Discussion Paper Series A No.672

The Long-Run Dynamics of the Labour Share in Japan

Kyoji Fukao
(Institute of Economic Research, Hitotsubashi University)
and
Cristiano Perugini
(Department of Economics, Finance and Statistics,
University of Perugia)

March 2018

Institute of Economic Research
Hitotsubashi University
Kunitachi, Tokyo, 186-8603 Japan

The Long-Run Dynamics of the Labour Share in Japan

Kyoji Fukao (Hitotsubashi University)

Cristiano Perugini (University of Perugia)

Abstract

In this paper we investigate the long-term drivers of the share of output accruing to labour in Japan. We contribute to this strand of literature by extending the theoretical SK schedule model proposed by Bentotila and Saint-Paul (2003) to multiple inputs and by providing new empirical evidence on Japan at detailed sector-level over the period 1970–2012. The econometric analysis is carried out by means of an error correction model (ECM) that allows testing the existence of long-run relationships while accounting for cross-sectional heterogeneities and dependence. Results indicate that the macro-sector of low-knowledge-intensive market services was mainly responsible for the decline in the labour share experienced by the Japanese economy in the four decades considered. This was related to technological change and, more importantly, to labour market factors - such as the role of unions and a high substitutability of regular with non-regular workers - and product market structural features. These drivers could have significantly contributed to reducing the bargaining power of labour vis-à-vis employers and, consequently, the labour share.

Keywords: labour share, non-regular work, markup, Japan
JEL Classification: E25, J30, L11, O14

The authors are indebted to Paul Saumik for his valuable comments and insights in the initial stage of the research; they are also grateful to the participants of the International Workshop on Productivity, Innovation and Intangible Investments (Assisi, 22-23 September 2017) for their useful comments.

1. Introduction

Aspects related to functional income distribution have been regaining importance in the economic research agenda in the last two decades, after having been marginalised for a long time (Krueger, 1999; Bentotila and Saint-Paul, 2003; Atkinson, 2009; Daudey and Garcia-Penalosa, 2007). In particular, many authors have contributed to the recent focus on the widespread evidence of a declining output share accruing to labour in the last 30–40 years across the whole developed world (Elsby et al., 2013; Karabarbounis and Neiman, 2014). Explanations of the decreasing labour share trend range from factors related to the production function, such as capital-augmenting technological change and capital deepening (Bentolila and Saint-Paul, 2003; Antràs, 2004; Piketty, 2014; Piketty and Zucman, 2014), to globalisation (Elsby et al., 2013; Bockerman and Maliranta, 2012; Jaumotte and Tytell, 2007; Jayadev, 2007), and to labour and product market imperfections that shape the bargaining power of workers *vis-à-vis* employers (Bental and Demougin, 2010; OECD, 2011; Azmat et al., 2012; Autor et al., 2017; Barkai, 2016). The welfare implications of the decline of the labour share, strictly dependent on its drivers, have also been extensively considered (Zeira, 1998; Blanchard and Giavazzi, 2003). In particular, due to capital income and profits being more unequally distributed than labour income, the negative association between labour share and personal income inequality has been extensively documented (Mai et al., 2017; Schlenker and Schmid, 2015). The well-known heterogeneity in marginal propensity to consumption at different income levels explains why the trend in the labour share is crucial in determining domestic demand patterns. These reasons make the analysis of the dynamics of the labour share in Japan particularly interesting, since in the last decades the country has experienced a long period of stagnation, coupled with an unprecedented increase in economic inequality (Funabashi and Kushner, 2015; Minami, 2008).

This paper contributes to this literature by documenting and studying the long-run pattern of the labour share in Japan, on which research has so far been rather limited (see Agnese and Sala, 2011; Takeuchi, 2005; Wakita, 2006). Figure 1 (left panel) shows that, compared to the level in the early 1970s, the Japanese labour share (S_L) in the whole market economy decreased by approximately ten percentage points in the following three decades, mainly as a result of the first wave of decline that took place from the mid-70s until the end of the 1990s[1]. A second wave followed from the late 1990s to the outburst of the 2007–2008 global crisis. Lower levels of the S_L are clearly associated with higher income concentration and inequality (Figure 1, right panel).

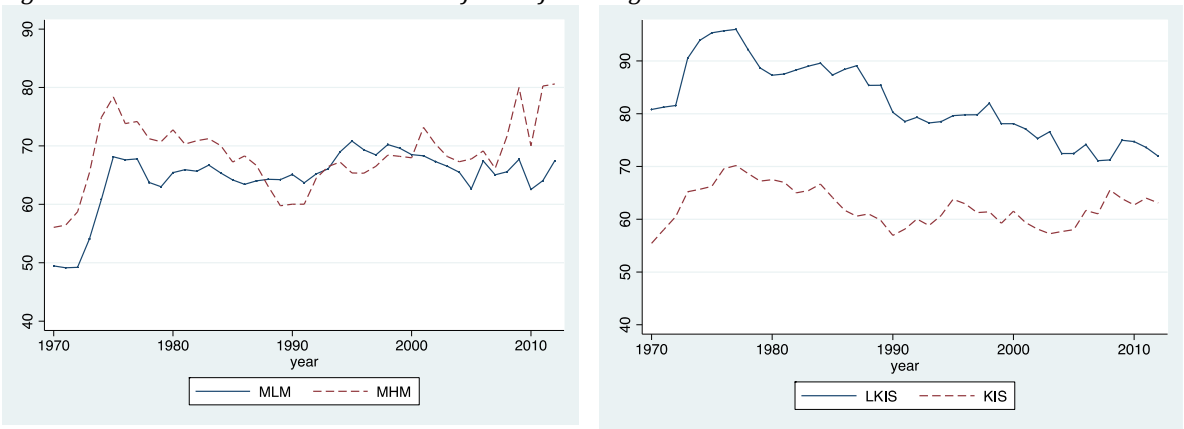
[1] The labour share reported in Figure 1 is calculated using JIP data (Japan Industrial Productivity). A similar S_L pattern is obtained using AMECO or KLEMS data. Observable differences (in particular the higher S_L levels described by the JIP data) are due to the direct inclusion in the JIP data of remunerations of all labour types, including self-employed and family work. See Section 4.1 for the details on the calculation of the S_L and the dataset.

Figure 1. Labour share in the market economy and income inequality (top 1% share of income) in Japan

Source: Authors' elaborations of JIP database and WWID data

With respect to what happened in contexts usually compared to Japan, for example the US, in which the decline of the labour share mainly took place in manufacturing while remaining substantially unchanged in services, data for Japan highlights the opposite pattern. Figure 2 plots the trend over time of the S_L with a sectoral breakdown based on the widely used Eurostat industry classification into medium- and medium-high-technology manufacturing sectors (MHM), medium- and medium-low-technology manufacturing sectors (MLM), knowledge-intensive services (KIS), and less-knowledge-intensive services (LKIS) (see section 4.1 and Appendix A for further details on the classification).

Figure 2. Labour share in macro-sectors of manufacturing and services

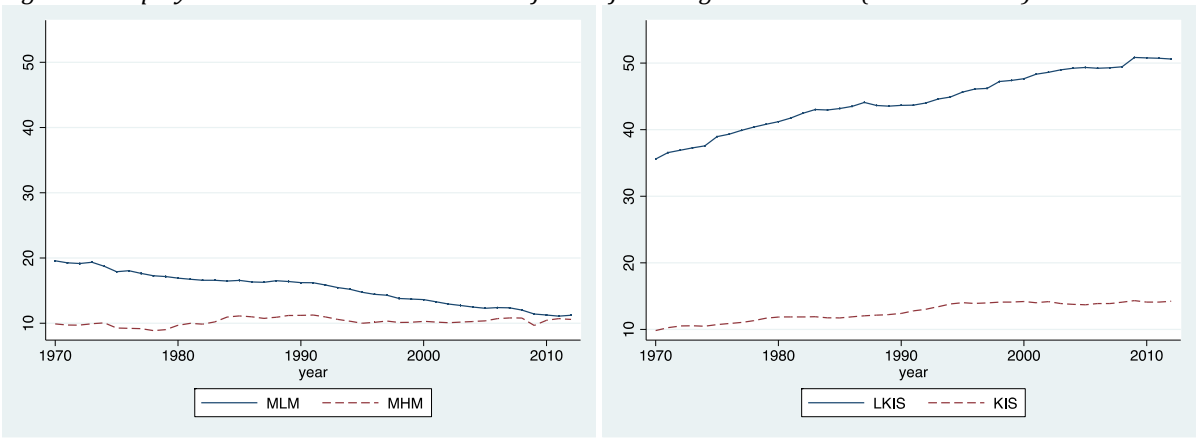


Source: Authors' elaborations of JIP database

The decline of the labour share in Japan took place almost exclusively in low-knowledge-intensive services, the macro-sector that experienced the largest expansion in terms of employment share and which at the end of the period considered accounted for over half of total hours worked in Japan (Figure 3). It is therefore apparent that any attempt to explain the pattern of the S_L in Japan needs a sectoral perspective of analysis. This is what we do in this paper, trying to relate the dynamics of the labour share to evolutions that occurred in product and labour markets over the last decades. In particular, labour market features (see Hamaaki et al., 2012) underwent massive changes in Japan

along three main and intertwined dimensions: i) the decline of the lifetime employment system (Ono, 2010; Kawaguchi and Ueno, 2013); ii) the increase in non-regular work (Asano et al., 2013; OECD, 2017a); and iii) the huge increase of women in the labour force (Inoue et al., 2016). On the product market side, both domestic and international forces reshaped the structural features of markets in terms of concentration, exposure to competitive pressures, and market power, giving rise to profit and markup patterns that significantly differ across sectors (Fukao and Nishioka, 2017).

Figure 3. Employment shares in macro-sectors of manufacturing and services (hours worked)



Source: Authors' elaborations of JIP database

Our paper contributes to the existing knowledge on different fronts. First, in terms of theory, we propose an original extension to more than two inputs of the seminal model by Bentotila and Saint-Paul (2003), based on the SK (labour share/capital) schedule; this enables us to investigate the degree of substitutability of different types of capital (IT and non-IT) and labour (regular and non-regular) and its impact on the S_L. On the empirical side, the contribution is manifold since, by directly accessing the Japan Industrial Productivity (JIP) database we are able to: i) provide long-run evidence of S_L dynamics in Japan; ii) carry out a detailed analysis (in 84 market industries) that fully accounts for sectoral specificities; iii) acknowledge the heterogeneity of labour (regular/non-regular work) and capital (IT and non-IT capital); and iv) explicitly consider and estimate the role of markups.

The rest of the paper is organised as follows. In Section 2 we provide the theoretical basis of our subsequent analysis. In Section 3 we describe the empirical model and the econometric methods. Section 4 illustrates the dataset and presents our results. Section 5 concludes.

2. Theory: the Extended SK Schedule and Deviations from the Schedule

Our conceptual framework builds on the model proposed by Bentotila and Saint-Paul (2003), which postulates a one-to-one relationship between labour share and capital-output ratio (the so-called share capital -SK- schedule) as long as labour is paid its marginal product. To enable the aims of this paper, in section 2.1 we propose an extension of the model to more than two factors of production: namely, we derive the SK schedule in the presence of two types of capital (IT and non-IT) and the SK schedule with two types of capital and two types of labour (regular and non-regular). The latter, linking the S_L of

regular workers to the intensity of all other production factors, allows investigating the degree of substitutability between different labour inputs.

In section 2.2 we discuss the factors that may cause a departure from the SK schedule, as identified by the existing literature, and which are relevant to the specific case of Japan.

2.1. The SK Schedule in the Presence of Multiple Inputs

In their baseline model, Bentolila and Saint Paul (2003) show that in the presence of two factors of production (K and L) and under the assumptions of constant returns to scale, capital and labour-augmenting technical progress – $Y_i = F(A_iK_i, B_iL_i)$ – and competitive markets, there is simple relationship between the labour share in industry *i* (S_L^i) and the capital–output ratio ($k_i = K_i/Y_i$). This is the so-called SK schedule [$S_L^i = g(A_ik_i)$]: a unique function *g* explains the labour share based on observable capital–output ratios, with changes in capital augmenting technological progress shifting the SK schedule. This implies that variations of the S_L across sectors, countries, and over time may be due to different values of the capital–output ratios and different elasticities of substitution between factors. A positive slope of the SK schedule means that the elasticity of substitution between capital and labour (σ) is lower than one (factor complementarity). Vice-versa, when K and L are substitutes, the SK is downward-sloping, except for the case in which $|\sigma| = 1$ (the Cobb-Douglas case), in which changes in relative factor intensities are exactly compensated by changes in their relative prices, and the labour share is consequently independent of capital intensity.

We now discuss the effects on the SK schedule of changes in the aggregate production function represented by the existence of heterogeneous types of capital and labour. To start with, we assume the following constant return-to-scale production technology in each industry *i* (suffix *i* not indicated for the sake of simplicity):

$$Y = Y_{IT}^{\gamma_{IT}} Y_{NIT}^{1-\gamma_{IT}} \tag{1}$$

$$Y_{IT} = \{\alpha_{IT}(A_{IT}K_{IT})^{\varepsilon_{IT}} + (1-\alpha_{IT})(B_{IT}L_{IT})^{\varepsilon_{IT}}\}^{\frac{1}{\varepsilon_{IT}}} \tag{2}$$

$$Y_{NIT} = \{\alpha_{NIT}(A_{NIT}K_{NIT})^{\varepsilon_{NIT}} + (1-\alpha_{NIT})(B_{NIT}L_{NIT})^{\varepsilon_{NIT}}\}^{\frac{1}{\varepsilon_{NIT}}} \tag{3}$$

The production activity of this industry consists of two processes: i) an IT capital-intensive process, in which labour, L_{IT}, and IT capital, K_{IT}, are employed; and ii) a non-IT capital intensive process, in which labour, L_{NIT}, and non-IT capital, K_{NIT}, are employed. In the two processes the elasticities of substitution, $1/(1-\varepsilon_{IT})$ and $1/(1-\varepsilon_{NIT})$ are constant. We assume that ε_{IT} and ε_{NIT} are smaller than 1. We also assume that, as equation (1) shows, elasticity of substitution between the two processes for total production is equal to one. γ_{IT} and $1-\gamma_{IT}$ denote the relative importance of the two processes, with $0<\gamma_{IT}<1$.

Let $s_{IT,L}$ and $s_{NIT,L}$ denote labour income share in the IT capital and non-IT capital-intensive process respectively. As Bentolila and Saint-Paul (2003, equation 10) have shown:

$$s_{IT,L} = 1 - \alpha_{IT}\left(A_{IT}\frac{K_{IT}}{Y_{IT}}\right)^{\varepsilon_{IT}} \tag{4}$$

$$s_{NIT,L} = 1 - \alpha_{NIT}\left(A_{NIT}\frac{K_{NIT}}{Y_{NIT}}\right)^{\varepsilon_{NIT}} \tag{5}$$

Equation (4) means that when the elasticity of substitution between IT capital and labour is greater than one ($0<\varepsilon_{IT}<1$), an increase of K_{IT}/Y_{IT} will reduce the labour income share in the IT capital-intensive process. When elasticity of substitution between IT capital and labour is smaller than one ($\varepsilon_{IT}<0$), an increase in K_{IT}/Y_{IT} will increase labour income share in the IT capital-intensive process.

Since Y is a Cobb-Douglas function of Y_{IT} and Y_{NIT}, cost shares of IT-intensive and non-IT-intensive processes in the total production cost are γ_{IT} and $1-\gamma_{IT}$, respectively. Therefore, the labour share in the total production process, s_L, is given by:

$$s_L = 1 - \gamma_{IT}\alpha_{IT}\left(A_{IT}\frac{K_{IT}}{Y_{IT}}\right)^{\varepsilon_{IT}} - (1-\gamma_{IT})\alpha_{NIT}\left(A_{NIT}\frac{K_{NIT}}{Y_{NIT}}\right)^{\varepsilon_{NIT}} \quad (6)$$

We should note that K_{IT}/Y_{IT} and K_{NIT}/Y_{NIT} are usually unobservable. However, we can rewrite the above equation as follows:

$$s_L = 1 - \gamma_{IT}\alpha_{IT}\left(A_{IT}\frac{K_{IT}}{Y}\right)^{\varepsilon_{IT}}\left(\frac{Y}{Y_{IT}}\right)^{\varepsilon_{IT}} - (1-\gamma_{IT})\alpha_{NIT}\left(A_{NIT}\frac{K_{NIT}}{Y}\right)^{\varepsilon_{NIT}}\left(\frac{Y}{Y_{NIT}}\right)^{\varepsilon_{NIT}} \quad (7)$$

where Y_{IT}/Y and Y_{NIT}/Y depend on firms' decision regarding substitution between IT-intensive and non-IT-intensive processes.

As we show in Appendix B, when IT capital cost is relatively lower than non-IT capital cost, firms will expand the IT-intensive process (higher Y_{IT}/Y) in comparison with the non-IT-intensive process (lower Y_{NIT}/Y). Again, Y_{IT}/Y and Y_{NIT}/Y are usually not observable. However, as shown in Appendix B, under our assumptions concerning the production process, Y_{IT}/Y is a continuously differentiable function of K_{IT}/Y and K_{NIT}/Y. This function is strictly increasing for K_{IT}/Y and strictly decreasing for K_{NIT}/Y. Y_{IT}/Y also depends on technology indices A_{IT}, A_{NIT}, B_{IT} and B_{NIT}:

$$\frac{Y_{IT}}{Y} = \theta_{IT}\left(\frac{K_{IT}}{Y}, \frac{K_{NIT}}{Y}, A_{IT}, B_{IT}, A_{NIT}, B_{NIT}\right) \quad (8)$$

In a similar way, we can also prove that Y_{NIT}/Y is a function of the same set of variables:

$$\frac{Y_{NIT}}{Y} = \theta_{NIT}\left(\frac{K_{IT}}{Y}, \frac{K_{NIT}}{Y}, A_{IT}, B_{IT}, A_{NIT}, B_{NIT}\right) \quad (9)$$

Y_{NIT}/Y is a decreasing function of K_{IT}/Y and an increasing function of K_{NIT}/Y.

Substituting the above two equations into equation (7), we obtain:

$$\begin{aligned} s_L = {} & 1 - \gamma_{IT}\alpha_{IT}\left(A_{IT}\frac{K_{IT}}{Y}\right)^{\varepsilon_{IT}}\theta_{IT}\left(\frac{K_{IT}}{Y}, \frac{K_{NIT}}{Y}, A_{IT}, B_{IT}, A_{NIT}, B_{NIT}\right) \\ & -(1-\gamma_{IT})\alpha_{NIT}\left(A_{NIT}\frac{K_{NIT}}{Y}\right)^{\varepsilon_{NIT}}\theta_{NIT}\left(\frac{K_{IT}}{Y}, \frac{K_{NIT}}{Y}, A_{IT}, B_{IT}, A_{NIT}, B_{NIT}\right) \end{aligned} \quad (10)$$

A linear approximation of this equation, augmented with factors able to shift the SK schedule (see section 2.2), is estimated in the empirical sections of the paper (sections 3 and 4).

Using a similar framework, we can further generalize our model to take into account heterogeneity of workers. We assume that there are four production factors: regular workers, non-regular workers, IT capital and non-IT capital. We also assume that there are three production processes: a non-regular labour-intensive process, in which regular workers $L_{NR,R}$ and non-regular workers L_{NR} are used; an IT capital-intensive process, in which regular workers $L_{IT,R}$ and IT capital K_{IT} are used; and a non-IT capital-intensive process, in which regular workers $L_{NIT,R}$ and non-IT capital K_{NIT} are used. We assume a constant return-to-scale production technology, which is defined by the following equations:

$$Y = Y_{NR}^{\gamma_{NR}} Y_{IT}^{\gamma_{IT}} Y_{NIT}^{1-\gamma_{NR}-\gamma_{IT}} \quad (11)$$

$$Y_{NR} = \left\{\alpha_{NR}(A_{NR}L_{NR})^{\varepsilon_{NR}} + (1-\alpha_{NR})\left(B_{NR}L_{NR,R}\right)^{\varepsilon_{NR}}\right\}^{\frac{1}{\varepsilon_{NR}}} \quad (12)$$

$$Y_{IT} = \left\{\alpha_{IT}(A_{IT}K_{IT})^{\varepsilon_{IT}} + (1-\alpha_{IT})\left(B_{IT}L_{IT,R}\right)^{\varepsilon_{IT}}\right\}^{\frac{1}{\varepsilon_{IT}}} \quad (13)$$

$$Y_{NIT} = \left\{\alpha_{NIT}(A_{NIT}K_{NIT})^{\varepsilon_{NIT}} + (1-\alpha_{NIT})\left(B_{NIT}L_{NIT,R}\right)^{\varepsilon_{NIT}}\right\}^{\frac{1}{\varepsilon_{NIT}}} \quad (14)$$

In a similar way as the in the case of the three-production-factor model, labour income share of regular workers, s_{RL}, is expressed by the following equation:

$$\begin{aligned} s_{RL} = {} & 1 - \gamma_{NR}\alpha_{NR}\left(A_{NR}\tfrac{L_{NR}}{Y}\right)^{\varepsilon_{NR}}\theta_{NR}\left(\tfrac{K_{IT}}{Y},\tfrac{K_{NIT}}{Y},\tfrac{L_{NR}}{Y},A_{NR},B_{NR},A_{IT},B_{IT},A_{NIT},B_{NIT}\right) \\ & -\gamma_{IT}\alpha_{IT}\left(A_{IT}\tfrac{K_{IT}}{Y}\right)^{\varepsilon_{IT}}\theta_{IT}\left(\tfrac{K_{IT}}{Y},\tfrac{K_{NIT}}{Y},\tfrac{L_{NR}}{Y},A_{NR},B_{NR},A_{IT},B_{IT},A_{NIT},B_{NIT}\right) \\ & -(1-\gamma_{NR}-\gamma_{IT})\alpha_{NIT}\left(A_{NIT}\tfrac{K_{NIT}}{Y}\right)^{\varepsilon_{NIT}}\theta_{NIT}\left(\tfrac{K_{IT}}{Y},\tfrac{K_{NIT}}{Y},\tfrac{L_{NR}}{Y},A_{NR},B_{NR},A_{IT},B_{IT},A_{NIT},B_{NIT}\right) \end{aligned} \quad (15)$$

2.2. Departures from the SK Schedule: Product and Labour Market Settings and Globalisation

The SK relationship is stable as long as the marginal product of labour is equal to the real wage. Any factor able to create a gap between them places the economy *off* the schedule. Bentotila and Saint-Paul (2003) identify and formalize three possible factors, related to product market and labour market structural settings. The first originates from the relaxation of the assumption of perfectly competitive markets and the consequent existence of a markup (μ) of prices over marginal costs. As the new SK relationship now reads $S_L = \mu^{-1}g(k)$, any change in the markup will generate a move away from the relationship between the labour share and capital intensity, affecting the labour share in the opposite direction. Some recent contributions have developed this intuition both theoretically and empirically. Azmat et al. (2012) focus on the role of privatisation and deregulation of product markets. In their model they show theoretically and empirically that privatisations, mainly due to a reduction in employment, account for a remarkable part of the decline in labour share in network industries in OECD countries. They also highlight how deregulation of product markets, leading to an intensification of competition between firms, is able to counteract this decline, driving the labour share upwards. Autor et al. (2017) uncover a negative industry-level correlation between concentration and labour share in the US. The bulk of their explanation lies in the complementary evidence provided by firm-level data: reallocation processes within industries materialised as the rise of a restricted number of 'superstar firms', able to increase revenues without increasing labour costs. Their higher profits explain a remarkable part of the decline in the labour share. Perugini et al. (2017) provide similar microeconomic empirical evidence (of profit margins negatively affecting the labour share) for six EU countries. Lastly, Barkai (2016) also finds a negative industry-level relationship between changes in labour share and changes in concentration for the United States. In addition, he also shows that higher market power translates into higher profits and a decline in the capital share (i.e., capital cost times capital stock), which is in fact of a significantly larger magnitude than the decrease in the labour share. The growing gap between labour productivity and wages and the lack of capital accumulation in response to the decline in the required rate of return are the features of declining competition that

impact on the factor shares. All available empirical contributions agree in identifying a very important quantitative impact of market concentration on the labour share dynamics.

A second group of factors identified as drivers of the labour share refer to the forces of globalisation. One channel through which their impact unfolds is obviously related to competitive pressures that trade or offshoring exert on firms; however, globalisation forces do not only impact on the size of profits (in different possible ways according to the type of trade – vertical versus horizontal – or the sectoral pattern of offshoring), but also on the way they are shared between capital and labour. This depends, indeed, on the bargaining power of workers vis-à-vis employers, shaped by institutional factors and by the direction in which globalisation affects relative labour demand. According to classical trade theories, developed countries specialize in capital-intensive industries, and this, with given factors' endowment, will drive r/w upwards and reduce K/L in all sectors. As a consequence, if the elasticity of substitution is lower than one (i.e., capital and labour are gross complements), the labour share will decline (European Commission, 2007). The introduction of labour heterogeneity (high- and low-skilled) complicates the predictions of the model, since the overall effect on the S_L will now depend on the relative elasticity of substitution of the different types of labour with respect to capital (Guscina, 2007; ILO, 2011). Additionally, in imperfectly competitive labour markets, globalisation forces tend to adversely affect the relative bargaining position of the least mobile production factor, i.e., labour (Rodrik, 1997; Slaughter, 2000). Workers' bargaining position will consequently deteriorate due to an increase in the outside options of firms (IMF, 2007). The threat of relocating the production process (or part of it) through FDI, outsourcing, or imports of intermediate inputs, is therefore likely to compress wages and to lead to a decline in the labour share. When domestic firms in developed countries decide to produce abroad, or to offshore the most unskilled labour-intensive segments, labour demand for low-skilled workers decreases and its wage elasticity grows (Crinò, 2012). Both factors are expected to drive the labour share downwards in developed countries, as confirmed by numerous empirical studies (Guscina, 2007; Harrison, 2002; Jaumotte and Tytell, 2007; Jayadev, 2007). The overall impact on the labour share in the presence of heterogeneous labour is ultimately an empirical matter, depending on the relative size of the gains/losses of the groups of workers. Guerriero and Sen (2012) provide empirical evidence on the different effect of trade openness on the labour share for OECD (negative) and non-OECD (positive) countries: when they distinguish between developed and developing countries they find that the effect of openness is positive in both cases, but much weaker for advanced economies.

The effects of changes in the competition environment on the labour share cannot be evaluated separately from institutional settings that may create/enhance the gap between labour productivity and real wages (Checchi and Garcia- Peñalosa, 2010; Jaumotte and Buitron, 2015). The existing literature tends to agree that in modern market economies certain factors contributed to the deterioration of labour power, reflected in the decline of workers' unions, in the change of their objective function, and in the evolution of employment legislation. Bentotila and Saint-Paul (2003) consider the role of unions in connection with different bargaining models. When negotiations between trade unions and firm representatives follow the 'efficient bargaining' model (i.e., both wages and employment are negotiated at the same time) the real wage paid by firms differs from the

marginal product of labour, the gap depending on the strength of the trade unions. The higher their power, the closer is the wage to the marginal product and the higher the labour share: $S_L = 1-(1-\delta)(Ak)^{\varepsilon}$, where δ is the workers' bargaining power. When negotiations take place on the basis of a 'right to manage' model (wages are bargained first, and afterwards firms unilaterally chose the level of employment equalising marginal product and wage), changes in the bargaining power do not shift the equilibrium away from the SK but move it along the SK, in the direction commanded by the elasticity of substitution between capital and labour. Other labour market institutional settings able to alter the SK relationship are related to employment protection legislation. Again, Bentolila and Saint Paul (2003) show that higher labour protection increases labour adjustment costs (due to hiring and firing); this increases labour costs for firms but only partially translates into higher real wages, thereby enhancing the wedge between real wage and productivity, and ultimately decreasing the S_L. In view of the changes observed in the Japanese labour market which are of interest here, limiting the focus to permanent employment might offer a partial view, especially in sectors that departed more significantly from the traditional institutional settings based on the dominance of regular jobs and lifetime employment. Damiani at al. (2017) offer a discussion and some empirical evidence on the detrimental effects of an increase in temporary employment on the labour share. The bargaining models described above are not applicable to the segments of non-regular workers, who are usually less unionised (OECD, 2012) and more weakly represented in negotiations by unions, which tend to favour longer-serving members and to agree to contracts with steep returns to seniority (Booth et al., 2002). This contributes to shaping a dual labour market (Boeri and Garibaldi, 2007) in which the secondary segment of non-regular work is likely to end up in an equilibrium wage that closely approaches the reservation wage. Since, especially in some tasks/sectors, regular and non-regular workers may be substitutes, what happens in the low-wage segment of the labour market could affect equilibrium wages in the whole economy by enhancing the outside option for firms and their bargaining power, vis-à-vis unions and labour in general.

3. Empirical Model and Econometric Methods

In order to derive an empirical model for the drivers of the labour share in Japan, we follow Bentotila and Saint-Paul (2003) in assuming a general multiplicative form of the labour share functions. From equations (10) and (15) we can therefore write:

$$S_L^{it} = g(k_{IT}^{it}; k_{NIT}^{it}; C^{it})h(Z^{it}) \qquad [16]$$

$$S_{RL}^{it} = g(k_{IT}^{it}; k_{NIT}^{it}; l_{NR}^{it}; C^{it})h(Z^{it}) \qquad [17]$$

where superscripts *i* and *t* denote sector and year, respectively, and the function $g(.)$ describes the labour-share drivers strictly derived from the production function (the SK schedule). $k_{IT}^{it}, k_{NIT}^{it}, l_{NR}^{it}$

correspond to $\frac{K_{IT}^{it}}{Y^{it}}, \frac{K_{NIT}^{it}}{Y^{it}}, \frac{L_{NR}^{it}}{Y^{it}}$, respectively; C^{it} is a measure of technological change that summarizes the effects of all types of technical change not labour-augmenting (A_{IT} and A_{NIT}) in equation (16) or not regular-labour-augmenting (A_{IT}, A_{NIT} and A_{NR}) in equation (17). The separate exponential function $h(.)$ is instead meant to account for the other potential factors (Z_{it}) that shift the economy off the SK schedule. They include globalisation, the emergence of markups, and labour-market institutional factors able to shape the relative bargaining power of labour and capital.

Assuming that both $g(.)$ and $h(.)$ are also multiplicative and by taking logs, we can express the labour shares as:

$$\ln S_L^{it} = \beta_{0i} + \beta_0 \ln(C^{it}) + \beta_1 \ln(k_{IT}^{it}) + \beta_2 \ln(k_{NIT}^{it}) + \gamma \ln(Z^{it}) + \vartheta^{it} \quad (18)$$

$$\ln S_{RL}^{it} = \beta_{0i} + \beta_0 \ln(A^{it}) + \beta_1 \ln(k_{IT}^{it}) + \beta_2 \ln(k_{NIT}^{it}) + \beta_3 \ln(l_{NR}^{it}) + \gamma \ln(Z^{it}) + \vartheta^{it} \quad (19)$$

where β_{0i} are sector fixed effects and ϑ_{it} is a residual error term.

As noted by O'Mahony et al. (2017) and Rincon-Aznar et al. (2015) in a similar context, equations (18) and (19) represent static models and their estimated coefficients can be interpreted as long-run elasticities. However, when the time dimension is large, as in our case (1970–2012), the estimation of a static model may suffer from limitations due to the bias in the coefficients produced by non-stationarity of the time series. The standard approach to address such issues is to rewrite the equations as autoregressive distributed lag processes ARDL(p,q). In the case of equation (18) (the same holds for equation (19), mutatis mutandis), and assuming for simplicity a maximum lag order of one, the model reads:

$$\ln S_L^{it} = \alpha_{0i} + \alpha_1 \ln S_L^{it-1} + \alpha_2 \ln(C^{it}) + \alpha_3 \ln(C^{it-1}) + \alpha_4 \ln(k_{IT}^{it}) + \alpha_5 \ln(k_{IT}^{it-1}) + \alpha_6 \ln(k_{NIT}^{it}) + \alpha_7 \ln(k_{NIT}^{it-1}) + \varphi_1 \ln(Z^{it}) + \varphi_2 \ln(Z^{it-1}) + \vartheta^{it} \quad (20)$$

Equation (20) can be reformulated as an error, or equilibrium, correction model (ECM) as follows:

$$\Delta \ln S_L^{it} = \gamma_{0i} + \gamma_1 \Delta \ln(C^{it}) + \gamma_2 \Delta \ln(k_{IT}^{it}) + \gamma_3 \Delta \ln(k_{NIT}^{it}) + \phi_1 \ln(Z^{it}) + \gamma_4 \ln S_L^{it-1} + \gamma_5 \ln(C^{it-1}) + \gamma_6 \ln(k_{IT}^{it-1}) + \gamma_7 \ln(k_{NIT}^{it-1}) + \phi_2 \ln(Z^{it-1}) + \vartheta^{it} \quad (21)$$

Equation (21), and a corresponding equation for the drivers of the labour share of regular workers, represents our empirical specification that we estimate using the augmented mean group (AMG) estimator proposed by Eberhardt and Teal (2010). The estimator is part of the panel time-series literature which emphasizes: i) possible non-stationarity of the processes; ii) cross-section dependence, i.e., the possible correlation in the disturbances across sectors; and iii) slope, not just group time-invariant, parameter heterogeneity (Eberhardt, 2013). Like other mean group (MG)

approaches (Pesaran and Smith, 1995; Pesaran, 2006), the AMG estimator first estimates N group-specific ordinary least-squares regressions and then averages the estimated coefficients across groups. Cross-sectional dependence is controlled for by the inclusion of a common dynamic effect, which in the AMG is obtained in the first step estimation of a pooled regression model augmented with year dummies, obtained by first difference ordinary least squares. The coefficients on the (differenced) year dummies represent an estimated cross-group average of the evolution of unobservables over time (the common dynamic process). This is included in the group-specific regression model, along with an intercept that captures time-invariant fixed effects. Lastly, the group-specific model parameters are averaged across the panel. By combining the parameters of equation (21) we can derive estimates of the long-run relationships between the explanatory variables and the S_L. As an example, the long-run effect (or co-integration parameter) of IT capital intensity on the labour share corresponds to $\gamma_{ITk}^{L} = -(\gamma_6/\gamma_4)$, while for non-IT capital intensity it is $\gamma_{NITk}^{L} = -(\gamma_7/\gamma_4)$. The coefficient of the lagged dependent variable (the labour share) γ_4 describes the speed of adjustment towards the long-run equilibrium, and inference on this parameter provides information on the presence of a long-run equilibrium relationship. This is indeed the intuition behind ECM models: following a shock in the economy, if $\gamma_4 \neq 0$ an error correction mechanism exists that drives the economy back into its long-run equilibrium path. This means that co-integration exists between the variables and processes in levels (Eberhardt and Presbitero, 2015).

4. Empirics

4.1 Data and Descriptive Evidence

Our data is entirely extracted from the Japan Industrial Productivity (JIP) database, compiled by RIETI (Research Institute of Economy, Trade and Industry) and Hitotsubashi University, Tokyo[2]. The latest release (JIP Database 2015) covers, for the period 1970–2012, various types of annual data necessary for estimating total factor productivity (TFP) in 108 industries covering Japan's economy as a whole. JIP sectors can be easily translated into international industry classifications such as ISIC and KLEMS. We excluded from our analysis non-market services (JIP codes 84 and 98–108) and other sectors which present levels of the labour share significantly exceeding 100%, such as private medical, education, research, and hygiene services (JIP codes 80–83) and housing (72) (see Appendix A for all relevant details). The pattern of the labour share described in Figure 1 refers to the total market economy (TME) and is therefore calculated on a total of 91 sectors. The econometric analysis of the total labour share is then restricted to 84 industries (referred to as non-primary market economy – NPME) after having excluded primary sectors (1 to 6 – agriculture, and 7 – mining). Lastly, the analysis of the drivers of the labour share for subsectors of market services (MSERV) and manufacturing (MAN) is carried out on a total of 78 sectors, after having excluded construction (JIP code 60) and utilities (62–66). Manufacturing and market services industries were reclassified according to the Eurostat

[2] See: https://www.rieti.go.jp/en/database/JIP2015/#01. For a detailed account of the JIP database, see Fukao et al. (2007).

classification, as follows[3]: medium- and medium-high-technology manufacturing sectors (MHM – 23 JIP sectors), medium- and medium-low-technology manufacturing sectors (MLM – 29 sectors), knowledge-intensive services (KIS – 12 sectors), less-knowledge-intensive services (LKIS – 14 sectors).

Our main variable, the labour share (S_L), is constructed as the ratio of nominal total labour compensation to nominal value added (at basic prices). The advantage of the JIP database is that it includes in labour compensation all types of remuneration received in exchange for any type of work employed in production; that is, employee compensation and mixed income (i.e., for labour supplied by self-employed and family workers). This distinctive feature of the dataset addresses one common issue in empirical S_L studies, that of adjusting the amount of labour compensation for remuneration of non-employees (Gollin, 2002; Arpaia et al., 2009). The methodology used in the JIP database to estimate mixed income is briefly described in Appendix C. A second important and distinctive feature of the JIP database is that it supplies labour remuneration by type of worker; this allows properly depicting the existing dichotomy and duality in the Japanese labour market (see Teruyama and Toda, 2017; Kalantzis et al., 2012; Miyamoto 2016) between regular employment (with dependent, full-time, open-ended contracts) and non-regular employment (temporary, part-time, self-employed and family workers). For each employment type, the number of workers and the average number of annual hours worked are also available: therefore hours, a much more accurate measure of labour quantity, have been used for the construction of variables such as the share of non-regular in total employment (L_{NR}/L) and the irregular labour intensity in value added (l_{NR}). The database also supplies separately the stock of real IT and non-IT capital, which have been used to build the capital intensity variables (k_{IT}; k_{NIT}). Our technological change variable C (TFP) is constructed starting from the JIP database TFP annual growth rate, as an index that is equal to 100 in the initial year (1970). Another distinctive feature of our dataset is the availability of the union density (UD) rate by sector, estimated by dividing the total number of union-member workers in each sector[4] by the total number of workers available in the JIP database.

Trade openness (Trade) has been constructed as the ratio of total imports plus total exports to value added, whereas input–output JIP tables have been used to derive a proxy for 'broad' offshoring (Off), commonly used in the literature since Feenstra and Hanson (1999); i.e., the ratio of imported intermediate input to total intermediate input (see Crinò, 2012; IMF, 2007).

Lastly, our measure of markup (Mark up) is related to the classical Lerner index of market power (see Maimaiti et al., 2010), and computed as the ratio of the value of output (minus indirect taxes and subsidies) over variable (labour + intermediate inputs) costs at the industry level (see Badinger, 2007 as an example of the use of the same index at broad sector-level for the EU)[5].

[3] The Eurostat classification is obtained by aggregating manufacturing and services based on NACE Rev. 2 (see http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf9). The classification largely overlaps with the one provided by the OECD (see: https://www.oecd.org/sti/ind/48350231.pdf)

[4] Data is provided in Japan in the Basic Survey on Labour Unions carried out annually by the Ministry of Labour, Health and Welfare (see: http://www.mhlw.go.jp/english/database/db-l/labour_unions.html). Detailed data is available (in Japanese) at: http://www.mhlw.go.jp/toukei/list/13-23.html

[5] An alternative indicator refers more directly to profits and can be computed as the ratio of the value of output (minus indirect taxes and subsidies) over total costs. This metric is highly correlated to our markup index (coefficient around 0.9 for manufacturing and 0.5 for services). Both indicators have a negative pairwise

Table 1. Summary statistics: labour share, factors intensity, and other potential drivers

	TME	NPME	MAN	MLM	MHM	MSERV	LKIS	KIS
S_L	70.560	71.192	66.293	64.616	68.482	75.201	82.122	62.387
S_{RL}	61.239	62.673	61.967	58.784	65.903	64.453	68.301	57.390
k_{IT}	0.128	0.130	0.116	0.088	0.169	0.140	0.126	0.170
k_{NIT}	1.838	1.697	1.467	1.451	1.825	1.677	1.913	1.224
A (TFP)	127.626	129.119	143.288	107.292	188.674	108.577	96.344	122.848
L_{NR}/L (workers)	36.477	30.109	21.377	26.503	13.838	34.355	38.149	20.649
L^h_{NR}/L^h (hours)	30.473	25.149	17.688	22.188	11.003	28.959	32.582	16.230
l_{NR}	0.106	0.078	0.051	0.065	0.037	0.101	0.132	0.037
UD	34.568	36.793	37.648	26.849	51.263	30.634	24.451	37.847
Trade	0.294	0.253	0.639	0.415	0.910	0.084	0.064	0.122
Off	0.081	0.082	0.095	0.103	0.086	0.055	0.039	0.073
Markup	1.008	1.014	1.041	1.060	1.018	0.963	0.891	1.056

Notes: l_{NR} *=n. hours of non-regular workers * 1000 / VA; Markup: 1970=1; TFP: 1970=100. For variables and sectors abbreviations see Appendix A.*

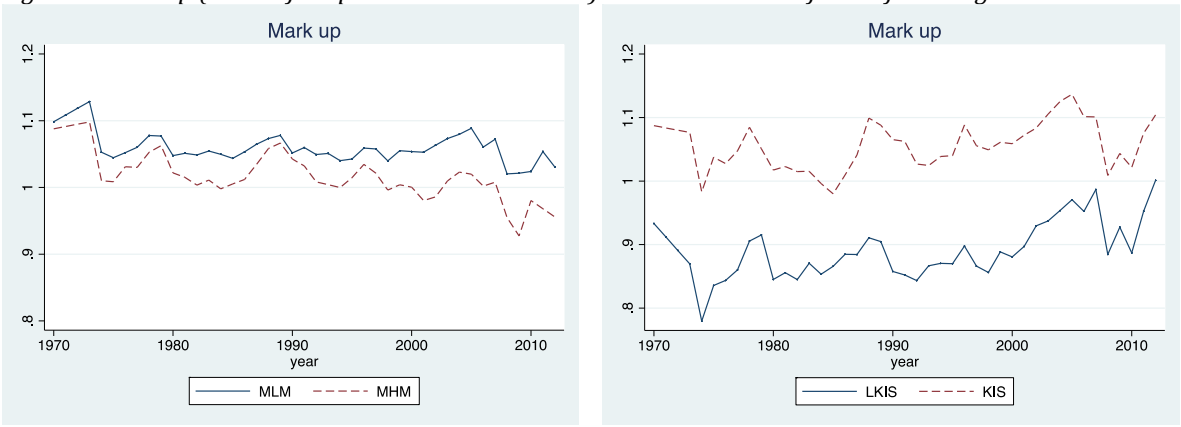
Source: Authors' elaborations of JIP database

Table 1 summarizes information on the main variables used in our study. All figures are averages over the period 1970–2012; therefore they mainly serve the purpose of highlighting differences across macro-sectors. As already shown in Figure 2, the level of the labour share differs remarkably between manufacturing and market services, but even more within the latter. The S_L is significantly higher in LKIS, the part of the economy in which the S_L accruing to non-regular workers is higher (on average, 14%). This, together with the remarkably high shares of non-regular work (L_{NR}/L and L^h_{NR}/L^h) and its high intensity (l_{NR}), suggests that a high substitutability could exist between regular and non-regular workers in low-knowledge-intensive services. To some extent the same pattern emerges in manufacturing for the medium-low technology sectors. A clear dichotomy seems therefore to exist between sectors in which the accumulation of industry- and firm-specific knowledge represents a crucial asset (MHM and KIS) and those in which some job positions are more flexible and experience a higher turnover (MLM and LKIS) because worker seniority is less important for productivity. Workers are also more unionised in manufacturing than in services and, within the two macro-sectors, in higher knowledge/technology-intensive industries. This overall duality is also reflected by differences in technological features. TFP levels are obviously higher in manufacturing, especially in the medium–high technology sectors: the same holds, but to a lesser extent, for knowledge-intensive industries. Similarly, these sectors are characterised by a relatively high IT capital intensity, whereas MLM and LKIS use traditional capital goods more intensively. The impact of globalisation is more obvious in manufacturing where medium–high technology sectors are characterised by higher trade openness and lower levels of offshoring compared to medium–low ones: our proxy variables are therefore fairly able to describe the position of Japan in the international

correlation with the labour share (for the whole market economy, about –0.50 for the markup over variable costs and –0.67 for the markup over total costs).

division of labour. As for services, KIS industries show a higher degree of tradability and involvement in global markets than LKIS, as expected, due to the fact that they include, for example, financial and insurance activities. The levels of markup deserve more attention, since average values only partially describe differences across sectors. Figure 4 reports the dynamics of the indicator across the whole period and, first of all, confirms the well-known countercyclical nature of the markup (Rotemberg and Woodford, 1999), which significantly dropped during the more severe recession episodes around 1973 and 2008. The heterogeneity within subsectors of manufacturing and market services also clearly emerges from the diagrams; more importantly, the trends highlight that while competition in manufacturing (especially medium–high tech) increased, the opposite holds for services, particularly for LKIS (on the industry differences in competition policy in Japan, also in a historical perspective, see Amsden and Singh, 1994). This evidence, taken together with the sharp decrease in self-employment and family work (from 25.5% in 1970 to 10% in total market services and from 30% to 11% in LKIS) addresses the possibility of a remarkable process of market concentration in segments that significantly increased their employment share over time, such as retail trade (see Matsuura and Motohashi, 2005) and hotels and restaurants (Høj and Wise, 2004).

Figure 4. Markup (value of output over variable costs) in macro-sectors of manufacturing and services



Source: Authors' elaborations of JIP database

4.2 Results

Before presenting our results of the estimation of our empirical models, we show some tests aimed at checking the presence of cross-sectional dependence (CD) and non-stationarity (Table 2), which strongly support the choice of the estimation method we described in section 3. Cross-sectional dependence is tested using the Pesaran (2004) CD test; in macro panel data it may arise from globally common shocks with heterogeneous impact across panels or be the result of spillover effects (Eberhardt and Teal, 2011). The evidence provided in Table 2 shows that the null hypothesis of cross-sectional independence cannot be accepted. In order to check the presence of unit roots we use the CADF test proposed by Pesaran (2003), designed for heterogeneous panels with cross-sectional dependence (see Lewandowski, 2007). Cross-sectional dependence is eliminated by augmenting the standard Dickey-Fuller (DF) or the augmented DF regressions with the cross-section averages of

lagged levels and first differences of the individual series. The null hypothesis assumes that all series are non-stationary, and results shown in Table 2 show that it cannot be rejected, the only exceptions being the variables UD and Off. Again as a preliminary step, we run Pedroni's panel cointegration tests, which clearly suggest a rejection of the null hypothesis of no cointegration (Pedroni 1999)[6].

Table 2. Tests for unit roots and cross sectional dependence (NPME)

	Unit Root Test		CSD	
	Z (t-bar)	P-value	CD-test	P-value
S_L	1.686	(0.954)	34.10	(0.000)
S_{RL}	1.176	(0.880)	229.61	(0.000)
k_{IT}	1.098	(0.864)	207.14	(0.000)
k_{NIT}	0.056	(0.522)	31.96	(0.000)
C (TFP)	–2.537	(0.006)	26.12	(0.000)
L^h_{NR}/L^h (hours)	0.816	(0.793)	118.79	(0.000)
l_{NR}	–0.606	(0.272)	60.32	(0.000)
UD	–4.597	(0.000)	118.15	(0.000)
Trade	–0.778	(0.218)	127.23	(0.000)
Off	–2.081	(0.019)	207.34	(0.000)
Markup	0.340	(0.633)	43.71	(0.000)

*Notes: NREG_VA=n. hours of non-regular workers * 1000 / VA; Markup: 1970=1; TFP: 1970=100. For variables and sectors abbreviations see Appendix A.*

Source: Authors' elaborations of JIP database

This is consistent with the evidence provided in the framework of the ECM estimations (Table 3). In each model we focus on the long-run estimates as well as the coefficient on the lagged level of the labour share, to investigate error correction and thus evidence for a long-run relationship (full ECM results are available on request). For all models there is strong evidence of error correction – the lagged S_L level variable is highly statistically significant. The size of the coefficient indicates a relatively high speed of adjustment to the long-run equilibrium, which is a common feature in estimates that allow for heterogeneity and between-group dependence (Imbs et al., 2005).

As for technological variables (the SK schedule), there is clear evidence of a high substitutability between labour and non-IT capital, in both manufacturing and services. However, the elasticity of substitution exceeds the value of 1 (the Cobb-Douglas case) first of all in medium–low tech manufacturing in which, on the contrary, IT capital emerges as complementary to labour. The knowledge-intensive segment (KIS) drives the negative sign of the non-IT capital in services (hence an elasticity of substitution with labour higher than one), whereas IT capital is complementary to labour in low-knowledge-intensive tertiary market industries. TFP is mostly insignificant: this result is not unexpected, considering the inclusion in the model of different types of capital (which capture the embodied technological change) and of other variables – in particular the market power of firms – that capture factors that would otherwise converge into the coefficient of the TFP.

[6] For example, the panel-ADF and the group-ADF (parametric t) statistics are –4.655 and –6.961, respectively, and –4.222 and –5.957 when a linear time trend is included.

Table 3. The drivers of total labour share in Japan (1970–2012) (Model 1)

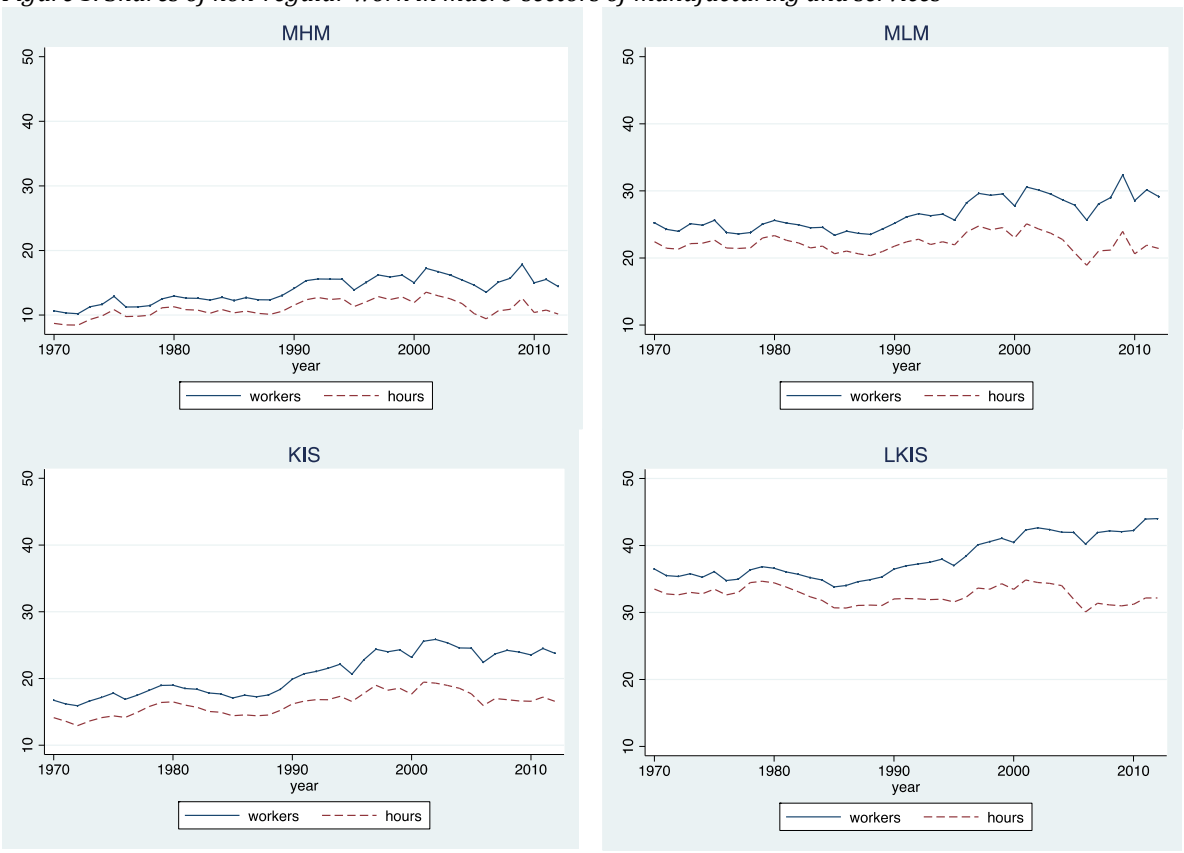
	NPME		MAN		MLM		MHM		MSERV		LKIS		KIS	
k_{IT}	0.053	*	0.059		0.113	***	0.044		0.015		0.086	*	0.049	
	(0.031)		(0.043)		(0.037)		(0.078)		(0.036)		(0.050)		(0.110)	
k_{NIT}	–0.036	***	–0.065	***	–0.048	***	–0.052		–0.048	**	–0.023		–0.062	**
	(0.013)		(0.019)		(0.016)		(0.036)		(0.020)		(0.024)		(0.031)	
C (TFP)	0.054		0.151		0.242	*	–0.121		–0.008		0.164	*	–0.033	
	(0.079)		(0.110)		(0.125)		(0.182)		(0.097)		(0.093)		(0.304)	
L^h_{NR}/L^h	–0.041	**	–0.013		–0.009		–0.000		–0.080	**	–0.168	***	–0.019	
	(0.020)		(0.025)		(0.030)		(0.050)		(0.039)		(0.063)		(0.046)	
UD	–0.097	***	–0.117	**	–0.069		–0.170	**	–0.045		–0.107	**	–0.001	
	(0.034)		(0.048)		(0.053)		(0.072)		(0.045)		(0.046)		(0.091)	
Trade	–0.021	***	0.008		–0.002		–0.010		–0.013	*	–0.015	***	–0.025	
	(0.006)		(0.013)		(0.015)		(0.020)		(0.007)		(0.005)		(0.020)	
Off	0.005		–0.004		–0.006		–0.025		0.027	**	0.009		0.051	*
	(0.009)		(0.013)		(0.022)		(0.020)		(0.012)		(0.021)		(0.027)	
Markup	–2.657	***	–3.146	***	–3.167	***	–3.306	***	–1.743	***	–1.543	***	–1.715	***
	(0.223)		(0.237)		(0.315)		(0.351)		(0.308)		(0.125)		(0.324)	
ECM	–0.696	***	–0.727	***	–0.735	***	–0.737	***	–0.583	***	–0.642	***	–0.550	***
	(0.034)		(0.036)		(0.044)		(0.056)		(0.067)		(0.108)		(0.067)	
RMSE	0.0277		0.0326		0.0327		0.0317		0.0126		0.0093		0.0145	
Wald chi^2	1318.28	***	1635.49	***	911.17	***	938.95	***	402.68	***	61069.86	***	226.73	***
Obs	3,528		2,184		1,218		966		1,092		588		504	
Groups	84		52		29		23		26		14		12	

Notes: RMSE is the root mean squared error test (sigma); average long-run coefficients computed from the ECM results; standard errors computed via the Delta method. For variables and sectors abbreviations see Appendix A.

Source: Authors' elaborations of JIP database

As regards the labour market variables, the share of irregular workers plays a negative role in the total S_L and this effect seems driven by low-knowledge-intensive services. This is likely the result, first of all, of the composition effect of the particularly large presence of irregular workers in LKI services, as clearly described in Figures 5 and 6. The first shows how in LKI services over 30% of hours worked (and over 40% of workers in the most recent years) are on a non-regular basis; the second indicates that the wage gap between regular and non-regular workers (as in all other sectors) basically tripled over the period considered (see also OECD, 2017a).

Figure 5. Shares of non-regular work in macro-sectors of manufacturing and services



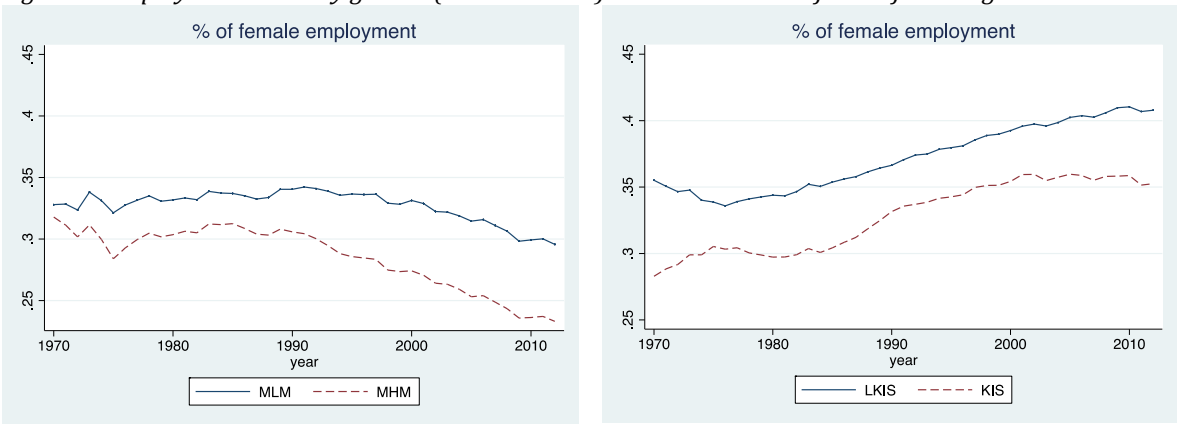
Source: Authors' elaborations of JIP database

In view of the employment share reached by LKI industries (see Figure 3), it is not surprising that what happens in these sectors affects the labour share of aggregate services and of the total economy. However, that the massive presence and availability of non-regular workers in such industries also adversely affected the bargaining power of regular workers cannot be ruled out if the two types of work have a high rate of substitutability. This is something we test by estimating our second empirical model, but it is already indicated descriptively by the fact that in those sectors in which non-regular work is more intensively used (LKI services and ML manufacturing) the wage rates of regular workers experienced a significantly weaker growth compared to other sectors with a lower presence of non-regular workers (see Figure 6). This is probably related to a significant extent to changes on the labour market supply side, namely the massive entrance of women into the labour force, which has been markedly concentrated in LKI services (see Figure 7).

Figure 6. Regular/non-regular hourly wage gap, LKIS services

Source: Authors' elaborations of JIP database

Figure 7. Employment share by gender (hours worked) in macro-sectors of manufacturing and services



Source: Authors' elaborations of JIP database

The strength of unions emerges as detrimental to the total labour share: this evidence is probably explained by the labour relations model peculiar to Japan, in connection to the declining unionisation rate and labour market evolutions in the past decades. Among the features taken as examples of the Japanese employment system there are the strong decentralisation of the role of unions at the company level and union activities focusing on cooperation and discussion with the management rather than conflict and antagonism (Fujimura, 2012). However, enterprise unions in Japan have primarily been organized around regular employees and the increase in non-regular

workers over time has significantly reduced the coverage of the company workforce in discussions with the management. Despite the fact that they can now join some unions and their unionisation rate is growing, the interests of part-time and contract workers are still largely under-represented (according to the 2010 Basic Survey of Labour Unions they accounted for about 7% of total union members in 2009). The negative relationship between union density and labour share might hence be the result of the asymmetric action of unions, which, where possible, encourages the substitution of regular jobs with less rigid and cheaper labour or with some type of capital. This would be consistent with the explanation provided by Bentotila and Saint-Paul (2003) regarding bargaining systems centred on wage levels, which is the case of the *Shunto* system in Japan, where the annual wage negotiations between enterprise unions and employers take place in spring and involve two key parameters, wage revision and bonuses (see Komiya and Yasui, 1984). Compared to decades ago, the potential of the *Shunto* to revise base wages upwards has declined remarkably (see OECD, 2017b) due to adverse economic conditions driving unions to focus their attention on protecting the existing pay structures and their members' jobs. At the same time, the small space left for wage level negotiations has increasingly taken the form of bonus bargaining, which are used to remunerate non-regular workers to a much more limited extent (Kato, 2016). This bundle of asymmetric effects generated by the bargaining model and actions of unions could have contributed to shaping non-regular wage and employment levels and, ultimately, the dynamics of the labour share in the direction described by our results.

While the factors related to globalisation seem to offer rather limited insight, the variable used as a proxy for market power emerges as a very powerful explanation of the variability in the labour share. The two results are not unrelated, since the main effects of trade and production internationalisation patterns on the labour share unfold through changes in the competitive pressures to which firms are exposed. It is therefore likely that the markup indicator is able to account for such evolutions driven by globalisation forces (the correlation between the variables 'trade' and 'markup' amounts to –0.32, significant at 1%). The negative sign and the magnitude of the coefficient clearly indicate that when firms are able to produce extra profits, rent-sharing patterns develop in a direction detrimental to workers. This does not come as a surprise, given the labour market evolutions already described, which all acted against the bargaining position of labour. Our result is consistent with expectations based on the existing theoretical and empirical literature (Bentotila and Saint-Paul, 2003; Autor et al., 2017; Barkai, 2016) and provides new corroborating evidence. Unfortunately, due to the nature of our (sector) data, it is not possible to identify which transmission channels are at work. Hence, complementary research efforts are needed to identify the microeconomic mechanisms taking place within the firms, also in view of their possible heterogeneity along the avenue indicated by Autor et al. (2017). In any case, the markup indicator efficiently captures and controls for the economic cycle, highlighting how the counter-cyclical variations of the markup cause pro-cyclical shifts in the labour share (see also Figures 1 and 4).

The results showing the drivers of the total labour share are largely confirmed if we look at the determinants of the labour share of regular workers (S_{RL}) (Table 4). This is not surprising given the close correlation existing between the two dependent variables. The crucial additional information

emerging from the table is that the impact of non-regular work on the regular workers' labour share is due to (and driven by) what happens in low-skill/knowledge-intensive sectors (both in manufacturing and services). In other words, in ML manufacturing and LKI services, substitutability between regular and non-regular workers is high, exceeding the unitary elasticity of substitution suggested by the insignificance of the l_{NR} coefficient in the other sectors.

Table 4. The drivers of regular workers' labour share in Japan (1970–2012)

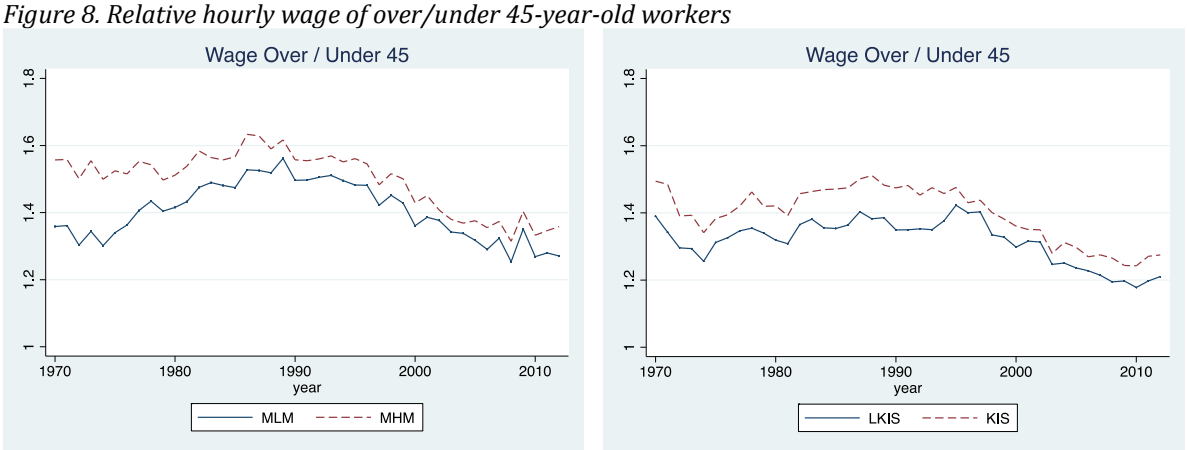
	NPME	MAN	MLM	MHM	MSERV	LKIS	KIS
k_{IT}	0.046	0.062	0.111 *	0.086	–0.035	–0.018	0.016
	(0.030)	(0.046)	(0.058)	(0.097)	(0.046)	(0.030)	(0.103)
k_{NIT}	–0.028 *	–0.078 ***	–0.063 ***	–0.056 *	–0.041 **	–0.029 *	–0.053
	(0.015)	(0.020)	(0.021)	(0.030)	(0.018)	(0.015)	(0.036)
C (TFP)	–0.025	0.060	–0.002	0.191	–0.176	–0.243 *	–0.219
	(0.097)	(0.132)	(0.181)	(0.177)	(0.136)	(0.126)	(0.227)
l_{NR}	–0.053 **	–0.049 *	–0.081 **	–0.016	–0.052	–0.183 **	0.007
	(0.023)	(0.026)	(0.040)	(0.027)	(0.047)	(0.082)	(0.057)
UD	–0.092 **	–0.134 **	–0.097	–0.209 **	–0.027	–0.071	0.049
	(0.037)	(0.054)	(0.072)	(0.093)	(0.063)	(0.054)	(0.105)
Trade	–0.030 ***	0.001	–0.015	–0.025	–0.010	–0.012 *	–0.011
	(0.008)	(0.014)	(0.017)	(0.023)	(0.010)	(0.007)	(0.022)
Off	0.003	–0.012	–0.023	–0.031	0.037 **	0.026	0.055 *
	(0.011)	(0.014)	(0.024)	(0.020)	(0.016)	(0.017)	(0.033)
Mark up	–2.647 ***	–3.023 ***	–3.036 ***	–3.218 ***	–1.815 ***	–1.660 ***	–1.831 ***
	(0.221)	(0.244)	(0.319)	(0.384)	(0.271)	(0.341)	(0.402)
ECM	–0.649 ***	–0.705 ***	–0.724 ***	–0.720 ***	–0.562 ***	–0.621 ***	–0.572 ***
	(0.031)	(0.038)	(0.050)	(0.059)	(0.053)	(0.089)	(0.079)
Obs	3,528	2,184	1,218	966	1,092	588	504
RMSE	0.0276	0.0307	0.0313	0.0304	0.0141	0.0115	0.0149
Wald chi^2	1325.66 ***	1441.21 ***	835.43 ***	788.84 ***	419.87 ***	3623.56 ***	188.34 ***
Obs	3,528	2,184	1,218	966	1,092	588	504
Groups	84	52	29	23	26	14	12

Notes: RMSE is the root mean squared error test (sigma); average long-run coefficients computed from the ECM results; standard errors computed via the Delta method. For variables and sectors abbreviations see Appendix A.
Source: Authors' elaborations of JIP database

This result is consistent with contributions emphasising the importance of human capital and firm-specific knowledge accumulation to firms' performance (e.g., Blundell et al., 1999; Kleinknecht et al., 2014; Vergeer and Kleinknecht, 2014), which strongly depends on the productive/technological contexts in which they operate. As showed, for example, by Pieroni and Pompei (2008), in high-technology/knowledge-intensive industries, skills and competencies are mainly accumulated at the

firm level and are a function of innovation activities. Firms benefit from the tenure of the workforce and both firms and workers have incentives to invest in firm-specific skills, because the employment relationship is expected to last for a long time (Wasmer, 2006; Arulampalam and Booth, 1998; Fukao and Otaki, 2003). In such contexts, labour turnover tends to be lower than when knowledge-related factors play a less crucial role in shaping firms' competitive advantage. This is clearly the case in LKI services and ML manufacturing industries, in which not only is the use of non-regular work clearly more intensive (Table 1 and Figure 5) but seniority is also less important. This can be indirectly grasped from Figure 8, in which we plot the relative hourly wage of workers aged over/under 45 years. In order to reduce the effects of factors other than seniority, the comparison is between average wages of male, tertiary-educated, regular workers. The diagrams summarize various pieces of information: first, starting from the 1990s, the level of the wage ratio, and hence the importance of seniority, started to decline (see for similar evidence Yamada and Kawaguchi, 2015). This can be explained by the gradual weakening of the so-called lifetime employment system, one of the main distinctive features of Japanese employment relations, based on an implicit firm–employer pact of mutual commitment and loyalty over the entire working life of the employee. In terms of wages, this went hand in hand with a deferred compensation system, strongly seniority-based (*nenkō joretsu*). Despite the real extent of the lifetime employment system being debated (Ono 2010), there is agreement on the fact that its importance for the Japanese economy started to decline during the 1990s in the context of the prolonged economic recession. The downward trends observed in Figure 8 reflect this decline, which materialised as a reduction in the wage gap between older and younger workers, likely driven by a decrease in seniority and tenured positions. However, what really matters here is that within manufacturing and services, low-knowledge/technology-intensive segments highlight relatively lower levels of the gap, corroborating the idea that in such productive contexts the accumulation of specific knowledge through seniority is less crucial.

Figure 8. Relative hourly wage of over/under 45-year-old workers



Source: Authors' elaborations of JIP database

5. Conclusions

In this paper we investigate the long-term drivers of the share of output accruing to labour in Japan. We contribute to this strand of literature by extending the SK schedule model proposed by Bentotila and Saint-Paul (2003) to multiple inputs, namely different types of capital (IT and non-IT) and labour

(regular and non-regular work). On the empirical side, taking advantage of the JIP database, our contribution lies in providing a detailed sector-level analysis of the period 1970–2012, in accounting for the role of heterogeneity of production factors, and in rendering explicit the role of market power. Our error correction model (ECM) allowed testing the existence of a long-run relationship and the long-term effects of the potential drivers of the labour share, after having allowed for the heterogeneity of estimated parameters across panels (sectors) and possible correlation in their disturbances (cross-sectional dependence).

Our results can be summarised as follows. The decline observed in the S_L in Japan has a clear sectoral connotation, being essentially due to the downward trend of the labour share in low-knowledge-intensity (LKI) service sectors. This segment of the Japanese economy has been increasing its importance over time, accounting in most recent years for over half of the total hours worked in the country. This is also the labour market segment with the most intensive use of non-regular (and female) employment, which in Japan identifies the secondary pool of the labour market, characterised by a significant wage gap with respect to regular workers and little or no union coverage/representation. Due to the intrinsic features of such industries, the accumulation of knowledge is relatively less important and regular and non-regular labour are highly substitutable, with consequent effects on the equilibrium wages of both labour market segments. Low-knowledge-intensity services also represent the part of the economy in which the market power of firms increased, while it decreased in manufacturing and stayed virtually the same in the remaining market services. This is, of course, partly due to the non-tradable nature of the output produced, but also to the process of concentration that has occurred in the last decades, when, for example, large firms in the trade sectors replaced little family business (mom and pop stores), gaining in market power and in bargaining power vis-à-vis labour. This is corroborated by the evidence proposed by our data, particularly the changes in the composition of non-regular labour. Similar to the conclusion reached by Kambayashi and Kato (2013), our data shows that the decrease in self-employment and family work was offset by the growth of contract/part-time employment. In LKI services the share of non-regular hours worked remained substantially stable over time at around 33% (see Figure 5); however, while in 1970 part-time employment accounted for 3.6% of total hours worked and self/family employment 29.9%, in 2012 their shares were 21.2% and 10.9%, respectively. To sum up, an increasing number of workers employed in the low-knowledge-intensity service sectors was confronted with a variety of adverse circumstances originating in market forces, social transformation, structural changes, and labour and product market institutions. All these factors contributed to reducing the share of output accruing to labour, with likely negative repercussions for very sensitive aspects of the Japanese economy, such as income inequality and aggregate demand. Given the relevance of the aspects involved, the analysis proposed here should be a starting point for developing complementary research that sheds light on the micro-economic mechanisms governing the allocation of value produced in the context of a changing institutional environment, which policymakers can utilize to take action.

Appendix A: List of acronyms and abbreviations

Acronym / Abbreviation	*Description*
Y	Total output
Y_{IT}	Output of IT capital-intensive process
Y_{NIT}	Output of non-IT capital-intensive process
Y_{NR}	Output of non-regular labour-intensive process
K_{IT}	IT capital employed in IT capital-intensive processes
K_{NIT}	Non-IT capital employed in non-IT capital-intensive processes
L_{IT}	Total labour employed in IT capital-intensive process
L_{NIT}	Total labour employed in non-IT capital-intensive process
$L_{NIT, R}$	Regular labour employed in non-IT capital-intensive process
$L_{IT, R}$	Regular labour used in IT capital-intensive processes
L_{NR}	Non-regular labour used in non-regular labour-intensive processes
$L_{NR, R}$	Regular labour used in non-regular labour-intensive processes
A_{IT}	IT capital-augmenting tech progress
A_{NIT}	Non-IT capital-augmenting tech progress
A_{NR}	Non-regular labour-augmenting tech progress
B_{IT}	Labour-augmenting tech progress in IT capital-intensive process
B_{NIT}	Labour-augmenting tech progress in non-IT capital-intensive process
B_{NR}	Labour-augmenting tech progress in non-regular labour-augmenting process
S_L	Total labour share (labour incomes/value added)
S_{RL}	Labour share of regular workers (regular labour income/value added
k_{IT}	IT capital intensity (K_{IT}/value added)
k_{NIT}	Non-IT capital intensity (K_{NIT}/value added)
l^h_{NR}	Non-regular labour intensity (L^h_{NR}/value added) – hours worked
L_{NR}/L	Share of non-regular workers
L^h_{NR}/L^h	Share of non-regular hours worked
C (TFP)	TFP index (1970 = 100)
UD	Union Density (n. of union members/workers)
Trade	Trade Openness [(exports + |imports|)/GDP]
Off	Imported intermediate input/total input
Mark up	Output (minus indirect taxes and subsidies) over variable costs (labour + intermediate inputs)
Industry aggregations	
TME	Total Market Economy: All JIP sectors excluding: housing (72), Private Education (80), Private Research (81), Private Medical (82), Private Hygiene (83)
NPME	Non-Primary Market Economy: ME minus Primary sectors (1-6) and Mining (7)
MAN	Manufacturing JIP sectors 8–59
MLM	Medium- and medium-low-technology manufacturing JIP sectors: 8-–22, 30–41, 58–59
MHM	Medium- and medium-high-technology manufacturing JIP sectors: 23–29, 42–57
MSERV	Market services: JIP sectors: 61, 67–71, 73–79, 85–97
LKIS	Less-knowledge-intensive services JIP sectors: 67–68, 71, 73–74, 77, 79, 86–88, 94–97
KIS	Knowledge-intensive services JIP sectors: 61, 69–70, 75–76, 78, 85, 89–93,

Appendix B

In this appendix we show that when IT capital cost is relatively lower (higher) than non-IT capital cost, firms will choose higher (lower) Y_{IT}/Y in comparison with Y_{NIT}/Y. We also show that Y_{IT}/Y is an increasing function of K_{IT}/Y and a decreasing function of K_{NIT}/Y. Y_{IT}/Y also depends on technology indices A_{IT}, A_{NIT}, B_{IT} and B_{NIT}. In a similar way, we can prove that Y_{NIT}/Y is a function of the same set of variables and Y_{NIT}/Y is a decreasing function of K_{IT}/Y and an increasing function of K_{NIT}/Y.

Let p_{IT} and p_{NIT} denote the unit production cost of the IT-intensive process output Y_{IT} and that of the non-IT intensive output Y_{NIT}. From first order conditions of cost minimization and production functions (2) and (3) we have:

$$p_{IT} = \frac{r_{IT}K_{IT}+wL_{IT}}{Y_{IT}} = \left(\alpha_{IT}^{\frac{-1}{1-\varepsilon_{IT}}}A_{IT}^{\frac{\varepsilon_{IT}}{1-\varepsilon_{IT}}}r_{IT}^{\frac{-\varepsilon_{IT}}{1-\varepsilon_{IT}}} + (1-\alpha_{IT})^{\frac{-1}{1-\varepsilon_{IT}}}B_{IT}^{\frac{\varepsilon_{IT}}{1-\varepsilon_{IT}}}w^{\frac{-\varepsilon_{IT}}{1-\varepsilon_{IT}}}\right)^{-\frac{1-\varepsilon_{IT}}{\varepsilon_{IT}}} \quad \text{(A1)}$$

$$p_{NIT} = \frac{r_{NIT}K_{NIT}+wL_{NIT}}{Y_{NIT}}$$

$$= \left(\alpha_{NIT}^{\frac{-1}{1-\varepsilon_{NIT}}}A_{NIT}^{\frac{\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}r_{NIT}^{\frac{-\varepsilon_{NIT}}{1-\varepsilon_{NIT}}} + (1-\alpha_{NIT})^{\frac{-1}{1-\varepsilon_{NIT}}}B_{NIT}^{\frac{\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}w^{\frac{-\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}\right)^{-\frac{1-\varepsilon_{NIT}}{\varepsilon_{NIT}}} \quad \text{(A2)}$$

Since equation (1) is Cobb-Douglas, we have $Y_{IT}=\gamma_{IT}\,pY/p_{IT}$ and $Y_{NIT}=\gamma_{NIT}\,pY/p_{NIT}$. By substituting these relationships into production function (1) we have:

$$p = \gamma_{IT}^{-\gamma_{IT}}(1-\gamma_{IT})^{-(1-\gamma_{IT})}p_{IT}^{\gamma_{IT}}p_{NIT}^{1-\gamma_{IT}} \quad \text{(A3)}$$

where p denotes output price. From the relationship $Y_{IT}=\gamma_{IT}\,pY/p_{IT}$ and the above three equations, we can write:

$$\left(\frac{Y}{Y_{IT}}\right)^{\varepsilon_{IT}} = \left(\frac{p_{IT}}{\gamma_{IT}p}\right)^{\varepsilon_{IT}} = \{\gamma_{IT}(1-\gamma_{IT})\}^{-(1-\gamma_{IT})\varepsilon_{IT}}\left(\frac{p_{IT}}{p_{NIT}}\right)^{(1-\gamma_{IT})\varepsilon_{IT}}$$

$$= \{\gamma_{IT}(1-\gamma_{IT})\}^{-(1-\gamma_{IT})\varepsilon_{IT}}\frac{\left(\alpha_{IT}^{\frac{-1}{1-\varepsilon_{IT}}}A_{IT}^{\frac{\varepsilon_{IT}}{1-\varepsilon_{IT}}}\left(\frac{r_{IT}}{w}\right)^{\frac{-\varepsilon_{IT}}{1-\varepsilon_{IT}}}+(1-\alpha_{IT})^{\frac{-1}{1-\varepsilon_{IT}}}B_{IT}^{\frac{\varepsilon_{IT}}{1-\varepsilon_{IT}}}\right)^{-(1-\gamma_{IT})(1-\varepsilon_{IT})}}{\left(\alpha_{NIT}^{\frac{-1}{1-\varepsilon_{NIT}}}A_{NIT}^{\frac{\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}\left(\frac{r_{NIT}}{w}\right)^{\frac{-\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}+(1-\alpha_{NIT})^{\frac{-1}{1-\varepsilon_{NIT}}}B_{NIT}^{\frac{\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}\right)^{-(1-\gamma_{IT})\varepsilon_{IT}\frac{1-\varepsilon_{NIT}}{\varepsilon_{NIT}}}} \quad \text{(A4)}$$

The above equation implies that when the IT capital cost is relatively lower (higher) than the non-IT capital cost, firms will choose higher (lower) Y_{IT}/Y in comparison with Y_{NIT}/Y.

Next, let us study the relationship between relative importance of IT-intensive and non-IT intensive production processes, Y_{IT}/Y and Y_{NIT}/Y, and IT capital and non-IT capital intensity, K_{IT}/Y and K_{NIT}/Y. As Bentolila and Saint-Paul (2003, equation 9) have shown, we can derive the following relationship from equation (2):

$$\frac{K_{IT}}{Y_{IT}} = \left(\frac{{K_{IT}}^{\varepsilon_{IT}}}{\alpha_{IT}(A_{IT}K_{IT})^{\varepsilon_{IT}}+(1-\alpha_{IT})(B_{IT}L_{IT})^{\varepsilon_{IT}}}\right)^{\frac{1}{\varepsilon_{IT}}} = \left(\frac{1}{\alpha_{IT}{A_{IT}}^{\varepsilon_{IT}}+(1-\alpha_{IT}){B_{IT}}^{\varepsilon_{IT}}\left(\frac{L_{IT}}{K_{IT}}\right)^{\varepsilon_{IT}}}\right)^{\frac{1}{\varepsilon_{IT}}} \quad \text{(A5)}$$

From the above equation, we have:

$$\frac{L_{IT}}{K_{IT}} = \left(\frac{\left(\frac{K_{IT}}{Y_{IT}}\right)^{-\varepsilon_{IT}}-\alpha_{IT}{A_{IT}}^{\varepsilon_{IT}}}{(1-\alpha_{IT}){B_{IT}}^{\varepsilon_{IT}}}\right)^{\frac{1}{\varepsilon_{IT}}} \quad \text{(A6)}$$

From first order conditions of profit maximization and equation (A6), we have:

$$\frac{r_{IT}}{w}=\frac{\alpha_{IT}}{1-\alpha_{IT}}\left(\frac{A_{IT}}{B_{IT}}\right)^{\varepsilon_{IT}}\left(\frac{L_{IT}}{K_{IT}}\right)^{1-\varepsilon_{IT}}=\frac{\alpha_{IT}}{1-\alpha_{IT}}\left(\frac{A_{IT}}{B_{IT}}\right)^{\varepsilon_{IT}}\left(\frac{\left(\frac{K_{IT}}{Y_{IT}}\right)^{-\varepsilon_{IT}}-\alpha_{IT}{A_{IT}}^{\varepsilon_{IT}}}{(1-\alpha_{IT}){B_{IT}}^{\varepsilon_{IT}}}\right)^{\frac{1-\varepsilon_{IT}}{\varepsilon_{IT}}} \tag{A7}$$

In a similar way, we also have:

$$\frac{r_{NIT}}{w}=\frac{\alpha_{NIT}}{1-\alpha_{NIT}}\left(\frac{A_{NIT}}{B_{NIT}}\right)^{\varepsilon_{NIT}}\left(\frac{L_{NIT}}{K_{NIT}}\right)^{1-\varepsilon_{NIT}}=\frac{\alpha_{NIT}}{1-\alpha_{NIT}}\left(\frac{A_{NIT}}{B_{NIT}}\right)^{\varepsilon_{NIT}}\left(\frac{\left(\frac{K_{NIT}}{Y_{NIT}}\right)^{-\varepsilon_{NIT}}-\alpha_{NIT}{A_{NIT}}^{\varepsilon_{IT}}}{(1-\alpha_{NIT}){B_{NIT}}^{\varepsilon_{NIT}}}\right)^{\frac{1-\varepsilon_{NIT}}{\varepsilon_{INT}}} \tag{A8}$$

By substituting the above two equations into equation (A4), we obtain:

$$\left(\frac{Y}{Y_{IT}}\right)^{\varepsilon_{IT}}=\{\gamma_{IT}(1-\gamma_{IT})\}^{-(1-\gamma_{IT})\varepsilon_{IT}}\times \frac{\left(\alpha_{IT}{}^{-\frac{1+\varepsilon_{IT}}{1-\varepsilon_{IT}}}(1-\alpha_{IT})^{\frac{1}{1-\varepsilon_{IT}}}{A_{IT}}^{\varepsilon_{IT}}{B_{IT}}^{\frac{\varepsilon_{IT}}{1-\varepsilon_{IT}}}\frac{1}{\left(\frac{Y_{IT}}{Y}\frac{Y}{K_{IT}}\right)^{\varepsilon_{IT}}-\alpha_{IT}{A_{IT}}^{\varepsilon_{IT}}}+(1-\alpha_{IT})^{\frac{-1}{1-\varepsilon_{IT}}}{B_{IT}}^{\frac{\varepsilon_{IT}}{1-\varepsilon_{IT}}}\right)^{-(1-\gamma_{IT})(1-\varepsilon_{IT})}}{\left(\alpha_{IT}{}^{-\frac{1+\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}(1-\alpha_{NIT})^{\frac{1}{1-\varepsilon_{NIT}}}{A_{NIT}}^{\varepsilon_{NIT}}{B_{NIT}}^{\frac{\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}\frac{1}{\left(\frac{Y_{NIT}}{Y}\frac{Y}{K_{NIT}}\right)^{\varepsilon_{NIT}}-\alpha_{NIT}{A_{NIT}}^{\varepsilon_{IT}}}+(1-\alpha_{NIT})^{\frac{-1}{1-\varepsilon_{NIT}}}{B_{NIT}}^{\frac{\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}\right)^{-(1-\gamma_{IT})\varepsilon_{IT}\frac{1-\varepsilon_{NIT}}{\varepsilon_{NIT}}}} \tag{A9}$$

From equation (1), we have $(Y_{NIT}/Y)=(Y_{IT}/Y)^{-\gamma IT/(1-\gamma IT)}$. By substituting this relationship into equation (A9) and taking the log value of both sides of equation (A9), subtracting the right-hand side of the equation from the left-hand side, and dividing both sides of the equation by ε_{IT}, we obtain:

$$ln\left(\frac{Y_{IT}}{Y}\right)-(1-\gamma_{IT})ln\big(\gamma_{IT}(1-\gamma_{IT})\big)$$
$$-(1-\gamma_{IT})\frac{1-\varepsilon_{IT}}{\varepsilon_{IT}}ln\left(\alpha_{IT}{}^{-\frac{1+\varepsilon_{IT}}{1-\varepsilon_{IT}}}(1-\alpha_{IT})^{\frac{1}{1-\varepsilon_{IT}}}{A_{IT}}^{\varepsilon_{IT}}{B_{IT}}^{\frac{\varepsilon_{IT}}{1-\varepsilon_{IT}}}\frac{1}{\left(\frac{Y_{IT}}{Y}\frac{Y}{K_{IT}}\right)^{\varepsilon_{IT}}-\alpha_{IT}{A_{IT}}^{\varepsilon_{IT}}}+(1-\alpha_{IT})^{\frac{-1}{1-\varepsilon_{IT}}}{B_{IT}}^{\frac{\varepsilon_{IT}}{1-\varepsilon_{IT}}}\right)$$
$$+(1-\gamma_{IT})\frac{1-\varepsilon_{NIT}}{\varepsilon_{NIT}}ln\left(\alpha_{IT}{}^{-\frac{1+\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}(1-\alpha_{NIT})^{\frac{1}{1-\varepsilon_{NIT}}}{A_{NIT}}^{\varepsilon_{NIT}}{B_{NIT}}^{\frac{\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}\frac{1}{\left(\left(\frac{Y_{IT}}{Y}\right)^{\frac{-\gamma_{IT}}{1-\gamma_{IT}}}\frac{Y}{K_{NIT}}\right)^{\varepsilon_{NIT}}-\alpha_{NIT}{A_{NIT}}^{\varepsilon_{IT}}}+(1-\right.$$
$$\left.\alpha_{NIT})^{\frac{-1}{1-\varepsilon_{NIT}}}{B_{NIT}}^{\frac{\varepsilon_{NIT}}{1-\varepsilon_{NIT}}}\right)=0 \tag{A10}$$

From equations (2) and (3), we have:

$$\left(\frac{Y_{IT}}{Y}\frac{Y}{K_{IT}}\right)^{\varepsilon_{IT}}-\alpha_{IT}{A_{IT}}^{\varepsilon_{IT}}>0\ \text{ and }\ \left(\left(\frac{Y_{IT}}{Y}\right)^{\frac{-\gamma_{IT}}{1-\gamma_{IT}}}\frac{Y}{K_{NIT}}\right)^{\varepsilon_{NIT}}-\alpha_{NIT}{A_{NIT}}^{\varepsilon_{IT}}>0$$

The left-hand side of equation (A10) is a continuously differentiable function of Y_{IT}/Y, K_{IT}/Y and K_{NIT}/Y. It is also a strictly increasing function of Y_{IT}/Y. When Y_{IT}/Y goes to zero, the left-hand side of equation (A10) goes to minus infinity. When Y_{IT}/Y goes to plus infinity, the left-hand side of equation (A10) goes to plus infinity. Therefore, at any given positive values of K_{IT}/Y, K_{NIT}/Y, A_{IT}, A_{NIT}, B_{IT}, and B_{NIT}, the value of Y_{IT}/Y that satisfies equation (A10) exists uniquely. We can also show that the left-hand side of equation (A10) is strictly decreasing for K_{IT}/Y and strictly increasing for K_{NIT}/Y. By a standard implicit function theorem, we can show that Y_{IT}/Y is a continuously differentiable function of K_{IT}/Y, K_{NIT}/Y. Y_{IT}/Y also depends on technology indices, A_{IT}, A_{NIT}, B_{IT}, B_{NIT}:

$$\frac{Y_{IT}}{Y}=\theta_{IT}\left(\frac{K_{IT}}{Y},\frac{K_{NIT}}{Y},A_{IT},B_{IT},A_{NIT},B_{NIT}\right) \tag{A11}$$

and Y_{IT}/Y increases when K_{IT}/Y increases or K_{NIT}/Y decreases.

In a similar way, we can show that Y_{NIT}/Y is a continuously differentiable function of K_{IT}/Y, K_{NIT}/Y. Y_{NIT}/Y also depends on technology indices, A_{IT}, A_{NIT}, B_{IT}, B_{NIT}:

$$\frac{Y_{NIT}}{Y} = \theta_{NIT}\left(\frac{K_{IT}}{Y}, \frac{K_{NIT}}{Y}, A_{IT}, B_{IT}, A_{NIT}, B_{NIT}\right) \quad \text{(A12)}$$

and Y_{NIT}/Y increases when K_{NIT}/Y increases or K_{IT}/Y decreases.

Using the above two equations, we obtain equation (10). In a similar way, in the case of the four-factor model, we obtain equation (11).

Appendix C: Estimation of mixed income in the JIP database

In the JIP database, mixed income is split in the following way. The starting assumption is that (ex-ante) capital income shares in the production activity by the self-employed and all other production activities in the same sector *i* are identical. Labour income for each self-employed person and for each unpaid family worker is identical in each industry. Then we have the following two equations for $w_i^S(t)$ and $\alpha_i^*(t)$.

$$w_i^S(t) = \left(1 - \alpha_i^*(t)\right)\gamma_i(t) w_i^E(t) \delta_i(t) \qquad \text{(B1)}$$

where

$w_i^S(t)$: labour income of self-employed in industry *i*

$w_i^E(t)$: average labour cost of all the paid employees in industry *i*

$\gamma_i(t)$: mixed income per self-employed/average labour cost of all the employed (paid) workers in industry *i*

$\delta_i(t)$: number of self-employed/(number of self-employed plus unpaid family workers)

$\alpha_i^*(t)$: (ex-ante) capital income share

$$\alpha_i^*(t) = \frac{\sum_j u_{ij}(t) K_{ij}(t)}{\sum_j u_{ij}(t) K_{ij}(t) + w_i^E(t) L_i^E(t) + w_i^S(t) L_i^S(t)} \qquad \text{(B2)}$$

where

$u_{ij}(t)$: nominal capital cost of capital goods *j* in industry *i*

$K_{ij}(t)$: real capital stock of capital goods *j* in industry *i*

$L_i^E(t)$: total number of paid employees in industry *i*

$L_i^S(t)$: total number of self-employed and unpaid family workers in industry *i*

From the above two equations a quadratic equation of $\alpha_i^*(t)$ is derived. This equation has two solutions, but only the smaller one takes a value between 0 and 1; this solution is the estimate of $\alpha_i^*(t)$ used in equation (B2) to obtain $w_i^S(t)$. Since, in most industries, derived $w_i^S(t)$ is lower than $w_i^E(t)$, the labour share resulting from the JIP database tends to be lower than estimates in which $w_i^S(t) = w_i^E(t)$ is assumed.

References

Agnese, P., Sala, H., 2011. The Driving Forces Behind the Falling Labour Share and Persistent Unemployment in Japan. Pacific Economic Review 16(5), 577–603.

Amsden, A.H., Singh, A. 1994. The optimal degree of competition and dynamic efficiency in Japan and Korea. European Economic Review 38(4), 941-951.

Antràs, P., 2004. Is the U.S. aggregate production function Cobb-Douglas? New estimates of the elasticity of substitution. Contributions to Macroeconomics 4 (1) - http://dx.doi.org/10.2202/1534-6005.1161.

Arpaia, A., Prez, E, Pichelmann, K. 2009. Understanding labour income share dynamics in Europe. European Economy Economic Papers 379, May, European Commission, Brussels.

Arulampalam, W., Booth, A.L. 1998. Training and labour market flexibility: Is there a trade-off?. British Journal of Industrial Relations 36(4) 521–536.

Asano, H., Ito, T. Kawaguchi, D. 2013. Why has the Fraction of Nonstandard Workers Increased? A Case Study of Japan. Scottish Journal of Political Economy 60, 360–389.

Atkinson, A. B. 2009. Factor shares: the principal problem of political economy?. Oxford Review of Economic Policy 25(1): 3–16.

Autor, D., Dorn, D., Katz, L.F., Patterson, C., Van Reenen, J., 2017. Concentrating on the fall of the labor share. American Economic Review: Papers & Proceedings 107 (5), 180–185.

Azmat, G., Manning, A., Van Reenen, J., 2012. Privatization and the decline of labour's share: international evidence from network industries. Economica 79 (315), 470–492.

Badinger, H. 2007. Has the EU's Single Market Programme Fostered Competition? Testing for a Decrease in Mark- up Ratios in EU Industries. Oxford Bulletin of Economics and Statistics 69(4), 497-518.

Barkai, S., 2016. Declining Labor and Capital Shares. University of Chicago, mimeo.

Bental, B., Demougin, D., 2010. Declining labor shares and bargaining power: an institutional explanation. Journal of Macroeconomics 32, 443–456.

Bentolila, S., Saint-Paul, G., 2003. Explaining movements in the labor share. Contributions to Macroeconomics 3(1), 1–31.

Blanchard, O., Giavazzi, F., 2003. Macroeconomic effects of regulation and deregulation in goods and labor markets. Quarterly Journal of Economics 118(3), 879–907.

Blundell, R., Dearden, L., Meghir, C., Sianesi, B. 1999. Human capital investment: the returns from education and training to the individual, the firm, and the economy. IFS Working Paper.

Bockerman, P., Maliranta, M. 2012. Globalization, creative destruction, and labour share change: evidence on the determinants and mechanisms from longitudinal plant-level data. Oxford Economic Papers 64(2), 259–280.

Boeri, T., Garibaldi, P. 2007. Two Tier Reforms of Employment Protection: A Honeymoon Effect? Economic Journal. 117, 357-385.

Booth, A. L., Francesconi, M., Frank, J. 2002 Temporary Jobs: Stepping Stones Or Dead Ends?. The Economic Journal, 112(480), F189–F213.

Checchi, D., Garcia-Penalosa, C. 2008. Institutions and Inequality. Economic Policy 23(56), 601-649.

Crinò, R., 2012. Service offshoring and the skill composition of labour demand. Oxford Bulletin of Economics and Statistics 74(1), 375–401.

Damiani, M., Pompei, F., Ricci, A. 2017. Labour shares, employment protection and unions in European economies, mimeo.

Daudey, E. Garcia-Pe.alosa, C. 2007. The personal and the factor distributions of income in a cross-section of countries. Journal of Development Studies, 43(5), 812-829.

Eberhardt, M. 2013. Estimating panel time-series models with heterogeneous slopes. The Stata Journal 12(1), 61–71.

Eberhardt, M., Presbitero, A.F. 2015. Public debt and growth: Heterogeneity and non-linearity. Journal of International Economics 97, 45–58.

Eberhardt, M., Teal, F. 2010. Productivity analysis in global manufacturing production. Discussion Paper 515, Department of Economics, University of Oxford. http://www.economics.ox.ac.uk/research/WP/pdf/paper515.pdf.

Eberhardt, M., Teal, F. 2011. Econometrics for Grumblers: A New Look at the Literature on Cross-Country Growth Empirics. Journal of Economic Surveys 25(1), 109-155.

Elsby, M.W.L., Hobijn, B., Sahin, A., 2013. The decline of the U.S. labor share. Brookings Papers on Economic Activity 47(2), 1–63.

European Commission, 2007. The Labour Income Share in the European Union. In Employment in Europe 2007. Office for Official Publications of the European Communities, Luxembourg, 237–272.

Feenstra, R.C., Hanson, G.H., 1999. The impact of outsourcing and high technology capital on wages: estimates for the United States, 1979–1990. Quarterly Journal of Economics 114(3), 907–940.

Fujimura, H. 2012. Japan's Labour Unions: Past, Present and Future. Japan Labour review 9(1), 6-24.

Fukao, K., Hamagata, S., Inui, T., Ito, K. Ug Kwon, H., Makino, T., Miyagawa, T., Nakanishi, Y., Tokui, J. 2007. Estimation Procedures and TFP Analysis of the JIP Database 2006. RIETI Discussion Paper January 2007 07-E-003.

Fukao, K., Nishioka, S. 2017. Globalisation and the evolution of Mark-ups around the World, mimeo, Hitotsubashi University

Fukao, K. and Otaki, M. 1993. Accumulation of Human Capital and the Business Cycle. Journal of Political Economy 101(1), 73-99.

Funabashi, Y., Kushner, B. (Eds.) 2015. Examining Japan's Lost Decades, Routledge, London.

Gollin, D. 2002. Getting Income Shares Right. Journal of Political Economy 110(2), 458-474.

Guerriero, M., Sen, K., 2012. What Determines the Share of Labour in National Income? A Cross-country Analysis. IZA Discussion Papers 6643. Institute for the Study of Labor (IZA).

Guscina, A. 2007. Effects of Globalization on Labor's Share in National Income. IMF Working Paper, 06294. International Monetary Fund, Washington, DC.

Hamaaki, J., Hori, M., Maeda, S., Murata, K. 2012. Changes in the Japanese employment system in the two lost decades. Industrial & Labor Relations Review 65(4), 810-846.

Harrison, A. 2002. Has Globalization Eroded Labor's Share? Some Cross-country Evidence. Mimeo, UC Berkeley.

Høj, J., Wise, M. 2004. Product Market Competition and Economic Performance in Japan. OECD Economics Department Working Papers, No. 387, OECD Publishing, Paris.

ILO. 2011. The Labour Share of Income: Determinants and Potential Contribution to Exiting the Financial Crisis. Chapter 3 of World of Work Report 2011: Making Markets Work for Jobs. ILO, Geneva.

Imbs, J., Mumtaz, H., Ravn, M.O., Rey, H. 2005. PPP Strikes back: aggregation and the real exchange rate. Quarterly Journal of Economics CXX(1), 1-43.

IMF. 2007. The globalization of labor. World Economic Outlook April. IMF., Washington, DC, 161–192.

Inoue, M., Nishikitani, M., Tsurugano, S. 2016. Female non-regular workers in Japan: their current status and health. Industrial Health 54(6), 521-527.

Jaumotte, F., Buitron, C. 2015. Inequality and Labor Market Institutions. IMF Discussion Note SDN/15/14, International Monetary Fund.

Jaumotte, F., Tytell, I., 2007. How has the Globalization of Labor Affected the Labor Income Share in Advanced Countries?. IMF Working Papers, 298.

Jayadev, A. 2007. Capital Account Openness and the Labour Share of Income. Cambridge Journal of Economics 31(3), 423–43.

Kalantzis, Y., Kambayashi, Y., Lechevarier, S. 2012. Wage and Productivity Differentials in Japan: the Role of Labor Markert Mechanisms. Labour 26(4), 514-541.

Kambayashi, R., Kato, T. 2013. Good jobs, bad jobs, and the great recession: Lessons from Japan. CJEB Working Paper No. 326, New York, Columbia University.

Karabarbounis, L., Neiman, B., 2014. The global decline of the labor share. Quarterly Journal of Economics 129 (1), 61–103.

Kato, T. 2016. Productivity, wages and unions in Japan. Conditions of Work and Employment Series No. 73, ILO, Geneva.

Kawaguchi, D., Ueno, Y. 2013. Declining long-term employment in Japan. Journal of the Japanese and International Economies, 28, 19-36.

Kleinknecht, A., van Schaik, F.N., Zhou, H. 2014. Is flexible labour good for innovation? Evidence from firm-level data. Cambridge Journal of Economics, 38(5), 1207-1219.

Komiya, R., Yasui, K. 1984. Japan's macroeconomic performance since the first oil crisis: Review and appraisal. Carnegie-Rochester Conference Series on Public Policy, 20(1), 69-114.

Krueger, A. B. 1999. Measuring labor's share. American Economic Review 89(2), 45–51.

Lewandowski, P. 2007. PESCADF: Stata module to perform Pesaran's CADF panel unit root test in presence of cross section dependence. https://EconPapers.repec.org/RePEc:boc:bocode:s456732.

Mai C.D., Mitali, D., Zsoka, K., Weicheng, L. 2017. Why Is Labor Receiving a Smaller Share of Global Income? Theory and Empirical Evidence. IMF Working Paper, 17/169.

Maimaiti, Y., O'Mahony, M., Rincon-Anzar, A., Siebert, S., Van de Ven, J. 2010. Review of Market Environment Indicators, INDICSER Review Paper 2.

Matsuura, T. Motohashi, K. 2005. Market Dynamics and Productivity in Japanese Retail Industry in the late 1990's. RIETI Discussion Paper Series, 05-E-001.

Minami, R. 2008. Income Distribution of Japan: Historical Perspective and Its Implications. Japan Labor

Review, 5(4), 5-20.

Miyamoto, J. 2016. Growth and Non-regular Employment. The B.E. Journal of Macroeconomics, 16(2), 523-554.

O'Mahony, M., Vecchi, M., Venturini, F. 2017. The Long-Run Decline in Labor Share: Technology and heterogeneous capital, mimeo, University of Perugia.

OECD. 2011. Divided We Stand: Why Inequality Keeps Rising. OECD Publishing, Paris.

OECD. 2012. Employment Outlook. June, OECD Publishing, Paris.

OECD. 2017a. OECD Economic Survey of Japan, OECD Publishing, Paris.

OECD. 2017b. Employment Outlook. June, OECD Publishing, Paris.

Ono, H. 2010. Lifetime employment in Japan: Concepts and measurements. Journal of The Japanese and International Economies 24, 1–27.

Pedroni, P. 1999. Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. Oxford Bulletin of Economics and Statistics 61, 653-670.

Perugini, C., Vecchi, M., Venturini, F. 2017. Globalisation and the decline of the labour share: A microeconomic perspective Economic Systems 41, 524–536.

Pesaran, H., 2003. A Simple Panel Unit Root Test in the Presence of Cross Section Dependence. Cambridge Working Papers in Economics 0346, Faculty of Economics (DAE), University of Cambridge

Pesaran, M. H. 2006. Estimation and inference in large heterogeneous panels with a multifactor error structure. Econometrica 74, 967-1012.

Pesaran, M. H., Smith, R. 1995. Estimating long-run relationships from dynamic heterogeneous panels. Journal of Econometrics 68, 79-113.

Pesaran, M.H. 2004. General Diagnostic Tests for Cross Section Dependence in Panels. IZA Discussion Paper No. 1240.

Pieroni, L., Pompei, F. 2008. Evaluating innovation and labour market relationships: the case of Italy. Cambridge Journal of Economics 32 (2), 325-347.

Piketty, T. 2014. Capital in the Twenty-first Century. Harvard University Press, Cambridge

Piketty, T., Zucman, G. 2014. Capital is back: wealth-income ratios in rich countries 1700–2010. Quarterly Journal of Economics 129, 1255–1310.

Rincon-Aznar, A., Vecchi, M., Venturini, F. 2015. Functional Income distribution in European Transition Economies. In: Perugini, C. and Pompei, F. (eds) Inequalities during and after transition in Central and Eastern Europe. Palgrave MacMillan, London, 59-92.

Rodrik, D. 1997. Has Globalization Gone Too Far? Institute for International Economics, Washington, DC.

Rotemberg, J.J. Woodford, M. 1999. The cyclical behavior of prices and costs. In: Taylor J.B., Woodford, M. (ed.), Handbook of Macroeconomics. Elsevier, Edition 1, Chapter 16, 1051-1135.

Schlenker, E., Schmid, K.D. 2015. Capital income shares and income inequality in 16 EU member countries. Empirica 42, 241–268.

Slaughter, M.J. 2000. Production transfer within multinational enterprises and American wages. Journal of International Economics 50, 449–490.

Takeuchi, F., 2005. Causes of decline in labor's share in Japan. JCER Researcher Report No. 53.

Teruyama, H. Toda, H. 2017. Polarization and Persistence in the Japanese Labor Market. KIER Discussion Paper Series 957, Institute of Economic Research, Kyoto University.

Vergeer, R., Kleinknecht, A. 2014. Does labor market deregulation reduce labor productivity growth? A panel data analysis of 20 OECD countries (1960-2004). International Labour Review 153(3), 365-393.

Wakita, S. 2006. The Lost Decade in the Japanese Labor Market: Labor's share and Okun's Law. Public Policy Review 2(1), 77-96.

Wasmer, E. 2006. General versus specific skills in labor markets with search frictions and firing costs. American Economic Review 96(3), 811–831.

Yamada, K., Kawaguchi, D. 2015. The changing and unchanged nature of inequality and seniority in Japan. The Journal of Economic Inequality 13(1), 129-153.

Zeira, J. 1998. Workers, Machines, and Economic Growth. Quarterly Journal of Economics 113(4), 1091-1117.