methodology is adopted. A similar but opposite conclusion attaches to the period 1982–2010 during which (RC-HC)/HC became smaller in magnitude.

This means that controversies over RC versus HC valuation methodologies are crucially dependent on the period of analysis. If the period under investigation is such that (RC-HC)/HC is roughly same at both end points, then fixed asset valuation methodology is irrelevant. If, on the other hand, (RC-HC)/HC is different at the two end points then the choice between RC and HC will have an impact on the conclusions of profitability analysis. This observation can throw some light on debates over profitability trends in the postwar U.S. economy between representatives of the TSSI school and other Marxist scholars.

When we compare 1946 and 2010, we find that both RC and HC profit rates declined by roughly similar magnitudes in percentage terms. This is because RC profit rates declined by more over the period 1946–1982 (because the percentage difference between RC and HC capital stock became larger over this period), and gained by more between 1982–2010 than HC profit rates (because the percentage difference between RC and HC capital stock became smaller over this period). TSSI scholars often stress the relatively larger increase in RC profit rates during the second sub-period (1982–2010) but neglect to mention that RC profit rates had also declined more over the first sub-period (1946–1982).

The rest of the paper is organized as follows: the next section introduces alternative, i.e., his-

[1] One could just as well say that replacement cost profit rates are "rotated" version of the historical cost profit rates. Which profit rate is chosen as a reference is a matter of convention.

torical cost and replacement cost, profit rate measures focusing on the conditions under which they diverge; the next section explains the methodology adopted by the BEA to compute estimates of historical and replacement cost measures of the net stock of capital in the U.S. economy. The following section discusses the notion of a threshold rate of inflation of capital goods prices that keeps the percentage difference between RC and HC capital stock constant and thereby makes the choice of capital stock valuation irrelevant for profitability analysis. The next section illustrates the argument of this paper using capital stock and profit rate data for U.S. economy since 1929. The last section concludes the discussion. Mathematical proofs are collected together in an appendix.

2 Replacement and Historical Cost Profit Rates

2.1 Divergence between Replacement Cost and Historical Cost Profit Rates

Let π_t denote the flow of profit income in period t; then the profit rate is given by

$$r_t = \frac{\pi_t}{K_t},$$

where K_t is the value of the capital stock that was advanced for generating the profit income, π_t. When historical cost valuation of the capital stock is used, the profit rate becomes

$$r_t^H = \frac{\pi_t}{H_t}, \tag{1}$$

with H_t denoting the historical cost value of the capital stock; I will call r_t^H the historical cost profit rate. When replacement (or current) cost valuation is used, the profit rate becomes

$$r_t^C = \frac{\pi_t}{C_t}, \tag{2}$$

where C_t denotes the replacement cost value of the capital stock; I will call r_t^C the replacement cost profit rate.

Lemma 1. *For any two time periods $t_1 < t_2$ we have*

$$\frac{r_{t_2}^C - r_{t_1}^C}{r_{t_1}^C} = \frac{r_{t_2}^H - r_{t_1}^H}{r_{t_1}^H} \iff \frac{C_{t_2} - H_{t_2}}{H_{t_2}} = \frac{C_{t_1} - H_{t_1}}{H_{t_1}}.$$

Proof. The proof follows immediately from the definitions of the historical cost and replacement cost profit rates in (1) and (2) respectively. □

Lemma 1 shows the following: if the percentage difference between replacement and historical cost capital stock values are same at two time periods t_1 and t_2, then the change in the historical cost profit rate between periods t_1 and t_2 will be equal to the change in the replacement cost profit rate over the same period.

2.2 "Rotation" of Profit Rates

What happens when the percentage difference between replacement and historical cost capital stock values are not the same at the two end points of the period under investigation?

Let us first take up the case when the percentage difference between the replacement and historical cost capital stock value is greater at t_2 than at t_1. Note that

$$\frac{C_{t_2} - H_{t_2}}{H_{t_2}} > \frac{C_{t_1} - H_{t_1}}{H_{t_1}} \implies \frac{r^C_{t_2} - r^C_{t_1}}{r^C_{t_1}} < \frac{r^H_{t_2} - r^H_{t_1}}{r^H_{t_1}}.$$

We need to distinguish between three different cases.

1. $(r^H_{t_2} - r^H_{t_1})/r^H_{t_1} < 0$: in this case, the absolute magnitude of the percentage change in the historical cost profit rates will be smaller than the corresponding value for the replacement cost profit rates;

2. $(r^C_{t_2} - r^C_{t_1})/r^C_{t_1} > 0$: in this case, the absolute magnitude of the percentage change in the historical cost profit rates will be larger than the corresponding value for the replacement cost profit rates.

3. $(r^C_{t_2} - r^C_{t_1})/r^C_{t_1} < 0 < (r^H_{t_2} - r^H_{t_1})/r^H_{t_1}$: in this case we cannot say anything definite about the relative magnitude of the percentage change in the replacement and historical cost profit rates.

We can summarize the above results as follows: if the change in the replacement and historical cost profit rates between t_1 and t_2 have the same sign *and* the percentage difference between the replacement and historical cost capital stock value is greater at t_2 than at t_1, the historical cost profit rate time series between t_1 and t_2 is a *counter-clockwise* "rotated" version of the replacement cost profit rates.

Next, we need to study the situation when the percentage difference between the replacement and historical cost capital stock value is smaller at t_2 than at t_1. Since

$$\frac{C_{t_2} - H_{t_2}}{H_{t_2}} < \frac{C_{t_1} - H_{t_1}}{H_{t_1}} \implies \frac{r^C_{t_2} - r^C_{t_1}}{r^C_{t_1}} > \frac{r^H_{t_2} - r^H_{t_1}}{r^H_{t_1}}$$

we need to distinguish between three different cases as before.

1. $(r^H_{t_2} - r^H_{t_1})/r^H_{t_1} > 0$: in this case, the absolute magnitude of the percentage change in the replacement cost profit rates will be larger than the corresponding value for the historical cost profit rates;

2. $(r^C_{t_2} - r^C_{t_1})/r^C_{t_1} < 0$: in this case, the absolute magnitude of the percentage change in the replacement cost profit rates will be smaller than the corresponding value for the historical cost profit rates.

3. $(r^H_{t_2} - r^H_{t_1})/r^H_{t_1} < 0 < (r^C_{t_2} - r^C_{t_1})/r^C_{t_1}$: in this case we cannot say anything definite about the relative magnitude of the percentage change in the replacement and historical cost profit rates.

In an analogous manner to the earlier scenario, we can summarize the above results as follows: if the sign of the changes in replacement and historical cost profit rates are the same *and* the percentage difference between the replacement and historical cost capital stock value is smaller at t_2 than at t_1, the historical cost profit rate time series between t_1 and t_2 is a *clockwise* "rotated" version of the replacement cost profit rates.

Thus, if the period of analysis is such that the difference between replacement and historical cost capital stock values are same at the two end points, then historical and replacement cost profit rates will change by the same magnitude (in percentage terms) over that period. On the other hand, if the period of analysis is such that the difference between replacement and historical cost capital stock values are different at the two end points, then historical and replacement cost profit rates will change by different magnitudes (in percentage terms) over the period in question. Thus, differences in conclusions of profitability analysis rests on two separate factors: (a) the use of historical versus replacement cost capital stock values, *and* (b) the period of analysis. While TSSI theorists emphasize the first, they often fail to mention the second.

But, what drives the difference between replacement and historical cost capital stock values? The replacement cost value of the capital stock is the cost of replacing it in the current period, i.e., by purchasing elements of the capital stock at prices prevailing in the current period. The historical cost value of the capital stock is the historical cost incurred to purchase it, i.e., the actual prices at which elements of the capital stock were purchased. Thus, the difference between the two measures must be a function of the difference in current and historical prices of elements of the capital stock.

We can go one step further and assert that there is a "threshold" value of inflation in the price of capital goods that would keep the percentage difference between replacement and historical cost values of the capital stock constant. If the actual rate of inflation over some period crosses this "threshold", the difference between replacement cost and historical cost values of the capital stock will become larger over time; if the actual rate of inflation falls below the "threshold" value, the difference will become smaller over time. To make this intuition more concrete, we must first understand how replacement cost and historical cost capital stock values are constructed in practice, especially by the BEA.

3 Alternative Measures of Capital Stock

The net stock of fixed capital, which supports the generation of surplus value in a capitalist economy, can be valued in at least two different ways. The first method is to use historical cost valuation, where the capital stock is valued at prices prevailing at the time the capital assets were purchased. The second method is to use replacement (or current) cost valuation which, in principle, is the market value at which the stock of capital assets could be bought or sold in the market in the current period.

For both historical cost and replacement cost measures, the BEA of the U.S. Department of Commerce uses the perpetual inventory method (PIM) to estimate the net stock of capital (i.e., fixed assets and durables).[2] The PIM entails adding up all the gross investment flows over the past (i.e., from an initial period to the current period); by correcting the gross investment flows for depreciation, the PIM arrives at the estimate of the net stock of the capital stock.[3]

3.1 Historical Cost Valuation

To work out the differences between replacement and historical cost valuation methodologies in a rigorous manner, let b refer to an arbitrarily chosen base year, and let the economy have $j = 1, 2, \ldots, J$ capital assets. Let I_{ij} denote the current-dollar value of gross investment in year i for purchase of capital asset j, where gross investment includes new investment (i.e., purchase of new assets) and net purchase of used assets.

Let P_{ij}^b denote the value of a price index (with base year b) for asset j in year i. Then, the constant-dollar investment in year i on asset j is given by (I_{ij}/P_{ij}^b). If δ_j denotes the depreciation rate for asset j, then for $t \geq i$

$$N_{tij} = \frac{I_{ij}}{P_{ij}^b}\left(1 - \frac{\delta_j}{2}\right)\left(1 - \delta_j\right)^{t-i},$$

and

$$H_{tij} = I_{ij}\left(1 - \frac{\delta_j}{2}\right)\left(1 - \delta_j\right)^{t-i},$$

where N_{tij} and H_{tij} are the constant-dollar and current-dollar, respectively, *contribution* to the net stock of asset j in year t arising *due to investment* in year i on asset j.[4]

Summing over all vintages of constant-dollar investment flows gives the constant-dollar net stock of asset j in year t

$$N_{tj} = \sum_{i=1}^{t} N_{tij} = \sum_{i=1}^{t} \frac{I_{ij}}{P_{ij}^b}\left(1 - \frac{\delta_j}{2}\right)\left(1 - \delta_j\right)^{t-i}; \tag{3}$$

In an analogous manner, summing over all current-dollar investment flows gives the current-dollar net stock of asset j in year t

$$H_{tj} = \sum_{i=1}^{t} H_{tij} = \sum_{i=1}^{t} I_{ij}\left(1 - \frac{\delta_j}{2}\right)\left(1 - \delta_j\right)^{t-i}. \tag{4}$$

[2]The only exception to the use of the PIM is for estimating the net stock of autos, for which the physical inventory method is used. With the physical inventory method, independently estimated prices are multiplied by the number of each type of auto to arrive at an estimate of the nominal value of the net stock of autos.

[3]The 1995 comprehensive revision of the NIPA has led to the use of geometric depreciation rates derived from empirical studies instead of fixed line depreciation (the earlier method). As a result, estimates of "gross stocks" (value of the stock before the deduction of depreciation) and "discards" (gross value of the investment that is retired) are no longer calculated by the BEA. The discussion of alternative methods of capital stock valuation in this paper draws heavily on BEA (2003).

[4]The term $\delta_j/2$ comes from the implicit assumption that capital goods are incorporated into the production process, on average, in the middle of the year of purchase.

Summing the constant-dollar investment flows over all the j capital assets gives the constant-dollar net stock of capital assets in year t for the whole economy as

$$N_t = \sum_{j=1}^{J} N_{tj} = \sum_{j=1}^{J}\sum_{i=1}^{t} N_{tij} = \sum_{j=1}^{J}\sum_{i=1}^{t} \frac{I_{ij}}{P^b_{ij}}\left(1-\frac{\delta_j}{2}\right)\left(1-\delta_j\right)^{t-i}. \tag{5}$$

Similarly, summing the current-dollar investment flows over all the j capital assets gives the historical net stock of capital assets in year t for the whole economy as

$$H_t = \sum_{j=1}^{J} H_{tj} = \sum_{j=1}^{J}\sum_{i=1}^{t} H_{tij} = \sum_{j=1}^{J}\sum_{i=1}^{t} I_{ij}\left(1-\frac{\delta_j}{2}\right)\left(1-\delta_j\right)^{t-i}. \tag{6}$$

Note that the only difference between (5) and (6) is that the former deflates investment flows by the relevant price index for all the J assets whereas the latter uses current-dollar investment flows.

3.2 Replacement Cost Valuation

The replacement cost valuation of the capital stock builds from the constant-dollar net stock at the level of asset j by inflating it with the value of the price index for the relevant asset. Let C_{tj} denote the replacement (or current) cost net stock of capital asset j in year t; if P^b_{tj} is the value of the price index (with base year b) for asset j in year t, then

$$C_{tj} = P^b_{tj} N_{tj} = P^b_{tj} \sum_{i=1}^{t} N_{tij}.$$

Using (3), this becomes, for $t \geq i$,

$$C_{tj} = P^b_{tj} \sum_{i=1}^{t} N_{tij} = \sum_{i=1}^{t} I_{ij}\left(\frac{P^b_{tj}}{P^b_{ij}}\right)\left(1-\frac{\delta_j}{2}\right)\left(1-\delta_j\right)^{t-i}. \tag{7}$$

Summing over the assets, then, gives the replacement cost net stock of capital asset in year $t \geq i$

$$C_t = \sum_{j} C_{tj} = \sum_{j=1}^{J} P^b_{tj} \sum_{i=1}^{t} N_{tij} = \sum_{j=1}^{J}\sum_{i=1}^{t} I_{ij}\left(\frac{P^b_{tj}}{P^b_{ij}}\right)\left(1-\frac{\delta_j}{2}\right)\left(1-\delta_j\right)^{t-i}. \tag{8}$$

4 The "Threshold" Value of Inflation in Capital Stock Prices

We can now use (6) and (8) to investigate the difference between the replacement cost and historical cost value of the net stock of capital. From (6) and (8) it is obvious that the difference between the two valuations boil down to movements in the price index for capital goods. This is exactly in line with our intuitive understanding hinted at earlier. But, how exactly does the evolution of capital good prices impact on the difference between replacement cost and historical cost values of the capital stock? The main result in this section is that it is possible to define a threshold rate of inflation of capital goods prices that keeps the percentage difference between replacement and historical cost values of fixed assets constant.

To derive this result rigorously, we abstract away from inessential details. First, we assume that there is only one type of fixed asset so that the index j in (6) and (8) drops out. Second, we assume that there is no depreciation, i.e., $\delta = 0$. Third, since we are interested in understanding impacts of changes in the *price of fixed assets*, we remove investment expenditure from the analysis by normalizing it to unity in every period. Thus, I_{ij} drops out of (6) and (8).

Under these simplifying assumptions, the replacement cost value of fixed assets is given by

$$C_t = \sum_{i=1}^{t} (P_t/P_i), \tag{9}$$

where P_i is the value of the price index for the fixed asset in period i; the historical cost value of fixed assets is given by

$$H_t = \sum_{i=1}^{t} 1 = t. \tag{10}$$

Thus,

$$\frac{C_t}{H_t} = P_t \left(\frac{1}{t} \sum_{i=1}^{t} (1/P_i) \right) = P_t G(t, P_1, P_2, \ldots, P_t), \tag{11}$$

where

$$G(t, P_1, P_2, \ldots, P_t) = \frac{1}{t} \sum_{i=1}^{t} (1/P_i) \tag{12}$$

is the inverse of the harmonic mean of the sequence of prices. In a similar manner, for any integer $k \in \{0, 1, 2, \ldots\}$, we will have

$$\frac{C_{t+k}}{H_{t+k}} = P_{t+k} \left(\frac{1}{t+k} \sum_{i=1}^{t+k} (1/P_i) \right) = P_{t+k} G(t+k, P_1, P_2, \ldots, P_{t+k}). \tag{13}$$

Now we can define a "threshold" average inflation rate between period t and $t+k$ in the price of capital goods, $\pi^*_{t,k}$, as:

$$\left(1 + \pi^*_{t,k}\right)^k = \frac{G(t, P_1, P_2, \ldots, P_t)}{G(t+k, P_1, P_2, \ldots, P_{t+k})} = \prod_{j=0}^{k-1} \left(\frac{G(t+j, P_1, P_2, \ldots, P_{t+j})}{G(t+j+1, P_1, P_2, \ldots, P_{t+j+1})} \right). \tag{14}$$

Under the condition that capital goods prices (weakly) increase over time, it can be shown that the threshold rate of inflation $\pi^*_{t,k}$ in (14) is positive, justifying the identification of this measure as a rate of *inflation*. The next Lemma summarizes this result.

Lemma 2. *If capital good prices form a nondecreasing sequence, i.e., if $P_1 \leq P_2 \leq \cdots$, then the threshold rate of inflation in the price of capital goods, $\pi^*_{t,k}$, defined in (14) is nonnegative, i.e., $\pi^*_{t,k} \geq 0$.*

In the following section, we will show that the assumption of nondecreasing capital goods prices is empirically valid for the U.S. economy since 1929. What is important for the argument of this paper is that Lemma 2 can be used to prove the main result of this paper.

Proposition 1. *Let k be a nonnegative integer. If the average rate of inflation in the price of capital goods between period t and t+k is equal to the threshold value $\pi^*_{t,k}$, defined in (14), i.e.,*

$$P_{t+k} = P_t \times \left(1 + \pi^*_{t,k}\right)^k,$$

then the percentage difference in replacement cost and historical cost values of the capital stock in period t is the same as in period t+k, i.e.,

$$\frac{C_{t+k} - H_{t+k}}{H_{t+k}} = \frac{C_t - H_t}{H_t}.$$

The result proved in Proposition 1 has an immediate corollary that provides an answer to the question posed earlier: what drives the divergence between the replacement and historical values of the capital stock? The important factor turns out to be the relative magnitude of the actual and threshold rates of inflation in the price of capital goods. If the actual rate of inflation in the price of capital goods between any two time periods t and $t+k$ exceeds (falls below) the threshold value over that period, $\pi^*_{t,k}$, then the percentage difference between replacement and historical cost values of the capital stock will be larger (lower) in period $t+k$ than in period t.

5 Discussion of Results

We can use the results of the previous sections to discuss movements in replacement cost and historical values of the capital stock and profit rates.

5.1 Capital Stock Value

Figure 1 plots the historical and replacement cost value of fixed assets for both the corporate business and the non-financial corporate business sectors between 1929 and 2010.[5] The replacement cost value of the capital stock is greater than the historical cost value for every year, implying that there has been inflation in the price of capital assets for every year between 1929 and 2010, i.e., the price index for capital goods has increased by a positive amount from its value in the previous year. This provides empirical justification for the assumption made in Proposition 1 that the sequence of capital good prices is a nondecreasing sequence.

[5] The base year for these calculations is 1996 (BEA, 2003). Estimates of net capital stock is presented by the BEA from 1925 onwards.

Figure 1: *Year-end estimates of fixed assets in the U.S. economy, 1929–2010, using both replacement (current) cost and historical cost valuation. The left panel is for the corporate business sector and the right for the non-financial corporate business sector. KCURRCB: replacement cost net stock of capital for the corporate business sector; KHISTCB: historical cost net stock of capital for the corporate business sector; KCURRNFCB: replacement cost net stock of capital for the non-financial corporate business sector; KHISTNFCB: historical cost net stock of capital for the non-financial corporate business sector. Source: NIPA Fixed Assets Table 6.1 and 6.3.*

The difference between the replacement cost and historical measures, as a percentage of the historical cost value, is plotted in Figure 2. It shows that the difference has been positive for all the years between 1929 and 2010. While the difference was small during the initial years, it has become larger since the mid-1940s, remaining above 35 percent. There are two periods of pronounced upward movement: 1933–1948, and 1967–1982; there is another, smaller, period of upward movement since 2000. There are two periods of decline: 1948–1967, and 1982–2000.

What do periods of upward (and downward) movement in the percentage difference between the replacement and historical cost of the capital stock convey? Using Proposition 1, we can see that periods of upward movement in the percentage difference between replacement and historical values of the capital stock are periods when the rate of inflation in the price of capital assets is above the "threshold" value; similarly, periods of downward movement in the percentage difference between replacement and historical values of the capital stock are defined by the rate of inflation in the price of capital assets falling below the threshold value.

Hence, the periods 1933–1948 and 1967–1982 were periods of above-threshold inflation in the price of capital goods; and the periods 1948–1967 and 1982–2000 were periods of below-threshold inflation in the price of capital goods. If the price of capital goods is related to the pace of technological change in the capital goods producing industries, then periods of below-threshold inflation are periods of relatively rapid technological change, and periods of above-threshold inflation are periods of muted or no technological change, in the capital goods producing industries.[6]

[6]It is beyond the scope of this paper to investigate the relationship between inflation in capital goods prices and technological change. A partial treatment of this can be found in Basu and Vasudevan (ming).

5.2 Profit Rates

Using Lemma 1 and Proposition 1, we can make concrete the suggestion made earlier in the paper that the time series of the historical cost profit rate is a "rotated" version of the time series of the replacement cost profit rate, and that the magnitude of rotation depends on the *magnitude* of difference between the two valuations. During a period when the replacement cost value of the net capital stock diverges *away* from the historical cost value of the net capital stock, the historical cost profit rate is a counterclockwise rotated version of the replacement cost profit rate; during a time period when the replacement cost value of the net capital stock converges *towards* the historical cost value of the net capital stock, the historical cost profit is a clockwise rotated version of the replacement cost profit rate.[7]

Let us see how we can use this intuition about "rotation" of profit rates to approach profitability trends in the U.S. economy. Figure 3 plots the profit rate for the corporate business and the non-financial corporate business sectors between 1929 and 2010 using both historical cost and replacement cost measures of the capital stock (fixed asset) with two definitions of profit flows: (1) net operating surplus, i.e., net value added *less* compensation of employees and taxes on production and imports less subsidies, and (2) profit before tax, i.e., net operating surplus *less* net interest and miscellaneous payments and net business current transfer payments.

Figure 1 shows that the historical cost value of the capital stock is always lower than the replacement cost value. Hence, the historical cost profit rate is always higher than the replacement cost profit rate, as can be seen in Figure 3. Moreover, Figure 2 shows that the percentage difference between the replacement cost and historical cost value of the capital stock, though always positive, has a cyclical time profile. As we have pointed out earlier, there are two long periods of upward movement in the difference: 1933–1948, and 1967–1982; there is another, shorter, period of upward movement since 2000. These are broken by two long periods of decline: 1948–1967, and 1982–2000.

In Table 1, data for net operating surplus and profit-before-tax from NIPA Table 1.14 has been used to compute two profit rates for the corporate business and non-financial corporate business sectors of the U.S. economy for the period 1929–2010 using both historical and replacement cost capital stock values. For brevity, I have reported profit rates for selected years only. To see how the "rotation" argument plays out in a concrete case, let us look at the two different measures of profit and two different periods: 1946–1982 and 1982–2010.

During the former period the percentage difference between replacement cost and historical cost capital stock values increased in magnitude; during the latter period, the percentage difference decreased in magnitude. Hence, if the sign of the change in replacement and historical cost profit rates were same, then during the former period the historical cost profit rates must have *fallen* relatively less than the corresponding replacement cost profit rates. During the latter period, on the other hand, historical cost profit rates must have *increased* relatively less than the corresponding replacement cost profit rates. The data bears this out.

Starting with net operating surplus as the measure of profit income, we see that during 1946–

[7]Both these claims being valid only if the sign of the change in replacement and historical cost profit rates are the same. Typically, it is the case that this condition is satisfied, i.e., changes in historical and replacement cost profit rates move in the same direction. Of course, there can be periods when they do not as we see below.

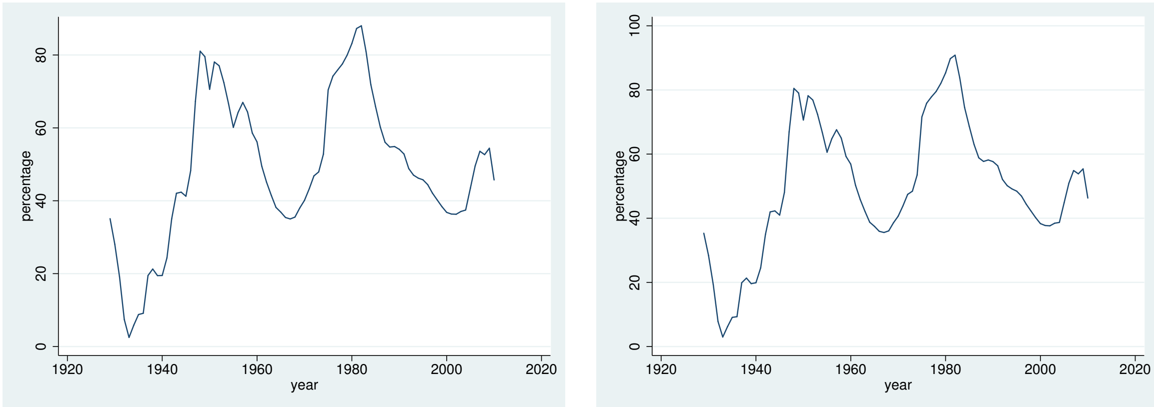

Figure 2: *Percentage difference in the year-end estimates of fixed assets in the U.S. economy between replacement (current) cost and historical cost valuation. The left panel is for the corporate business sector and the right for the non-financial corporate business sector. The difference is expressed as a percentage of the historical cost value of the capital stock.*

1982, the replacement cost profit rate changed by −34.15% for the CB sector and −36.86% for the NFCB sector. During the same period, the historical profit rate changed by −16.48% in the CB sector and −18.60% in the NFCB sector. Moving to profit-before-taxes as a measure of profit income, we see that during 1946–1982, the replacement cost profit rate changed by -21.16% in the CB sector and −31.89% in the NFCB sector. During the same period, the historical profit rate changed by −20.47% in the CB sector and −30.55% in the NFCB sector. Hence, with both measures of profit income, the fall in the historical cost profit rate is smaller in magnitude than fall in the replacement cost measure.

Turning to the next period and starting with net operating surplus as the measure of profit income we see that during 1982–2010, the replacement cost profit rate changed by 50.49% in the CB sector and by 29.75% in the NFCB sector. During the same period, the historical cost profit rate changed by 16.62% in the CB sector and −0.54% in the NFCB sector. Using profit-before-tax as the measure of profit income we see that during 1982–2010, the replacement cost profit rate changed by 114.04% in the CB sector and by 76.97% in the NFCB sector. During the same period, the historical profit rate changed by 65.88% in the CB sector and by 35.66% in the NFCB sector. Hence, with both measures of profit income, the historical cost profit rate increased by less than the corresponding replacement cost profit rate.

Thus, the analysis in this paper can throw light on the debates on profit rate movements in the postwar U.S. economy that arise from the use of replacement versus historical cost values of the capital stock. It is generally agreed among Marxist economists that profit rates in the U.S. economy declined in the postwar period till about 1982. The period since 1982 has generated more debate. TSSI scholars advance the claim that, in the period since 1982, the rate of profit did not regain the magnitude lost during the run up to the structural crisis of the 1970s. To illustrate their point, TSSI scholars show that replacement cost profit rates have risen much more than the historical cost profit rates since 1982. In the context of profitability analyses, this is a true but incomplete statement.

The analysis in this paper shows that between 1946 and 2010, both historical and replacement

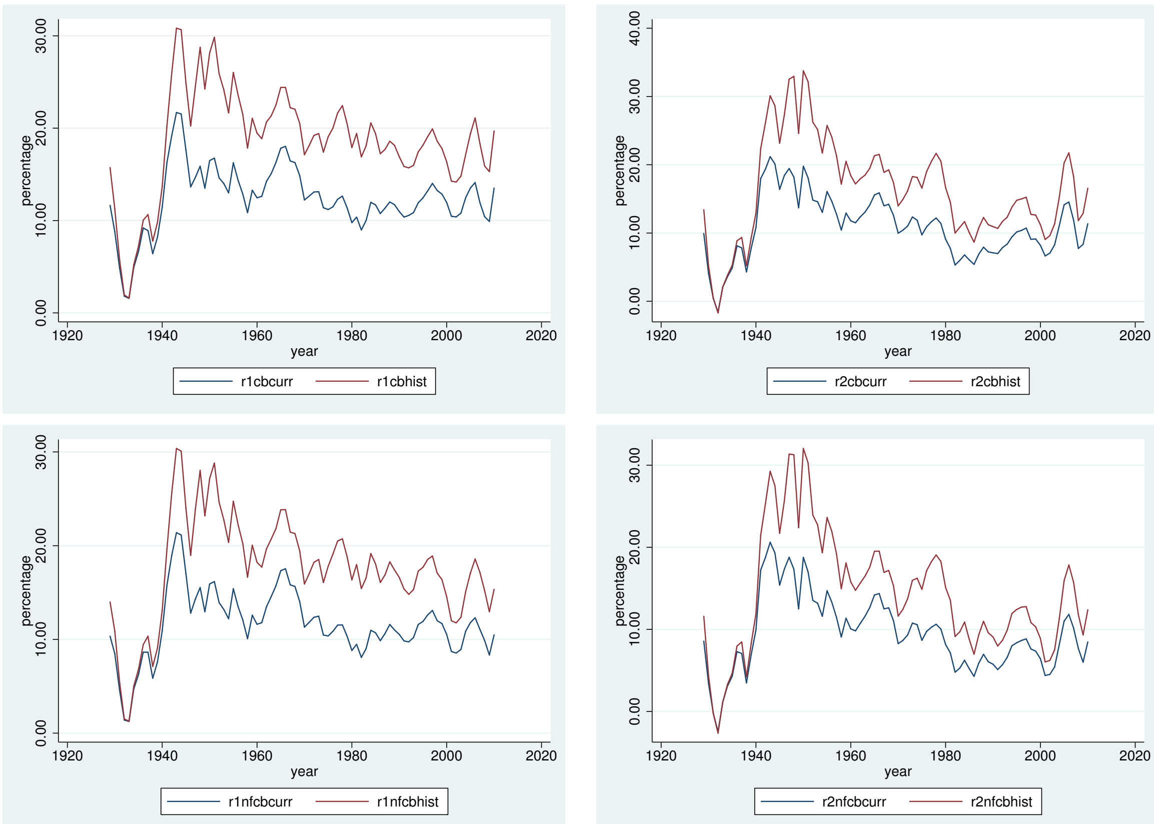

Figure 3: *Annual estimates of profit rates in the U.S. economy, 1929–2010, using both replacement (current) cost and historical cost valuation of fixed assets. The top panel is for the corporate business (CB) sector and the bottom for the non-financial corporate business (NFCB) sector. "r1" uses net operating surplus as a measure of profit; "r2" uses profit-before-tax as the measure of profit. "curr" refers to replacement cost valuation, and "hist" refers to historical cost valuation of the capital stock. Source: net operating surplus and profit-before-tax data is from NIPA Table 1.14; capital stock data from NIPA Fixed Assets Table 6.1 (replacement cost) and NIPA Fixed Assets Table 6.3 (historical cost).*

cost profit rates changed by similar magnitudes. The divergence between the two profit rates occur over the sub-periods 1946–1982 and 1982–2010. Between 1946 and 1982, replacement cost profit rates fall more than historical cost profit rates; between 1982 and 2010, replacement cost profit rates rise more than historical cost profit rates. TSSI scholars emphasize the latter but ignore the former. We have also demonstrated that the divergence in the movements over the two sub-periods arise from the differences between the actual and the "threshold" rates of inflation of capital goods prices.

5.3 Comparing Trends in Profitability

But comparing two points in time can be problematic. The results might be driven by the specific points chosen. An alternative method is to compute trends in the series and compare those trends.[8] Figure 4 plots the profit rates for the post war period, 1929–2010, but now with Lowess trends (computed with a bandwidth of 0.4) inserted into the time series plot.[9]

What patterns does the trend in the profit rate series show? The trends in the replacement cost and historical cost profit rates display similar movements, especially for the postwar period, 1946–2010. Using net operating surplus as the measure of profit income, we see in Figure 4 that there is a distinct decline in the trend of the replacement cost and historical cost profit rate series for both the CB and the NFCB sectors over the period 1946–2010: the average of the trend profit rate is higher in the immediate postwar decades (regulated capitalism) than the later decades of the 20^{th} century (neoliberal capitalism). There is a minor difference between the trends in replacement and historical cost profit rates: while the former has a flat (or mildly increasing) portion after the early 1980s, the declining trend in the latter runs till the late 1990s (CB sector) or mid 2000s (NFCB sector).[10]

If we, instead, use profit-before-tax as the measure of profit income, then trends in the replacement cost and historical cost profit rates display a strikingly similar pattern. For both the CB and NFCB sectors, there is a period of almost secular decline from 1946 to the early 1980s (with a flat period in the early to mid 1960s), followed by a period of mildly upward sloping trend. The average value of trend profit rates is significantly lower in the neoliberal period than in the regulated period of post war capitalism.

[8]Some researchers compare peak-to-peak profit rates. While this is better than comparing arbitrary time points, it suffers from the problem of ignoring information in the downturns. A trend uses information for the whole series and is, therefore, a better method for comparison.

[9]There is no single method for extracting the trend from a time series; hence, there is no unique trend. The computation of trends depend on the specific methods adopted and the parameters chosen to implement the method. Some common examples of trend-cycle decomposition are: Hodrick-Prescott filter, locally weighted regressions (Lowess), unobserved components model. In this paper, I present results with Lowess trends as developed in Cleveland (1979) and implemented in Stata 11 by the command `lowess`.

[10]These divergences, recall, must be driven by the movements in the price index of capital goods summarized in Figure 2.

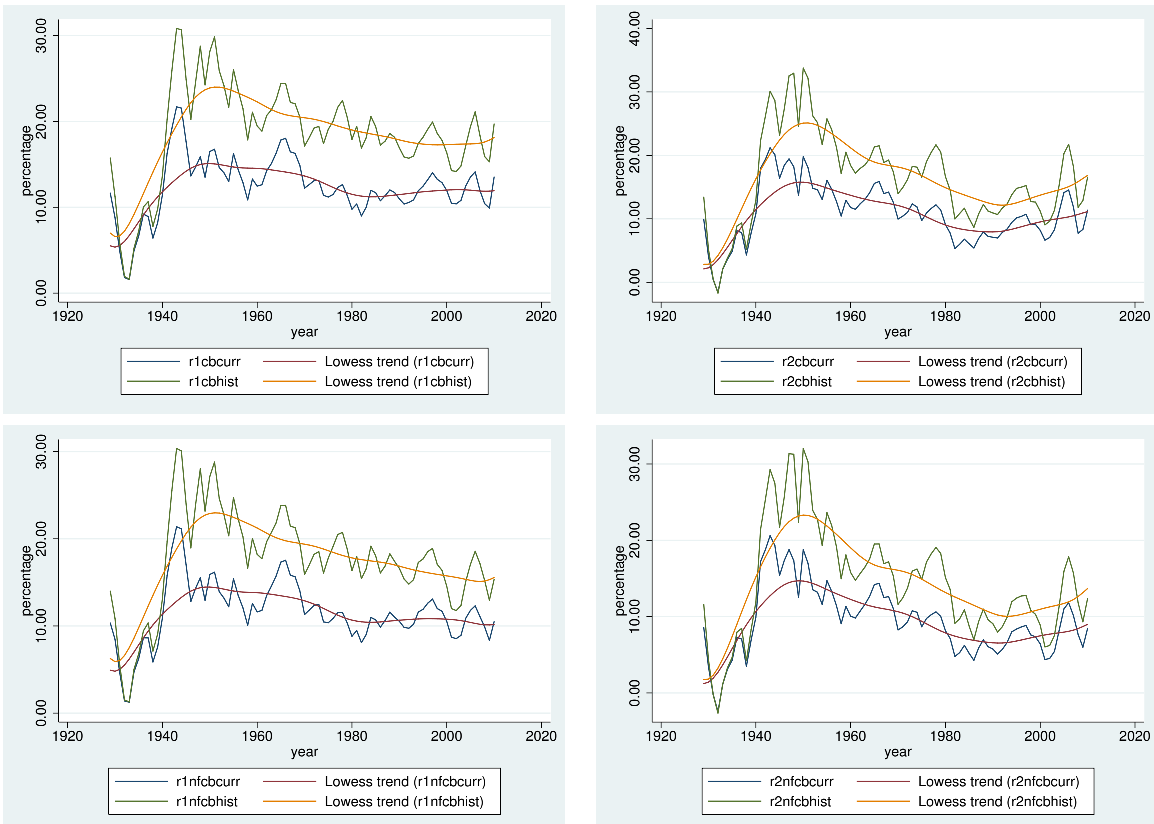

Figure 4: *Annual estimates of profit rates (with Lowess trend, bandwidth=*0.4*) in the U.S. economy, 1929–2010, using both replacement (current) cost and historical cost valuation of fixed assets. The top panel is for the corporate business (CB) sector and the bottom for the non-financial corporate business (NFCB) sector. "r1" uses net operating surplus as a measure of profit; "r2" uses profit-before-tax as the measure of profit. "curr" refers to replacement cost valuation, and "hist" refers to historical cost valuation of the capital stock. Source: net operating surplus and profit-before-tax data is from NIPA Table 1.14; capital stock data from NIPA Fixed Assets Table 6.1 (replacement cost) and NIPA Fixed Assets Table 6.3 (historical cost).*

Table 1: *U.S. Profit Rates (%) for Selected Years*[a]

	Net Operating Surplus				Profit before Tax			
	CB		NFCB		CB		NFCB	
YEAR	CURR (1)	HIST (2)	CURR (3)	HIST (4)	CURR (5)	HIST (6)	CURR (7)	HIST (8)
1933	1.58	1.62	1.25	1.29	2.06	2.11	1.12	1.16
1946	13.64	20.23	12.80	18.95	18.45	27.34	17.36	25.70
1948	15.89	28.76	15.54	28.04	18.20	32.95	17.33	31.27
1967	16.45	22.21	15.82	21.45	13.99	18.88	12.50	16.94
1982	8.98	16.89	8.08	15.43	5.31	9.99	4.79	9.13
2000	11.96	16.36	10.53	14.56	8.20	11.22	6.43	8.89
2010	13.52	19.70	10.49	15.35	11.37	16.57	8.47	12.39

[a] This table gives the profit rate (= profit income divided by the value of capital stock) for selected years for the corporate business (CB) and non-financial corporate business (NFCB) sector of the U.S. economy where profit income is defined as (1) net operating surplus, and (2) profit before tax. CURR: replacement cost value of capital stock; HIST: historical cost value of capital stock. Source: net operating surplus and profit-before-tax data is from NIPA Table 1.14; capital stock data from NIPA Fixed Assets Table 6.1 (replacement cost) and NIPA Fixed Assets Table 6.3 (historical cost).

6 Conclusion

Drawing on BEA (2003), this paper explains the construction of the historical and replacement cost measures of the net capital stock by the BEA of the U.S. Department of Commerce. A comparison of the two measures between 1929 and 2010 show that the replacement cost value is always higher than the historical cost value of the net stock of capital. This is caused by the continuous increase in the price index of capital assets between 1929 and 2010.

The percentage difference between the replacement cost and historical cost values of the net capital stock is driven by changes in the price index for capital goods. A closer look at this difference (between the replacement cost and historical cost measures of the net capital stock) over the whole period (1929–2010) shows that periods when the difference grows in magnitude alternates with periods when the difference becomes smaller, the difference always remaining positive nonetheless. Periods during which the difference grows in magnitude are periods when there is above "threshold" rate of inflation in the price of capital assets; periods during which the difference becomes smaller are periods when there is below "threshold" rate of inflation in the price of capital assets (the "threshold" rate of inflation being the rate of increase in the price index for capital goods that would keep the percentage difference between the replacement cost and historical cost values of the capital stock unchanged).

If these medium-run changes in the price of capital assets is driven by technological change, then periods of below-threshold inflation are periods of technological improvement in the capital goods industries, and periods of above-threshold inflation are periods of technological stagnation.

Hence, comparison of the two measures of capital stock might have interesting information to offer about the pace of technological change in the capital goods sector.

Since the profit rate is the ratio of profit income (suitably defined) and the value of the capital stock, systematic divergence in the replacement cost and historical cost values of the net capital stock make the historical cost profit rate series "rotated" versions of the replacement cost profit rate series. During periods of growing (narrowing) difference between replacement cost and historical cost values of the capital stock, the historical cost profit rate is a counter-clockwise (clockwise) rotated version of the replacement cost profit rate, if the sign of the change in the replacement cost and historical cost profit rates are the same.

Since the rotation of profit rates is driven by the divergence between the replacement and historical cost valuation of the capital stock which is, in turn, driven by the inflation in the price index of capital goods, periods when the actual and "threshold" rate of inflation in capital goods prices are equal changes in the two profit rates are equal. During such periods, the choice of capital stock valuation becomes irrelevant to analyses of profitability trends.

The postwar period of U.S. capitalism is precisely one such period. As can be seen from Figure 2, the percentage difference between the replacement cost and historical cost value of the capital stock in 2010 was roughly equal to its value in 1946. Hence, both replacement cost and historical cost profit rates show similar movements over this period (i.e., comparing the change in the profit rates between the two end points of the time period). On the other hand, periods during which the price index for capital goods witness above-threshold (or below-threshold) rate of inflation, replacement cost and historical cost profit rates will show different magnitudes of change. Interesting and widely studied examples of such periods for the U.S economy are: 1946–1982, and 1982–2000. It is also interesting to note that long term (Lowess) trends in the profit rates for both the corporate business and non-financial corporate business sectors in the U.S. display remarkably similar movements, especially over long periods of time, e.g., the postwar period 1946–2010.

Appendix

In this appendix, I state and give a proof of Lemma 2 and Proposition 1.

Lemma 2

Proof. Using (12), we know that

$$\begin{aligned} G(t+j+1, P_1, P_2, \ldots, P_{t+j+1}) &= \frac{1}{t+j+1}\left(\frac{1}{P_1} + \cdots + \frac{1}{P_{t+j+1}}\right) \\ &= \left\{\frac{t+j}{t+j+1}\right\} G(t+j, P_1, P_2, \ldots, P_{t+j}) + \frac{1}{t+j+1} \times \frac{1}{P_{t+j+1}}. \end{aligned}$$

Hence

$$\frac{G(t+j,P_1,P_2,\ldots,P_{t+j})}{G(t+j+1,P_1,P_2,\ldots,P_{t+j+1})}=\left\{1-\frac{1}{P_{t+j+1}(t+j+1)G(t+j+1,P_1,P_2,\ldots,P_{t+j+1})}\right\}\times\left\{1-\frac{1}{t+j+1}\right\}^{-1}.$$

Since

$$G(t+j+1,P_1,P_2,\ldots,P_{t+j+1})=\frac{1}{t+j+1}\left(\frac{1}{P_1}+\cdots+\frac{1}{P_{t+j+1}}\right)$$

we have

$$(t+j+1)P_{t+j+1}G(t+j+1,P_1,P_2,\ldots,P_{t+j+1})=\left(\frac{P_{t+j+1}}{P_1}+\cdots+\frac{P_{t+j+1}}{P_{t+j+1}}\right)\geq(t+j+1)$$

where the last inequality follows from the fact that the the sequence of capital good prices is a nondecreasing sequence, $P_1\leq P_2\leq\cdots$, so that for $i=1,2,\ldots,k$, $P_{t+j+i}/P_i\geq 1$. Hence

$$\frac{G(t,P_1,P_2,\ldots,P_t)}{G(t+k,P_1,P_2,\ldots,P_{t+k})}=\prod_{j=0}^{k-1}\left(\frac{G(t+j,P_1,P_2,\ldots,P_{t+j})}{G(t+j+1,P_1,P_2,\ldots,P_{t+j+1})}\right)\geq 1$$

because each term in the product is greater than unity. From (14), we know that

$$\left(1+\pi^*_{t,k}\right)^k=\frac{G(t,P_1,P_2,\ldots,P_t)}{G(t+k,P_1,P_2,\ldots,P_{t+k})}=\prod_{j=0}^{k-1}\left(\frac{G(t+j,P_1,P_2,\ldots,P_{t+j})}{G(t+j+1,P_1,P_2,\ldots,P_{t+j+1})}\right).$$

Hence, $\pi^*_{t,k}\geq 0$. □

Proposition 1

Proof. Since the average rate of inflation in th price of capital goods between period t and $t+k$ is $\pi^*_{t,k}$, we have

$$\frac{P_{t+k}}{P_t}=\left(1+\pi^*_{t,k}\right)^k.$$

But, from (14), we have

$$\left(1+\pi^*_{t,k}\right)^k=\frac{G(t,P_1,P_2,\ldots,P_t)}{G(t+k,P_1,P_2,\ldots,P_{t+k})}.$$

Hence

$$\frac{P_{t+k}}{P_t}=\frac{G(t,P_1,P_2,\ldots,P_t)}{G(t+k,P_1,P_2,\ldots,P_{t+k})}. \tag{15}$$

Thus, we have

$$
\begin{aligned}
\frac{C_{t+k} - H_{t+k}}{H_{t+k}} &= \frac{C_{t+k}}{H_{t+k}} - 1 \\
&= P_{t+k} G(t+k, P_1, P_2, \ldots, P_{t+k}) - 1 \quad \text{[using (13)]} \\
&= P_t G(t, P_1, P_2, \ldots, P_t) - 1 \quad \text{[using (15)]} \\
&= \frac{C_t}{H_t} - 1 \\
&= \frac{C_t - H_t}{H_t},
\end{aligned}
$$

which completes the proof. □

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