Depreciation, Devaluation and the Rate of Profit

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Abstract

This paper presents two innovations in measuring and analysing the rate of profit (ROP).

The first allows for a more accurate measurement of the value composition of capital (VCC), by introducing a measure of the turnover time of variable capital. This shows that the VCC increased substantially since 1947 in the US. However, the turnover time of variable capital also shortened substantially, and this constituted a significant counter-tendency to the falling ROP.

The second innovation creates a measure of the real rate of depreciation in labour value terms. This tends to drop sharply over a period of 5-8 years before recessions, and then to sharply increase. I suspect this is due to asset price bubbles and the destruction of constant capital during crises.

These two techniques are combined to argue that the VCC most important factor behind the post-war boom, its demise and the current slump.

The approach is based on a rejection of both standard 'current cost' measures of the ROP, and Kliman's 'historical cost' measure. The paper offers a critique of both approaches, and lays out some (though not all) of the theoretical basis for my alternative approach.

Introduction

In the *Grundrisse*, Marx argues that the tendency for the rate of profit to fall "is in every respect the most important law of modern political economy", and is crucial to explaining why economic crises occur under capitalism.[1] Marxists, however, are divided over its significance for explaining the current slump.

This paper provides new, preliminary evidence supporting Marx's hypothesis of the tendency of the rate of profit to fall. Both Marx and Engels argue that the average turnover time of variable capital tends to shorten over time, and that this constitutes an important counter-tendency to the falling rate of profit. It is also necessary to account for turnover time in order to measure the value composition of capital correctly, and its influence on the rate of profit. Yet Marxists rarely attempt to measure turnover time. I provide a method for doing so, and for separating out the contributions to changes

1 Karl Marx, *Grundrisse: Foundations of the Critique of Political Economy (rough Draft)* (Harmondsworth, Eng: Penguin Books, 1973), 748.

in the rate of profit of turnover time; the value composition of capital; and the rate of surplus value (ROSV). This reveals that the value composition of capital rose substantially during the post-war period in the US, and that this was the largest contribution to changes in the rate of profit. However, the turnover time also shortened substantially over the period, and its positive influence on the rate of profit was also significant (though it did not outweigh the effects of the rising VCC). The rate of surplus value had the smallest overall effect on changes in the rate of profit.

The paper also provides a new method for measuring the rate of profit that is more sensitive to measuring the effects of asset price bubbles on profitability. This emerges from a criticism of the way depreciation is measured in both standard current cost measures of the rate of profit, and Andrew Kliman's historical cost method. Using this approach, I show that sharp drops in the rate of depreciation correspond to short-lived increases in the rate of profit, followed by a drop in the rate of profit and recession. While this does not occur in the lead up to every recession, every time it has happened in the US in the post-war period it has been associated with a recession, including the two most important slumps of the mid-70s and late-2000s.

These two techniques can be combined quite usefully to examine Marx's hypothesis of the tendency of the rate of profit to fall.

The paper first presents the results the techniques produce, and then outlines the method used to calculate them, as the discussion of the method is quite technical. It arises from a new mathematical formalisation of a temporal single system interpretation of Marx's value theory. Unfortunately there is not space to argue for this formalisation in detail, so only the most important results as they pertain to measuring and analysing the rate of profit are presented here.

Main Results

Turnover time and the value composition of capital

The VCC is often thought of as the ratio of the stock of constant capital to the wages bill over the course of a year. But this is incorrect. The VCC is in fact the ratio of the stock of constant capital to the *stock* of variable capital – i.e., the amount of variable capital tied up in the stock of capital at a point in time. This is equivalent to the total wages bill for the year divided by the number of times the stock of variable capital turns over during that year.

As Figure 1 shows, if we do not adjust the VCC for turnover time, then it shows up as having actually *declined* since 1947. If this were a true measure of the VCC, then it is hard to see how we could justifiably conclude that the rate of profit fell due to a tendency for the VCC to rise. But if we do adjust for turnover time, the VCC shows up as more than doubling since 1947.

The approach outlined below also makes it possible to calculate the contribution to changes in the rate of profit made by the VCC, the turnover time of variable capital and the ROSV. This is illustrated in Figure 2, which plots the rate of profit on the right axis, and the cumulative contributions to changes in the rate of profit made by each of the three factors since 1947. This shows that changes in the value composition of capital and turnover time were far more significant influences on the rate of profit than changes in the rate of surplus value. However, the effects of the first two influences usually roughly cancel each other out.

In the years preceding the recessions of 1974 and 2008, however, the chart shows a marked slackening off of improvements in turnover time, while the rising VCC continues to exert a negative influence on the ROP. Yet the rate of profit itself actually rises up until each crash.

The second new technique used in this paper helps to explain why.

Figure 1: Value Composition of Capital, Rate of Surplus Value and Turnover Time

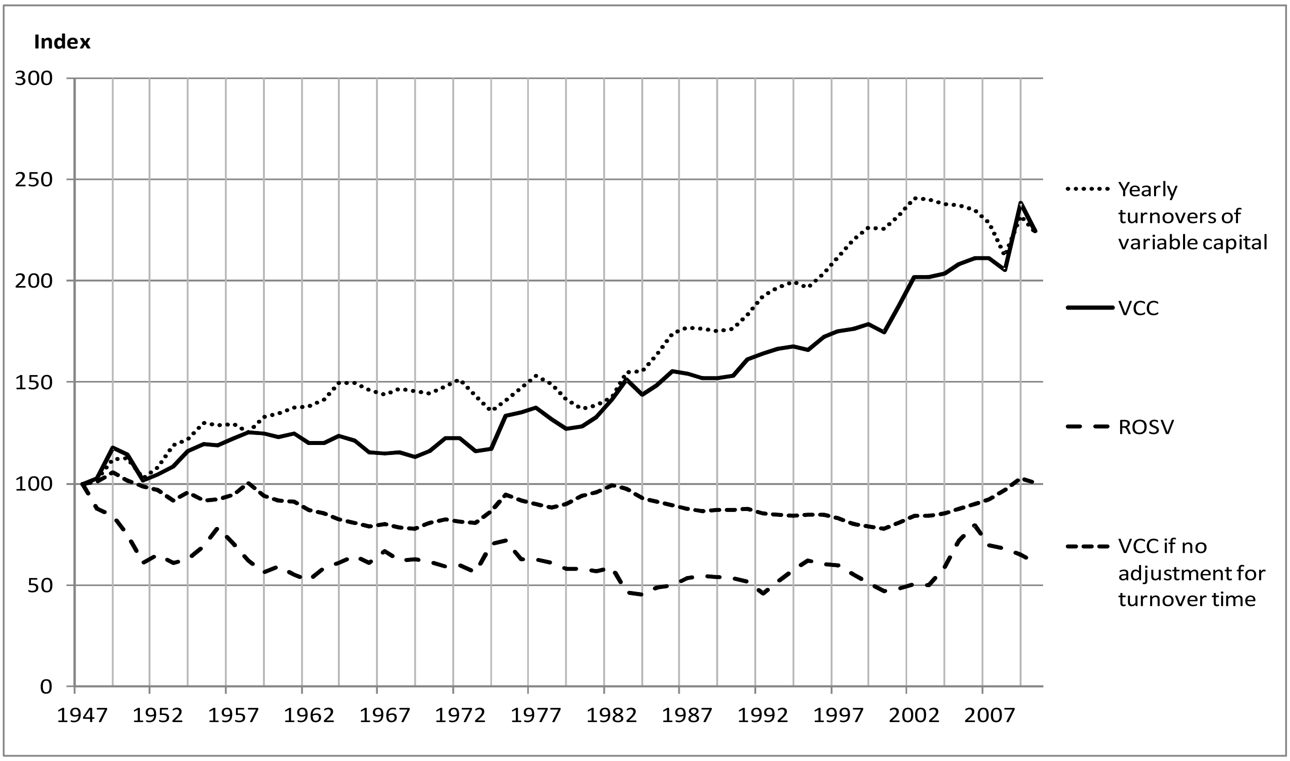


Figure 2: The Rate of Profit Decomposed

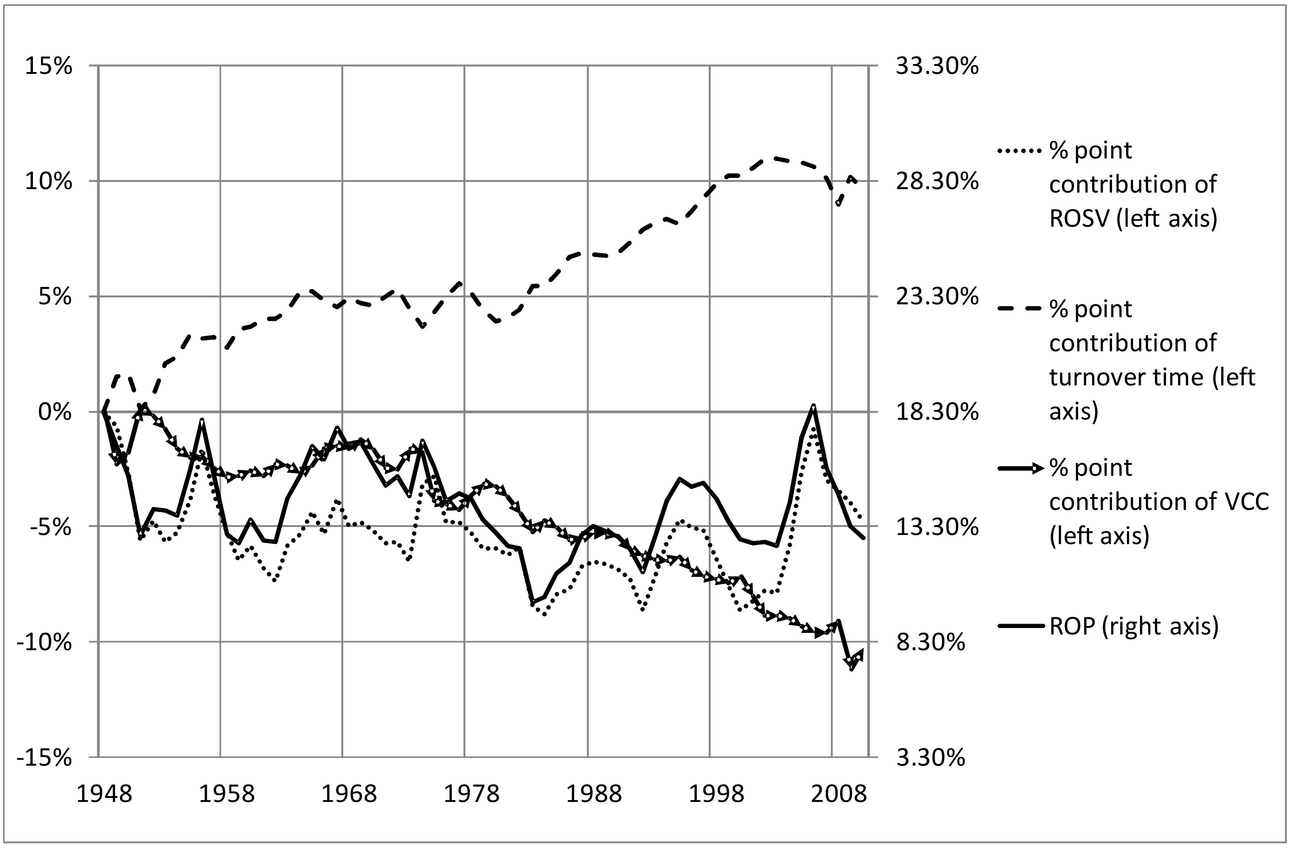
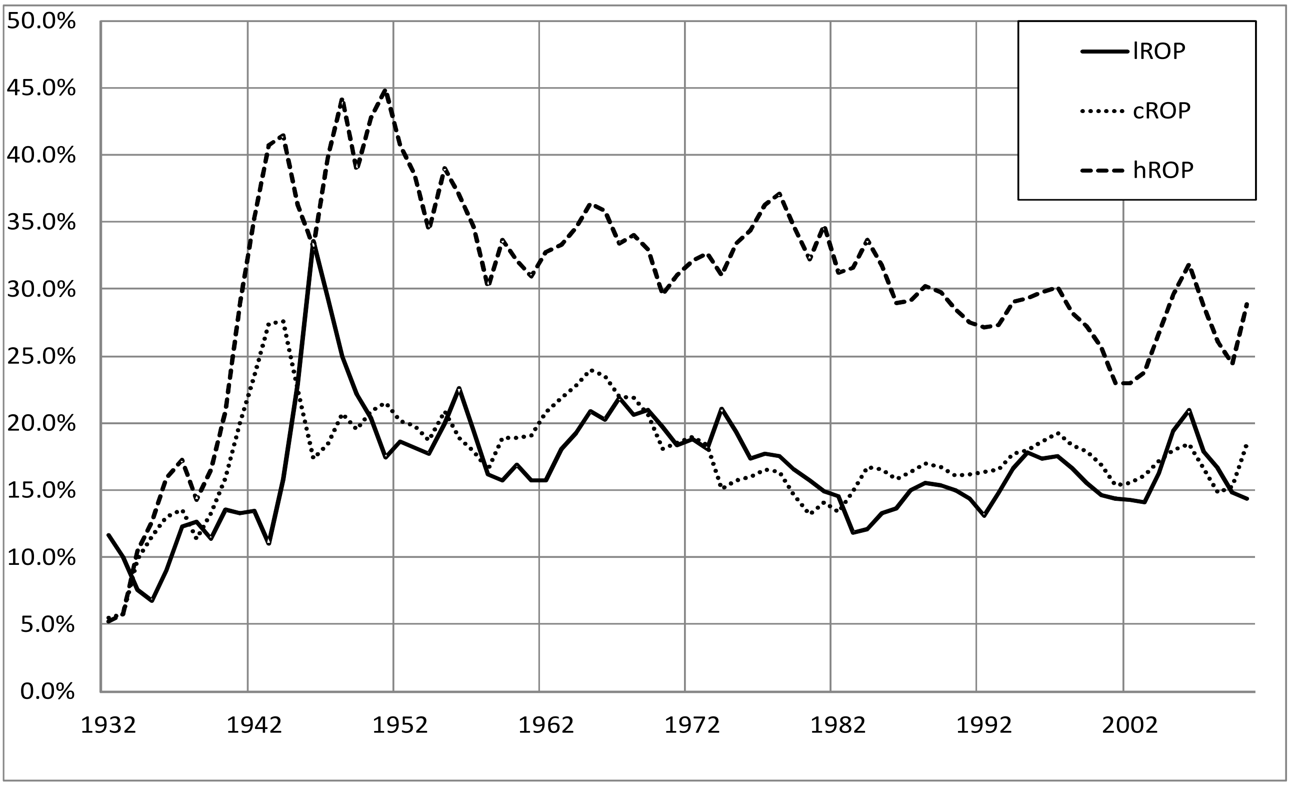


Figure 3: Rates of Profit Compared



The rate of depreciation and asset price bubbles

First, it is necessary to explain that the approach creates a new method for measuring the ROP. The results for the ROP itself are not particularly novel or striking. Figure 3 compares my approach (lROP) with a standard, current cost measure (cROP) and Kliman's historical cost measure (hROP). lROP looks very similar to the current cost measure, though it has a wider range of variation across the economic cycle. This is because my approach calculates the rate of depreciation in labour value terms, not according to the physicalist models used in national accounts.

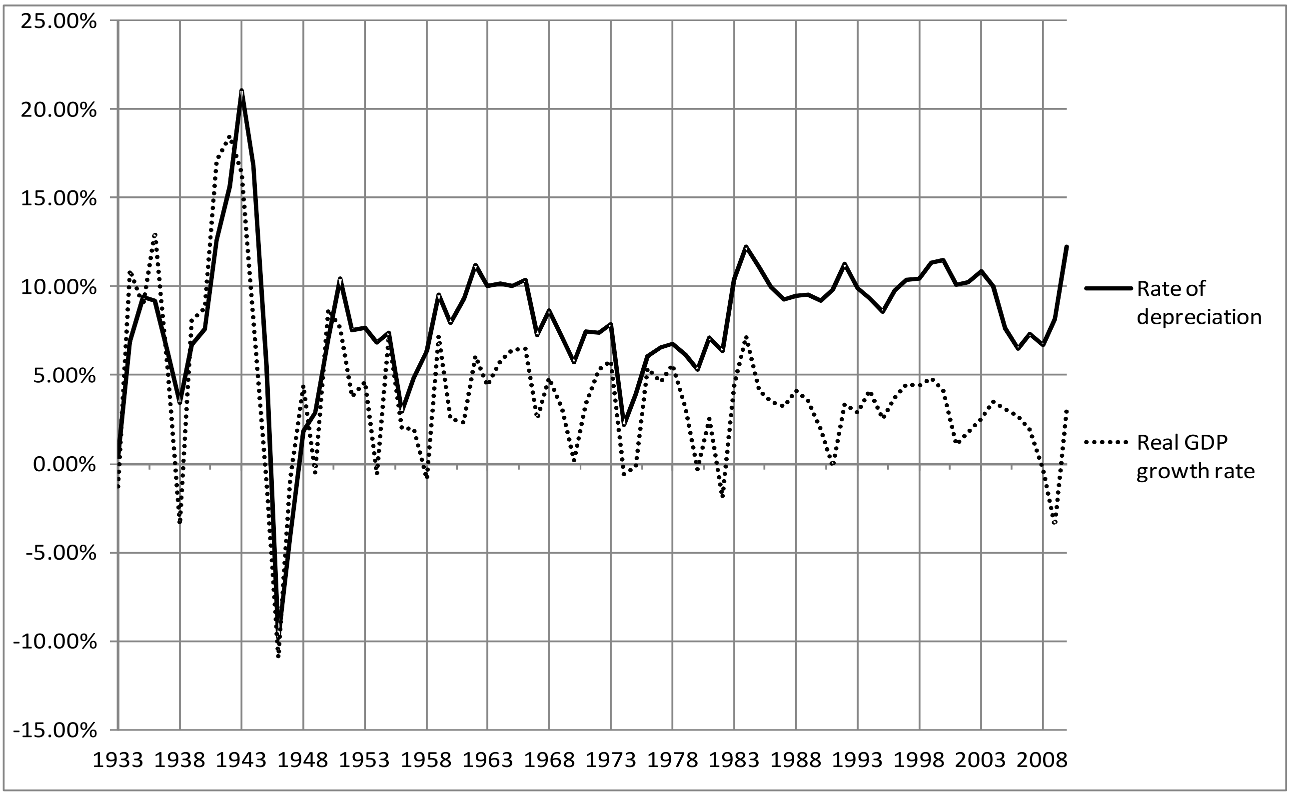
Figure 4 demonstrates the empirical importance of this new measure of depreciation. We are used to thinking of the rate of depreciation as a fairly stable variable, and as something that does not change much or at all for individual assets over the course of their lives. But Marx was quite clear that assets depreciate in value more quickly during crises – this, I argue below, is the way crises 'destroy' value. Figure 2 suggests that the reverse side to this is that a sustained fall in the rate of depreciation tends to be followed by a crisis. Before the crises of 1974 and 2008 the rate of depreciation drops substantially, starting from a peak 7 or 8 years in advance of the crisis. If we exclude the very volatile results pre-1951, the only other periods in which the rate of depreciation could be said to have declined in a sustained way is 1951-56, which incorporates the recession of 1954 and precedes the recession of 1958; and 1984-1990, preceding the 1991 recession.

Sustained falls in the rate of depreciation do not precede every recession. The recessions of 1980 and 1982 are preceded by only a small drop in the rate of depreciation between 1978 and 1980. But every sustained fall in the rate of depreciation is followed by a recession. This suggests that sustained falls in the rate of depreciation are a good leading indicator for recessions.

I suspect this is due to the emergence of asset price bubbles. The 'popping' of these bubbles shows up in the rapid increase in the depreciation rate associated with each of the crises (or, in the case of the 1974 recession, in the following year). This helps to explain why crises tend to coincide with sharp, temporary increases in the rate of profit, showing up in the decomposition above as an increase in the ROSV. Because I have had to make the assumption that the sum of profits is equal to the sum of surplus value produced at the national level (and not at the international level), this temporary increase in profits shows up as a temporary increase in the ROSV.

This asset price bubble phenomenon was particularly pronounced in the lead up to the 2008 recession, as we can see from the spike in the ROP caused by a spike in the contribution of the ROSV that starts in 2003.

Figure 4: Rate of Depreciation vs GDP Growth Rate



Implications for the hypothesis of the tendency of the rate of profit to fall

These new analytical techniques are at an early stage of development, and the empirical analysis offered here is still somewhat preliminary. But they do appear to be broadly consistent with Marx's hypothesis of the tendency of the rate of profit to fall. They also suggest that improvements in turnover time play a more significant role than Marxists have attributed to them.

First, they show a strong tendency for the VCC to rise over time. If there had been no tendencies countering this, the ROP would have fallen from 18% to 8% between 1947 and 2010.

However, this effect is almost exactly countered by shortening turnover times. The combined effect on the ROP of the VCC and the turnover time of variable capital over the period was -0.7 percentage points. Though the ROSV was the least significant influence on the ROP, contributing -5 percentage points, it appears to be a more significant influence, because the effect of the other two tendencies cancel out. This cancelling out explains why the strongly rising VCC did not cause the ROP to decline remorselessly.

To understand the causes of the major crises of the post-war period, we need to look at movements in the tendencies and counter-tendencies over shorter lengths of time.

It is difficult to ascertain the underlying causes of the recessions of 1954 and 1958, because the data only allow us to calculate turnover times back to 1947, and the results between 1947 and 1958 are very volatile. As argued above, there are signs of an asset price bubble, but the influences of the VCC and turnover time appear to cancel each other out.

We can, however, give an explanation for the longevity of the post-war boom. After 1958 the VCC stops falling, and actually rises right through until 1969 – consistent with the permanent arms economy hypothesis. The VCC and turnover time contribute + 2 percentage points each to the ROP from 1958-67, while the ROSV contributes + 0.4.

The ROP then starts to decline. Initially this coincides with a return to a rising VCC (starting from 1969) and a flattening off of improvements in turnover time (starting from 1964). But actually the combined effect of these influences between 1969 and 1974 was only -0.7%, while the ROSV contributed -1.7%. This suggests that the most important cause of the asset price bubble associated with the 1974 recession was in fact a fall in the ROSV.

But over 1967-1982, from the peak of the ROP until just before the trough in 1983, 3.0% of the 5.2% fall in the ROP was contributed by the rising VCC, compared to -2.1% from the ROSV (the turnover time contributed -0.1%).[2]

The recovery in the ROP following 1983 was volatile but significant. It was made possible by the combination of a more or less continuous improvement in turnover times between 1980 and 2002, which counter-acted the influence of the rising VCC, and a rising but very volatile ROSV. This volatility might be explained by changes in the difference between profits and surplus value within the US.

However, the rising trend in the contribution of the ROSV over this period reduces dramatically if we measure workers' compensation more broadly. Figure 5 gives the same decomposition as above, but adds the difference between social spending and contributions to social insurance to employees' compensation, in the same way that Kliman does.[3]

This is not a perfect measure, since employees' compensation as reported by the BEA covers all employees (including non-workers) and is a pre-tax measure. But it suggests that a combination of improvements in turnover time and *halt* to the fall in the ROSV were the key determinants of the partial recovery, and not an actual increase in the ROSV.

2 The results change if we include the trough year of 1983, but as is clear from the graphs, the fall in the ROSV in that year was only temporary, and connected to the large increase in the rate of depreciation after the 1982 recession.

3 Kliman, *The Failure of Capitalist Production: Underlying Causes of the Great Recession*, 152–155.

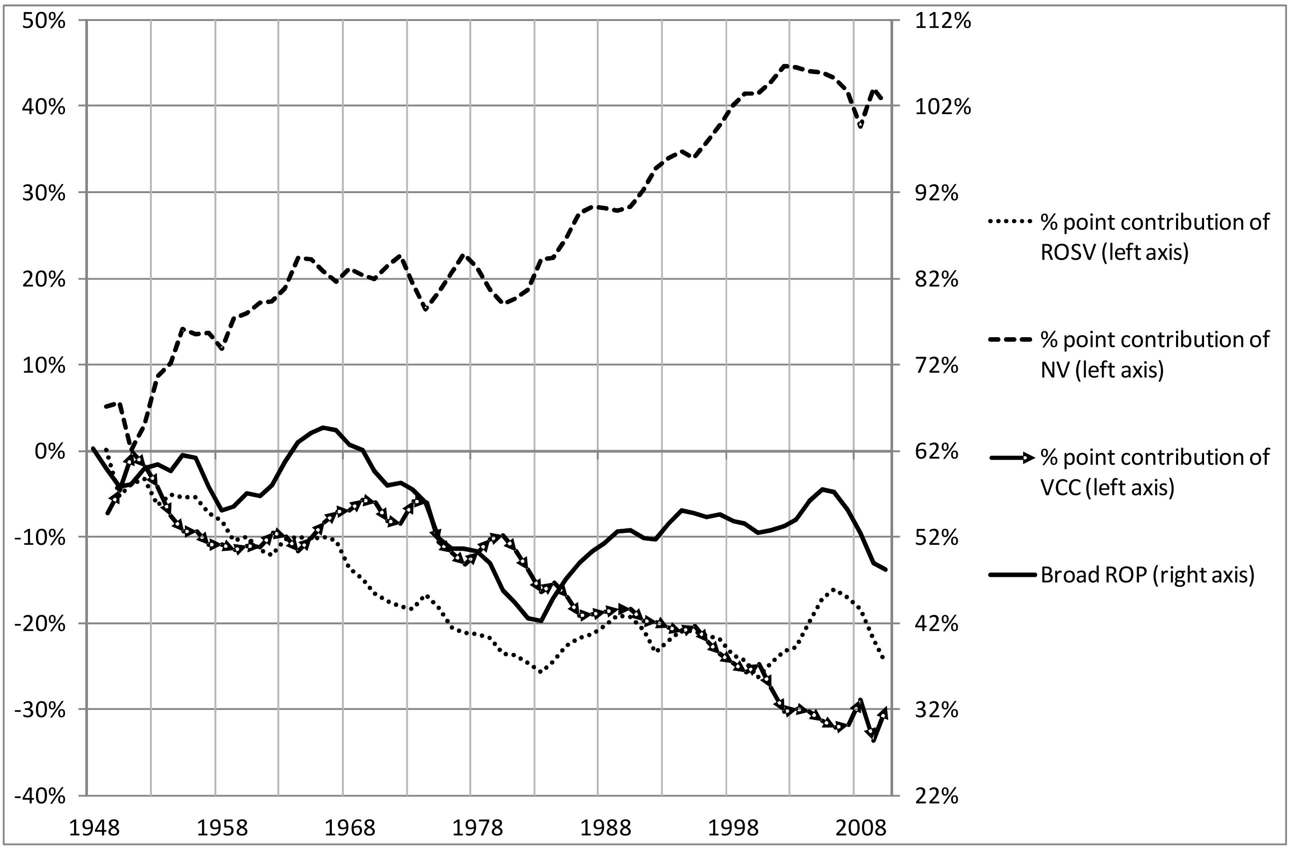
Then, from 2002, improvements in turnover time ceased, and this factor started to contribute negatively to the ROP. The ROP nevertheless increased due to increases in the ROSV. As argued above, this was in fact driven by a sharp fall in the rate of depreciation – i.e., an asset price bubble – and was not a real increase in the ROSV at all.

The bursting of this bubble was the manifestation of the 2008 crisis, but its underlying cause was the continuing rise in the VCC, amplified by the lengthening of turnover times.

Thus the evidence suggests that the most important common cause of both the latest crisis and the end of the post-war boom was the tendency of the VCC to rise. But the rising VCC did not cause a relentless fall in the ROP from the end of the boom until the current crisis because of shortening turnover times over the 1980s and 90s.

The rest of this paper explains the theoretical basis for these results, and discusses some aspects of them in more detail.

Figure 5: The Rate of Profit Decomposed, Using a Broader Definition of Workers' Compensation



Measures of the rate of profit

Existing measures

The most common measure of the rate of profit is to divide profits by the 'current cost' of the stock of fixed assets. This is just (the closest approximation to) the price the assets would sell for currently if they were individually put on the market, often thought of as their 'replacement cost'.

Andrew Kliman argues that this "is simply not a rate of profit in the normal sense of the term".[4] He argues for the use of a 'historical cost' measure of capital advanced. The 'historical cost' of an asset is its original purchase price less modelled depreciation. So, using a current cost measure, price changes influence the value of existing fixed assets; using a historical cost measure, they only influence the value of newly produced assets.

Kliman argues that a historical cost measure of the rate of profit corresponds more closely to measures that capitalists themselves use, such as net present value, and follows from the Temporal Single System Interpretation (TSSI) of Marx's value theory that he has played a leading role in developing. Using this method, he finds the rate of profit has either declined or been trendless since the early 1980s, whereas standard current cost measures record some recovery.[5]

This choice also has implications for measuring of the mass of profit. A broad measure typically takes an aggregate from the national accounts such as gross domestic product and subtracts wages and depreciation. But depreciation can be measured relative to either the historical or the current cost of fixed assets.

Profits can also be measured more narrowly using, for example, corporate profits as reported directly by the US Bureau of Economic Analysis (BEA). These measures are also based on particular definitions of depreciation. The BEA reports corporate profits by industry based on the depreciation measures used by firms for tax purposes, but also reports total corporate profits adjusted for current cost depreciation.[6]

So which should we choose? Kliman argues capitalists do not actually have to 'advance' the cost of *replacing* their assets – i.e., they do not have to pay for the *current* valuation of their assets. He argues they only need to have paid the cost of purchasing their assets at the price for which they

4 Andrew Kliman, *The Persistent Fall in Profitability Underlying the Current Crisis: New Temporalist Evidence* (New York: Marxist-Humanist Initiative, 2010), 41.
5 Andrew Kliman, *The Failure of Capitalist Production: Underlying Causes of the Great Recession* (Pluto Press, 2011), 17.
6 US Bureau of Economic Analysis, "News Release: Gross Domestic Product," *National Income and Product Accounts News Release*, March 29, 2012, http://www.bea.gov/newsreleases/national/gdp/2012/gdp4q11_3rd.htm.

originally bought them: so we should use historical cost valuation.

Depreciation and accountancy

This sounds plausible. But how do accountants see the matter? From an accountancy point of view, it is clear that the current value of a company is determined by the current, market value of its assets (in so far as this value can be determined). For example, if the value of the land that a company owns declines substantially, the company cannot continue to keep the original purchase price of that land on its books. It must write down the value of the land, and record this against its profit and loss figures for the current period. The same applies to any asset.

Of course, it is not always possible to estimate this reliably. For some assets, there might not be enough commodities of a similar type being sold at observable prices to determine what the current price is. That is why the International Accounting Standards Board (IASB) allows companies to choose between the 'cost model' (i.e., historical cost accounting) and the 'revaluation model' when accounting for property, plant and equipment:

> An entity shall choose either the cost model or the revaluation model as its accounting policy and shall apply that policy to an entire class of property, plant and equipment.
>
> Cost model: After recognition as an asset, an item of property, plant and equipment shall be carried at its cost less any accumulated depreciation and any accumulated impairment losses.
>
> Revaluation model: After recognition as an asset, an item of property, plant and equipment whose fair value can be measured reliably shall be carried at a revalued amount, being its fair value at the date of the revaluation less any subsequent accumulated depreciation and subsequent accumulated impairment losses. Revaluations shall be made with sufficient regularity to ensure that the carrying amount does not differ materially from that which would be determined using fair value at the end of the reporting period.[7]

Although the IASB offers this choice of methods, the important point is that they are both aimed at ascertaining the *current value* of the assets held by an entity. This includes cases where relevant price valuations are not available, and the cost model is the best method for estimating this current value. If the IASB were interested in the best estimate of the *historical value* of an entity's assets, it would not give entities the option to use the revaluation model.

7 IFRS Foundation, “International Accounting Standard 16: Property, Plant and Equipment”, December 2010, A536, http://eifrs.iasb.org/eifrs/bnstandards/en/ias16.pdf.

The IASB also stipulates that changes in asset values – whether due to depreciation or revaluation – be recorded as income (but again, with some qualifications):

> If an asset's carrying amount is increased as a result of a revaluation, the increase shall be recognised in other comprehensive income and accumulated in equity under the heading of revaluation surplus. However, the increase shall be recognised in profit or loss to the extent that it reverses a revaluation decrease of the same asset previously recognised in profit or loss. If an asset's carrying amount is decreased as a result of a revaluation, the decrease shall be recognised in profit or loss. However, the decrease shall be recognised in other comprehensive income to the extent of any credit balance existing in the revaluation surplus in respect of that asset.
>
> … The depreciation charge for each period shall be recognised in profit or loss unless it is included in the carrying amount of another asset.[8]

In other words, if using the revaluation model, devaluation must always be counted as a loss, while revaluations are not allowed to be counted towards profits unless they reverse a previous decrease, though this is still counted as 'income'. I suspect this apparently arbitrary rule is intended to prevent companies reporting fictitious profits by manipulating their revaluations, a precaution we do not need to take when using national accounts data.

The basic conclusion I draw from this is that revaluations (and devaluations) need to be counted against income and profits. A revaluation is a change in wealth, and a change in wealth is income, even if no cash changes hands. Any other definition of income makes little sense. Yet it is also clearly true that a purely nominal gain in wealth made by holding on to an asset (a 'holding gain') does not add to the total stock of value across the economy as a whole. We will come back to the question of how these two propositions be reconciled.

However, both current cost and historical cost measures of depreciation – as reported in national accounts – are designed to exclude the effects of revaluation. Historical cost measures do this in the most straightforward way, by simply not counting revaluation against the value of assets or as depreciation.

Current cost measures, on the other hand, count revaluations against assets, but separately from depreciation. The BEA, for example, defines depreciation as "the decline in the value of the stock

8 Ibid., A537–A538.

of assets due to wear and tear, obsolescence, accidental damage, and aging."[9] Any gain (or loss) in value that the BEA deems not to be due to these causes is classified as a holding gain (or loss).

Why this distinction? From an accounting perspective it seems quite strange: surely a loss is a loss, whether a statistician attributes this loss physical wear and tear, accidental damage, or an increase in sun spot activity.

Depreciation and national accounts

National accounts, however, aim to measure the real wealth and income of the nation. To do this, they need a method for separating nominal losses or gains in asset prices from 'real' ones. The common-sense way to do this is to try to separate losses in value due to some physical cause – i.e., wear and tear, obsolescence, accidental damage or aging – from losses caused by something else.

If one rejects the labour theory of value, then some version of this approach seems necessary. If there is no 'third thing' against which to measure value, then real wealth must be measured according to other criteria. National accounts measure the 'real value' of newly produced commodities using indexes of the physical quantity of output produced: e.g., a GDP price index or a consumer price index. Depreciation models are attempts to carry this same physicalist logic over to accounting for the destruction of value. So changes in the market value of existing assets that arise from general changes in the prices of newly produced assets of the same sort are classified as 'revaluation' (i.e., holding gains or losses), just as physical volume indexes attempt to hold the price of newly produced commodities constant over time. Changes in market value that arise from causes that are more particular to the individual assets – such as aging and physical wear and tear – are thus classified as depreciation that alters real wealth.[10]

There is no consensus amongst statisticians over which causes have the power to inflict 'real' depreciation. In 2009, for example, the BEA decided to no longer count damage due to natural disasters.[11] And although the BEA itself counts depreciation due to obsolescence as 'real', a paper they commissioned to improve their depreciation models defines depreciation due to obsolescence

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9 US Bureau of Economic Analysis, *Concepts and Methods of the U.S. National Income and Product Accounts*, 2011, 2–9, http://www.bea.gov/national/pdf/chapters1-4.pdf.

10 Moral depreciation seems to fall somewhere between these two categories, and this may explain why statisticians differ over how to classify it. While the BEA counts obsolescence as 'real' depreciation in its published figures, a discussion paper published by the BEA counts it as 'revaluation' (i.e., a holding loss). See Barbara Fraumeni, "The Measurement of Depreciation in the U.S. National Income and Product Accounts," *Survey of Current Business* (July 1997): 8, http://www.bea.gov/scb/pdf/national/niparel/1997/0797fr.pdf.

11 US Bureau of Economic Analysis, *Concepts and Methods of the U.S. National Income and Product Accounts*, 2–9 fn. 21.

as revaluation.[12]

For those of us who adopt a labour theory of value, I think these distinctions are not useful. More importantly, when Marxists do use depreciation models to calculate a current cost rate of profit, we are severing the link between profits and capital advanced, as I will discuss below. It then becomes possible for holding gains or losses to affect capital advanced without being marked against profits.

The current cost rate of profit and 'holding gains'

Let me illustrate this with the following numerical example. Suppose, over the course of a year, gross operating surplus (i.e., income to business owners before subtracting depreciation of fixed assets, but after subtracting labour and input costs) is $20, and current cost depreciation is $10. This gives us a standard current cost profits figure of $10.

Suppose also that the stock of fixed assets at the end of the year is worth $100. According to the standard current cost method, this gives a rate of profit of 10 / 100, or 10%.

Suppose further that the stock of fixed assets at the start of the year was worth $105, and that there was no investment during the year. If we apply a standard accounting approach – i.e., we count revaluations as income – then the balance sheet will read:

- Assets at start of year: $105
- Income: $20
- Assets at end of year: $100
- Net capital losses: $5
- Net profit: $15.

Hence the rate of profit under this approach is 15 / 100 = 15% (if we compare profits to the stock of constant capital at the end of the year). This is different from the current cost measure, because capital losses ($5) differ from measured depreciation ($10). The standard current cost measure defines away $5 of holding gains.

Now, it is open to advocates of a current cost approach to argue that these holding gains are

12 US Department of Commerce. Bureau of Economic Analysis, "Fixed Assets and Consumer Durable Goods in the United States, 1925-97" (US Government Printing Office, 2003), M–5 fn. 14, http://www.bea.gov/national/pdf/Fixed_Assets_1925_97.pdf.

meaningless: that, at least across the whole economy, they reflect a purely nominal change in prices, and so should be disregarded. In that case though, surely their preferred measure should be totally unaffected by any change in holding gains.

But it isn't. If the stock of fixed capital at the end of the period instead happened to come to $105, simply because holding gains were $10 rather than $5, then the standard current cost measure of the rate of profit would change. Instead of 10%, it would be 10 / 105, or roughly 9.5%.

Kliman's rate of profit and moral depreciation

Kliman's historical cost measure 'solves' this problem by excluding holding gains from the value of fixed assets. As argued above, this reflects a questionable definition of income and profit. It creates other problems as well.

Kliman argues that, for Marx, “the value of any commodity is the monetary expression of the average amount of labor (living and past) currently needed to *reproduce* commodities of the same kind”.[13] Thus he argues that if a commodity is produced using a fixed asset that has declined in value due to obsolescence (what Marx calls 'moral depreciation'), its value will be determined by the monetary expression of the smaller amount of ASNLT needed to produce commodities of this kind with more advanced machinery. This leads him to conclude that obsolete assets do not pass on their full value to the commodities they are used to produce, and the owner of an obsolete asset “realizes a loss”.[14]

Since the BEA includes depreciation due to obsolescence in its estimates of depreciation, and Kliman's estimates of profit are 'net' of this depreciation, Kliman thinks moral depreciation should ideally be added back in to these profit figures. That is, moral depreciation should be subtracted from the BEA's estimate of depreciation (which, in turn, is subtracted from gross profits to obtain net profits).

Kliman also thinks moral depreciation should be added back in to the BEA's estimates for the stock of fixed assets at historical cost: i.e., the BEA's figures underestimate the true level of capital advanced.[15]

I will illustrate this using a numerical example that compares two cases: one where there is moral depreciation, and one where there is not. Suppose, in the case without moral depreciation, at the

13 Kliman, *The Persistent Fall in Profitability Underlying the Current Crisis: New Temporalist Evidence*, 73.
14 Ibid., 74.
15 Ibid., 79–80.

start of the year, the true value of Kliman's measure of the stock of capital advanced is $100. Also suppose:

1. Historical cost depreciation, as it would be measured by the BEA, is $10;

2. Gross operating surplus is $20; and

3. There is no investment.

In this case, profits will be $20 - $10 = $10, and the stock of capital advanced at the end of the period will be $100 - $10 = $90.

Now consider a case in which there is $5 of moral depreciation. Assume the initial stock of fixed capital, gross operating surplus and investment are the same as before. But now, historical cost depreciation as the BEA would measure it is $15 – since, we assume, their models successfully pick up the $5 of moral depreciation as well as the $10 worth of ordinary wear and tear.

In this case, according to Kliman's method, profits will be $20 - ($15 - $5) = $10. This is the same as before, because Kliman subtracts moral depreciation from the BEA's measure of depreciation. According to Kliman's approach, the stock of capital advanced at the end of the period will similarly be unchanged at $100 - ($15 - $5) = $90. If we also assume that total hours worked and wages are the same across the two cases, then I think it follows from Kliman's approach that real profits are also identical.

But wait a minute: in the second case, we are assuming capitalists suffer a $5 loss due to moral depreciation. In the first case, they do not suffer this loss. In both cases, total income and all other costs remain the same. Yet, according to Kliman's accounting, capitalists earn the same profits in both cases; and, in both cases, capital advanced is $90 at the end of the period.

This sounds wrong. But perhaps, according to Kliman, moral depreciation causes value to be transferred from the capitalists who own the depreciated assets to other capitalists; hence, across the economy as a whole, no net losses are made.

If that is the case, we are left with $5 that the BEA has written off from the stock of fixed assets, but that Kliman wants to keep as part of capital advanced. But how will this component of capital advanced ever depreciate? The BEA's models won't account for it any more. How will Kliman? It's not at all clear how this could be done, even in theory, since this component of capital advanced is no longer tied to an asset.

If this is an accurate interpretation of Kliman's position, and Kliman cannot solve this problem, his approach leaves us with a component of capital advanced that never turns over, and can never be wiped from the books.

Marx on moral depreciation and devaluation

There are also interpretative problems with Kliman's approach. While discussing devaluation, Marx discusses

> [t]he constant improvements which rob existing machinery, factories, etc., of a part of their use-value, and therefore also their exchange-value. This process is particularly significant at times when new machinery is first introduced, before it has reached a certain degree of maturity, and where it thus constantly becomes outmoded before it has had time to reproduce its value. This is one of the reasons for the unlimited extension of working hours that is usual in periods of this kind, work based on alternating day and night shifts, so that the value of the machines is reproduced without too great costs having to be borne for wear and tear. If the short working life of the machines (their short life-expectancy vis-à-vis prospective improvements) were not counter-balanced in this way, they would transfer too great a portion of their value to the product in the way of moral depreciation and would not even be able to compete with handicraft production.[16]

Marx states clearly here that the short life expectancy of machines "vis-à-vis prospective improvements" would cause them to "*transfer* [my emphasis] too great a portion of their value to the product in the way of moral depreciation" if this were not offset by extending the working day in the way he describes. This is somewhat counter-intuitive: Marx is saying that the initial effect of the introduction of more productive machines is to raise the value of each unit of output, at the same time as the price of output should be falling as a result of the new machines. Note, however, that Marx is not saying that this extra value will be realised by the owners of the depreciated machines. Indeed, Marx suggests that the cost price of these commodities would rise so high that they would not even be able to compete with handicraft production. But regardless of whether these particular capitalists realise this value (i.e., regardless of whether the sale price is high enough to cover this value transferred by moral depreciation), Marx is clear that this value is transferred to the product. Kliman, on the other hand, wants to exclude moral depreciation from the value of the product by subtracting it from the BEA's measure of ordinary depreciation.

16 Karl Marx, *Capital*, trans. David Fernbach, vol. 3 (London [etc.]: Penguin, 1981), 208–209.

Indeed, in the passage above, Marx even seems to conflate the concepts of moral depreciation and depreciation due to wear and tear. He says the working day is extended is "so that the value of the machines is reproduced without too great costs having to be borne for wear and tear." Then, in the next sentence, he says the need to counter-balance "moral depreciation" is the reason for longer working hours. This suggests that Marx does not make the sharp distinction between these two types of depreciation that Kliman attributes to him.

But doesn't Marx use straight line models of depreciation? If he does insist on using only such models, this would call the interpretation I have offered into question, since moral depreciation tends to happen in sudden 'jumps' as new techniques are introduced, rather than taking place gradually over the life of each machine.

However, it seems more likely that Marx uses straight line models as a simplifying assumption or loose accounting convention. For example, Marx argues

> [t]he portion of the price which must replace the wear-and-tear of the machinery enters the account more in an ideal sense, as long as the machinery is still at all serviceable; it does not very much matter whether it is paid for and converted into money today or tomorrow, or at any particular point in the capital's turnover time.[17]

So it makes sense that in numerical examples where the only form of depreciation occurring is simple physical wear-and-tear, Marx would make the simplest assumption possible: a straight line model. But this does not mean he was committed to the proposition that value can only be transferred to new commodities at a rate that stays constant over time.

If this proposition is nevertheless read back into Marx's work, then I think it hinders a useful interpretation of the way he thinks crises destroy value. Under Kliman's approach, revaluation can never influence the value of capital advanced. This implies that the rate at which the existing stock of capital advanced loses its value over time can only change if the process of physical wear and tear is accelerated.[18]

Marx did indeed consider this aspect of the destruction of capital important. He explains that the destruction of capital

> will extend in part to the material substance of capital; i.e. part of the means of production, fixed and circulating, will not function and operate as capital, and a part of the productive

17 Ibid., 3:213.

18 Or if there is an increase in the rate of accidental damage, which seems much less likely.

> effort that was begun will come to a halt. Even though, as far as this aspect goes, time affects and damages all means of production (except the land), what we have here is a far more intense actual destruction of means of production as the result of a stagnation in their function.[19]

However, the more important aspect of devaluation is that caused by the non-physical destruction of value:

> The chief disruption, and the one possessing the sharpest character, would occur in connection with capital in so far as it possesses the property of value, i.e. in connection with capital values. The portion of capital value that exists simply in the form of future claims on surplus-value and profit, in other words promissory notes on production in their various forms, is devalued simultaneously with the fall in the revenues on which it is reckoned. A portion of ready gold and silver lies idle and does not function as capital. Part of the commodities on the market can complete their process of circulation and reproduction only by an immense reduction in their prices, i.e. by a devaluation in the capital they represent. *The elements of fixed capital are more or less devalued in the same way* [my emphasis].[20]

If we use a current cost measure of depreciation, we count the effect this devaluation has on capital advanced, but we ignore the effect it has on profits. If we use a historical cost measure, we define away both effects.

The alternative I propose is a current cost measure based on a broad definition of depreciation. If we simply define depreciation as the change in the current, market value of an asset due to any cause, less the value of new investment, then the effect of revaluation is counted against both profits and capital advanced. The immediate problem with such an approach, however, is that genuinely inflationary holding gains will be recorded as profits. In other words, this is will produce a purely nominal measure of the rate of profit.

To construct a measure of the 'real' rate of profit, that doesn't rely on a physicalist conception of depreciation, we need an appropriate mathematical interpretation of Marx's labour theory of value. The next section considers the most important attempt to construct such an approach.

19 Marx, *Capital*, 3:362.
20 Ibid., 3:362–363.

Freeman's approach

Alan Freeman makes a similar argument about the need for non-physicalist measure of depreciation (in this case, I suspect, directed against Sraffians):

> The vast and resourceful literature on scrapping, vintages, and joint production is beside the point; when prices change *for whatever reason*, goods and capitals alike lose or gain value. It makes no difference to profits if some accounting date passes and a machine has a birthday. Theories of ageing belong in the theory of production; attempts to explain price by age originate with the misguided belief that value is a component of physical being.[21]

Indeed, this argument was the starting point for writing this paper. However, I do not think Freeman succeeds in providing a non-physicalist formalisation of depreciation.

The difficulties start with the way Freeman understands the distinction between fixed and circulating constant capital. He illustrates this using the following numerical example. As Freeman describes it, this involves

> two producers P_I and P_{II} producing homogeneous commodities C_I and C_{II} respectively. Suppose over some period of time they and their labourers consume, produce or reproduce the following quantities of C_I and C_{II} and labour power V, measured in their natural units.[22]

He sets this out in the table copied below:[23]

FLOWS		C_I	C_{II}	V		C_I	C_{II}	Labour Power
Producer P_I	used	35		300	and produced	50		
Producer P_{II}	used	10		200	and produced		100	
Labourers	consumed		50		and reproduced			500

Table 1: Quantities consumed and produced in period 1 in Freeman's example

Here, Freeman measures CI and CII "in their natural units" – for example, in tonnes of coal, or loaves of bread – not in terms of money or ASNLT. To begin with, he assumes the initial stock of both CI and CII are completely used up during the period. So if we know the initial value of the stock of CI, and the monetary expression of the hours of ASNLT worked by labourers for each producer, we can use this table to calculate the value of the new commodities produced during the

21 Alan Freeman, "Price, Value and Profit - A Continuous, General, Treatment," in *Marx and Non-Equilibrium Economics*, ed. Alan Freeman and Guglielmo Carchedi (Cheltenham, UK; Brookfield, US: Edward Elgar, 1996), 254.
22 Ibid., 228.
23 Ibid.

period. Note that, in this example, the stock of CI turns over completely over the course of the period.

Next, Freeman relaxes this assumption. Instead he assumes that "fixed capital turns over once every two periods."[24] However, what he calls fixed capital here is not what we commonly understand it to be. Freeman continues to measure quantities of C_I and C_{II} in their 'natural units'. All he changes is the rate at which stocks of C_I are used up. So, in this second example, P_I starts with a stock of 70 C_I, and P_{II} owns a stock of 20 C_I. After one period, these stocks have reduced to 35 C_I owned by P_I, and 10 C_I owned by P_{II}. But if C_I is indeed fixed capital – as we usually understand the term, and as Marx uses it – then the stock of C_I that remains physically intact and operational should be unchanged by the end of the period, or only a small proportion of C_I should have completely broken down. It would only be in special cases that, for fixed capital, the quantity of use values physically destroyed corresponded to the value transferred – e.g., if half of all widget-making machines broke down at the end of the first period, and the other half died at the end of the third period, giving an average life of two periods.

In other words, Freeman's 'fixed capital' does not transfer its value to products gradually over time, but all at once, in the same way constant circulating capital transfers its value. Indeed, for Freeman, the difference between fixed constant capital and circulating constant capital is simply whether the turnover time of the type of constant capital in question exceeds the length of the (arbitrarily chosen) period:

> Why does C_I appear as fixed, and C_{II} as circulating capital, in Tables 11.5 and 11.6? Because we took as our period of reproduction a unit of time in which C_{II} is completely used up. But there is no basis for this choice. If we had taken the period of reproduction to be a week instead of a month, or a day instead of a week, C_{II} and indeed variable capital would have turned over only partially in this time.[25]

This does not capture the real distinction between fixed and circulating constant capital. A type of use value is fixed constant capital if it only transfers part of its initial value to the commodities it is used to produce over the course of the period – i.e., if it does not fully depreciate. This is why, after fixed capital has been introduced, we need a method for calculating the magnitude of this depreciation, and cannot simply rely on observing quantities of use values. On the other hand, if a use value is completely depreciated over the course of the period, we do not need such a method,

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24 Ibid., 252.
25 Ibid., 260.

since we know its entire value at the start of the period has been passed on to the commodities it was used to produce. This is true even if the stock of commodities of the same type has not fully turned over. So, for example, if we know the price of coal at the beginning of the period, and how many tonnes of coal were consumed, we need only multiply the two together to determine the value transferred to the product – regardless of whether the entire stock of coal turns over during the period. However, we cannot simply calculate the value transferred from a machine that remains in use at the end of the period in the same way. A partially 'used up' machine is not the same as a partially used up pile of coal.

I think this mistaken distinction between fixed and circulating capital is carried through consistently in Freeman's general attempt to formalise Marx's theory, but there is not space to make that argument here.

However, I think it is possible to modify Freeman and Kliman's approaches to solve the problems raised here. The most important features of this revised approach are explained below.

An Alternative Approach

Unfortunately, it is not possible to explain the approach I am advocating in detail in this paper. So rather than building up the approach logically from its starting premises, I will just give the most important results, as they pertain to measuring the rate of profit.

Notation

We first need to introduce some conventions for the mathematical notation (and more are added as the exposition proceeds). These conventions are mostly taken from Freeman, but modified slightly.

The most important is that variables can be expressed in units of currency ($) or units of ASNLT. So, for example, the value of the stock of constant capital at time *t* can be expressed as

$$\$_t C_t \quad \text{or} \quad C_t \quad .$$

The first is measured in $, the second in worker-years of ASNLT. We can convert from one measure to the other using the MELT, which is introduced later.

Note that the *t* subscript comes after the $ sign as well as after *C* – meaning that this is the value of *C* without making any adjustments for inflation (i.e., at the price level at time *t*). Later, we introduce a way of making such adjustments.

Depreciation

The simple and broad definition of depreciation explained above can be formalised as

$$DCF_{t,t+1} = CF_t + IF_{t,t+1} - CF_{t+1}$$

i.e., depreciation of fixed constant capital between time t and time $t + 1$ ($DCF_{t\,,\,t+1}$) is equal to the stock of fixed constant capital at the start of the period (CF_t) plus investment in fixed capital over the period ($IF_{t,t+1}$) less the stock of fixed capital at the end of the period (CF_t). Note that this is a measure of real depreciation, since the magnitudes above are measured in ASNLT (though I haven't yet given a method for converting observable magnitudes to ASNLT).

This is equivalent to

$$\$_{t,t+1}\, DCF_{t,t+1} = \$_{t,t+1}\, CF_t + \$_{t,t+1}\, IF_{t,t+1} - \$_{t,t+1}\, CF_{t+1}$$

i.e., the same magnitudes as before but measured in dollars, and adjusted for MELT inflation to the average price level for the period (which, again, we are simply assuming is possible for the moment).

Value added in ASNLT

Still assuming we can measure magnitudes in ASNLT, we can approximately measure total inflation-adjusted value added in production using:

$$VA_{t,t+1} = GDP_{t,t+1} - DCF_{t,t+1}$$

i.e., GDP less depreciation. This is equivalent to

$$VA_{t,t+1} = GDP_{t,t+1} - CF_t - IF_{t,t+1} + CF_{t+1} \quad .$$

The MELT

According to the labour theory of value, the only source of new value added during the period is living labour. The MELT is just the monetary expression of this labour time. So we can say

$$\$_{t,t+1}\, VA_{t,t+1} = n_{t,t+1}\, L_{t,t+1}$$

where $n_{t,t+1}$ is the average MELT over the period between t and t+1; and $L_{t,t+1}$ is the number of worker-years worked during the period. [26] This definition of the MELT is similar to the one Kliman

26 Ideally, this would be restricted to productive workers, but this has not been done in this paper.

uses.[27]

Note that the equation above assumes that, at the national level, the sum of values is equal to the sum of prices (and, hence, that the sum of surplus value is equal to the sum of profits). Ideally, this assumption should only be applied at the level of the world economy, and we should allow for unequal exchange between nations. I hope to be able to relax this assumption, at least a little, in future work.

Now let us introduce a 'point in time' MELT: i.e., the price level at a particular *point* in time, rather than the average price level over a *length* of time. We will make the assumption that the average MELT over the course of a year is equal to the average of the point in time MELTs at the beginning and end of the year, i.e. that

$$n_{t,t+1}=\frac{n_t+n_{t+1}}{2}$$

where n_t is the MELT at point in time t.

This means we are assuming that MELT inflation takes place at a smooth, even rate across the course of the year. This assumption could be refined in various ways, but I suspect this would not influence the results a great deal.

What does this point in time MELT mean? I interpret it to be the monetary expression of one unit of the labour time 'embodied' in stocks at a point in time. So the MELT at point in time t allows us to convert the stock of, for example, fixed capital measured at current prices, into a measure of the stock of fixed capital in terms of ASNLT. That is,

$$n_t=\frac{\$_t CF_t}{CF_t}$$

The same applies to the stock of any economic magnitude. This point in time MELT is very similar to the definition of the MELT offered by Freeman.[28] Thus, in a way, this approach combines the two different definitions of the MELT used by Kliman and Freeman.

Now we can convert the currency value of a stock at a point in time to a currency measure based on the average price level over a length of time, using:

27 Kliman, *The Persistent Fall in Profitability Underlying the Current Crisis: New Temporalist Evidence*, 19.

28 Alan Freeman, “Time, The Value of Money and the Quantification of Value,” *Unpublished* (1998), http://mpra.ub.uni-muenchen.de/2217/.

$$\$_{t,t+1}CF_t=\frac{n_{t,t+1}}{n_t}\$_tCF_t \quad .$$

Value added in dollars

Now, since all new value added is the product of living labour, i.e.

$$\$_{t,t+1}VA_{t,t+1}=n_{t,t+1}L_{t,t+1} \quad \text{(from above),}$$

we can say

$$n_{t,t+1}L_{t,t+1}=\$_{t,t+1}GDP_{t,t+1}-\$_{t,t+1}CF_t-\$_{t,t+1}IF_{t,t+1}+\$_{t,t+1}CF_{t+1}$$

or, expressing the value of constant capital in terms of the price level at the start and end of the year,

$$n_{t,t+1}L_{t,t+1}=\$_{t,t+1}GDP_{t,t+1}-\frac{n_{t,t+1}}{n_t}\$_tCF_t-\$_{t,t+1}IF_{t,t+1}+\frac{n_{t,t+1}}{n_{t+1}}\$_{t,t+1}CF_{t+1} \quad .$$

Now the only unknown variables are the MELTs; the others can be estimated using national accounts data.

Solving for the MELT

Since we have assumed that

$$n_{t,t+1}=\frac{n_t+n_{t+1}}{2} \quad ,$$

we can say

$$\frac{n_t+n_{t+1}}{2}L_{t,t+1}=\$_{t,t+1}GDP_{t,t+1}-\frac{n_t+n_{t+1}}{2n_t}\$_tCF_t-\$_{t,t+1}IF_{t,t+1}+\frac{n_t+n_{t+1}}{2n_{t+1}}\$_{t,t+1}CF_{t+1} \quad .$$

As it is, this equation is indeterminate, since the two point in time MELTs are both unknown. However, if we knew the level of the MELT at the start of the first period, we would be able to solve for the MELT at the end of the first period. Then, since the end of the first period is also the start of the second period, we could solve for the MELT at the end of the second period – and, hence, find the point in time MELTs for all years in the time series.

Freeman's method leads to a similar situation.[29] His solution is to estimate the initial MELT, and

29 Ibid., 14.

demonstrate that the errors introduced by this estimate die away rapidly over time.

I have not been able to prove, in the general case, that errors will die away rapidly using my approach. However, I am able to demonstrate this proposition for the data presented here using sensitivity testing (incorporating extreme values), and I have no reason to suspect that other data would give a different result. These results are presented further below.

Estimating the initial MELT

If errors decay sufficiently rapidly, then making an accurate initial estimate of the MELT is only of secondary importance. However, the sensitivity testing below shows that if the initial estimate is more accurate, the results will be more accurate for the first few periods, and the errors will converge to near zero more quickly.

To make this estimate, we can fall back on the depreciation models in the national accounts. Assume, for the purposes of this estimate, that in the first two years the depreciation models 'get it right', i.e., that

$$DCF_{t,t+1} = MDCF_{t,t+1}$$

where $MDCF_{t,t+1}$ is fixed capital depreciation as measured by national accounts depreciation models. So, under this assumption,

$$n_{t,t+1} = \$_{t,t+1} GDP_{t,t+1} - \$_{t,t+1} MDCF_{t,t+1}$$

which we can use to calculate the average MELT for the first two years.

Now, make the further assumption (for the purposes of this first estimate only) that the point in time MELT at the end of the first year is equal to the average of the average MELTs for the first two years, i.e.

$$n_t = \frac{n_{t-1,t} + n_{t,t+1}}{2} \quad .$$

This gives us our initial estimate of the MELT. Since this estimate is for the end of the first year, we cannot calculate the MELT for the start of the first year (since moving backwards in time does compound the errors in the MELT estimates), so MELT data for the first year have been disregarded in the empirical results below.

Determining the MELT in subsequent years

Now that we have an estimate of the initial MELT, we just need to re-arrange the equation given above, i.e.

$$\frac{n_t+n_{t+1}}{2}L_{t,t+1}=\$_{t,t+1}GDP_{t,t+1}-\frac{n_t+n_{t+1}}{2n_t}\$_t CF_t-\$_{t,t+1}IF_{t,t+1}+\frac{n_t+n_{t+1}}{2n_{t+1}}\$_{t,t+1}CF_{t+1} \quad .$$

This is equivalent to

$$(L_{t,t+1}+\frac{1}{n_t}\$_t CF_t)n_{t+1}+n_t L_{t,t+1}-2\$_{t,t+1}GDP_{t,t+1}+2\$_{t,t+1}IF_{t,t+1}+\$_t CF_t-\$_{t+1}CF_{t+1}-\frac{n_t}{n_{t+1}}CF_{t+1}=0 \quad .$$

Multiplying through by n_{t+1} so we can solve using the quadratic formula:

$$(L_{t,t+1}+\frac{1}{n_t}\$_t CF_t)n_{t+1}^2+(n_t L_{t,t+1}-2\$_{t,t+1}GDP_{t,t+1}+2\$_{t,t+1}IF_{t,t+1}+\$_t CF_t-\$_{t+1}CF_{t+1})n_{t+1}-n_t CF_{t+1}=0$$

and now, applying the quadratic formula,

$$n_{t+1}=\frac{-b\pm\sqrt{(b^2-4ac)}}{2a}$$

where

$$a=L_{t,t+1}+\frac{1}{n_t}\$_t CF_t \quad ;$$

$$b=n_t L_{t,t+1}-2\$_{t,t+1}GDP_{t,t+1}+2\$_{t,t+1}IF_{t,t+1}+\$_t CF_t-\$_{t+1}CF_{t+1} \quad \text{; and}$$

$$c=-n_t CF_{t+1} \quad .$$

Errors in the MELT

The error in the MELT as a proportion of its true value is

$$en_{t+1}=\frac{n'_{t+1}-n_{t+1}}{n_{t+1}}$$

where n' = the estimated level of the MELT. This is

$$n'_{t+1}=\frac{-b'\pm\sqrt{(b'^2-4a'c')}}{2a'}$$

where

$$a' = L_{t,t+1} + \frac{1}{n'_t} \$_t CF_t \quad ;$$

$$b' = n'_t L_{t,t+1} - 2\$_{t,t+1} GDP_{t,t+1} + 2\$_{t,t+1} IF_{t,t+1} + \$_t CF_t - \$_{t+1} CF_{t+1} \quad \text{; and}$$

$$c' = -n'_t CF_{t+1} \quad .$$

The rate of profit

Now we can give an expression for the real, MELT-adjusted rate of profit. Standard current cost measures of the rate of profit compare profits over the course of the year to the stock of constant capital at the end of the year. Kliman's historical cost measure uses the stock of constant capital at the start of the year.

I cannot see a good reason for either of these choices. Since profits are generated over the course of a year, a good measure of the rate of profit should take into account the changes in the stock of capital advanced over the course of that year.

More precisely, I think an ideal measure of the average rate of profit would either be the sum of the rates of profit appropriated on every sale (i.e., profits on each sale divided by the whole stock of capital advanced at each point in time), or the integral for the year of surplus value over capital advanced as a function of time.[30] The first would measure the average return on a dollar invested in productive capital over a year, the second the yearly rate at which productive capital 'produces' surplus value. In both cases, the average rate of profit could roughly be thought of as an average of a series of 'snapshots' of the rate of profit over the course of the year.

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30 More formally, the first alternative is:

$$\sum_{u=0}^{u=v} \frac{\$_u \pi_u}{\$_u CF_u + \$_u INV_u}$$

where *v* is the number of sales throughout the economy over the course of the year;
u is a series of integers from 0 to v representing each sale in succession;
π_u = profits on a single sale *u*;
CF_u = the stock of fixed constant capital at the time of sale u;
INV_u = the stock of inventories at the time of sale u (incorporating the stock of constant circulating capital and, ideally, unsold inventories at cost price).
The second alternative is

$$\int_0^1 \frac{S(w)}{C(w)} dw$$

where *w* is the proportion of the year that has passed (from 0 to 1);
S (w) is surplus value as a function of time; and
C (w) is the stock of constant capital as a function of time.

Obviously neither of these measures could be calculated in practice, but I think our estimate of the rate of profit should approximate one or the other as closely as possible. So the results below divide profits by the average of capital advanced at the start of the year and capital advanced at the end of the year, i.e.

$$ROP_{t,t+1} = \frac{\$_t \pi_{t,t+1}}{\frac{1}{2}(\$_t CF_t + \$_t INV_t + \$_t CF_{t+1} + \$_t INV_{t+1})}$$

where π = profits net of DCF (estimated in several ways below);

CF = the stock of fixed constant capital; and

INV = the stock of inventories.[31]

We could also estimate the nominal rate of profit by using the equation above without the adjustments for inflation, and measuring profits net of nominal depreciation.

Turnover time

We also want to be able to usefully decompose the sources of change in the rate of profit. This is usually an exercise in trying to separate the effects of changes in the rate of surplus value from changes in the value composition of capital.[32] However, Marx and Engels identified a third major factor that influences the rate of profit: the turnover time of variable capital.

Early in *Capital* Volume 3 Marx assumes away the influence of turnover time on the rate of profit, and says he will take this up in a later chapter.[33] As it turned out, Engels wrote a chapter on the subject and inserted it as Chapter 4, extending the logic Marx develops in Volume 2. In this chapter, Engels argues

> the formula $p' = s'v / C$ is strictly correct only for a single turnover period of the variable capital, while for the annual turnover the simple rate of surplus-value s' has to be replaced by $s'n$, the annual rate of surplus-value, n standing for the number of turnovers that the variable capital makes in the course of a year.[34]

31 Ideally this would have constant circulating capital at current prices, and unsold and unfinished commodities at cost prices, which, combined with fixed capital, measures the total amount of money tied up in commodities yet to be turned into revenue at any point in time. But national accounts inventories figures give both at full current prices.

32 Kliman does this, for example. Kliman, *The Persistent Fall in Profitability Underlying the Current Crisis: New Temporalist Evidence*, 56–57.

33 Marx, *Capital*, 3:142.

34 Ibid.

Here, s' = the rate of surplus value; n = the number of turnovers of circulating constant and variable capital throughout the year (Engels assumes they are equal); v = the variable capital advanced for a single turnover; and C = the total capital advanced (constant and variable).

This correction is necessary because a shorter turnover time for variable capital means that the same amount of surplus value can be produced over the course of a year for a smaller outlay of variable capital at any point in time. For example, suppose initially that a business's variable capital of $100 turns over twice in a year. That is, on average, each dollar spent on labour power to produce a commodity takes half a year to return to the capitalist as revenue made from selling that commodity. To keep production going at the same scale, at any point in time the capitalist would need to keep half a year's worth of wages tied up in unfinished and unsold commodities. Also suppose that the rate of surplus value is 100 percent: i.e., half the working day is spent creating surplus value. This means that, over the course of a single turnover of variable capital, workers will create $100 of surplus value. But over the whole year, they will create $200 of surplus value, even though, at any point in time, the capitalist only has to advance $100 of variable capital. If this turnover time were to shorten to a quarter of a year, then the same annual surplus value of $200 would be possible on a variable capital of only $50 at any point in time. The *annual* rate of surplus value ($s'n$) would increase to 400 percent, even though the rate of surplus value over a single turnover (s) would remain constant.

Marx comments that confusion surrounding the distinction between the annual rate of surplus value and the rate of surplus value "led to the complete destruction of the Ricardian school", yet in contemporary Marxists studies of the rate of profit this distinction is generally not recognised or considered too difficult to make in practice.[35]

If we are to accurately separate the effects of changes in the turnover time of variable capital from changes in the rate of surplus value, we first need a method for measuring turnover time. Unfortunately, I have not found anywhere where Marx or Engels gives such a method. At the end of Chapter 4, Engels explains that we cannot calculate the amount of variable capital tied up in a business based on wages data alone, since this would only tell us vn, not v. Thus he sets out a method for calculating v, based on an example from a spinning mill Marx gives in Volume 1. However, in this example, Engels explains "[t]he circulating capital was not given; we shall take it to be £2,500."[36] Now, once Engels has *assumed* we know the value of the circulating capital tied up at any point in time, it is possible to calculate the turnover time of circulating capital, based on the

35 Karl Marx, *Capital*, trans. David Fernbach, vol. 2 (London [etc.]: Penguin, 1978), 373.
36 Marx, *Capital*, 3:168.

weekly expenses Marx sets out in the original example. Based on Engels further assumption that the turnover time for circulating capital is equivalent to the turnover time for variable capital, the latter can be calculated. However, since Engels does not give us any basis or method for calculating the value of circulating capital tied up at any point in time, the effect is to re-state the original problem in a different form, rather than to solve it.

This problem could be solved if it were possible to directly measure the variable capital needed for a single turnover. Marx argues capitalists need to 'advance' enough variable capital to cover a single turnover of variable capital:

> To take capital *A* of £500, for instance. It is advanced for five weeks, but each week only £100 of it successively enters the labour process. In the first week, one fifth of it is applied [£100]; four fifths [£400] is advanced without being applied, although since it must be on hand for the labour process if the four following weeks it must certainly be advanced.[37]

If this were true, and if it were possible to separate the money capital put aside for this purpose from other money capital, then we could calculate capital 'advanced' for a single turnover. This would be the wages bill for the year, divided by the average sum of money capital put aside for wages during the year, plus the average variable capital 'embodied' in unfinished and unsold commodities.

But not only would it be impossible to calculate this in practice, I think it would also be undesirable. Unfortunately, Marx does not say more about *why* he thinks £400 must be advanced in the section from which the quotation was taken. He is probably assuming the capitalist in question does not have access to credit, in which case it would be necessary to keep this £400 on hand to cover wages until the first turnover has been completed.

But if we relax this assumption (as we should), the capitalist could borrow money as the turnover period proceeds, keeping just enough cash on hand to cover unexpected expenses. Precisely how much money capital to keep on hand would be up to the capitalist in question, and would be very difficult to measure. But since I do not propose to measure the money capital that capitalists keep on hand for other purposes – such as purchasing constant capital – there is no need to try to estimate the money capital they keep on hand for paying wages.

This means that the stock of variable capital advanced at any point in time is just the wages costs 'embodied' in unfinished and unsold commodities (call this VS_t). This grows by the difference between the wages bill ($W_{t,\,t+1}$) and the variable capital component of the cost price of commodities

37 Marx, *Capital*, 2:374.

sold during the period (call this $VR_{t,t+1}$), i.e.

$$VS_{t+1} - VS_t = W_{t,t+1} - VR_{t,t+1} \quad .$$

VR can also be thought of as the total turnover of variable capital during the year. So the average number of turnovers of variable capital in a single year can be approximated by *VR* divided by the average stock of variable capital tied up at any point in time, i.e.

$$NV_{t,t+1} = \frac{\$_t VR_{t,t+1}}{\frac{1}{2}(\$_t VS_t + \$_t VS_{t+1})}$$

where *NV* is the number of turnovers of the stock of variable capital over the year.

I cannot see a way to measure these variable exactly using national accounts data. The most straightforward proxy for *VR* is just the wages bill for the year. This then makes it impossible to measure the growth of *VS* using the difference between the wages bill and *VR*.

However, we can estimate *VS* more directly. First, *VS* can be calculated by multiplying the current stock of unfinished and unsold commodities by the average wages share of the cost of producing these commodities, i.e.

$$VS_t = \frac{VS_t}{PS_t} \cdot PS_t$$

where PS_t is the current price of the stock of unsold and unfinished commodities.

Now, the wage cost share of *PS* is likely to be very similar to the wage cost share of GDP, so it could be estimated that way. But this means our estimate of NV will be:

$$NV_{t,t+1} = \frac{\$_t W_{t,t+1}}{\frac{1}{2}\frac{\$_t W_{t,t+1}}{\$_t GDP_{t,t+1}}(\$_t PS_t + \$_t PS_{t+1})} = \frac{2\$_t GDP_{t,t+1}}{\$_t PS_t + \$_t PS_{t+1}}$$

i.e., the average ratio of GDP to the stock of unsold and unfinished commodities. So there is in fact no need to estimate the wage cost share of *PS*.

The ratio of *GDP* to *PS* can best be estimated using the BEA's inventories data. The BEA's inventories data only includes industries that produce 'physical' output – i.e., manufacturing, agriculture, construction etc. - and not industries that produce services (except insofar as they purchase physical inputs). This is problematic, since some 'non-physical' industries do have stocks of unsold and unfinished commodities: unfinished conference papers, for example. So we will just have to assume that these industries have the same turnover time as the industries for which the BEA reports inventories data. If 'non-physical' industries have shorter turnover times – as seems reasonable to expect – then this procedure will tend to underestimate improvements in turnover time if the share of 'non-physical' industries grows over time.

The other issue is that the BEA's figures incorporate materials and supplies, which are a component of constant capital and not a component of *PS*. Fortunately, the BEA reports inventories of materials and supplies, work-in-progress and finished goods separately (after 1967), so we can separate out the first category.[38] Alongside their figures for inventories, the BEA publishes estimates of final sales of businesses, so we can estimate the ratio of GDP to PS using final sales of the industries for which inventories data is collected divided by inventories of works-in-progress and finished goods.

Decomposing changes in the rate of profit

As given above, the expression for the rate of profit used here is

$$ROP_{t,t+1} = \frac{\$_t \pi_{t,t+1}}{\frac{1}{2}(\$_t CF_t + \$_t INV_t + \$_t CF_{t+1} + \$_t INV_{t+1})} \quad .$$

Let us define a proxy for the rate of surplus value as

$$s_{t,t+1} = \frac{\$_{t,t+1} \pi_{t,t+1}}{\$_{t,t+1} W_{t,t+1}}$$

where *W* is a measure of the wages bill (two different measures are used in the empirical results).

So now

$$ROP_{t,t+1} = \frac{s_{t,t+1} \$_t W_{t,t+1}}{\frac{1}{2}(\$_t CF_t + \$_t INV_t + \$_t CF_{t+1} + \$_t INV_{t+1})} \quad .$$

We can express this as

38 Before 1967 I have assumed that the ratio of materials and supplies to other industries is the same as the 1967. This ratio does not change a great deal between 1967 and 2010.

$$ROP_{t,t+1} = \frac{s_{t,t+1} NV_{t,t+1} \frac{\$_t W_{t,t+1}}{NV_{t,t+1}}}{\frac{1}{2}(\$_t CF_t + \$_t INV_t + \$_t CF_{t+1} + \$_t INV_{t+1})} \quad .$$

Now we will define a proxy for the average value composition of capital (VCC) over the year as

$$VCC_{t,t+1} = \frac{\frac{1}{2}(\$_t CF_t + \$_t INV_t + \$_t CF_{t+1} + \$_t INV_{t+1})}{\frac{\$_t W_{t,t+1}}{NV_{t,t+1}}}$$

i.e., average capital advanced divided by the variable needed for a single turnover. This is not precisely what Marx meant by the VCC, since Marx calls it "a specific ratio between variable and constant capital".[39] Here, since we are including inventories in the numerator, we are including variable capital tied up in unfinished and unsold commodities. But this definition makes the decomposition much simpler, and seems just as useful conceptually.

There is no need, in this definition, to adjust the measure of capital advanced to only reflect the capital advanced for one turnover period, since capital advanced measures a stock, and not a flow.

Now we can express the rate of profit as

$$ROP_{t,t+1} = \frac{s_{t,t+1} NV_{t,t+1}}{VCC_{t,t+1}} \quad .$$

These are the three most important immediate determinants of the rate of profit: the value composition of capital, the rate of surplus value, and the turnover time of variable capital. We can now isolate their effects as the rate of profit changes. Consider the difference between the rate of profit during one period, and the rate of profit during the next period:

$$ROP_{t+1,t+2} - ROP_{t,t+1} = \frac{s_{t+1,t+2} NV_{t+1,t+2}}{VCC_{t+1,t+2}} - \frac{s_{t,t+1} NV_{t,t+1}}{VCC_{t,t+1}}$$

$$= \frac{(\Delta s + s_{t,t+1})(\Delta NV + NV_{t,t+1})}{\Delta VCC + VCC_{t,t+1}} - \frac{s_{t,t+1} NV_{t,t+1}}{VCC_{t,t+1}}$$

(where $\Delta s = s_{t+2,t+1} - s_{t+1,t}$ [40]; $\Delta NV = NV_{t+2,t+1} - NV_{t+1,t}$; $\Delta VCC = VCC_{t+2,t+1} - VCC_{t+1,t}$)

39 Marx, *Capital*, 3:142–143.

40 The full subscript that would be in keeping with the conventions here is (t + 2, t + 1; t +1, t) but this has been abbreviated.

so $ROP_{t+1,t+2} - ROP_{t,t+1} =$

$$\frac{\Delta NV + NV_{t,t+1}}{\Delta VCC + VCC_{t,t+1}} \Delta s + \frac{s_{t,t+1}}{\Delta VCC + VCC_{t,t+1}} \Delta NV + \frac{s_{t,t+1}}{\Delta VCC + VCC_{t,t+1}} NV_{t,t+1} - \frac{s_{t,t+1}}{VCC_{t,t+1}} NV_{t,t+1}$$

$$= \frac{\Delta NV + NV_{t,t+1}}{\Delta VCC + VCC_{t,t+1}} \Delta s + \frac{s_{t,t+1}}{\Delta VCC + VCC_{t,t+1}} \Delta NV + s_{t,t+1} NV_{t,t+1} \left(\frac{1}{\Delta VCC + VCC_{t,t+1}} - \frac{1}{VCC_{t,t+1}} \right)$$

$$= \frac{\Delta NV + NV_{t,t+1}}{\Delta VCC + VCC_{t,t+1}} \Delta s + \frac{s_{t,t+1}}{\Delta VCC + VCC_{t,t+1}} \Delta NV + s_{t,t+1} NV_{t,t+1} \frac{VCC_{t,t+1} - VCC_{t,t+1} - \Delta VCC}{(\Delta VCC + VCC_{t,t+1}) VCC_{t,t+1}}$$

$$= \frac{NV_{t+1,t+2}}{VCC_{t+1,t+2}} \Delta s + \frac{s_{t,t+1}}{VCC_{t+1,t+2}} \Delta NV - \frac{s_{t,t+1} NV_{t,t+1}}{VCC_{t,t+1} VCC_{t+1,t+2}} \Delta VCC \quad .$$

These three terms correspond respectively to the direct effect on the ROP of a changing rate of surplus value, changing turnover time of variable capital, and changing value composition of capital. We can see from this equation that, as we would expect, an increase in the rate of surplus value or the number of turnovers of variable capital in a year leads to an increase in the rate of profit, while an increase in the VCC leads to a decrease in the rate of profit.

Results in more detail

Kliman has helpfully posted a spreadsheet with his empirical results online, so I have been able to directly compare my results with his.[41] I have, however, updated his 2009 results to include the BEA's new and revised data.

The MELT

There is little empirical difference between my approach to measuring changes in the MELT and Kliman's approach, as Figure 6 below demonstrates. However, it is necessary to demonstrate that the method used to estimate the MELT does not introduce significant errors into the analysis.

So Figure 7 charts the errors introduced by the technique of estimating MELT depreciation in the first two years by using the BEA's depreciation models under three assumptions. The first two assumptions are extreme: that true MELT depreciation is only one tenth of the estimate, and that true depreciation is double the estimate. In both these cases, the error in the estimate of inflation is high but falling for the first two years (-8.3% and 10.6% respectively in the first year, -3.2% and

41 Andrew Kliman, “Data and Graphs Accompanying ‘The Persistent Fall in Profitability Underlying the Current Crisis: New Temporalist Evidence’”, October 2009, http://akliman.squarespace.com/persistent-fall/.

4.2% in the second), but low in the third year (-1.4% and 1.8%). By the tenth year the error has shrunk to a magnitude of less than 0.01% in both cases.

In the more realistic case, where we assume true depreciation is 20% higher than the BEA's figures, the error is down to -0.8% by the second year. So MELT results are used from the second year onwards.

Figure 6: Price Indexes (1931 = 100)

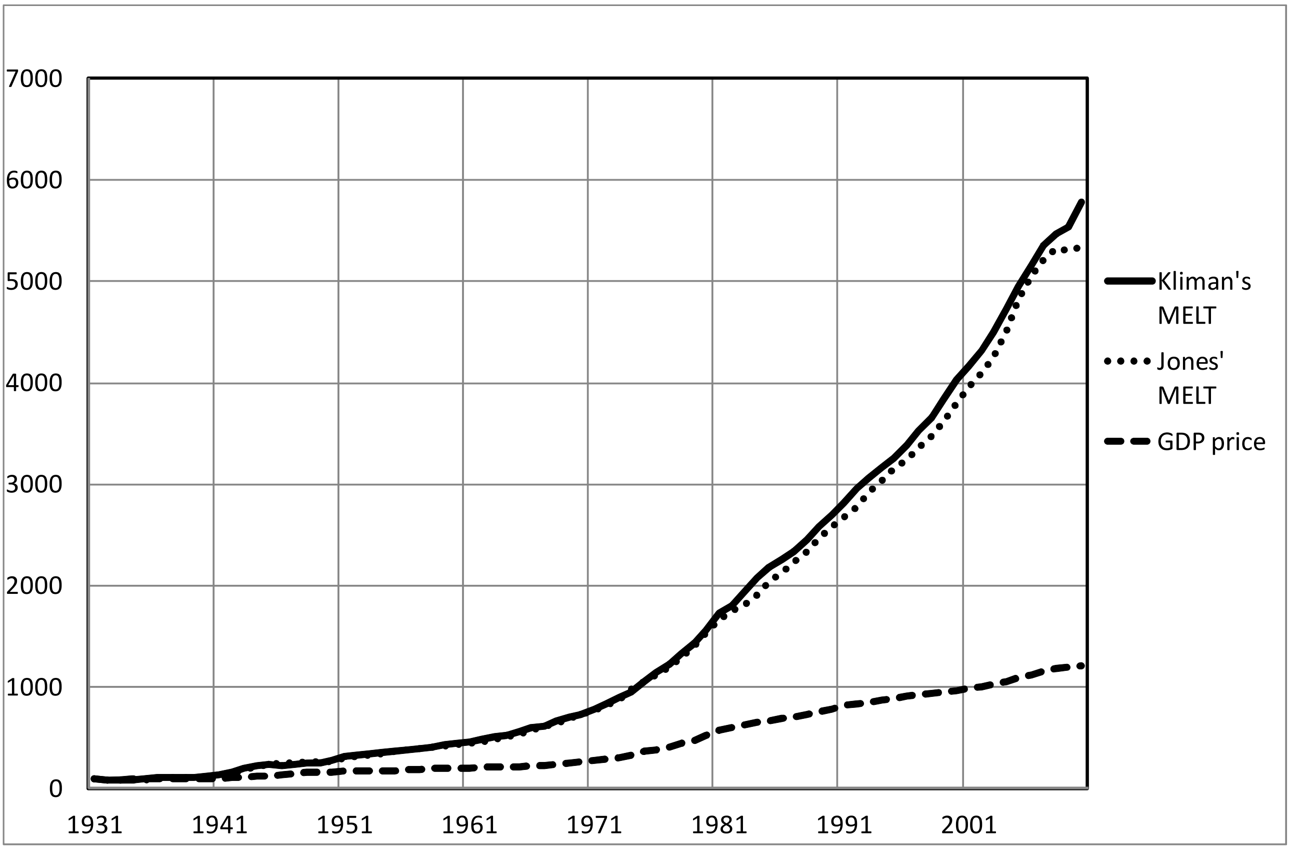
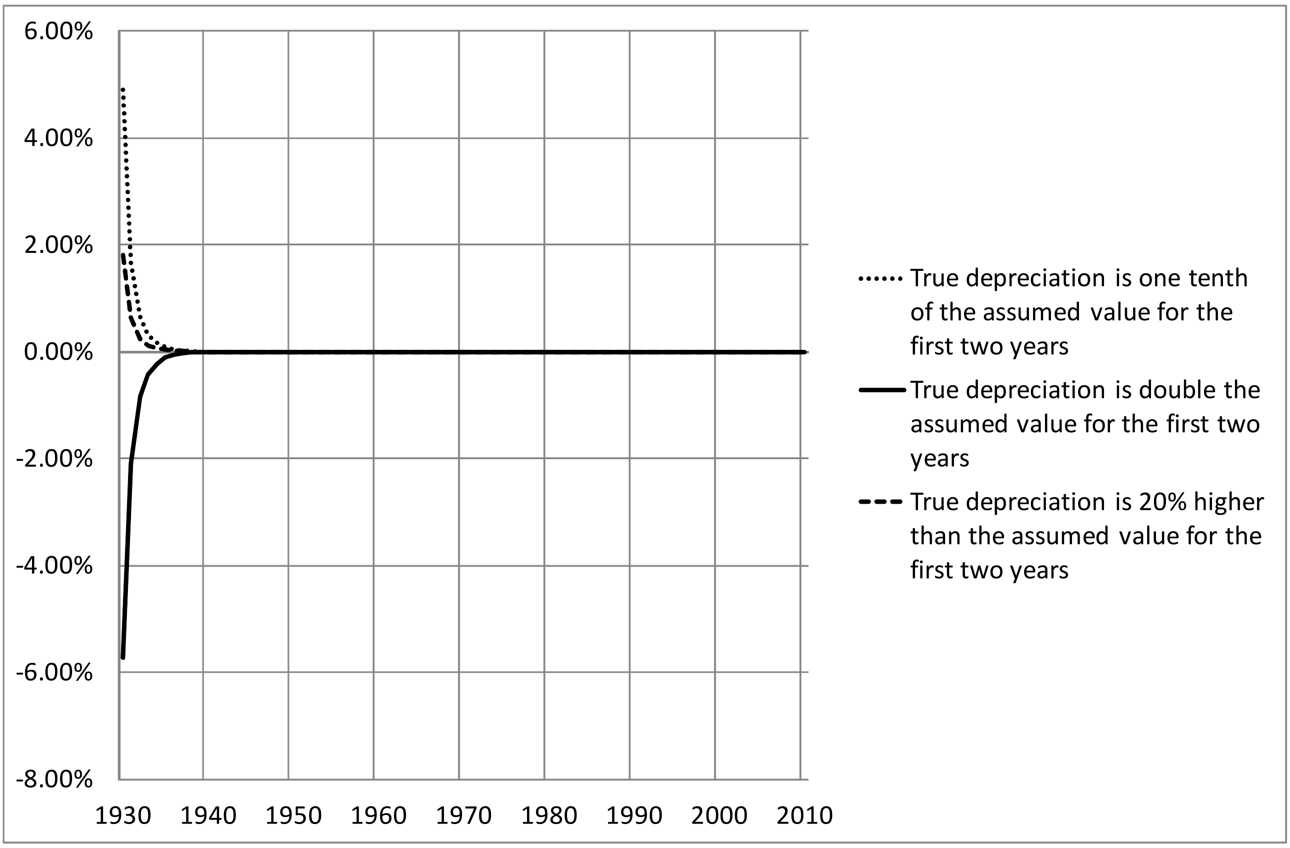


Figure 7: Percentage Point Errors in The Estimated MELT For Three Cases



Turnover time of variable capital

In the main results section above, it was observed that the number of turnovers of variable capital over a year (NV) tends to increase over time, but that this process either slowed or reversed in the lead up to the recessions of 1958, 1974 and 2008. So it is worth examining why this might have happened.

One possibility is that turnover times stopped shortening because firms found it increasingly difficult to sell their output, and hence built up larger stocks of inventories than would have been otherwise necessary. This would tend to support an underconsumptionist explanation of why rates of profit fell.

So Figure 9 looks at the components of NV in more detail, adjusted for MELT-inflation. It shows that NV reaches a local peak in 1964 (at 2.1 per year), and starts a slight declining trend from then until about 1980. In other words, NV stops rising well before the post-war boom ends, in a period when we would not expect firms to have any particular difficulties selling their output. Moreover, total sales rise throughout almost all of the period of 1964-1980, only dipping temporarily in 1974. The key cause of the levelling off of NV is that the stock of unsold and unfinished commodities starts to rise from 1964-65, when previously it had been falling, and only starts falling again from 1980-81.

Why did the stock of inventories rise in this way? I do not really know. These results still do not rule out an underconsumptionist explanation. It is possible that, for whatever reason, companies were finding it increasingly difficult to sell their output, so built up stocks of inventories while they looked for market outlets. But the problem with this explanation is that the share of total inventories made up by materials and supplies actually rises a little over the course of the period (see Figure 9). If underconsumption were a chronic problem, and the structure of production remained unchanged, then we would expect firms to keep the same or fewer materials and supplies on hand while their stock of unsold and, perhaps, unfinished commodities piled up.

It seems more likely that, for whatever reason, it became necessary to hold onto more inventories as a proportion of output in order to prevent disruptions to production. However, this question needs considerably more research.

Figure 8: Number of Turnovers of Variable Capital and Its Components

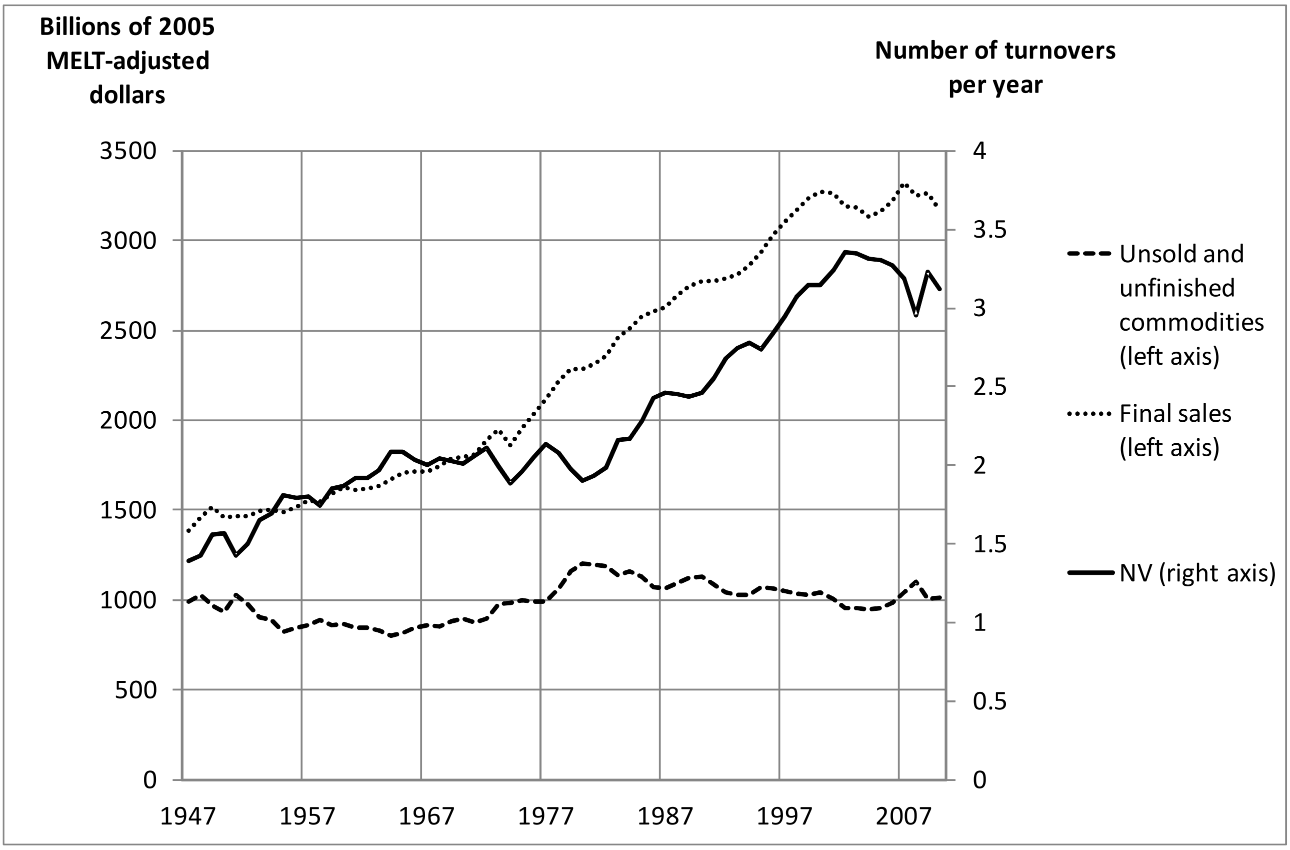
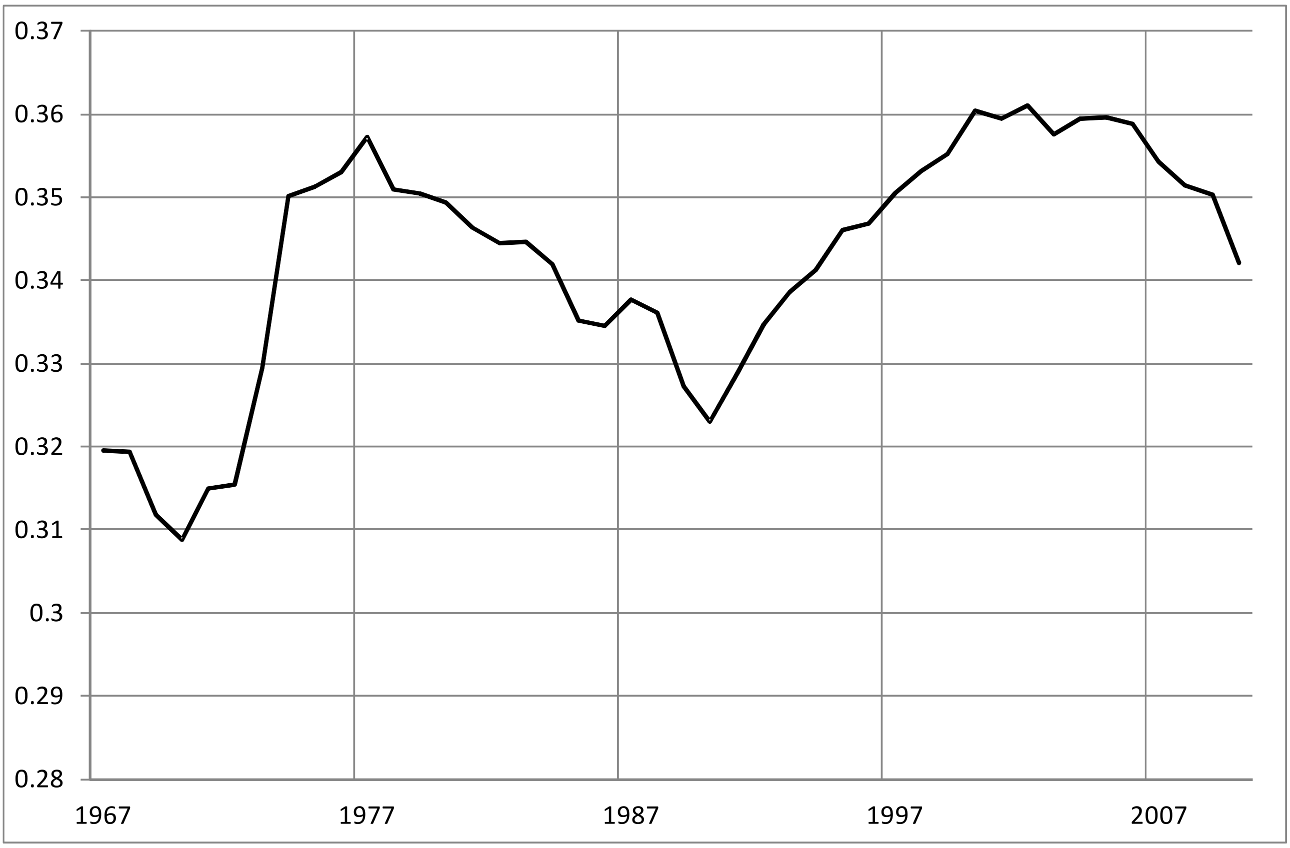


Figure 9: Materials and Supplies as a Share of Total Inventories



The value composition of capital

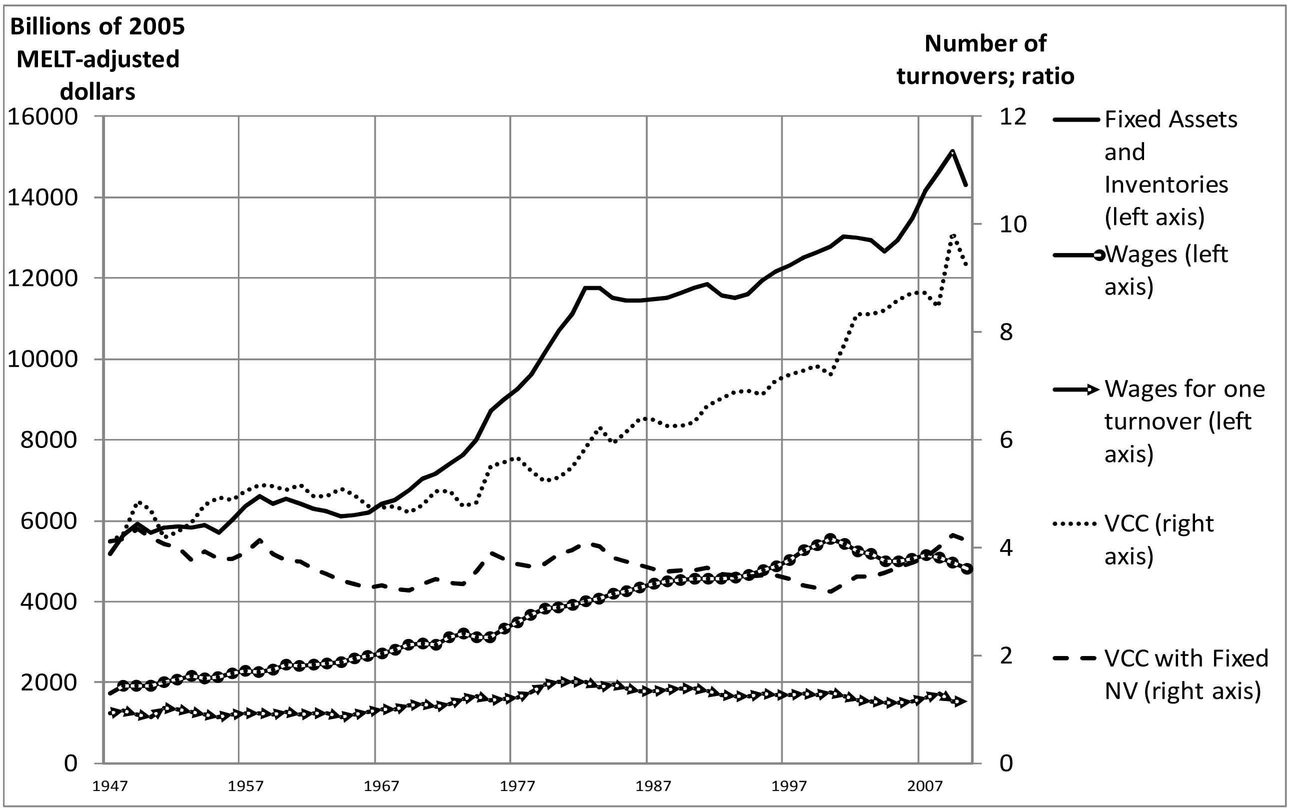
It is also worth examining the components that make up the VCC. The most interesting aspect of Figure 10 is that, in MELT-adjusted terms, the variable capital required for a single turnover has changed little over the post-war period. Increases in the total wages bill have been counteracted by increases in the number of turnovers per year.

The rate of accumulation of constant capital divides into four periods. Before 1964, it proceeded relatively slowly. From about 1968 it starts to grow rapidly until 1982, at the same time as the rate of profit drops most substantially. From 1982-1994, accumulation stagnates, then picks up again until the most recent crisis.

The VCC follows a similar pattern, though its increase at the end of the post-war is delayed by an increase in the stock of variable capital. It also continues to rise despite the stagnation of accumulation from 1982-94, because the stock of variable capital decreases from 1981 onwards.

If NV had not increased throughout the post-war period, then the VCC would have peaked in 1949.

Figure 10: The Value Composition of Capital and Its Components



Conclusion

The approach outlined in this paper has the following theoretical advantages:

- it accounts for the ROP in a way that is consistent with accounting conventions – i.e., it incorporates all profits;
- it allows the rate of depreciation to vary, meaning it can register the destruction of constant capital in crisis; and
- it incorporates the turnover time of variable capital into the analysis, allowing a major counter-tendency to be accounted for.

The empirical results are consistent with Marx's classic picture of the tendencies and counter-tendencies that influence the rate of profit. Over the period as a whole, the falling rate of profit was the tendency, in the sense that the rate of profit really did fall as capital accumulated. The main cause of this fall was the rising value composition of capital. Without the adjustment for turnover time, the VCC does not rise at all – a result that would rule out Marx's hypothesis if it were true. The new method used to calculate depreciation also helps to explain why crises are generally preceded by short-term increases in the ROP, and provides a leading indicator for crises.

What, if anything, do these results say about future trends in the rate of profit? We know that the crisis has only so far destroyed a small portion of constant capital (bringing it back from its peak of around $15 trillion 2005 MELT-adjusted dollars in 2009, down to $14.3, somewhere between its level in 2007 and 2008). On the other hand, we do not know if improvements in turnover time will re-materialise, or if the ROSV will be driven back up as a result of the current austerity agenda, or a new asset price bubble.

Further research might tell us why improvements in turnover time have followed the pattern observed in this paper. It might also be able to relax the assumption that, at the national level, the sum of surplus value is equal to the sum of profits. This would help us to measure the ROSV more accurately, and may mean that the effect of asset price bubbles is instead recorded as a temporary increase in unequal exchange (i.e., a change in the difference between profits and surplus value at the national level), rather than a temporary increase in estimate for the ROSV. There may also be a secular trend in unequal exchange and its influence on the ROP.

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