



The relationship between factor shares and economic development

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ABSTRACT

The stability of factor shares has long been considered one of the “stylized facts” of macroeconomics. Most factor share studies, however, acknowledge only two factors of production (total capital and total labor), which yields misleading results. I distinguish between reproducible and non-reproducible factors of production. I disentangle physical capital's share from natural capital's share and human capital's share from unskilled labor's share. Results reveal that non-reproducible factor shares decrease with the stage of economic development, and reproducible factor shares increase with the stage of economic development. This evidence suggests that studies relying on the macroeconomic paradigm of constant factor shares should be revisited. The evidence also supports endogenous growth models that allow technical progress to manifest itself via changes in factor shares.

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1. Introduction

Some factor share studies, such as Gollin (2002), present empirical evidence suggesting that factor shares are unrelated to output per worker. Others, such as Zuleta (2008a), conclude that factor shares vary systematically across countries. Despite conflicting empirical evidence and despite the doubts about the constancy of factor shares expressed by Keynes (1939) and Solow (1958), most researchers accept the claim that factor shares are constant, which was made by Phelps Brown and Weber (1953) and reiterated by Kaldor (1961), as a “stylized fact” of macroeconomics. As a result, the standard assumption in studies involving aggregate production functions is that capital shares and labor shares are constant over time and across countries and equal to $1/3$ and $2/3$, respectively.

Factor shares are not constant across countries when factors of production are properly defined and measured. The key step is making a distinction between reproducible factors and non-reproducible factors. In most factor share studies, only two factors of production, capital and labor, are acknowledged. I show that failure to acknowledge more than two factors yields results and conclusions that are misleading at best.

When discussing capital, economists generally refer to physical or human capital—physical capital being tools, machinery, and structures, and human capital encompassing education, health, and training. However, standard empirical measures of capital's share include the fractions of income paid to physical capital as well as natural capital, which encompasses all natural resources including land, minerals, and oil. Physical capital and natural capital are two distinct factors. Physical capital is reproducible, meaning it can be accumulated, whereas natural capital is non-reproducible and cannot be accumulated.¹ Therefore, any claim about the standard capital share and how it relates to the stage of economic development is

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¹ Non-reproducible factors are those factors with which an economy is endowed. Reproducible factors have to be produced.

really a claim about two separate factor shares and their collective relationship with the stage of economic development. Likewise, standard empirical measures of labor's share entangle the fractions of income paid to human capital, a reproducible factor, and unskilled labor, a non-reproducible factor.

Using estimates of physical and natural capital stocks provided by [The World Bank \(2006\)](#), I disentangle physical capital's share from natural capital's share. I use returns to education and educational attainment data from [Psacharopoulos and Patrinos \(2004\)](#) and [Barro and Lee \(2010\)](#) to disentangle human capital's share from unskilled labor's share. The evidence reveals that non-reproducible factor shares decrease with the stage of economic development and reproducible factor shares increase with the stage of economic development. This finding has theoretical and empirical implications. First, it provides support for theoretical growth models, such as those presented by [Peretto and Seater \(2009\)](#) and by [Zuleta \(2008b\)](#), that incorporate factor-eliminating technical progress. Secondly, it suggests that any theoretical or empirical study relying on Kaldor's claim that factor shares are constant should be revisited.

The remainder of the paper is organized as follows. In Section 2, I discuss the economic theory pertaining to the relationship between factor shares and economic development as well as the background for my empirical analysis in subsequent sections. In Section 3, I disentangle physical capital's share from natural capital's share, and in Section 4 I disentangle human capital's share from unskilled labor's share. In both sections, estimates of factor shares are presented, and a formal analysis of the relationship between each share and output per worker is provided. In Section 5, I analyze the relationship between output per worker and the fractions of income paid to all reproducible factors (physical capital plus human capital) and all non-reproducible factors (natural capital plus unskilled labor). Section 5 also incorporates the relative abundance of factors into the analysis and provides a more direct test of the theories discussed in Section 2. Section 6 discusses the contribution of the paper to the literature. Section 7 concludes.

2. Factor shares and economic development

2.1. Theoretical motivation

The main contribution of this paper is the empirical work revealing a systematic relationship between factor shares and economic development. However, a brief discussion of the relevant theoretical models provides a useful backdrop for the analysis.

The work of [Cobb and Douglas \(1928\)](#) and [Kaldor \(1961\)](#) suggesting that factor shares were constant created a paradigm in macroeconomics. However, new theories and a general refinement in the way we think about factors and factor shares call into question the precedent set forth by Cobb and Douglas and Kaldor. Recent work in endogenous growth theory distinguishes between reproducible and non-reproducible factors and posits that technical change can alter factor shares. These theoretical advances yield specific predictions about the systematic relationship between the stage of economic development and both reproducible and non-reproducible factor shares across countries.

Perpetual economic growth requires that the marginal products of reproducible factors of production be bounded away from zero ([Jones and Manuelli, 1997](#)). This means that the non-reproducible factors must either be augmented or eliminated. Virtually all analyses focus on augmentation. However, [Peretto and Seater \(2009\)](#) develop a theory of endogenous growth that focuses on factor elimination. Factor intensities are allowed to change endogenously via spending on Research and Development, and this serves as the catalyst for growth.² As economies advance, non-reproducible factors of production become less important, and reproducible factors of production become more important. In other words, the theory predicts that non-reproducible factor intensities should decrease with output per worker, and reproducible factor intensities should increase with output per worker.^{3,4}

In a related paper, [Zuleta \(2008b\)](#) develops an endogenous growth model in which growth occurs via capital using and labor saving technological progress. Like Peretto and Seater, Zuleta incorporates endogenous factor intensities. Though there are slight differences between the two models, the empirical implications pertaining to factors shares are the same. Namely, reproducible factor shares are positively related to the stage of economic development, and non-reproducible factor shares are negatively related to the stage of economic development.

There are exogenous growth models that yield similar predictions. [Hansen and Prescott \(2002\)](#), who build on [Galor and Weil \(2000\)](#), propose a model of transition from a primitive to an advanced economy. In their model advancements in the

² Since non-reproducible factors cannot be accumulated they create diminishing returns to the reproducible factors, assuming production is characterized by a nonlinear function that is homogeneous of degree one. Unless the non-reproducible factors are augmented or eliminated, the marginal products of the reproducible factors will decline until additional accumulation of reproducible factors is no longer warranted, and growth will stop. Augmenting the non-reproducible factors effectively increases the amount of non-reproducible factors. This offsets the drag that non-reproducible factors have on the marginal products of the reproducible factors, thereby sustaining the incentive for reproducible factors to be accumulated. With factor elimination, the economy develops a technology that uses only reproducible factors of production. Since non-reproducible factors become inessential to the production process, the fixed nature of non-reproducible factors no longer poses a threat to growth.

³ The term "factor intensity" refers to the elasticity of output with respect to a factor of production.

⁴ The Peretto and Seater theory allows for monopolistic competition in the intermediate goods sector. As a result, firms earn excess profits, and payments to the factors of production do not exhaust firm revenues. Consequently, factor intensities and factor shares, though related, are not equivalent. However, to the extent that factor shares measured using national income account data are reasonable estimates of factor intensities, the theory suggests that non-reproducible factor shares should decrease with output per worker and reproducible factor shares should increase with output per worker.

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