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A PRIMER ON THE DRIVERS OF LABOR INCOME SHARE

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Abstract

Despite its long pedigree, studies on the role of the substitution elasticity between capital and labor mostly assume a homogeneous labor market. This paper extends this literature by considering a heterogeneous labor market with capital-skill complementarity. Technological advancement, global integration, regulation of labor market and structural transformation also play important roles in the distribution of income. However, the process of structural transformation, technological advancement, and the promotion of skill deepening varies significantly across developing economies. It is imperative that we identify the factors behind these diverse trends to design policies for a more equitable distribution of income in the developing economies. To this extent, we suggest a deeper analysis of the role of firm restructuring, skilled emigration, and premature deindustrialization, among others.

Keywords: labor income share, substitution elasticity, drivers of labor income share

JEL Classification: E24, E22, E25

Contents

"The great mystery of the modern theory of distribution is why anyone regards the share of wages and profits as an interesting problem."

– Blaug (1996: 467)

1. INTRODUCTION

Economists have always been concerned with the functional distribution of income. David Ricardo's statement, published back in 1817, serves as a testimony to this fact, "*To determine the laws which regulate [this] distribution is the principal problem in political economy.*" As emphasized by both Atkinson (2009) and Glyn (2009), the study of factor income shares play an important role in understanding the relationship between national income and personal income, the relationship between wage inequality and wealth inequality, and how they link to overall income inequality and concerns for fairness in different sources of income.

A large body of research documents a global decline in the labor income share and offers several theoretical explanations for this phenomenon (Elsby, Hobijn, and Sahin 2013; Piketty 2014). According to the "Accumulation view," a decline in the labor income share is driven by a decline in the relative price of capital (Karabarbounis and Neiman 2014) or a rise in the stock of capital relative to income through a growth in aggregate savings (Piketty 2014). On the other hand, Rognlie (2015) supports the "scarcity view," which assumes an increase in capital share due to the relative scarcity of some forms of capital, as opposed to the "accumulation view." In either case, the assumption of a non-unitary elasticity of substitution (σ) between capital and labor plays a crucial role in the movement of the labor income share. The crucial role of σ in analyzing the factor income shares has been noted since the seminal work of Hicks (1932) and Robinson (1933). Following the Hicksian partial elasticity of substitution, Elsby, Hobijn, and Sahin (2013) demonstrate the relationship between labor income share (L_S) and σ as $dlnL_S = -(1 - L_S)\frac{\sigma-1}{\sigma}dln(\frac{K}{L})$. It suggests a drop in L_S when σ > 1. With σ = 1, factor income shares remain constant. If capital and labor are gross complements, then a decline in effective capital per unit of effective labor can lead to a more than proportionate increase in the rental rate compared to wages. This mechanism can lead to a lower income share of labor (Alvarez-Cuadrado, Long, and Poschke 2015). At the same time, the "Accumulation view" assumes capital and labor to be gross substitutes. To this extent, either σ > 1 (capital and labor as gross substitutes) or σ < 1 (capital and labor as gross complements) can account for changes in the labor income share and rightly so, researchers are widely divided on this issue. We extend the theoretical analysis by considering both homogeneous and heterogeneous labor market, and the comparative statics outcomes on the labor income share.

We discuss empirical findings on the main drivers of labor income share under three broad categories: (a) technological change and capital intensity, (b) structural transformation and (c) institutional changes. As the burgeoning literature shows, there could be numerous channels at work within these broad categories. Since these channels overlap and interact to a large extent, it is difficult to attribute changes in the labor income share to a specific driver. For example, the declining the rate of unionization falls under the broad category of institutional change, and it leads to a decline in labor's bargaining power and consequently to a decline in the labor income share. However, the process of globalization, or the participation of a country into the global value chain could cause a decline in the unionization rate. Moreover, the participation of global value chain is allowed by the reduction in shipping or communication cost through the technological change. At the same time, the reduction of corporate income tax rate can also be categorized under institutional change and globalization if it is implemented because of international pressure or is driven by capital mobility across nations. Thus, the drivers of labor income share are intertwined and difficult to identify unless we have rigorous data to support the empirical analysis.

In this paper we follow a systematic way to review the theoretical models and empirical studies, and then highlight several potential areas of research on the drivers of labor income share. Section 2 discusses the theory, which is followed by a comprehensive analysis of empirical studies in section 3. Section 4 concludes by summarizing the potential areas of future research.

2. THEORY

2.1 Production Technology

We begin with a simple two-input production function with technology to understand the role of technological change and factor ratios in productivity growth and factor shares. In equation (1), output (Y) is produced with capital (K), labor (L) and technological progress (A).

$$Y = f(K, L, A) \tag{1}$$

Hicks (1932) defined technological progress that leaves the composition of capital and labor in the production process unchanged. This is known as Hicks-neutral technological progress, which can be expressed as a variant of equation (1): $Y = Af(K, L)$. Equation (1) takes the form of $Y = f(K, AL)$ when technological progress is labor-augmenting. This is also known as Harrod-neutral technological progress (Harrod, 1942). And finally, we can write equation (1) as $Y = f(AK, L)$. This reflects capital-augmenting technological progress and is also known as Solow-neutral technological progress (Solow, 1958). Acemoglu (2002) defined factor bias in technological progress when technological progress affects the marginal productivity ratios of input factors.

$$\frac{\partial}{\partial A}\left[\frac{dY}{dL}\Big/\frac{dY}{dK}\right] > 0 \tag{2}$$

Constancy of factor income share can be shown using either (1) a Cobb-Douglas production framework, or (2) a Constant-Elasticity-of-Substitution (CES) production framework reflecting Harrod-neutral production technology in a neoclassical balanced growth model (Gollin 2002). Since the primary goal of this section is to summarize the key theoretical models that explain changes in the labor income share, we do not elaborate on the theoretical models that show constant factor income shares.

2.2 The Role of Elasticity of Substitution between Capital and Labor ($\boldsymbol{\sigma}$)

The assumption of a non-unitary elasticity of substitution (σ) between capital and labor plays a crucial role in the movement of the labor income share.[1] The discussion of labor income share dates back to David Ricardo (1821). However, the neoclassical economists achieved a significant milestone in the early twentieth century. Marshall's (1920) laws of derived demand provided the foundation, and later the mathematical formulation of the theories of supply and demand (Hicks 1932; Allen 1938) put the discussion of factor income share and the role of factor elasticities and factor substitutions therein at the core.[2] We provide a simple two-factor production function to discuss the link between elasticity of substitution and factor income shares. Consider a linear homogeneous production function with constant returns to scale,

$$Y = F(K, L), \text{ where } F_i > 0, F_{ii} < 0, \text{ and } F_{ij} > 0. \quad (3)$$

Firms maximize profit ($\pi = F(K, L) - rK - wL$) in a competitive market structure, r is return to capital and w stands for wages. Thus, the ratio of marginal productivities equal factor prices, i.e., $\frac{F_L}{F_K} = \frac{w}{r}$. Holding output constant, Allen (1938, 341) defined the elasticity of substitution as

$$\sigma = \frac{dln(\frac{K}{L})}{dln(\frac{w}{r})} = \frac{dln(\frac{K}{L})}{dln(\frac{F_L}{F_K})}. \quad (4)$$

Following Hammermesh (1993, 23-29), we write the price elasticity of labor demand holding the output and the return to capital constant (Marshall's first law of derived demand) as

$$\eta_{LL}{}^{Compensated} = -(1 - L_S)\sigma < 0, \quad (5)$$

where $L_S = \frac{wL}{Y} (> 0)$ is the labor income share.

Equation (3) implies that a higher value of σ leads to higher own-price elasticity of labor. Similarly, the cross-price elasticity of demand can be written as

$$\eta_{LK}{}^{Compensated} = (1 - L_S)\sigma > 0. \quad (6)$$

Demand elasticities in equations (5) and (6) are also known as compensated demand elasticities as they do not allow for the aggregate output to change because of the change sin input prices. Assuming competitive market, we can now introduce the scale effect or Marshall's second law of derived demand, which leads to expressions for the uncompensated demand elasticities. The scale effect implies that a 1% increase in the

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1 The crucial role of σ in analyzing the factor income shares has been noted since the seminal work of Hicks (1932) and Robinson (1933). Following the Hicksian partial elasticity of substitution, Elsby, Hobijn, and Sahin (2013) demonstrate the relationship between labor income share (L_S) and σ as $dlnL_S = -(1 - L_S)\frac{\sigma - 1}{\sigma} dln(\frac{K}{L})$. It suggests a drop in L_S when σ > 1. With σ = 1, factor income shares remain constant.

2 For a detailed discussion on the evolution of historical thoughts on factor income share, see Kraemer (2010).

factor prices raises the cost and product prices by that factor's share. Uncompensated demand elasticities consider this effect.

$$\eta_{LL}{}^{Uncompensated} = -(1 - L_S)\sigma - L_S\eta \text{ (Own-price elasticity)}$$

$$\eta_{LK}{}^{Uncompensated} = (1 - L_S)(\sigma - \eta) \text{ (Cross-price elasticity)} \quad (7)$$

From equation (7) we can infer that the uncompensated labor demand elasticity is higher when the price elasticity of demand for the product goes up. A higher elasticity of substitution produces a similar effect. Finally, the higher the labor share, the higher the uncompensated labor demand elasticity. These rules of derived demand play a key role when movements in the labor income share are explained by changes in wages and the level of employment.[3]

The literature on the estimation of σ is large and still growing[4] but is often plagued by subjective choices on parametric assumptions and functional form of the production (Leon-Ledesma, McAdam, and Willman 2010). Two recent studies attempt to overcome these issues. Oberfield and Raval (2014) use a novel micro-level framework to estimate the aggregate elasticity of substitution (σ_{Agg} from here on). They take into consideration the elasticity of substitution between factor inputs within a plant and reallocation of factor inputs across plants. Using plant-level data, they find estimates of σ_{Agg} to be less than one. On the other hand, Chirinko and Mallick (2017) obtain similar findings by using low pass filters in panel data to identify the long-run relations in production technology. Despite these insightful attempts, a consensus on the estimates of the aggregate elasticity of substitution between capital and labor is yet to be reached.

2.3 Changes in the Labor Income Share with Homogeneous Labor Market

Although the recent literature shows that the skill composition of the labor force is a crucial factor in explaining changes in the labor income share, we begin this section by reviewing a theoretical model that assumes homogeneous labor. Bentolila and Saint-Paul (2003) developed the share-capital (SK) model to analyze the drivers of labor income share. They showed that in a CES production function, under the assumption of constant returns to scale and labor-augmenting technological progress, perfectly competitive factor markets can produce a stable relationship between the labor income share and capital-output ratio, which they called the "Share capital (SK)" curve. We consider a standard CES production function with two inputs capital (K) and labor (L) as shown in equation (8):

$$Y = \left[(AK)^{\frac{\sigma-1}{\sigma}} + (BL)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \quad (8)$$

From equation (8), the labor income share can be derived as

$$L_S = \frac{(BL)^{\frac{\sigma-1}{\sigma}}}{(AK)^{\frac{\sigma-1}{\sigma}} + (BL)^{\frac{\sigma-1}{\sigma}}} \quad (9)$$

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3 Schneider (2011) provides a comprehensive summary on this topic in a recent survey article on the labor income share.

4 See Chirinko (2008) for a comprehensive summary.

and the capital-output ratio as

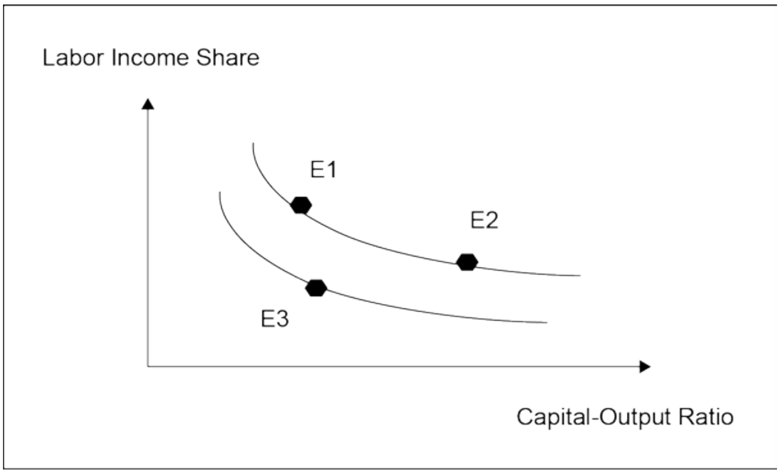
$$k = \left[\frac{(AK)^{\frac{\sigma-1}{\sigma}}}{(AK)^{\frac{\sigma-1}{\sigma}} + (BL)^{\frac{\sigma-1}{\sigma}}}\right]^{\frac{\sigma}{\sigma-1}} \quad (10)$$

Combining (9) and (10), we get

$$L_S = 1 - (k)^{\frac{\sigma-1}{\sigma}}. \quad (11)$$

The expression for the labor income share in equation (11) is known as the "SK" schedule, which shows a functional relationship between the labor income share and capital-output ratio. For σ > 1, that is labor and capital are gross substitutes, a higher k reduces the labor share. When σ < 1, i.e., labor and capital are gross complements, a higher *k* increases the labor income share. However, this relationship remains unaltered in changes in factor prices or quantities, or labor-augmenting technological progress. Any changes on these parameters only produce a movement along the SK curve (movement from E1 to E2), as shown in Figure 1. However, a change in the capital-augmenting technological progress (A) can move the SK curve from E1 to E3, perturbing the stable relationship between the labor income share and capital-output ratio. As Bentolila and Saint-Paul (2003) argue, other factors such as a wedge between the marginal product of labor and the real wage could also make the SK curve shift in a similar manner in the (L_S, k) plane.

Figure 1: The Capital-Share (SK) Curve



2.4 Changes in the Labor Income Share with Heterogeneous Labor Market

The substitutability between capital and labor with heterogeneous labor provides a much richer set of possible distributional outcomes (Atkinson, 2009). The relevance of capital-skill substitutability in studying changes in the labor share of income can also be discussed in light of a two-stage production structure. As Goldin and Katz (1998) argued, in the first stage it is plausible to expect that skilled workers adopt new technology and make use of capital efficiently showing high capital-skill complementarity. In the second stage, if unskilled workers take over the routine maintenance of machines and technology, then we can expect a lower level of capital-skill complementarity in the second stage compared to the first stage. To model heterogeneous labor market, a nested-CES production function is generally considered with three inputs: capital (K), skilled labor (S) and unskilled labor (U).[5] With three inputs, the CES production function can be nested in following ways: $Y = f[(K,S)U]$, $Y = f[(K,U)S]$ and $Y = f[(S,U)K]$ (nested-inputs are within the first bracket). Since $Y = [(S,U)K]$ boils down to a standard 2-factor CES production. Karabarbounis and Neiman (2014) consider the other two functions to examine the link between capital-skill complementarity and the labor share of income. The literature on capital-skill complementarity relies on the first nesting strategy (Griliches 1969; Fallon and Layard 1975; Krusell et al. 2000) and we present a standard version of $Y = f[(K,S)U]$ in equation 12.

$$Y = f[(K,S)U] = \left[\theta\left[\emptyset(AK)^{\frac{\rho-1}{\rho}} + (1-\emptyset)(B_S S)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}\frac{\sigma-1}{\sigma}} + (1-\theta)(B_U U)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}. \quad (12)$$

In equation (12), Y is output, K, S and U denote capital, skilled labor and unskilled labor, θ and $\emptyset$ represent distribution parameters, σ denotes the elasticity of substitution between K and U (similarly, between U and S), ρ denotes the elasticity of substitution between K and S. Efficiency parameters A, B_S, and B_U represent technological progress in capital, skilled labor and unskilled labor. The skill-capital complementarity assumes $\sigma > \rho$. It implies that if capital is more substitutable with unskilled labor than skilled labor (Griliches 1969; Berman, Bound, and Griliches 1994), then a drop in the share of income is likely to be larger for the unskilled labor compared to the skilled labor resulting from a drop in the relative price of capital.[6] Under the assumption of perfectly competitive factor markets, the labor income share can be written as

$$L_S = \frac{\frac{\partial f}{\partial S}S + \frac{\partial f}{\partial U}U}{f[(K,S)U]}. \quad (13)$$

In equation (13), real wages equal to marginal productivity of each type of laborers. Using this notion of perfectly competitive factor markets, from equation (13) we derive an expression for the labor income share as

$$L_S = 1 - \frac{\emptyset}{1-\emptyset}(Ak)^{\frac{\rho-1}{\rho}}\left[\theta^{\frac{\sigma(\rho-1)}{\rho-\sigma}}(1-\emptyset)^{\frac{\rho(\sigma-1)}{\rho-\sigma}} + (1-\theta)^{\frac{\sigma(\rho-1)}{\rho-\sigma}} l^{\frac{\sigma-1}{\rho-\sigma}} \omega^{\frac{\rho(\sigma-1)}{\rho-\sigma}}\right]^{\frac{\rho-\sigma}{\rho(\sigma-1)}}. \quad (14)$$

In equation (14), k denotes the capital-output ratio $\left(\frac{K}{Y}\right)$, l represents the relative supply of skilled labor $\left(\frac{B_S S}{B_U U}\right)$ and ω denotes the skill premium $\left(\frac{\frac{\partial f}{\partial S}/B_S}{\frac{\partial f}{\partial U}/B_U}\right)$. An equation like (14) can explain changes in the labor income share driven by capital-augmenting technological progress, changes in the capital-skilled labor ratio, and changes in the skill composition of labor market, i.e., changes in the ratio of unskilled labor to skilled labor. Arpaia, Perez, and Pichelmann (2009) also derive an expression for the labor income share in terms of input-ratios (equation 15). In section 2.3, we discussed that

[5] Two level bested CES production function was originally developed by Sato (1975), and since then it has been used extensively in many fields, including capital-skill complementarity (Krusell et al. 2000). More recently, Karabarbounis and Neiman (2014) use a similar version of multi-input nested-CES production function to explain changes in the labor income share.

[6] This is also related to a large literature on skill-biased technical change (SBTC). See Grilliches (1969); Acemoglu (2002); Autor, Levy, and Murnane (2003); Caselli (1999), among others.

labor income share moves along a stable non-linear relationship (SK curve) and certain factors shift the SK curve upward or downward. In equation (15), heterogeneous labor shifts the labor income share (SK curve) through (a) changes in the relative supply of capital to skilled labor and (b) changes in the relative supply of skilled labor to unskilled labor.

$$L_S = 1 - \phi (Ak)^{\frac{\rho-1}{\rho}} \theta^{\frac{\sigma(\rho-1)}{(\sigma-1)\rho}} \left[1 + \frac{1-\theta}{\theta} l^{\frac{1-\sigma}{\sigma}} \left\{ \phi \left(\frac{AK}{B_S S} \right)^{\frac{\rho-1}{\rho}} + (1-\phi) \right\}^{\frac{\rho(1-\sigma)}{\sigma(\rho-1)}} \right]^{\frac{(\rho-1)\sigma+\rho}{\rho(\sigma-1)}} \quad (15)$$

[7]

2.4.1 Comparative Statics of L_S

Following Arpaia, Perez, and Pichelmann (2009), we derive comparative statics results for L_S. We differentiate the expression for the labor income share in equation (15) with respect to the Solow-neutral technological progress (*A*).

$$\frac{\partial L_S}{\partial A} = -\phi \frac{\rho-1}{\rho} A^{\frac{-1}{\rho}} k^{\frac{\rho-1}{\rho}} \theta^{\frac{\sigma(\rho-1)}{(\sigma-1)\rho}} \left[1 + \frac{1-\theta}{\theta} l^{\frac{1-\sigma}{\sigma}} \left\{ \phi \left(\frac{AK}{B_S S} \right)^{\frac{\rho-1}{\rho}} + (1-\phi) \right\}^{\frac{\rho(1-\sigma)}{\sigma(\rho-1)}} \right]^{\frac{(\rho-1)\sigma+\rho}{\rho(\sigma-1)}} -$$

$$\frac{(\rho-1)\sigma+\rho}{\rho(\sigma-1)} \phi (Ak)^{\frac{\rho-1}{\rho}} \theta^{\frac{\sigma(\rho-1)}{(\sigma-1)\rho}} \left[1 + \frac{1-\theta}{\theta} l^{\frac{1-\sigma}{\sigma}} \left\{ \phi \left(\frac{AK}{B_S S} \right)^{\frac{\rho-1}{\rho}} + (1-\phi) \right\}^{\frac{\rho(1-\sigma)}{\sigma(\rho-1)}} \right]^{\frac{(\rho-1)\sigma+\rho}{\rho(\sigma-1)}-1} \times$$

$$\left[\frac{\rho(1-\sigma)}{\sigma(\rho-1)} \frac{1-\theta}{\theta} l^{\frac{1-\sigma}{\sigma}} \left\{ \phi \left(\frac{AK}{B_S S} \right)^{\frac{\rho-1}{\rho}} + (1-\phi) \right\}^{\frac{\rho(1-\sigma)}{\sigma(\rho-1)}-1} \right] \phi \frac{\rho-1}{\rho} A^{\frac{-1}{\rho}} \left(\frac{K}{B_S S} \right)^{\frac{\rho-1}{\rho}}. \quad (16)$$

From equation (16), $\frac{\partial L_S}{\partial A} < 0$ if $\sigma > \rho > 1$. This is a sufficient condition for the labor income share to decrease with capital-augmenting technological progress and capital-skill complementarity ($\sigma > \rho$).

2.4.2 Comparative Statics of L_S using the Morishima Elasticity of Substitution

In the previous section, the comparative statics outcomes suggest that if both elasticity parameters are greater than unity, then it is a sufficient condition to have a decline in the labor income share with capital-augmenting technological progress. This condition appears rather strict. Maintaining the assumption of capital-skill complementarity (i.e., $\sigma > \rho$), in this section, we investigate the comparative statics outcomes when $\sigma > 1 > \rho$. The equation (9) provides ambiguous results, as the sign of the derivative $\frac{\partial L_S}{\partial A}$ depends on the relative magnitude of the two terms. We take an alternative route. Some recent studies use the Morishima Elasticity of Substitution (MES here on) to measure the degree of substitutability and complementarity between factors for a production function with more than two inputs, and their effects on the changes in the factor shares (Atkinson, 2009; Paul, 2018). A nested-CES production function (like equation 12) with three inputs suggests the elasticities of substitution to be

[7] Both equations (8) and (9) show the labor income share under assumption of perfectly competitive factor markets. Arpaia, Perez, and Pichelmann (2009) derive similar conditions for imperfect factor markets.

different between within-nest (ρ) and across-nest (σ).[8] The MES provides a natural generalization of the Hicksian two-input elasticity of substitution[9] (Blackorby and Russel, 1989). The MES holds prices of other factor inputs constant and adjusts the measure of the elasticity of substitution accordingly, which is expressed as a function of own-price and cross-price elasticities of two inputs in the following way

$$MES_{ij} = \frac{dlogx_j}{dlogp_i} - \frac{dlogx_i}{dlogp_i}{}^{10}. \tag{17}$$

Equation (10) provides a direct link between the factors' prices and the ratio of factor input use. Furthermore, Blackorby and Russel (1989) show that changes in the ratio of factor income shares can be directly predicted by MES using equation (17):

$$\frac{dlog\frac{p_i x_i}{p_j x_j}}{dlog\frac{p_i}{p_j}} = 1 - MES_{ij}. \tag{18}$$

Following Paul (2018), we derive the similar expressions for MES using a three-input nested-CES structure. We rewrite the CES production structure in equation (12) as a two-stage function consisting of two sub-processes or nests, as follows:

$$Y = f[(K,S)U] = N_1(K,S) + N_2(U) \tag{19}$$

From equation (12), ρ denotes the intra-nest elasticity of substitution between K, and S and σ denote the inter-nest elasticity of substitution between K and U. The sub-processes N_1 (with inputs K and S), and N_2 (with only input U) are mutually exclusive and exhaustive. As shown by Anderson and Moroney (1993), for more than two inputs case, we can write the direct link between changes in relative prices of factor inputs and the labor income share for the nested-CES production function, $y = N_1(K,S) + N_2(U)$, as:

$$\frac{dlog\frac{W_S\,S}{r\,K}}{dlog\frac{W_S}{r}} = 1 - MES_{SK}(=\rho) = 1 - \frac{dlogK}{dlogW_S} + \frac{dlogS}{dlogW_S} \tag{20}$$

Equation (20) suggests that a drop in the relative price of capital (an increase of the ratio $\frac{W_S}{r}$) leads to a lower share of the skilled labor income (i.e., $\frac{dlog\frac{W_S\,S}{r\,K}}{dlog\frac{W_S}{r}} < 0$) if $MES_{SK} > 1$. The skilled labor income share declines due to the availability of cheaper capital when capital and skilled labor (intra-nest inputs) are gross substitutes. In a similar way, equation (14) shows that a drop in the relative price of capital (an increase of the ratio $\frac{W_U}{r}$) leads to a lower share of the unskilled labor income (i.e., $\frac{dlog\frac{W_U\,U}{r\,K}}{dlog\frac{W_U}{r}} < 0$) if $MES_{UK} > 1$ or capital and unskilled labor (inter-nest inputs) are gross substitutes.

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8 ρ and σ could be identical in the special case when the distribution parameters (θ and $\emptyset$) are identical and in the restricted CES structure that allows for Morishima elasticity of substitutions to be symmetric (Blackorby and Russel, 1989).

9 A number of alternative estimates have been developed (Hicks and Allen 1934; Allen 1938; Uzawa 1962; McFadden 1963; Morishima 1967; Mundlak 1968; Blackorby and Russel 1989) to address such issues and to generalize the concept of elasticity of substitution for an arbitrary number of inputs ($i > 2$).

10 p_i and $p_j$are the prices of inputs x_i and x_j.

$$\frac{dlog\frac{W_U U}{r K}}{dlog\frac{W_U}{r}} = 1 - MES_{UK}(=\sigma) = 1 - \theta\left[\frac{dlogN_2}{dlogP_{N_1}} - \frac{dlogN_1}{dlogP_{N_1}}\right] + \frac{dlogK}{dlogP_K} \quad (21)$$

We show the expressions for both ρ and σ for two nested-CES production functions: $Y = f[(K,S)U]$ and $Y = f[(K,U)S]$ in Table 1. While the intra-nest MES (ρ) is simply the difference in the cross-price and own-price elasticities of the factor inputs, for the inter-nest MES (σ) the own-price elasticity factor is replaced by the MES across two nests (N_1 and N_2). Another point to note is that MES estimates vary across different nested-CES production functions and, particularly for inter-nest MES (σ), they vary subject to the relative prices of the factor inputs.

Table 1: MES for Two Different Nested-CES Production Functions with Three Inputs

	(1)	(2)
	$Y = \left[\theta\left[\emptyset K^{\frac{\rho-1}{\rho}} + (1-\emptyset)S^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}\frac{\sigma-1}{\sigma}} + (1-\theta)U^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} = N_1(K,S) + N_2(U)$	$Y = \left[\theta\left[\emptyset K^{\frac{\rho-1}{\rho}} + (1-\emptyset)U^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}\frac{\sigma-1}{\sigma}} + (1-\theta)S^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} = N_1(K,U) + N_2(S)$
ρ	$\rho = MES_{KS} = \frac{dlogS}{dlogr} - \frac{dlogK}{dlogr}$ $\rho = MES_{SK} = \frac{dlogK}{dlogW_S} - \frac{dlogS}{dlogW_S}$	$\rho = MES_{KU} = \frac{dlogU}{dlogr} - \frac{dlogK}{dlogr}$ $\rho = MES_{UK} = \frac{dlogK}{dlogW_U} - \frac{dlogU}{dlogW_U}$
σ	$\sigma = MES_{KU} = \theta\left[\frac{dlogN_2}{dlogP_{N_1}} - \frac{dlogN_1}{dlogP_{N_1}}\right] - \frac{dlogK}{dlogr}$ $\sigma = MES_{UK} = \theta\left[\frac{dlogN_2}{dlogP_{N_1}} - \frac{dlogN_1}{dlogP_{N_1}}\right] - \frac{dlogU}{dlogW_U}$	$\sigma = MES_{KS} = \theta\left[\frac{dlogN_2}{dlogP_{N_1}} - \frac{dlogN_1}{dlogP_{N_1}}\right] - \frac{dlogK}{dlogr}$ $\sigma = MES_{SK} = \theta\left[\frac{dlogN_2}{dlogP_{N_1}} - \frac{dlogN_1}{dlogP_{N_1}}\right] - \frac{dlogS}{dlogW_S}$

Note: At equilibrium, $P_K = r$, $P_S = w_S$ and $P_U = w_U$.
Source: Author.

In a recent paper, Paul (2018) derives the necessary and sufficient conditions for a decline in labor income share resulting from a capital deepening or decrease in the relative price of capital to labor. He shows that assuming $\sigma > \rho$ (i.e., capital is more complementary to skilled labor), the necessary condition and the sufficient condition for a decline in the aggregate labor income share with a drop in the relative price of capital are $\sigma > 1$, and $\rho > 1$, respectively. With $\sigma > \rho$, $\rho > 1$ ensures that both elasticities are greater than one.[11] However, a decline in the labor share can also be obtained with a less strict condition when $\sigma > 1 > \rho$ as long as we have $\left|\frac{dlog\frac{W_S S}{r K}}{dlog\frac{W_S}{r}}\right| < \left|\frac{dlog\frac{W_U U}{r K}}{dlog\frac{W_U}{r}}\right|$ or $|1-\rho| < |1-\sigma|$.

As a final step, following Paul (2018) we consider a numerical example and discuss the possible range of values for which $\sigma_{Agg} < 1$ if $\sigma > 1 > \rho$. In line with the existing literature (Karabarbounis and Neiman 2014; Rognlie 2015), we assume that $\sigma = 1.15$ and $\rho = .9$, then $\frac{dlog\left(\frac{L_S}{1-L_S}\right)}{dlog(\frac{W}{r})} < 0$ since $|1-.9| < |1-1.15|$. The aggregate elasticity of

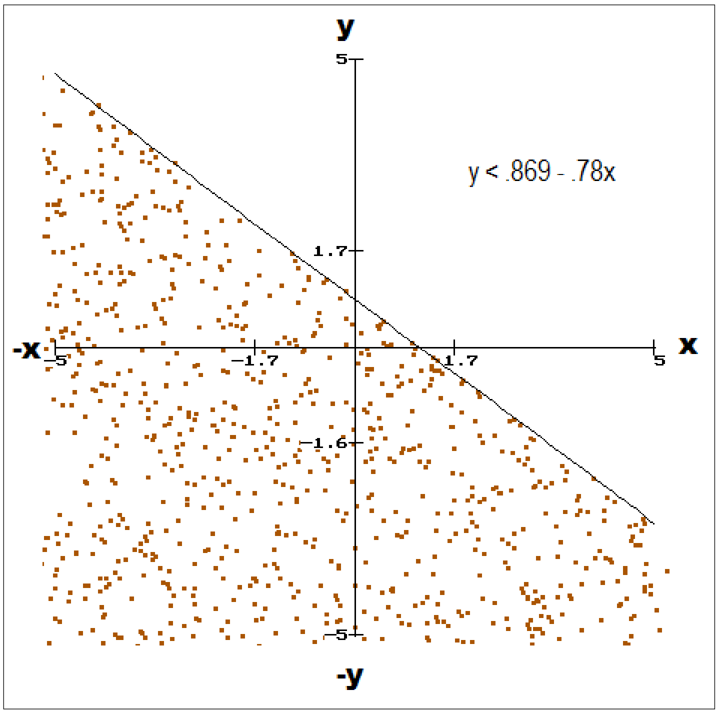
[11] This is in line with the empirical findings by Karabarbounis and Neiman (2014) and Piketty (2014).

substitution between capital and labor can be written as a weighted average of σ and ρ (with y and x as weights)

$$\sigma_{Agg} = y\sigma + x\rho. \quad (22)$$

Imposing the condition for aggregate complementarity between capital and labor, Equation (22) becomes an inequality $1 > 1.15y + .9x$ or $y < .869 - .78x$ (after applying the values of $\sigma = 1.15$ and $\rho = .9$). The feasible range of values that satisfies the inequality is plotted in Figure 2. Any point (combination of weights) in the shaded area implies that the weighted average of σ and ρ (with y and x as weights) must be less than the unity for the given values of $\sigma = 1.15$ and $\rho = .9$. This hypothetical example suggests that it is possible to have complementarity between capital and labor (σ_{Agg} < 1) for a feasible set of values of σ and ρ, which corresponds with a decline in the labor income share. To put it differently, this could imply that a decline of the LIS alongside a drop in the relative price of capital occurs when the loss of income share due to a decrease in the unskilled labor force outweighs the income gained due to an increase in the skilled labor force. The relevance of capital-skill substitutability in studying changes in the labor share of income can also be drawn using a two-stage production structure (Goldin and Katz 1996). In the first stage, skilled workers adopt new technologies and efficiently use capital, thus showing high capital-skill complementarity. In the second stage, unskilled workers continue the mechanical process of machine maintenance indicating a relatively low level of capital-skill complementarity. With this note we conclude this section and move on to a more elaborated discussion on the drivers of labor income share drawing from empirical studies in the next section.

Figure 2: A Feasible Range of Weights for σ_{Agg} < 1



Note: This graph shows a numerical example. It shows the feasible range of value for an equation showing inequality.

Source: Authors.

3. EMPIRICS

3.1 Technological Change and Capital Intensity

Technology enables customer to obtain latest and broader information. It also enables customers to choose the goods at the lowest price and enjoy the better quality of goods they consume. At the same time, it allows companies to exploit their competitive advantages. Technology favors large farms, especially if the industry requires a huge fixed cost, which in turn reduces the marginal cost, with the help of technological advancement. In recent years, the advent and growing prominence of social networking services has propelled the network effect, which again enables customers to choose the most popular goods. This also indirectly makes the goods that are technologically savvy more popular. Technological change has been increasingly capital-augmenting in recent decades, leading to higher capital-intensive production processes. The relationship between capital-income ratio and the labor income share (Bentotila and Saint-Paul 2003) depends on the elasticity of substitution between capital and labor. With a drop in the price of capital, the labor income share is lower with capital and labor as complements, and it is higher if capital and labor are gross substitutes. However, the recent empirical literature provides mixed results on the value of the elasticity of substitution (Piketty 2014; Piketty and Zucman 2014; Karabarbounis and Neiman 2014; Antràs 2004).

3.2 The Decline of L_S, Capital Deepening and σ < 1: How to Address the Puzzle?

The assumption of a non-unitary elasticity of substitution (σ) between capital and labor plays a crucial role in explaining the changes in the labor income share. Research in recent years documents a global decline in the labor income share.[12] With capital and labor as gross substitutes (σ > 1), the primary drivers of the falling labor income share are, among others, an increasing capital-income ratio (Piketty 2014) and a declining relative price of capital (Karabarbounis and Neiman 2014). It is documented in the literature (Karabarbounis and Neiman 2014; Piketty 2014) that gross substitutability between capital and labor (aggregate, skilled, and unskilled) can explain a decline in the aggregate labor income share with the availability of cheaper capital. To this extent, both Piketty (2014) and Karabarbounis and Neiman (2014) estimate the values of elasticity of substation between capital and labor to be greater than unity. At the same time, many studies find an estimate of σ to be less than one (Leon-Ledesma, McAdam, and Willman 2010; Oberfield and Raval 2014; Chirinko and Mallick 2017).[13] With σ < 1, these causal mechanisms in fact predict a rise in the labor income share. In a recent study, Alvarez-Cuadrado, Long, and Poschke (2015) argue that if capital and labor are gross complements, then a decline in capital per unit of effective labor can lead to a more than proportionate increase in the rental rate compared to wages. This mechanism can lead to a lower income share of labor. Overall, these findings point to an apparent puzzle. The decline of labor income share resulting from capital deepening or capital-augmenting technological progress (availability of cheaper capital) is not feasible if capital and labor are gross complements (σ < 1).

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[12] Elsby, Hobijn, and Sahin (2013); Karabarbounis and Neiman (2014); Piketty (2014); Piketty and Zucman (2014); Bentolila and Saint-Paul (2003); Blanchard and Giavazzi (2003); Gollin (2002).

[13] Using sectoral level data, Herrendorf, Herrington, and Valentinyi (2015) show elasticity of substitution to be 1.58 in agriculture, .80 in manufacturing and .75 in services.

We discuss two very recent studies that address this puzzle. The first study is by Grossman et al. (2017). Their theoretical model relies on the human capital accumulation in a standard framework of neoclassical growth model. Let us denote three elasticity parameters as follows: (1) between human capital and physical capital as $\sigma_{HC,PC}$, between human capital and raw labor as $\sigma_{HC,RL}$, and between total labor and physical capital as $\sigma_{L,PC}$. They show that if $\sigma_{HC,PC} < \sigma_{HC,RL}$ and $\sigma_{L,PC} < 1$, then holding the level of schooling constant, the movement in the share of labor in national income and the rate of labor productivity growth will be positively correlated across steady states. This way a slowdown in labor productivity growth implies a drop in the labor income share. Then the authors discuss this mechanism by considering the case of a drop in the interest rate relative to growth rate of wages. This prompts individuals to achieve a higher level of human capital for any steady state level of technology and the size of capital stock. Since, $\sigma_{HC,PC} < \sigma_{HC,RL}$ (i.e., human capital is more complementary to physical capital than raw labor), this generates a shift in the relative factor demand in favor of a rise in the capital income share. Thus, in their model, they show that a decline in the labor income share is feasible with $\sigma < 1$ if there is a slowdown of labor productivity growth.

The second study by Paul (2018) addresses this puzzle by arguing for proper identification of the elasticity of substitution parameters. Drawing insights from the micro-level estimation of the σ_{Agg} (Oberfield and Raval 2014) and the literature on differential capital-skill substitutability (Krusell et al. 2000; Karabarbounis and Neiman 2014), he shows that it is possible to have a decline in the labor income share resulting from a fall in the relative price of capital when $\sigma_{Agg} < 1$. This paper proposes a framework to identify and estimate the elasticity of substitution parameters (ρ and σ) using a three-input nested-CES production structure. In a production structure with more than two inputs, the primary identification problem emerges from the simultaneous changes in prices of factor inputs apart from the two directly used to estimate elasticities of substitution. Paul (2018) uses the concept of Morishima Elasticity of Substitution (MES, here on),[14] which holds prices of other factor inputs constant and adjusts the measure of the elasticity of substitution accordingly. He then shows that both ρ and σ can be approximated by the differences in own-price and cross-price elasticities in a nested-CES production framework. Moreover, MES directly links the changes in relative factor input prices to labor income share trends. Using this framework with capital-skill complementarity ($\sigma > \rho$), the necessary and the sufficient condition for a decline in the aggregate labor income share with a drop in the relative price of capital are $\sigma > 1$ and $\rho > 1$, respectively. However, a decline in the labor share can also be obtained with a less strict condition when $\sigma > 1 > \rho$ and as long as we have $\left|\frac{dlog\frac{W_S S}{r K}}{dlog\frac{W_S}{r}}\right| < \left|\frac{dlog\frac{W_U U}{r K}}{dlog\frac{W_U}{r}}\right|$ or $|1-\rho| < |1-\sigma|$. And, in this case, it is feasible to expect the value of σ_{Agg} to be less than unity.

Technological advancement, measured by the long-term change in the relative price of investment goods, together with the initial exposure to routinization, have been the largest contributors to the decline in labor income shares in advanced economies. The empirical analysis suggests that about half of the total decline in labor shares can be traced to the impact of technology. Importantly, for a given change in the relative price of investment, economies with high exposure to routinization experienced about four times the decline in labor income shares than those with low exposure (Dao et al. 2017). This paper also concludes that in the emerging market, there is no discernible

[14] Morishima Elasticity of substitution is the natural multi-input generalization of Hicksian two-input elasticity of substitution (Blackorby and Russel 1989 and Anderson and Moroney 1993).

rode of technology in the evolution of labor shares. This reflects both a relatively mild decline in the relative price investment goods and, importantly, a much lower exposure to routinization, which has limited labor displacement arising from routine-based technology. While the very extensive literature on skilled-biased technical change provides useful hints, but little evidence exists on the impact of different types of capital on the labor income share (Koh, Santaeulalia-Llopis, and Zhang 2016; O'Mahony, Robinson and Vecchi 2008 and on their impact on the share of output accruing to different types of labor (European Commission 2007; Lawless and Whelan 2011).

3.3 Globalization as a Catalyst

Globalization has been broadly defined to include everything from falling prices for goods that use low-skill labor (such as garments) to increasing outsourcing by multinationals (Harrison 2002). The owners of capital have greater bargaining power over laborers, ostensibly because capital is footloose and can quickly relocate to wherever it can find the highest returns (Harrison 2002; Rodrik 1997). Slaughter (2001) argues that trade can make labor demand more elastic in two main ways: by making output markets more competitive and by making domestic labor more substitutable with foreign factors. Trade can generate these effects without also generating product-price changes and, via the Stolper-Samuelson theorem, factor price changes.[15] Classical trade theories predict patterns of specialization and specific factor demand drive relative factors endowment. Factor reallocation in the production function induced by trade also crucially deepens on the wage flexibility/rigidity regimes as shown by Decreuse and Maarek (2015). Decreuse and Maarek (2015) assume a frictional labor market with productive heterogeneity and claim that foreign direct investment (FDI) has two opposite effects on the labor income share. The first is a negative effect originated by technological advancement and then a positive effect due to an increasing labor market competition between firms. Using data from 98 developing countries over the period from 1980 to 2000, they find a U-shaped relationship between labor income share and the proportion of foreign firms. Furthermore, they argue that the magnitude of the relationship is governed by the technological gap between foreign and local firms. In addition, the effect of trade openness on the labor income share also depends on the elasticity of substitution between different types of labor and capital (Guscina 2006; EC 2007). Foreign direct investment (FDI) or offshoring can also have a negative effect on the labor income share by providing firms an outside option with decreasing workers' bargaining power (especially for the low-skilled workers) (Guscina 2006; Harrison 2002; Jaumotte and Tytell 2007; Jayadev 2007).

New trade theories emphasize the role of firm heterogeneity in production. The factors such as capital intensity, skills, among others drive productivity and determine the impact of increasing openness on the labor income share of different types of workers. Elsby, Hobijn, and Sahin (2013) noted that increased import penetration would be expected to depress labor's share of domestic income if imported intermediates were more substitutable with labor than with capital from the perspective of an aggregate production technology. The same authors argue that for the more labor-intensive part of US production, the remaining production in the US economy would be expected to become more capital intensive by offshoring. If, in addition, capital is more than

[15] For example, in a Heckscher-Ohlin trade model, if an economy's autarky relative endowment equals that of the rest of the world, then when that country opens to trade it experiences no change in product prices and thus (via the Stolper-Samuelson theorem) no change in wages. But this opening can make foreign factors more substitutable with domestic ones. If product markets are imperfectly competitive in autarky, opening can also make product markets more competitive.

unit-elastic with respect to labor, then applying the concept of Hicksian elasticity (Hicks 1932) this will imply that the labor income share in the US will fall.

The rise of superstar firms can also contribute to a decline in the labor income share as shown by Autor et al. (2017). They analyze micro panel data from the US Economic Census since 1982, and international sources and document empirical patterns to assess a new interpretation of the fall in the labor income share based on the rise of "superstar firms." If globalization or technological changes advantage the most productive firms in each industry, product market concentration will rise as industries become increasingly dominated by superstar firms with high profits and a low share of labor in firm value-added and sales. As a result, as the importance of superstar firms increases, the aggregate labor share will tend to fall. In a related study, Kehring and Vincent (2017) also ascribe the growing dominance of superstar firms as an explanation for a fall in the labor income share. As studies show, global integration has also played a key role, largely by lowering labor shares in tradables sectors (Dao et al. 2017). To this extent, the empirical literature suggests that rising trade shares reduce labor share from their country-level panel data analysis (Stockhammer 2013; Harrison 2005; Jayadev 2007). The impact from trend changes in the participation in global value chain on the decline in labor income share is homogeneous across the emerging market, while the impact from exposure to the routinization and relative price decline contain significant differences among individual economies (Dao et al. 2017).

One of the drivers that explain the global decline of labor share, according to a study by Elsby, Hobijn, and Sahin (2013), is the offshoring of tasks that are more capital intensive relative to the other tasks in the receiving countries. Analogously, Feenstra and Hanson (1997) argue that offshored, low-skill tasks from advanced countries actually require skilled labor in the recipient countries. In an earlier study, Diwan (2001) shows that financial crises have systemically led to a decline in labor share relative to capital, but does not address the role of globalization directly. Harison (2005) conducted panel data analysis using data from more than hundred countries. In the period from 1960 to 1997, she finds that labor income share in low-income countries fell, while the share in high-income countries increased. She also finds that rising trade shares and exchange rate crises reduce labor income share, while capital controls and government spending increase labor income share. In addition, foreign investment inflows are associated with a fall in labor income share.

Rodrik (1997) and Slaughter (2001) argue that globalization is affecting labor by increasing the elasticity of labor demand. However, Slaughter (2001) finds that there is no strong relationship between globalization and change in labor elasticity using the data of the US from 1961–1991. Jaumotte and Tytell (2007) show that though technological change, especially in the information and communications sectors, has a large magnitude to the labor income share, especially for the unskilled sectors, globalization, which includes aspects such as trade prices, offshoring, and immigration, reduces the labor income share in 18 developed countries over 1982–2002. Jaumotte and Tytell (2007) also find that countries that have enacted reform to lower the cost of labor to business and improve labor market flexibility have generally experienced a smaller decline in the labor income share.

3.4 Structural Transformation

In the literature, the national (aggregate) labor income share has been commonly used as an approximation for the sectoral labor income shares. A recent paper by Valentinyi and Herrendorf (2008) shows that the sectoral labor income shares could be different from the aggregate labor income share. In this section, we elaborate on the importance of sectoral labor income share trends. We provide a snapshot of the existing literature available at the disaggregated level including both industries and sectors, and some novel insights for future research. In one of the early papers, Bentolila and Saint-Paul (2003) studied the labor income shares in the value-added of the 13 industries in the business sectors in 12 OECD countries during 1972–1993. Two other papers (Young, 2006 and Zuleta and Young 2013) also looked at the labor income shares of 35 industries (value-added) in the US for the period from 1958 to 1996. In another study on the US, Valentinyi and Herrendorf (2008) find that the smallest labor income share is in agriculture, followed by manufactured consumption, services, equipment, and construction. Moreover, the labor income share of agriculture is less than two times that of construction and more than 50% smaller than that of the aggregate economy. They aggregate the factor income shares in the industry outputs to get the sectoral level.

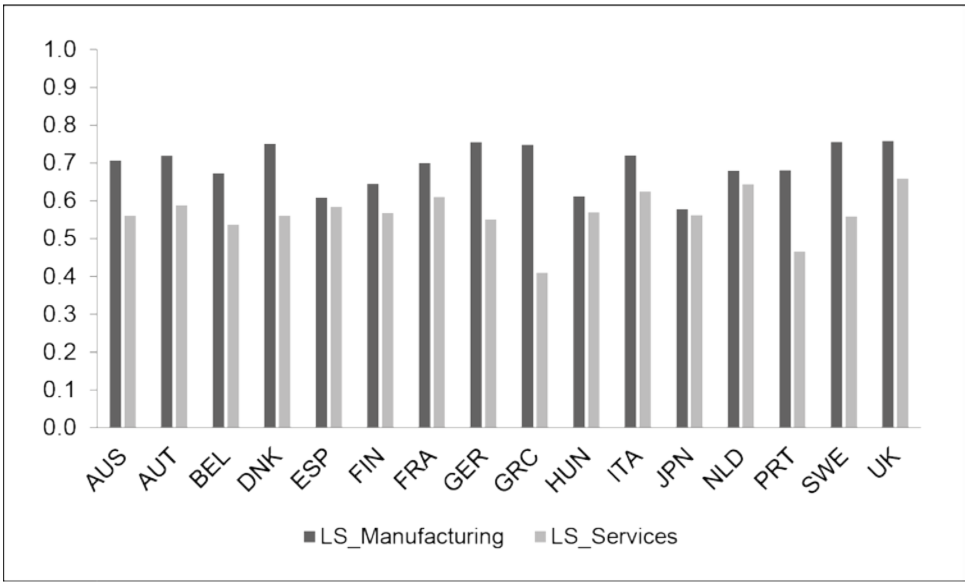
To highlight the role of structural transformation behind the link between sectoral (or industry-specific) labor income shares and the aggregate labor income share, we next discuss the shift-share decomposition framework. Following a variant of the canonical shift-share decomposition methodology (see Fabricant 1942, for the original decomposition; de Vries, Timmer, and de Vries 2013; and Arpaia, Perez, and Pichelmann 2009, for the variant) we write changes in the aggregate labor income share between t and $t+1$ as follows:

$$\Delta LIS = \sum_i (\theta_i^t)(\Delta LIS_i) + \sum_i (\Delta\theta_i)(LIS_i^t) \quad (23)$$

where LIS_i is the labor income share in sector *i*, and LIS denotes the aggregate labor income share. Labor is reallocated across sectors between two points in time, t and $t+1$, and θ_i^t denotes the sectoral labor share of sector *i* in period *t*. The first term on the right-hand side of equation (1) measures the contribution of within-sector effect (changes in the labor income share within a sector) whereas the second term measures the contribution of between-sector effect (changes in the weights of the sector) or structural transformation. In the absence of structural transformation, the aggregate labor income share trend would simply be a weighted average of the sectoral labor income share trends. Many studies (Lawrence 2015; Elsby, Hobijn, and Sahin 2013; Rodriguez and Jayadev 2013) find that the change in the aggregate labor income share is driven by declines in within-industry labor shares rather than the process of structural transformation through an increasing flow of activities from high to low labor share industries. In another study, Dao et al. (2017) find that almost 90% of the changes in the aggregate labor income shares in PRC come from within-industry changes rather than sectoral reallocation. In addition, reallocation from agriculture to other industries accounts for most of the decline in the labor share of income in People's Republic of China, from 1993–2014 (Dao et al. 2017). Arpaia, Perez, and Pichelmann (2009) examine the role of structural transformation for a panel of OECD countries and find similar evidences on the dominance of within-sector effects. However, in a separate paper, de Serres, Scarpetta, and de la Maisonneuve (2002) estimate that about 50% of the variation in the labor share is due to structural transformation in the US.

Next, we compare the labor income share trends between two broad sectors, manufacturing and services. If the elasticity of substitution between factor inputs is different from one, and varies across sectors (e.g., manufacturing versus services), then sectoral labor income share trends could follow different trajectories. In a recent study on the US, Alvarez-Cuadrado, Long, and Poschke (2015) show that a larger decline in labor income share in manufacturing relative to that in services is partly driven by a larger elasticity of substitution (or in other words a higher elasticity of substitution between capital and labor) in manufacturing associated with a much faster labor-augmenting productivity growth relative to services. Alvarez-Cuadrado, Long, and Poschke (2015) use Jorgenson's 35-sector KLEM database for 16 developed economies. They calculate the labor income share for two broad sectors, manufacturing and services, computed as compensation of employees over value-added. In Figure 3, we compare the average labor income share between manufacturing and services sectors across 16 developed economies for the period from 1970-2007.

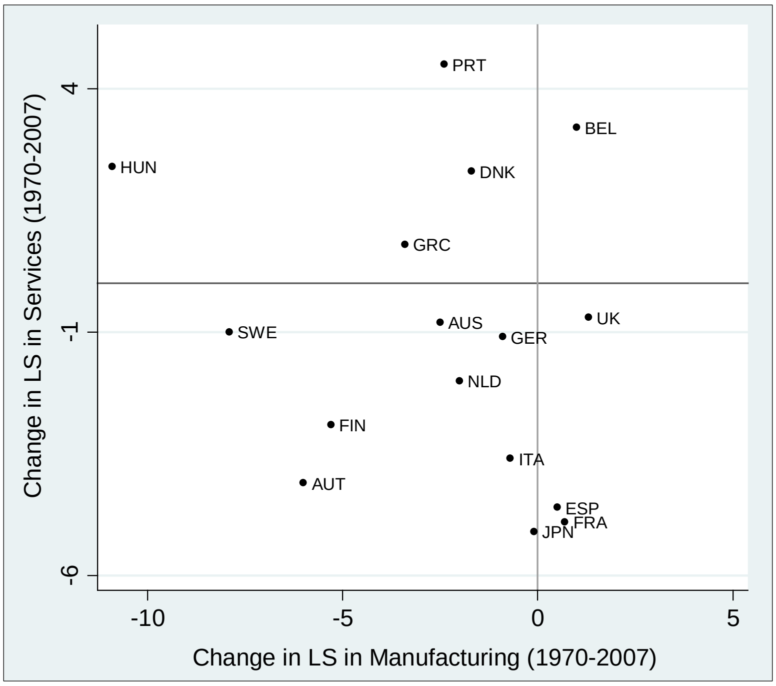
Figure 3: Average Sectoral Labor Income Share for 16 Developed Countries, 1970–2007



Source: Authors' elaborations based on Cuadrado, Long, and Poschke (2015); original data source: http://www.euklems.net

On average, the labor income share in manufacturing sectors was higher than that in the services sectors. In countries like Hungary, Japan, and Spain, the sectoral gap in labor income share between manufacturing and services was less than 3 percentage points, whereas in countries like Greece, Denmark, and Portugal the gap was more than 15 percentage points. As a next step, we examine how a change in the sectoral labor income share is related to the observed global decline in the aggregate labor income share. This also helps us understand the role of structural transformation in the decline in the labor income share better. Figure 4 shows a scatterplot of 16 countries between changes in the labor income shares in manufacturing and changes in the labor income share in services. We find four categories of countries. Belgium is the only country that had an increase in the labor income share in both sectors. Then we have the next category consisting of Greece, Hungary, Denmark, and Portugal, where the labor income share declined only in the manufacturing sector.

Figure 4: Changes in Labor Income Shares: Manufacturing versus Services, 1970–2007

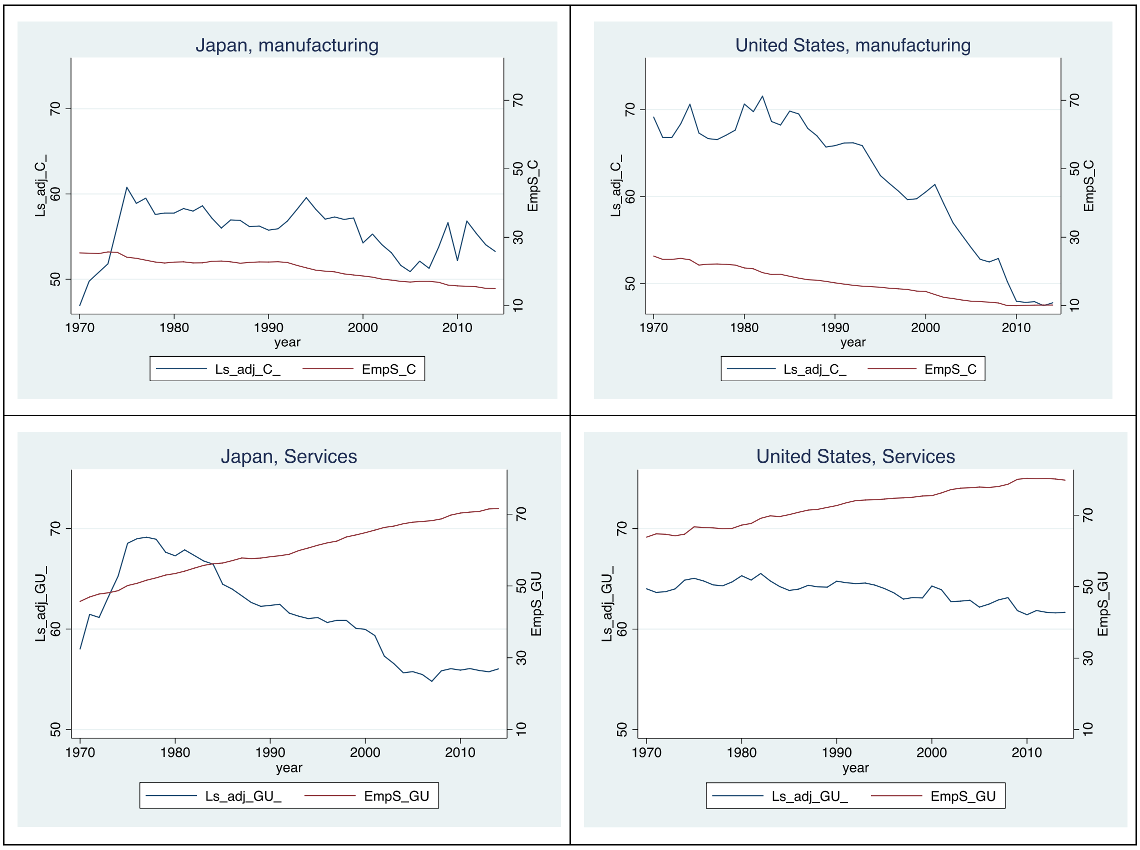


Source: Authors' elaborations based on Cuadrado, Long and Poschke (2015); original data source: http://www.euklems.net

Spain, France, and the UK made up the next group of countries that had a drop in the labor income share only in services. Finally, the largest group of countries (Australia, Austria, Finland, Japan, Italy, Germany, Sweden, and the Netherlands) shows declining labor income shares in both sectors. These four groups of countries demonstrate heterogeneous relationships between structural transformation and movements in the labor income share. The highest decline in labor income share (in terms of percentage point differences) in services and manufacturing was in Japan and Portugal, respectively. Moving on, we next compare the labor income share trends in manufacturing and services between the US and Japan using annual data from Ameco[16] for the period from 1970 to 2014 (Figure 5). Manufacturing labor income share in Japan shows an upward trend since the early 1990s, whereas labor income share in services steadily declined since the early 1980s, contributing to a declining total labor share in Japan over the last two decades. This is in sharp contrast to sectoral labor income share trends observed in the US, where labor income share declines faster in manufacturing compared to services (Alvarez-Cuadrado, Long, and Poschke 2015).

16 https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/macro-economic-database-ameco/ameco-database_en

Figure 5: Changes in Sectoral Labor Income Shares: Japan versus the US



Source: Authors' elaborations on Ameco data.

3.5 Institutional Changes

Until this point, the analysis of the drivers of labor income share has relied primarily on the assumption of a perfectly competitive market. In this section we discuss, the role of imperfect competition, which arises in both goods and labor market. Kalecki's seminal studies (1938, 1954) were among the first ones to analyze the labor income share considering an imperfectly competitive market. Essentially, in an imperfectly competitive market, the price contains a mark-up over the marginal cost, which we elucidate with the help of a simple production function below. Assume a lineal homogeneous production function with constant returns to scale,

$$Y = f(K, L) = Kf\left(1, \frac{L}{K}\right) = Ff(l) \tag{24}$$

Firms maximize profit $= pK(fl) - wKl - rk$ and goods market clear when $\frac{w}{p} = f'(l)$. This prompts us to write the labor income share (LIS) as

$$LIS = \frac{wL}{pY} = \frac{lf'(l)}{f(l)}. \tag{25}$$

A price mark-up ($\emptyset$) can enter the profit maximization condition in an imperfectly competitive market as $\emptyset \frac{w}{p} = f'(l)$, which results in a slightly different expression for the labor income share as shown in equation (26), which suggests a counter-cyclical movement in the labor income share if the movement in the mark-up is pro-cyclical.

$$LIS = \frac{wL}{pY} = \emptyset^{-1} \frac{lf'(l)}{f(l)}. \quad (26)$$

On the other hand, the main source of imperfect competition in the labor market arises from the bargaining power of trade unions and other related institutional factors (Blanchard and Giavazzi 2003; Autor et al. 2017; Barkai 2016). In many countries, trade unions exhibit bargaining power to set the wages different from the marginal product of labor (leaving the paradigm of the competitive market). Consider an effective bargaining model (Blanchard, Nordhaus, and Phelps 1997), then the first order condition of the profit maximization (goods market clearing condition) defines the real wage as a weighted sum of the average product of labor and the real reservation wage. The weight reflects the bargaining power of the workers (Equation 27).

$$\frac{w}{p} = \theta \frac{f(l)}{l} + (1-\theta) \frac{\overline{w}}{p}. \quad (27)$$

Like equation (26), we can write the labor income share assuming the effective bargaining model as

$$LIS = \frac{wL}{pY} = \frac{wl}{pf(l)} = \theta + (1-\theta) \frac{\overline{w}l}{pf(l)}. \quad (28)$$

Equation (28) suggests that a higher bargaining power of trade union (a higher value of θ) lowers the sensitivity of the labor income share to capital-output ratio. Both equation (26) and equation (28) can shift the SK curve, a movement from point E1 to E3 in Figure 1.

In the presence of imperfectly competitive markets, the extent to which emerging rents accrue to labor or to capital becomes crucial to explain the dynamics in factors income shares (Blanchard and Giavazzi 2003). However, the extent of this phenomenon also depends on workers' bargaining power, shaped by macroeconomic conditions and labor market institutional settings (European Commission 2007). Many studies provide evidence of the decline of labor union organizations (union density, collective bargaining systems) and labor market regulations (employment protection, minimum wage provisions), which might have contributed to the decreasing trend in the labor share (Bentolila and Saint-Paul 2003; OECD 2011). The net effect on the labor income share, however, depends on the bargaining models and, once again, on the elasticity of substitution between production factors (Zuleta and Yong 2013). Globalization has reduced labor bargaining power (Lawrence 2015).

An emerging strand of the labor share literature emphasizes the role of rising concentration and markups. Institutional settings shape rent-sharing patterns: if price markups are larger than wage markups, a lower degree of competition is expected to decrease the labor share (Autor et al. 2017; Barkai 2016). The quantitate impact of changes in policies and institutions and reforms in product and labor markets appears to be limited, but may reflect in part the difficulty of empirically separating trends in global integration and de-unionization (Dao et al. 2017). Blanchard and Giavazzi (2003) consider labor market regulation as a determinant of the bargaining power of workers, and they show that the decrease in the labor share in Europe during the 1980s was primarily caused by a decrease in the bargaining power of workers. On the other hand, in a recent study, Rognlie (2015) shows that capital share is higher because higher markups came alongside increased globalization.

Another recent study by Grullon, Larkin, and Michaely (2016) uses firm-level data to document that most US industries became more concentrated over time because the most successful firms made large profits and realized the most outstanding stock returns as well as profitable mergers and acquisitions. Barkai (2016) shows that markups have grown over time, lowering both the labor and capital shares. This paper shows a negative relationship between changes in the concentration of firms and changes in the labor income share using the industry level data. In this study, a Cobb-Douglas production function for the representative firm at the industry level implicitly assumes that a decline in the labor income share is driven by within firms as the fall in relative factor prices is shared within the industry.

4. WAY FORWARD

In this section we highlight several potential areas of research on the drivers of labor income share (LIS).

4.1 LIS and Skilled Emigration

A competitive labor market model has clear and unambiguous implications for a migration-induced reduction in skilled labor supply. A reduction in the supply of skilled labor outflows because of migration should increase the wages of those workers remaining behind, at least in the short run. However, an upward push in wages because of migration-induced skilled labor supply shock holds only if there is no employment demand shock. This can happen if an increased demand for skilled labor in an industry is independent of the emigration that is generated by the higher remittances inflows. Under these circumstances, higher labor demand could reinforce the labor market impact, leading to a further increase in real wages and returning employment back toward its original level. In many developing economies, where resource reallocation is still taking place, several sectors could be contracting where labor shedding occurs. Under these circumstances, the impact on employment is unambiguous, i.e. it declines. In such cases, the impact of wages would depend on the relative magnitudes of the labor supply and demand shocks in the sector. If the labor supply shock dominates, then wages will go up in that sector (Bouton, Paul, and Tiongson 2010).The reverse is true if the decline in labor demand dominates.

The simple labor market framework we considered so far in our discussion assumes a single labor market with a homogeneous labor force. This implies the perfect substitutability of workers with different skills. This could be a rare example, since a labor market in most of the cases is highly fragmented and the degree of substitutability between different groups of workers depends on the proximity of skills. Considering these issues in a theoretical model, Card and Lemieux (2001) predict that a group of workers affected by an emigration shock experiences a higher effect on wages than any other group. To prove this, we adopt a simple theoretical model from Docquier et al. (2014), which is based on the labor market (Katz and Murphy 1992; Card and Lemieux 2001) and growth (Caselli and Coleman 2001) literature.

We assume a production function where the labor aggregate is represented as a nested Constant-Elasticity-of-Substitution (CES) function of different types of workers. At time t output (Yt) is produced in a country according to a constant-returns-to-scale Cobb-Douglas production function with two factors, physical capital (Kt), and labor in efficiency units (Lt):

$$Y_t = A_t\, K_t^{1-\alpha} L_t^{\alpha} \tag{29}$$

The term A_t represents the total factor productivity (TFP), and α is the income share of labor. The returns to physical capital are equalized across countries. Also, if R^* denotes the net interest rate, then the following arbitrage condition indicates the equilibrium capital to labor ratio

$$R^* = (1-\alpha)\, A_t\, K_t^{-\alpha} L_t^{\alpha} \tag{30}$$

Substituting (2) into (1), the aggregate output condition can be expressed as follows, with $\bar{A}_t$ a modified TFP and an increasing function of TFP.

$$Y_t = \bar{A}_t\, L_t \tag{31}$$

Based on Katz and Murphy (1992) and Card and Lemieux (2001) the labor in efficiency unit as a nested-CES function can be expressed as

$$L_t = \left[\theta\, L_{S,t}^{\frac{\sigma-1}{\sigma}} + (1-\theta)\, L_{U,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{32}$$

where $L_{S,t}$ and $L_{U,t}$ can be thought of as skilled and unskilled workers. The relative productivity level of high skilled workers is distinguished by the parameter θ and σ is the elasticity of substitution between two groups of workers. For the sake of simplicity, we assume here that natives and immigrants have the same distribution in both groups. This is to keep the effect of emigration on immigrants across skill groups constant, since our focus is to find the changes in average wages of non-migrant natives. Equation (32) provides the changes in average wages of non-migrant natives due to the emigration flow from t-1 to t period, as a function of the changes in wages for high skilled and low-skilled natives.

$$\Delta\, W_t = \left(W_{S,t} - W_{S,t}{}^{*}\right)\frac{N_{S,t}}{N_{S,t} + N_{U,t}} + \left(W_{S,t} - W_{U,t}{}^{*}\right)\frac{N_{U,t}}{N_{S,t} + N_{U,t}} \tag{33}$$

where $W_{High,t}{}^{*}$ and $W_{Low,t}{}^{*}$ are the wages in period t estimated by using the stock of high and low-skilled emigrants from period t-1, respectively. The respective population share weights the differences in the actual wage of non-migrant natives and emigrants for both skill groups. Going one step further, we can link equation (33) with equation (14), with skill premium approximated by the differences in the growth rates of skilled and unskilled wages $\omega = \frac{\frac{\partial f}{\partial S}/B_S}{\frac{\partial f}{\partial U}/B_U} \cong \frac{W_{High,t} - W_{High,t}{}^{*}}{W_{Low,t} - W_{Low,t}{}^{*}}$. Combining these two equations, we get

$$L_S = 1 - \frac{\emptyset}{1-\emptyset}(Ak)^{\frac{\rho-1}{\rho}}\left[\theta^{\frac{\sigma(\rho-1)}{\rho-\sigma}}(1-\emptyset)^{\frac{\rho(\sigma-1)}{\rho-\sigma}} + (1-\theta)^{\frac{\sigma(\rho-1)}{\rho-\sigma}} l^{\frac{\sigma-1}{\rho-\sigma}} \frac{\mathrm{W}_{High,t} - \mathrm{W}_{High,t}{}^{*}}{\mathrm{W}_{Low,t} - \mathrm{W}_{Low,t}{}^{*}}^{\frac{\rho(\sigma-1)}{\rho-\sigma}}\right]^{\frac{\rho-\sigma}{\rho(\sigma-1)}} .(34)$$

Equation (34) suggests that skilled emigration may lower the labor income share through an increase in the skill premium. Ouyang and Paul (2018) in a recent paper show that wage growth for skilled workers is much higher in developing countries (Table 2).

Table 2: Evolution of Monthly Wages (% change between 1990 and 2000)

	Developed	Developing
Traded skilled worker	12.22%	79.40%
Traded unskilled worker	11.67%	39.47%
Nontraded skilled worker	16.00%	50.05%
Nontraded unskilled worker	14.15%	36.85%

Source: Ouyang and Paul (2018).

For empirical reasons, one can assume that workers with the same level of education are closer substitutes than those with a different education level. Similar strategies have been used to identify the effect of emigration on real wages. One last point to note about the model we have just discussed is important. It has been assumed throughout that capital in this economy is fixed. If capital could fully adjust, migration would probably lead to capital outflows, since a decrease in labor supply is likely to decrease the marginal product of capital. It also depends on capital-skill complementarity, as discussed in the first section. Thus, migration can have both direct and indirect effects on labor income share, and the literature has so far been silent on this topic. This remains one of most promising areas of research on the drivers of labor income share.

4.2 LIS, Remittances, and Brain-gain

According to recent World Bank estimates, the remittance flows to developing countries in 2011 were approximately $351 billion, with a staggering 215 million people living outside their countries of birth. This has enormous implications for economic growth and welfare, as remittances over the past two decades have become more important than the formal, government-sponsored or international aid to fuel development (GEM 2009; WDI 2010). The burgeoning literature on migration and development indicates various direct and indirect channels through which remittances affect the aggregate income and welfare in receiving countries (de Haas 2007; Ratha and Shaw 2007). While the direct effects of remittances are manifested through human capital accumulation, better access to health, education, finance, and entrepreneurship, the lost labor outcome due to emigration is likely to impact on wages and households' labor supply decisions in migrant-sending countries.

The impact of remittances from a macroeconomic theoretical point of view can be analyzed by three competing postulates. Based on the Keynesian model, some researchers (El-Sakka and McNabb 1999; Kireyev 2006; Rapoport and Docquier 2006) maintain that remittances provide an increase in income and therefore expand the aggregated demand. In a standard Keynesian macroeconomic model, investment and exports are exogenous and not related to output. Similarly, an increase in a country's income through remittances (R) can also be considered as an increment of export receipts or as further investment. In a recent study, Singer (2010) employs the Mundell Fleming model to explain the impact of remittances. In this modified model, remittances are part of the money supply. The main argument goes that as the money supply is triggered by an inflow of remittances expands, it consequently produces an increase in growth. Kireyev (2006) explores the impact of remittances from the perspective of national accounts theory. He argues that the direct impact of remittances contributes to an expansion of the aggregate demand. Since remittances affect private flows, an increase in consumption is supported either by higher domestic outputs or higher imports.

The theoretical approach to analyzing the impact of remittances on labor income share through human capital closely corresponds to that of migration, since remittances are a direct consequence of international migration. Theoretical arguments show that migration presents positive as well as negative effects on human capital. On one hand, researchers argue that migration has a negative effect on the local stock of human capital by removing individuals with skills (Grubel and Scott 1966; Bhagwati and Hamada 1974; Kwok and Leland 1982). These studies highlight the negative impact of migration particularly for developing countries; sustaining that migration creates a scarcity of skilled workers (commonly known as brain-drain). On the other hand, Vidal (1998) and Chen (2006) postulate that migration can have positive effects for migrant-sending countries. The general argument in this kind of research is that migration (and the consequently the inflow of remittances) fosters investment in education in migrant-sending countries (brain-gain argument). To this extent, three related studies (Beine, Docquier, and Rapoport 2008; Vidal 1998; Mountford 1997) show that migration prospects have a positive impact on human capital because they increase the expected returns to education, and additionally they may foster education investment in the migrant-sending countries. As a result, the source country could potentially end up with a higher level of human capital. This transforms the classical view of migration from brain-drain to brain-gain. Brain-gain or human capital development has direct bearing on labor income share as argued by Atkinson (2009).

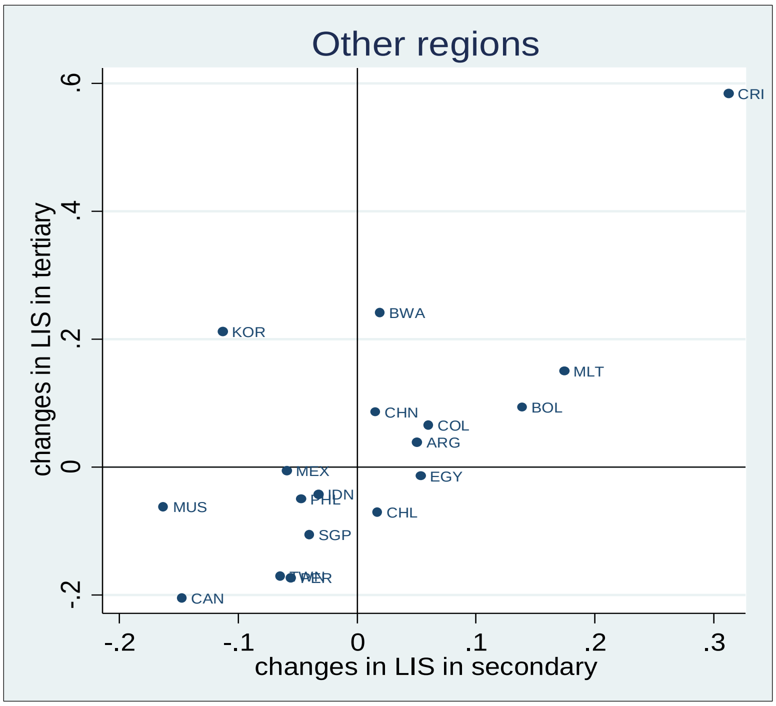
4.3 LIS, Remittances, and Negative Labor Supply

The theoretical approach to analyzing the impact of remittances on labor markets derives from neoclassical models of labor-leisure choice, developed by Barzel and McDonald (1973) and Killingsworth (1983), where remittances are non-labor income. In recent years, interest has grown in using general equilibrium models to analyze the specific transmitting channels through which remittances affect participation in labor markets (Bussolo and Medvedev 2008; Kim 2007). Bussolo and Medvedev (2008) develop a basic model where an increase in remittances is equivalent to a permanent increase in income of the household. They further argue that this increase influences the behavior of tradable and non-tradable goods in the economy: the increase of income in the household represents extra spending on tradable and non-tradable goods (if non-tradable goods are normal goods). The final link in this basic model, which assesses the impact of remittances, comes from a modification of the above model based on work by Annabi (2004), Barzel and McDonald (1973) and most prominently Killingsworth (1983), which introduced a consumption-leisure trade-off in the household utility function. The theoretical model concludes that the labor supply is decreasing in non-labor income, and the sign of the elasticity will depend on the ratio of non-labor income to the total consumption expenditure. Bussolo and Medvedev (2008) further explain that with an increase in non-labor income through remittances, individuals can consume more goods and leisure (i.e., the income effect dominates) and thus their labor supply is reduced. In a general equilibrium setting, wages are set to clear the labor market and reduced labor supply implies raising wages. According to them, this triggers second order effects. They show that higher wages raise the opportunity cost of leisure and the substitution effect can push individuals to increase their labor supply, up to the point where the income effect dominates again like a backward bending labor supply curve. It is difficult to conclude whether a negative labor supply effect through remittances can lower labor income share, as it depends on whether the primary effects dominates the secondary effect or vice versa. As shown in equation (26), in the absence of effective bargaining, a higher level of reservation wage can also restore a higher share of income for the laborers. Overall, remittance serves as a potential identification mechanism to link the changes in the labor income share to changes in employment or wages.

4.4 LIS and Premature Deindustrialization

The growth of low-skilled service jobs (Autor and Murnane 2003) could be a threat to already declining labor income share, and this leads to another promising area of research to examine the consequences of “premature deindustrialization” on the labor income share. The employment share in manufacturing typically follows an inverted U-shaped path as countries develop, but as Rodrik (2016) observes the turning point for developing countries arrives sooner and at much lower levels of income than what has been the case for developed countries in the previous decades. He further argues that globalization and labor-saving technological progress in manufacturing play crucial roles in this prematurity of deindustrialization. However, the evidence for premature deindustrialization or even deindustrialization at an aggregate level may not be there. As Haraguchi and Rezonja (2010) argue, industrial production can move from one country to another because of trade liberalization alongside productivity and income growth. For this reason, we may find some countries experiencing a lower industrial production and employment over time, which may not be the case for other countries. As a result, it provides a very interesting identification problem to handle especially among the developing countries. Not to mention, country size also plays a key role here (e.g., the People’s Republic of China). Moreover, one needs to be very careful about industry VA and industry employment as they could be very different and follow different growth trajectories. We can use both, but there is no reason to expect that the outcomes would converge. In a recent study, Oishi and Paul (2018) provide some evidence on the relationship between changes in the labor income share in the secondary and the tertiary sectors. They show that the change in the labor income share in the tertiary sector was the highest in Costa Rica and the lowest in the Peru. At the same time, the change in the labor income share in the secondary sector is the highest in Costa Rica and the lowest in Mauritius. Overall, this study finds a positive correlation between changes in the labor income share between tertiary and secondary sectors. One possible extension of this line of research is to compare the drivers of labor income share between manufacturing and services especially in the developing countries.

Figure 6: Changes in Labor Income Shares: Manufacturing versus Services



Note: Change in the labor income share is based on the starting year and the ending year for each country. For further details please see Oishi and Paul (2018).

Source: Oishi and Paul (2018).

4.5 LIS and Firm Restructuring

In this section, we discuss another potential area of research on the drivers of labor income share from the micro perspective. The literature on the effect of the ownership structure of firms, e.g., how labor income share differs between state owned, privately owned and foreign-owned firms has been most mostly silent, except for Decreuse and Maarek (2015), Zhou (2016) and some other studies. Using data from 98 developing countries over the period from 1980 to 2000, Decreuse and Maarek (2015) find a U-shaped relationship between labor income share and the proportion of foreign firms. Furthermore, they argue that the magnitude of the relationship is governed by the technological gap between foreign and local firms. We use a simple model following Decreuse and Maarek (2015). Assume that there are two types of firms. The proportion of the first type of firm is δ, with income level y_1 and the proportion of the second type of firm is $1-\delta$ with income level y_2, and the first group of firms is more productive than the second group of firms, i.e., $y_1 > y_2$. This could be because type 1 firms use better technology, insertional set up, or unobserved factors related to ownership structures. We maintain the homogeneity assumption of labor to keep the model simple. Firm 2 enters the market first, and first 1 sets a wage with a mark-up over first 2's wage assuming $w_1 > w_2$, in the following manner:

$$w_1 = \frac{[\delta y_1 + (1-\delta) y_2] w_2}{y_2} > w_2. \qquad (35)$$

Plugging this into the labor income share formula, we can write expressions for the labor income share for both types of firms as follows:

$$LIS_1 = \frac{w_1}{y_1} = \frac{[\delta y_1 + (1-\delta) y_2] w_2}{y_1 y_2} \text{ and } LIS_2 = \frac{w_2}{y_2}. \quad (36)$$

Combining LIS_1 and LIS_2, we get the aggregate labor income share as follows:

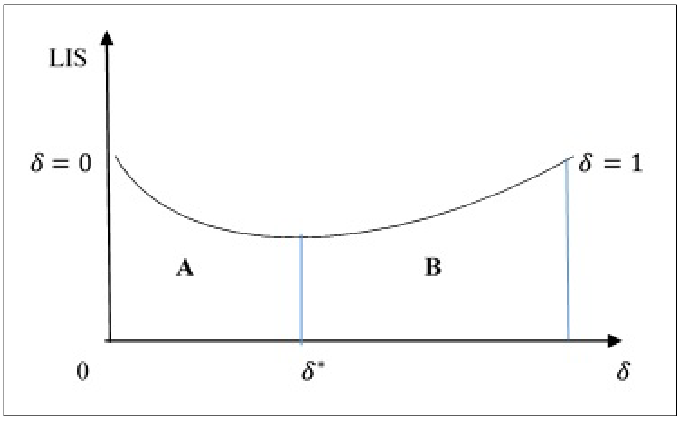
$$LIS = \frac{w_1}{y_1} = \frac{\delta w_1 + (1-\delta) w_2}{\delta y_1 + (1-\delta) y_2} = \frac{\delta \frac{[\delta y_1 + (1-\delta) y_2] w_2}{y_2} + (1-\delta) w_2}{\delta y_1 + (1-\delta) y_2}. \quad (37)$$

Differentiating the aggregate labor income share with respect to δ, we find a non-linear (convex) relationship between the aggregate labor income share and the share of productive firms as depicted in Figure 7.

$$LIS = \frac{dLIS}{d\delta} = \delta^2 y_1 - (1-\delta)^2 y_2; \frac{d^2 LIS}{d\delta^2} > 0. \quad (38)$$

The equation (38) shows that in a frictional labor market with productive heterogeneity, and shock such as foreign direct investment (FDI) can have two opposite effects on the labor income share. The first is a negative effect originated by technological advancement and then a positive effect due to an increasing labor market (wage) competition between firms. As evident from Figure 7, the technological effect dominates the wage coopetition effect when LIS is downward sloping (the region marked by A), whereas the wage coopetition effect dominates the technological effect when the LIS is upward sloping (the region marked by B).

Figure 7: Labor Income Share and the Ownership Structure of the Firm



Source: The authors, following Zhou (2016).

The enterprise survey data http://www.enterprisesurveys.org/data./ could be an effective tool to conduct empirical studies on labor income share by comparing firms of different ownership types, as well as for using information about the size and the age of the firm across countries.

4.6 LIS and Globalization at the Sectoral Level

In section 3.3, we discussed various channels that connect globalization to movements in the labor income share at the national level. The study of labor income shares at the sectoral level play an important role in understanding the relationship between sectoral value-added and personal income. However, the empirical studies on the effect of globalization on the labor income share are limited to the country-level analysis mainly because at the sectoral level, data on labor income share is available only for the advanced countries. In a recent study, Oishi and Paul (2018) construct a novel data set on labor income share at the 10-sector level[17] following the classification of Groningen Growth Data Centre (GGDC). This new data allows us to estimate sectoral labor income shares for 54 countries across five regions (9 from East Asia and the Pacific, 28 from Europe and Central Asia, 8 from Latin America and the Caribbean, 2 from the Middle East and North Africa, 2 from North America, and 5 from Sub-Saharan Africa). Out of 54 countries, 20 countries are developing countries (based on the World Bank classification). They found that on average, the labor income shares in developing countries are slightly lower than that in the developed countries. They also find considerable variation in the labor income share estimates within each region and within each broad category of sectors, measured at the level and changes over time. For example, labor receives the lowest share of income in primary sectors in all regions except in the Middle East and North Africa (MENA) and the Sub-Saharan Africa (SSA). In East Asia and the Pacific (EAP) and North America, the labor income share is the highest in the tertiary sector, whereas in the Europe and Central Asia region, the secondary sector shows the most favorable returns to labor. On the other hand, data on tariff rates at the sectoral are available from various data sources including COMTRADE https://comtrade.un.org/ and UNCTRADE https://unctad.org/en/Pages/statistics.aspx. Analyzing the cross-country sectoral patterns of labor income share in conjunction with the trade reforms can help us closely identify the drivers of the labor income share.

[17] We follow the Groningen Growth Data Center (GGDC) classification of 10 sectors (AGR, MIN, MAN, PU, CON, WRT, TRA, FIRE, GOV and OTH).

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