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Growth Accounting of the Value Composition of Capital and the Rate of Profit in the U.S. Economy: A Note Stimulated by Zarembka's Findings

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Abstract

The purpose of this article is twofold. On the one hand, to present a growth account of the evolution of the value composition of capital and in so doing to deal with some of the issues raised by Zarembka's (2015) contribution. And on the other hand, to review some crucial relations between the variables that relate to the movement of the rate of profit and the current predicament.

JEL Classification: B5, E1, O51

Keywords

composition of capital, capital accumulation, rate of profit, U.S. economy

1. Introduction

The question regarding the evolution of the composition of capital holds center stage in the discussions of the capital accumulation process and its periodic disruptions. The objective of this paper is to gain an insight into the existing relationships between variables that relate to the rate of profit which undoubtedly plays an instrumental role in conditioning the inherent volatility in the process of capital accumulation. The U.S. economy will serve as the reference country for the analysis to follow. The main thesis of this article is that the falling tendency in the rate of profit is consistent with the rising rate of surplus value and the increasing capitalization of production process as is reflected in the rising value composition of capital (VCC). The rising materialized composition of capital (MCC), a central variable in the movement of the VCC, and hence the rate of profit, has been questioned over the years by a number of authors and more recently by

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Zarembka (2015), who argues for a rather trendless variable. Despite the fact that this paper responds to his contention, the ultimate objective however is much broader in the sense that it attempts to highlight the importance of the determinants of the rate of profit in a rigorous and analytically tractable way.

The remainder of the paper is structured as follows: section 2 reviews the relationship between the rate of profit and the evolution of the materialized composition of capital and the rate of surplus value. Section 3 reviews the findings of Zarembka's (2015) recent contribution on the materialized composition of capital and contrasts these findings with those in the pertinent literature. Section 4 in a growth accounting exercise disentangles the growth of the value composition of capital into its constituent components and gives them precise empirical content. Section 5 shows that the rate of profit is inelastic to variations in the rate of surplus value and unitary elastic to changes in the materialized composition of capital, thus a small change in the latter might be decisive in the overall movement of the rate of profit. Finally, section 6 provides some concluding remarks.

2. The Compositions of Capital and the Rate of Surplus Value

The various expressions of the composition of capital have been the focal point of analysis of many radical authors amidst others Rosdolsky (1977), Steedman (1977), Fine and Harris (1979), and Weeks (1981). According to Shaikh (1987) the technical composition of capital (TCC), the "inner measure of the composition" of capital, refers to the vector of heterogeneous capital goods per worker. This is purely a theoretical measure for it refers to an array of heterogeneous use values and concrete labor and it is transformed to a scalar measure, when multiplied by the vector of labor values at the base year giving rise to an index called technical composition (TC). The later by the virtue of technological progress tends to rise secularly and in so doing affects the VCC, that is the ratio of the value of invested capital (C) over variable capital (v) both estimated in current prices. On the other hand, the materialized composition of (fixed) capital (MCC) has been discussed extensively in *Capital*, although the phrase MCC is not found in any of Marx's writings. The term has been coined by Shaikh (1987) as an intermediate step between the VCC and the TC. Formally, the MCC is defined as the ratio of the value of dead over living labor, C/l where l is the living labor or value added. Clearly, both the VCC and MCC depend on the TC, but also on the relative unit values of investment and wage goods as well as on income distribution. From these the TC is the crucial determinant for the relative unit values, which are expected to be very close to each other.[1] The connecting link between the VCC and the MCC is the rate of surplus value. Thus we may write,

$$\frac{C}{v} = \frac{C}{l}\frac{l}{v} = \frac{C}{l}\left(\frac{v+s}{v}\right) = \frac{C}{l}(1+e) \tag{1}$$

If the MCC (or in neoclassical terms the current prices capital-output ratio) is rising, then the VCC is also rising and if the rate of surplus value ($e = s/v$) is rising, then the VCC is rising by even more. Thus, if this is true, then it follows that a rising C/v reflects both the changes in the MCC, that is the ratio C/l, and the changes in income distribution. Thus, it is possible to have a combination of a constant or even falling MCC and a rising VCC as a result of a rising rate of surplus value. In effect, the MCC forms a lower boundary of the VCC.

[1]As is well-known the more aggregated the input-output tables, the closer the labor values to market prices. This is an empirical regularity which is ascertained in many studies in price-value deviations (Shaikh 1998; Tsoulfidis 2008; Mariolis and Tsoulfidis 2009; among others).

3. Zarembka's Estimates

In a recent contribution Zarembka (2015) argues that the estimates not only in Paitaridis and Tsoulfidis (2012) but also in other sources do not in effect show that the VCC (used interchangeably with the OCC) reflects changes in the TCC in the period 1964-2007 for the U.S. economy by claiming that only for the period 1948 to 1956 does the MCC rise while "[a]fter 1956 C/v rises only due to s/v rising" (Zarembka 2015).

In Figure 1 below, I present the two estimates of the MCC for the common (in the two studies) period 1964-2007. The dots in the figure are Zarembka's (2015) estimates of MCC measured on the right hand side (rhs) axis for meaningfully selected years and the continued dotted-line is the MCC estimates that are based on data derived by Paitaridis and Tsoulfidis (2012) and are also measured on the rhs axis. The difference between the two estimates arises because in Zarembka (2015) estimations of the MCC the total value added include only the part retained by the productive sectors of the economy, that is by subtracting from the total value added the value added of the unproductive sectors (in particular wholesale and retail trade; finance, insurance and real estate; professional services; management of companies; and a portion from food and drink services) of the economy. In similar fashion, the definition of fixed capital stock is restricted only to the production sectors of the economy. By contrast, in Paitaridis and Tsoulfidis (2012) the definition of the total value added is broader including the value added transferred to the unproductive sectors of the economy, together with their depreciation and material expenses, while the fixed capital stock of the private sector of the economy includes both production and circulation activities. Thus the two estimates of MCC, measured on the rhs axis of Figure 1, differ in that Zarembka's estimates of the capital stock and value added are both smaller than those in Paitaridis and Tsoulfidis (2012), whereas the estimated value added is much smaller than that in Paitaridis and Tsoulfidis (2012). As a consequence, the MCCs in the two estimates, although they display quite a similar pattern, nevertheless they differ in the year 1964 by 17.3 percent, whereas in the year 2007 the difference drops to 12.4 percent rendering the rise in the MCC in Zarembka's estimates less pronounced than those in Paitaridis and Tsoulfidis (2012). We cannot say anything more before we engage in a detailed examination of the overall movement of the MCC as well as its constituent components, and for this purpose we need to bring into the picture the VCC depicted in Figure 1 and measured on the left hand side (lhs) axis (for details on the source of data see the appendix).

In Figure 1, we observe a rising trend in the VCC throughout the period which is slowed down in the 1990s, and from the late 1990s returns to its rising path (see also estimates in Table 1). As for the movement of MCC, although it is subjected to long fluctuations, nevertheless there is a slightly overall rising trend, the details of which are examined through the use of a growth accounting technique.

Hence, it is important to point out that we are dealing with an old empirical issue, *i.e.* the evolution of the capital-output ratio, which in the classical tradition is expected to be rising, because technological progress is both capital-using and labor-saving, but this is not exactly what a host of old empirical studies find in the United States and other economies. These findings led Kaldor (1957) to postulate the alleged trendless capital-output ratio along with that of the profit share in income as the two most prominent from his list of six stylized facts of capitalist economies. More recent studies (Shaikh 1992; Duménil and Lévy 1993) show that starting from the nineteenth century the capital-output ratio, although subject to long fluctuations, nevertheless displays an overall rising trend. In particular, Duménil and Lévy (1993) in their study indicate a rising capital-output ratio from 1869-1919, and again from 1949-1989, where 1989 is the last year of their analysis. In these two periods the United States appears to undergo a labor-saving and capital-using, that is a classical-type, technical change, as the capital-output ratio is on the rise. In the interim period 1919-1949, the capital-output ratio falls sharply, most likely because

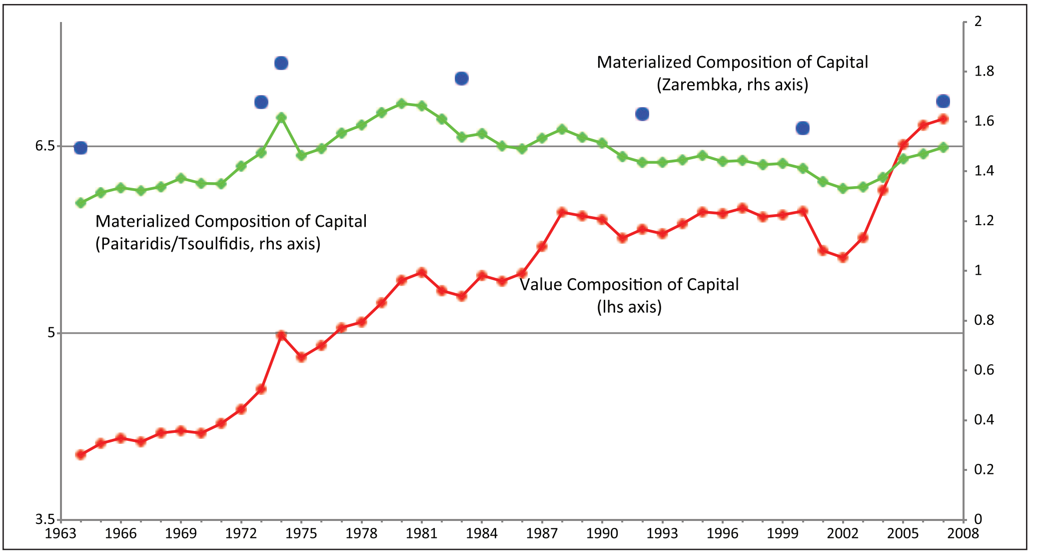

Figure 1. The VCC and MCC of capital adjusted for capacity utilization, USA, 1964-2007

of the massive business failures and devaluation of capital stock caused in the wake of the depression of 1930s; subsequently, the rising output especially during the World War years probably explains a great deal of this fall in the capital-output ratio. These developments suggest that the 1919-1949 period marks a structural change in the patterns of capital accumulation in the U.S. economy during which the capital-bias in technical change does not hold true. This seems to hold also for the 1980s, where the evidence based on data from the BEA (also displayed in Figure 1 above) shows that the capital-output ratio is falling indicating that the increase in output was higher than that of capital stock. Yet, from the mid-1990s and 2000s onwards, we observe that the classical or Marx-bias technical change is, once again, in place as the technological change increases mildly the capital-output ratio (or the MCC) in both sets of data presented in Figure 1. It is worth noting that the available empirical evidence from data spanning the period starting from the mid-to-late-nineteenth century until recent years shows an overall rising trend of the capital-output ratio for a number of countries. However, it should be stressed that the rising trends are punctuated by long-term fluctuations.[2]

4. Growth Accounting of the VCC

In what follows, we take a closer look at the components of the VCC during the period 1964-2007. The data that I have collated feature a part of the "golden age of accumulation" – which for the United States ends in the late 1960s – the so-called "silent depression" of 1970s and early 1980s, the new rising phase of the "new economy," and the onset of the "great recession" starting in the year 2007.[3] The VCC measured in terms of market prices (not in values) can be restated as follows:

[2]For detailed discussions, source of data, documentation, and pertinent literature see Mejorado and Roman (2014, especially ch. 7).

[3]The estimates, unless otherwise indicated, are based on data provided in Paitaridis and Tsoulfidis (2012: 225) and are given in the appendix.

$$\frac{C}{w_p} = \underbrace{\left[\frac{p_k}{p_y}\frac{K \cdot u}{y}\right]}_{MCC}\underbrace{\left(\frac{p_y y}{w_p}\right)}_{1+e} \tag{2}$$

where C is the value or the current price of invested capital (*i.e.* fixed capital stock); w_p stands for the wages of production workers (the variable capital); p_k and p_y are the price indices of capital and value-added respectively; K and y are capital and value-added in constant prices; finally, u is the capacity utilization rate.[4] The term in the brackets in equation (2) includes the constituent components of the MCC, whereas the term in the parenthesis is value added divided by production wages, *i.e.* $1 + e$. By taking growth rates of (2), we can disentangle the growth rate of the VCC into its components and in this growth accounting exercise to ascribe to each component its relative contribution to the overall growth of the VCC. Thus, we may write:

$$\widehat{\left(\frac{C}{w_p}\right)} = \underbrace{\widehat{\left(\frac{p_k}{p_y}\right)}}_{\text{Price Effect}} + \underbrace{\widehat{\left(\frac{K}{y}\right)}}_{\substack{\text{Technology}\\ \text{Effect}}} + \underbrace{\hat{u}}_{\substack{\text{Demand}\\ \text{Effect}}} + \underbrace{\widehat{\left(\frac{p_y y}{w_p}\right)}}_{\substack{\text{Distribution}\\ \text{Effect}}} \tag{3}$$

where a hat over a variable or a term indicates its annual average growth rate.

The first term of the right hand side of (3) signifies the contribution in the movement of the VCC of the relative price effect; the effect of technological change or the technical composition of capital on the movement of the VCC is captured by the second term. The third term stands for the growth rate of capacity utilization, which captures the strength of the demand relative to the supply effect,[5] and the last term stands for the distribution effect, that is the effect of the ratio of value-added to the variable capital or one plus the rate of surplus value of the economy $(1 + e)$.[6] The VCC therefore reflects not only the changes in the material features of the process of production, but also the induced changes in the structure of prices (relative prices) and income distribution as well as the strength of demand relative to supply. The effect of each and every one of these terms is given in Table 1 below. In the same table I display estimates based on data provided in Zarembka's article for the same variables and time period assuming that the relative price and demand factors are exactly the same, and reasonably assuming that the growth of the distributional factor cannot be any different from the estimates provided in Paitaridis and Tsoulfidis (2012). Consequently, one can estimate the growth rate of the value composition of capital on the basis of meaningfully selected time periods.[7]

[4]The source of data for the capacity utilization is the Federal Reserve Bank of St. Louis http://research.stlouisfed.org/fred2/series/TCU. I employed the average (instead of Zarembka's mid-year) capacity utilization rate of the entire (instead of just the manufacturing component) industrial sector of the U.S. economy. Furthermore, following Zarembka's (2015) idea I carried out my estimations by assuming that full capacity utilization is 90 percent. It goes without saying that the estimations are not affected by a different percentage of full capacity which is usually estimated around 82 percent, the so-called NAICU, that is the non-accelerating inflation capacity utilization rate (http://www.frbsf.org/economic-research/publications/economic-letter/1996/november/capacity-utilization-and-structural-change/).

[5]In Marx's analysis of *Capital* and also in classical economists, by and large, it is assumed that normal capacity utilization holds and so the demand relative to supply effect is zero (Tsoulfidis 2010: ch. 5).

[6]The distribution effect can be further broken down, for instance to the growth rates of productivity and real wages, but such a break down and detailed estimates go beyond the scope of the present paper.

[7]The interested reader may find the detailed data and their sources in the appendix.

Table 1. Growth accounting of the value composition of capital, annual rates.

Growth Rates Periods	Value Composition of Capital (1)=(2)+(3)+(4)+(5)	Relative Price Factor Effect (2)	Technical Change Factor Effect (3)	Demand Factor Effect (4)	Distributional Factor Effect (5)
1964-2007	1.19%	–0.59%	1.11%	–0.14%	0.82%
1964-1973	1.37%	–0.52%	1.80%	0.34%	–0.26%
1973-2007	1.15%	–0.61%	0.92%	–0.27%	1.10%
2000-2007	1.67%	–1.05%	2.04%	–0.16%	0.83%
		Zarembka's (imputed) Estimates			
1964-2007	1.09%	–0.59%	1.01%	–0.14%	0.82%
1964-1973	1.03%	–0.52%	1.46%	0.34%	–0.26%
1973-2007	1.11%	–0.61%	0.89%	–0.27%	1.10%
2000-2007	1.78%	–1.05%	2.154	–0.16%	0.83%

The average annual growth rate of the VCC adjusted by capacity utilization during the period 1964-2007 is estimated at 1.19 percent, whereas for the same time period the growth rate of the distributional effect, that is one plus the rate of surplus value, is 0.82 percent. These estimates result in an overall falling rate of profit.[8] Meanwhile, the adjusted for capacity utilization nominal MCC grows mildly over the years, at the average annual rate of 0.37 percent $(\approx -0.59 + 1.11\% - 0.14\%)$ and its trajectory is displayed in Figure 1. In the same figure, we observe that after 2000 the growth rate of the nominal MCC increases at a much higher rate estimated at 0.83 percent $(\approx -1.05\% + 2.04\% - 0.16\%)$. Zarembka's estimation of the annual growth rate of MCC during the 1964-2007 period is only 0.28 percent $(\approx -0.59\% + 1.01 - 0.14)$, which incidentally is not very different from that for the entire period 1948-2011 estimated at approximately 0.27 percent.[9] The MCC though for the period 2000-2007, selected for being common to both sets of data, is in the range of 1.33 percent which indicates a nearly fivefold increase relative to the average for the entire period. The results for the period 1973-2007 show that the distributional factor increases at the annual growth rate of 1.10 percent, somewhat higher than that of the technological factor whose annual growth rate is only 0.87 percent. Thus, the distributional factor is decisive in the movement of the MCC in both sets of data. The higher growth rate of the distributional factor is attributed mainly to labor productivity whose growth rate was much higher than that of the real wage (Paitaridis and Tsoulfidis 2012).

The slow growth in technological progress during the 1973-2007 period, together with the negative growth in the rate of capacity utilization and the fact that the prices of capital goods grew at a rate lower than that of the value-added deflator, led to a negligible increase in the MCC in both sets of data. Such a result should not come as a surprise given the long stagnation period that was not accompanied with sufficient technological change and devaluation of capital and falling prices.[10] Although the growth rate of the investment-goods deflator lags behind that of the value-added deflator, nevertheless the ratio of the two indexes cannot be (for reasons that have to

[8]In fact, given that the rate of surplus value increases during the same time period by 1.12 percent (see the appendix) and the value composition of capital by 1.19 percent, it follows that the general rate of profit (surplus value over capital stock) falls by an annual rate of -0.07 percent $(= 1.12\% - 1.19\%)$.

[9]In fact, Zarembka (2015) estimates the MCC for the period 1948-2011 and argues that only for the period 1948 to 1956 the MCC rises and then remains stable.

[10]Furthermore, the effect of new (mainly information) technologies in the 1980s was not reflected in the data of total factor productivity giving rise to Solow's (1987) often-cited aphorism: "we see the computer age everywhere except in the productivity statistics." This perhaps has to do with the time lag needed for new technologies to diffuse and spread their results in the entire economy (Dunn 2009: 230-1, 248).

do mainly with the rapid diffusion of technology across sectors) out of touch with each other and in fact they are not very different from one and, of course, they become equal to one in their common base year (see Table A1 in the appendix).

5. The Rate of Profit and its Components

The salient question that emerges is expressed as follows: to what extent, if any, does a relatively slow increase in the MCC cause the rate of profit to fall, in view of a rapidly rising rate of surplus value? In answering the question I express the rate of profit by including in its definition the MCC and in so doing put limits to the growth of the rate of surplus value since the total labor time $l = s + v$, thus we may write

$$r = \frac{s}{l}\frac{l}{C} = \frac{s/v}{1+s/v}\frac{1}{C/l} = \frac{e}{1+e}\frac{1}{Q} \tag{4}$$

where, $e = s/v$, the rate of surplus value, and $Q = C/l$ the capital-value added or labor ratio (the analog of the MCC). The expectation is that in the long run e and Q will be both rising, but the effect of the rising rate of surplus value, e, will be limited since the potential maximal value of the term $e/(1+e)$ cannot exceed a ceiling which is equal to one. In the usual microeconomics language, the rate of profit is highly inelastic with respect to (w.r.t.) e. For this purpose, we differentiate partially the rate of profit w.r.t. e, and we get

$$\frac{\partial r}{\partial e} = \frac{Q(1+e) - eQ}{[Q(1+e)]^2} = \frac{1}{(1+e)^2}\frac{1}{Q} \tag{5}$$

And in terms of elasticity of r w.r.t. e, we can write

$$\frac{\partial r}{\partial e}\frac{e}{r} = \frac{1}{(1+e)^2 Q}\frac{e}{r} = \frac{1}{(1+e)^2 Q}\frac{e}{\frac{e}{(1+e)}\frac{1}{Q}} = \frac{1}{1+e} \tag{6}$$

Clearly the higher the rate of surplus value, the lower its effect will be on the movement of the rate of profit. In the U.S. case, since the rate of surplus value in the post-1997 years ranges in the area of the 350 percent level (Paitaridis and Tsoulfidis 2012), it follows therefore that the elasticity of the rate of profit w.r.t. the rate of surplus value ranges between 1/4 and 1/5.[11]

In similar fashion, the evolution of Q, although it remains a key empirical question, nevertheless its upward movement is not limited by any upper boundary. Moreover, the partial elasticity of the rate of profit w.r.t Q gives

$$\frac{\partial r}{\partial Q}\frac{Q}{r} = -\frac{e(1+e)}{(1+e)^2 Q^2}\frac{Q}{\frac{e}{(1+e)}\frac{1}{Q}} = -1 \tag{7}$$

Thus we get a unitary elastic r w.r.t. Q, which means that if Q changes by say one percent, *ceteris paribus*, the rate of profit changes also by one percent, but in the opposite direction.[12] And given

[11]The estimates of the Greek economy give a rate of surplus value somewhat higher than 200 percent (see Tsoulfidis and Tsaliki 2014).

[12]The interested reader may find alternative and more complex proofs of the above relations in Mariolis (2010: ch. 10).

the high level of the rate of surplus value in the U.S. economy (see above), then it follows that a rise in the MCC by one percent requires a quadruple or quintuple percentage increase in the rate of surplus value in order to maintain the rate of profit at the same level. This is equivalent to saying that the movement of the MCC (capital-output ratio) becomes an increasingly more important determinant of the trend of the rate of profit and the effect of the rising rate of surplus value on the rate of profit progressively weakens. A corollary from this discussion might be that the so-called austerity programs that have been instituted in a number of debt-ridden EU countries may have only a minimal effect in restoring profitability assuming, of course, that the capital-output ratio displays even a slightly upward trend in the face of high rates of surplus value.

6. Concluding Remarks

In this study, I set out to show that by disentangling the growth rate of the value composition of capital into the growth rates of its constituent components, we can obtain a better understanding of its long-run evolution. In this growth accounting exercise, we found that the rising path of the VCC is mainly due to the rising technical composition effect and less to the distribution effect, while the effects of relative prices and capacity utilization were found to be minimal. Under these circumstances and given the exceptionally high rate of surplus value in the United States and other OECD economies, I show that even a slightly rising MCC is often sufficient to dominate the effect of the rising rate of surplus value and finally to lead to a falling rate of profit. In effect, the rate of profit displays a falling tendency since the year 1997, but even before that its level remained significantly lower than that of the 1960s or even 1970s, and such a lower profitability makes the system more crisis-prone.

Data Appendix

This appendix reports the data used in our estimations and the key steps in the analysis of the growth accounting exercise.

Table A1. Key Variables and their Growth Rates for Selected Periods.

Years	C/W_p	P_y	P_k	K/y (const.)	C/Y (cur.)	CU	C/Y (CU)	C/W_p (CU)	1+e	(K/y)**	(C/Y)* (CU)	e
1964	4.23	0.23	0.30	1.05	1.34	85.6	1.27	4.02	3.16	1.24	1.49	2.16
1973	4.64	0.33	0.40	1.24	1.50	88.3	1.47	4.55	3.09	1.41	1.68	2.09
1974	5.27	0.36	0.44	1.41	1.71	85.1	1.62	4.98	3.08	1.60	1.83	2.08
1983	6.36	0.69	0.81	1.57	1.85	74.9	1.54	5.30	3.44	1.81	1.77	2.44
1992	6.51	0.81	0.92	1.41	1.60	80.6	1.44	5.83	4.06	1.60	1.63	3.06
2000	6.61	0.85	0.91	1.47	1.56	81.4	1.41	5.98	4.24	1.64	1.57	3.24
2007	7.51	1.00	0.99	1.70	1.67	80.5	1.50	6.72	4.49	1.91	1.68	3.49
					Average Annual Growth Rates							
1964-2007	1.34	3.38	2.80	3.38	2.80	–0.14	0.38	1.19	0.82	1.01	0.28	1.12
1964-1973	1.03	3.77	3.25	1.80	3.58	0.34	1.63	1.37	–0.26	1.46	1.29	–0.38
1973-2007	1.42	3.28	2.68	0.92	0.32	–0.27	0.04	1.15	1.10	0.89	1.11	1.52
2000-2007	1.83	2.24	1.20	2.24	1.20	–0.16	0.83	1.67	0.83	2.15	0.95	1.08

Where C is the nonresidential fixed capital stock estimated in current prices with data from the BEA; W_p is the wage bill of the employed and the self-employed population in the production sectors of the economy (for details of the estimations see Paitaridis and Tsoulfidis 2012); P_k, P_y are the investment goods and the value-added deflators, respectively. The source of data is BEA with 2009 as the base year. K is the capital stock in constant prices; y is the value added in constant prices; CU is the capacity utilization rate with 90 percent as the full level (data are provided in the Fed of St. Louis (http://research.stlouisfed.org/fred2/series/TCU). Estimates for the rate of surplus value, *e,* are provided in Paitaridis and Tsoulfidis (2012). The starred variables are those derived on the basis of Zarembka's (2015) data. The growth rates are estimated by the formula $100 * \ln(x_t / x_{t-1}) / (n-1)$, where x is the variable whose growth rate we want to estimate, t stands for the year, and n is the number of years.

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