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INEQUALITY, TECHNICAL CHANGE OR LEVERAGE?

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Abstract Exploring the determinants of growing income inequality, I show how constant capital income shares and inequality can be explained without technical change. I show why despite the fact that technical change is capital augmenting, rather than labor augmenting, it may not be sufficient to explain the last few decades of growing capital share of income and inequality due to the balancing mechanism of depreciation. Finally, I show how the growth of leverage, which coincided with the growth of inequality, can explain the growth of capital share of income and inequality. I introduce a simple model of leverage and business cycle and show how leverage is justified by more leverage and how depressed interest rate allows leveraging and inequality growth to persist.

Keywords: Inequality, Technical Change, Leverage, Credit, Business Cycle

JEL: E10, E20, E22, E25, E30

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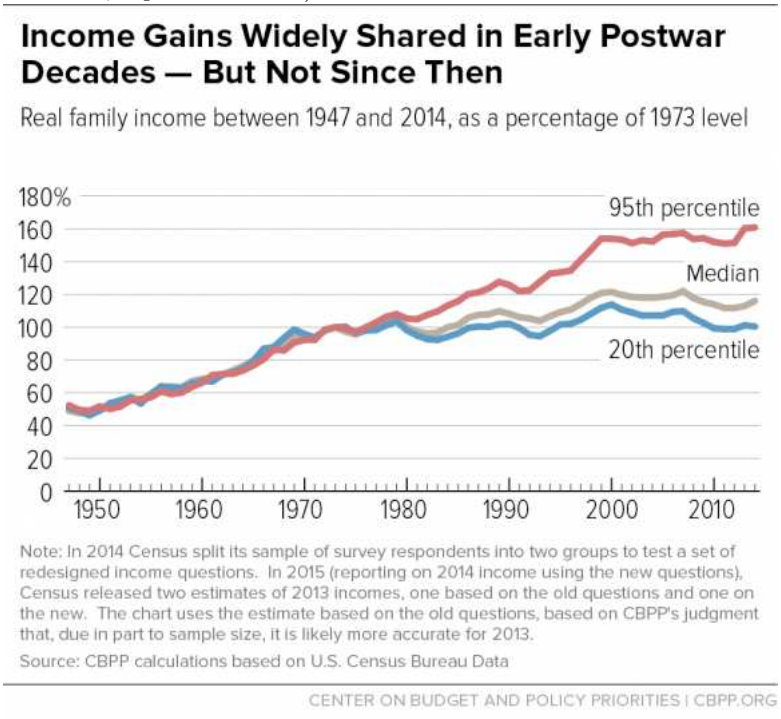
1 Introduction

"To determine the laws which regulate this (income) distribution is the principal problem in Political Economy" (Ricardo 1891 in reference to the distribution of income between land, capital and labor).



The census family income data, as compiled by CBPP (2015), suggest that since the late 70's the share of income gains between rich and poor have been diverging. Since "wages make a small fraction of very top incomes, and trends in wage inequality can only explain a small fraction of the trends in very top income shares" (Pikkety and Saez 2001), the goal of this paper is to explore the determinants of income distribution between capital and labor. Karabarbounis and Neiman (2013) note that global labor share of income has significantly declined since the early 1980s, with the decline occurring within the large majority of countries and industries.

2 Model

The quasi-marginalist focus of Ricardo on rent for land and profit for capital did not carry into modern economics but was somehow replaced with the hybrid of *rent for capital* often referred to as interest on capital. This concept of rent obscures the role of profits and their effect on growth and inequality. I assume that firms own the capital and are owned by the rich. Individual agents may be thought of as poor with varying degrees of rich. This structure accommodates a continuum of classes rather than just one or two classes (O'connell 1995). I assume zero saving rate out of wages (Pasinetti 1962). The rich divide their wealth between bonds and stocks but bonds, in a closed

economy, sum to zero in aggregate. Hence, interest on debt plays no roll in aggregate and capital's share of income equals the profits:

$$\pi = F(K, L) - w \cdot L$$

where π is the aggregate profit, F is the product, K capital, L labor and w the wage. I assume that markets are competitive and that all production functions are concave with constant returns to scale in both capital and labor and therefore, from profit maximization, labor earns its marginal product $w = MPL$. Using Euler's rule, the profits equal:

$$\pi = MPK \cdot K + MPL \cdot L - MPL \cdot L = MPK \cdot K$$

In this model the firms earn the marginal product of their capital. This structure solves an age-old conundrum that "If all inputs were paid their value marginal product, the firm would suffer losses" (Romer 1989 attributing to Schumpeter 1942).

2.1 Inequality

Inequality θ is defined as the ratio of profits to wages or profit per worker, to wage (Ricardo 1891):

$$\theta = \frac{\pi/L}{w}$$

This definition of income inequality focuses on the disparity between wealth derived income and wage derived income. It does not make any assumptions regarding the concentration of wealth. Under the assumption of competitive markets both capital and labor earn their marginal product. Therefore, inequality takes the form:

$$\theta = \frac{MPK \cdot K/L}{MPL} = \frac{MPK \cdot K}{MPL \cdot L} = MRS \cdot k$$

where $k = K/L$ is capital per worker. Hence, inequality, in this basic scenario, equals the marginal rate of substitution multiplied by capital per worker. It is interesting to note the natural dynamics of inequality before introducing technical change. If capital accumulates faster than labor, the marginal productivity of capital decreases more than the marginal productivity of labor. As a result, there is a natural balancing mechanism that keeps the income share of capital from diverging. Therefore, technical change is not necessary for explaining a constant share of income (Hicks 1932, Kaldor 1957 and 1961, Pasinetti 1962, Kennedy 1964, Drandakis and Phelps 1966). Perhaps, however, technical change can explain the divergence in the share of income since the 70', which motivates this work as mentioned in the introduction.

2.2 Induced Technical Change

I define technical substitution to include changes only in the quantities of capital and labor without any change to the parameters or the structure of the production function. Technical change, on the other hand, is a replacement of the production function

with another or change in the structure or the parameters of the production function, including the elasticity of substitution.

As capital accumulates, the return on capital $R = \pi/K$, which equals the marginal product of capital, decreases. The marginal entrepreneur who wishes to attract capital is forced to play "catch-up" by implementing production functions with ever higher marginal productivity of capital. This "rat race" is the key motivation for technical change, rather than factor saving.

I rely on others' treatment of the supply side of technical change (see Kaldor 1957, Kennedy 1964, Drandakis and Phelps 1966, Romer 1986 and 1990, Segerstrom et. al 1990, Aghion and Howitt 1990, Grossman and Helpman 1990, Young 1991, Acemoglu 2002, Perreto and Seater 2013) and focus on the demand side. Regardless of the mechanism that supplies novel production functions, the choice by entrepreneurs of which production function to implement can be easily modeled based on profit maximization. Entrepreneurs rank novel production functions by the increase in profit per unit of implementation cost , or in other words, according to the return on investment:

$$ROI = \frac{\pi' - \pi}{cost} = \frac{MPK' - MPK}{cost} \cdot K \approx \frac{MPK' - MPK}{cost}$$

where ROI is the return on investment, π' is expected profit and MPK' the marginal product of capital for a novel production function. Since capital is the same for all production functions, the ranking of novel production functions boils down to the increase in marginal productivity of capital (return) per unit of implementation cost (investment). Therefore, it is capital that is being augmented by induced technical change rather than labor (Hicks 1932, Kaldor 1957 and 1961, Pasinetti 1962, Kennedy 1964, Samuelson 1965, Acemoglu 2000, 2002). Consequently, "technological change provides the incentive for continued capital accumulation" (Romer 1989). I only comment in passing that this analysis supports the view of skilled labor as an augmenting factor of technical change (Katz and Murphy 1991, Autor et. al 1997, Galor and Moav 2000) instead of the other way around (Acemoglu 1998, 2002).

Since cost of technical change plays a key role (Blanchard 1997, Zuleta 2008), not just the degree of capital augmentation, and since the elasticity of substitution is also subject to change, it is impossible to predict whether inequality will increase or decrease as a result of a capital augmenting technical change. Moreover, capital augmenting technical change has a "Creative Destruction" (Schumpeter 1942, Aghion and Howitt 1990) balancing effect on inequality by obsoleting and depreciating previously accumulated capital.

In summary, as capital accumulates capital-returns decrease and motivate technical change, which increases returns (and requires skilled labor) but depreciates capital. Therefore, even with an elucidated bias in favor of capital augmenting technical change it seems that the "technical change view of inequality dynamics described above is not the whole story" (Piketty and Saez 2001:4).

2.3 Leverage

Schularick and Taylor (2012) note the "massive expansion of leverage that emerged after the war ...money and credit began a long postwar recovery, trending up rapidly and then *surpassing their pre-1940 levels compared to GDP by about 1970*" . The

expansion of leverage coincided with the increase in inequality and therefore warrants investigation.

In order to understand the possible effects of leverage expansion on inequality, I introduce rent of capital by way of import or fractional reserve into the basic model. Leverage multiple m along with endogenous capital K determine total assets $A = m \cdot K$, production is a function of assets and labor $F(A, L) = F(K, m, L)$, and rented capital $A - K = (m - 1) \cdot K$ incurs interest i. Net profits of the production sector of the economy π_p equal leveraged profits less the cost of leverage:

$$\pi_p = MPA \cdot m \cdot K - i \cdot (m-1) \cdot K = K \cdot [MPA \cdot m - i \cdot (m-1)] = K \cdot [MPA + (MPA - i) \cdot (m-1)]$$

When leveraged profits are larger than unlevered profits there is an incentive to leverage:

$$K \cdot [MPA + (MPA - i) \cdot (m - 1)] > K \cdot MPK$$

This condition can be re-written as:

$$(MPA - i) \cdot (m - 1) > MPK - MPA$$

where the left hand side (LHS) of the inequality is the incentive to leverage while the right hand side (RHS) is the incentive to de-leverage. Since assets are larger than capital $A > K$, the marginal product of capital is larger than the marginal product of assets $MPK > MPA$ and therefore the RHS incentive to de-leverage is positive and increasing in leverage multiple m. Despite that, as long as the marginal product of assets is larger than the interest rate $MPA > i$, a large enough leverage multiple m can tip the scales in favor of the LHS and create an overall incentive to leverage. Therefore, *leverage is justified by more leverage*. This simple model explains the gradual increase in leverage on one hand and the abrupt de-leveraging. As leverage multiple m grows, assets A and the economy as a whole grow, causing the marginal product of assets MPA to decrease and require an even higher leverage multiple m for maintaining the overall leverage incentive positive. However, once the incentive to de-leverage dominates, it incentivizes zero leverage or a leverage multiple of unity.

If interest rate i is determined by lenders' perceived risk or by capital rental demand and supply, it rises to meet the declining marginal product of assets MPA as the leverage multiple m increases, which stops the leveraging cycle and may even begin a de-leveraging cycle. If, however, interest is depressed, the leveraging process persists.

If leverage is created by way of fractional reserve then the cost of leverage incurred by the production sector equals the profit of the financial sector π_f and therefore the total profit in the economy equals $\pi = \pi_p + \pi_f = MPA \cdot A$. In both cases, import of rented capital and fractional reserve, leverage increases capital returns by design and therefore the nominator of inequality increases:

$$\theta = \frac{MPA \cdot A > K \cdot [MPA + (MPA - i) \cdot (m - 1)] > K \cdot MPK}{MPL \cdot L}$$

If, as a result of leveraging, employment levels L increase then the marginal productivity of labor MPL decreases. Therefore, leverage leads to increase in capital share of income and inequality, which leads to faster capital accumulation, further increasing inequality.

Leveraging can replace technical change as a way to boost capital returns when the marginal product of assets MPA declines. Alternatively, capital augmenting technical change may supplement leveraging by revamping MPA and keeping the overall

incentive to leverage positive by increasing LHS while decreasing RHS. As before, the shadow cost and balancing effect of technical change is depreciation. Therefore, the effect of capital augmenting technical change on inequality is indeterminate as before.

3 Conclusions

It seems that constant capital share of income can be explained without technical change by the inherent balancing mechanism of decreasing marginal product of capital as capital levels increase. I have shown why induced technical change is, first and foremost, capital rather than labor augmenting. This could have been an explanation for the divergence between capital and labor shares of income but for the balancing mechanism of depreciation, which reduces capital as it increases its marginal productivity.

Leverage, however, increases the capital share of income without a balancing mechanism. As a result, capital share of income and inequality increase. Consequently, the accumulation of capital accelerates, which further increases inequality. I have introduced a simple leverage and business cycle model and have shown how leverage is justified by more leverage and that if interest rate is not allowed to rise and curb leveraging, it persists along with growth in inequality.

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