Medium-Run Dynamics of Elasticity of Substitution and Labor Shares – Manufacturing and Service Sectors in the U.S. and Japanese Economy–[1]

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Abstract

One of the reasons of trend of labor shares declining which is widespread phenomena in OECD countries is that the elasticity of substitution between labor and capital is likely to be enlarging in the medium-run and long-run. Although there are debates about the value of this elasticity larger than unity or not in the macroeconomy, the level and the movements of this value may differ in the industry-level in each advanced country. These heterogeneities come from its own industry-specific and country-specific reasons such as the institutional changes, technological changes, globalization and the structural change. In this paper, focusing on the time series data from 2001 to 2017 in manufacturing and services industries in the U.S. and Japanese economy, we estimate the trends and the movements of the elasticities of substitution, compare them and investigate the reasons. We have the following findings. In both countries, the trend in the elasticity of substitution in the macroeconomy is almost likely to rise from 2001 to 2017, and the magnitude of this value, especially in the manufacturing industries in the U.S. economy is almost larger than that in Japanese economy. However, although the values in service sector such as retail trade are likely to be larger in the U.S. economy, the values in these sectors in Japanese economy are not always likely to be large. Our findings suggest that these trends can provide the difference of the declining labor shares in both countries, and the analysis implies that these trends can be mainly produced by the new technologies such as information and communication technology and substitution of computer-intensive machinery for workers and the structural change such as rising service sectors and declining manufacturing sectors.

JEL: D33, E25, L60, L80, O57

Keywords: elasticity of substitution, manufacturing and service sectors, labor shares, inequality

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1. Introduction

One of the reasons of trend in labor shares declining which is widespread phenomena in OECD countries is that the elasticity of substitution between labor and capital is likely to be enlarging in the medium-run and long-run. Although there are debates about the value of this elasticity larger than unity or not in the macroeconomy,[2] the level and the movements of this value differ in the industry-level in each advanced country. These heterogeneities come from its own industry-specific and country-specific reasons such as the institutional changes, technological changes such as computerization, globalization and the structural change such as rising service sectors and declining the manufacturing.

Focusing on the time series data from 2001 to 2017 in the manufacturing and services industries, we estimate the trends and the movements of the elasticities of substitution, compare them and investigate the reasons. In particular, focusing on the ten-year average series data in the motor vehicles manufacturing and the retail trade sector in the U.S. and Japanese economy, we analyze the medium-run trend in the elasticity of substitution in both countries from the millennium age.

Figure 1 and Table 1 show two movements of labor shares in the retail trade and motor vehicles manufacturing in the US and Japan from 2001-2017. First shows that the trends in labor shares in both retail trade and motor vehicles industries in both countries are likely to be declining although the labor shares in the motor vehicle industries countercyclically move during the Great Recession in both countries. The second shows that these indicate that the levels in labor shares in Japan tend to be constantly higher than in the US. Investigating the dynamics of industry-specific elasticity of substitution in the US and Japan, we analyze these trend and movement of such labor shares in the US and Japanese economy.[3]

We have two main findings. First, in both industries, the trend in the elasticity of substitution in the US economy indicates that the average elasticity of substitution tends to be larger than that in Japanese economy. In particular, the value of elasticity of substitution in the US economy is likely to be larger than unity, but the average elasticity of substitution in Japanese economy is likely to be lower than unity. This finding suggests that these trends can provide one of the reasons for larger declining labor shares in the US than that in Japan.[4]

Second, the movement of elasticity of substitution has the industry-specific feature in both countries, particularly after the great recession. Specifically, after the Lehman shock, the elasticity of substitution in the US motor vehicles industry tends to be large and to fluctuate more. In contrast, the elasticity of substitution in the Japanese retail trade tend to become larger and to fluctuate more.

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[2] For example, Klump et al. (2007), Oberfield and Raval (2014), Laurence (2015), Chirinko and Mallick (2017) provide the estimation of the elasticity of substitution less than unity. Conversely, Karabarbounis and Neiman (2014) and Piketty (2014) provide the estimation of this elasticity larger than unity. Recently IMF (2017) estimates the elasticity of substitution in the advanced economies larger than unity, while that in the emerging and developing economies less than unity.

[3] Alternatively, there are a lot of research for the concentration of industry and market for analyzing capital shares and labor shares. See Bartelesman et al. (2013), Autor et al. (2017), De Loecker and Eeckhout (2017).

[4] Hirakata and Koike (2018) obtain the similar results. However, their framework differs from ours.

These findings suggest that these trend and movements of such elasticity of substitution may be produced by not only the business cycle but also the new technologies such as information and communication technology and substitution of computer-intensive machinery for workers, mainly in the US, and moreover the structural changes and globalization[5] such as the declining manufacturing mainly in the US[6] and the rising service sector due to restructuring and merger in retail trade sectors mainly in Japan.

The structure of the paper is as follows. Section 2 provides Data, and Section 3 presents the results. Section 4 concludes.

2. Data

Following Kendrick and Sato (1963), Sato (1970), Sato and Morita (2009), we formulate the elasticity of substitution between capital and labor σ as follows: [7]

$$\sigma = (G_K - G_L)/(G_w - G_r), \quad (1)$$

where G_K represents the rate of change of capital stock, G_L the rate of change of labor force, G_w the rate of change of wage rate, G_r the rate of change of rate of return on capital. In our formulation, we have some notes. First, it is not crucial whether the remuneration rates are competitively determined or not in the medium-run and long-run unless the elasticities of factor demands with respect to remuneration rates do not change. This is because the elasticity of substitution depends on the rate of change of the relative ratio of remuneration rates $d(w/r)/(w/r) = G_w - G_r$, Also, because of the same reason, it is not significant whether the remuneration rates are evaluated by the nominal rate or not. We later use the nominal rate of G_w and G_r. Second, our formulation implies that the technical progress is total factor productivity type, in other words, Hicks neutral one.[8] If each factor-augmenting technical progress differs, the formulation may change.[9]

To measure the rate of change of capital stock G_K, the rate of change of labor force G_L, the rate of change of wage rate G_w, and the rate of change of rate of return on capital G_r in the retail trade sector and motor vehicles manufacturing sector in the US and Japan, we mainly use data from the US Bureau of Economic Analysis and the Japanese Financial Statements Statistics of Corporations by Industry issued by the Japanese Ministry of Finance annually. For labor force, we use data from the US Bureau of Labor Statistics and the Japan Main Productivity-Indicator Database issued by Japan Productivity Center. Specifically, we use these data for 2001-2017 by taking the ten-year average.

We calculate the rate of change of wage rate G_w and the rate of change of the rate of return on

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[5] See Bliss (2007) and Bourguignon (2015).

[6] See Baily and Bosworth (2014).

[7] See also Hicks (1963).

[8] Our production function is assumed to be of $Y = TF(K, L)$ where T is Hicks neutral technical progress.

[9] This means that if the production function to be of $Y = F(BK, AL)$, the elasticity of substitution modifies into the following : $\sigma = (G_B - G_A + G_K - G_L)/(G_B - G_A + G_w - G_r)$ where G_A represents labor-augmenting technical progress and G_B capital-augmenting technical progress. See also Sato and Morita (2009). However, based on this formulation, we have the identification problem. For the identification problem, see Diamond et al. (1978).

capital G_r in each sector as follows. First, to measure the rate of change of wage rate G_w in each sector, we calculate the rate of change of wage income G_{wL}, which consists of employees' compensation in the US Bureau of Economic Analysis and salaries and wages plus directors' remuneration plus welfare expense in the Japanese Financial Statements Statistics of Corporations by Industry. Second, we calculate the rate of change of labor force GL from US Bureau of Labor Statistics and the Japan Main Productivity-Indicator Database. Finally, the rate of change of wage rate is the rate of change of wage income minus the rate of change of labor force; thus $G_w = G_{wL} - G_L$. Similarly, we can calculate the rate of change of the rate of return on capital G_r. First, we calculate the rate of change of capital income G_{rK} from the US Bureau of Economic Analysis and the Japanese Financial Statements Statistics of Corporations. Then, we calculate the rate of change of capital stock G_K from the same data. Finally, we have the rate of change of rate of return on capital is the rate of change of capital income minus the rate of change of capital stock; thus $G_r = G_{rK} - G_K$. Note that G_w and G_r are respectively based on the rate of change at the nominal rate. However, it does not matter because the elasticity of substitution depends only on the relative change of the remuneration ratio.

Table 2 and 3 show each ten-year average of the rate of change of wage rate G_w, the rate of change of rate of return on capital G_r, the rate of change of capital stock G_K, the rate of change of labor force G_L, and the elasticity of substitution σ in the retail trade sector and motor vehicles manufacturing sector in the US and Japan in the recent decades. $\bar{\sigma}$ indicates the arithmetic mean of σ in each sector.

The next section shows the main findings.

3. Results

From Table 2 and 3, we have two main findings of the trend and movements of the elasticity of substitution in each sector in the US and Japan. First, about the trend in the elasticity of substitution in both industries, the average elasticity of substitution in the US tends to be larger than that in Japanese economy. In particular, the value of elasticity of substitution in the US economy is likely to be larger than unity, but the average elasticity of substitution in Japanese economy is likely to be lower than unity.[10] Specifically, during 2001-2017 in the US economy, the average elasticity of substitution in the retail trade is 1.463 and that in the motor vehicles 1.497. On the other hand, during the same decades in Japan, the average elasticity of substitution in the retail trade is 0.941 and that in the motor vehicles 0.162. This finding suggests that these trends can provide one of the reasons for larger declining labor shares in the US than that in Japan.

One of the reasons for the behavior of the larger elasticity of substitution in the US comes from the more advancement of new technologies such as substitution of computer-intensive machinery for workers and information and communication technology (ICT) and the deregulation produced by globalization of financial and commodity markets.[11] Besides, as in such a retail trade sector, the increase in the rate of return on capital and the decrease in capital may reflect the merger in this industry and the concentration of large firm and the market. These

[10] As noted, Hirakata and Koike (2018) obtain the similar results. Their estimates indicate that during the three decades 1985-2017, the elasticity of the substitution at the mean in the US is 1.475, while that in Japan is 0.199.

[11] See Bliss (2007) and Bourguignon (2015).

are other reasons for decreasing labor share in the US.[12] On the other hands, the possible reason for smaller elasticity of substitution in Japan comes from a prolonged stagnation[13] that implies the slow adjustment to the business recovery. However, even if the elasticity of substitution is below unity, Japanese economy has the labor share declining. This may imply that other reasons such as lack of aggregate demand, low productivity in supply side, and labor market deregulation are significant.[14] However, the elasticities of substitution in both sectors are getting larger although the motor vehicles are hit in the great recession. These come from the slow recovery, the advancement of the new technology, the globalization of financial and commodity market, the merger of the retail sector

Second, the movement of elasticity of substitution has the industry-specific feature in both countries, particularly after the great recession. Specifically, after the Lehman shock, the elasticity of substitution in the US motor vehicles industry tends to be large and to fluctuate more. In contrast, the elasticity of substitution in the Japanese retail trade tend to become larger and to fluctuate more. In both countries, these features come from the structural change and the great recession. In the US, in the motor vehicle industries, the decrease in rate of return on capital and the decrease in employment reflect the declining of motor vehicle industries implying the declining of the US manufacturing.[15]

On the other hands, In Japan, the decrease in wages and employment in the retail sector reflect the merger and restructure of the industry produced by the advancement of new technology such as computer intensive machinery and ICT network and globalization, implying the relatively rising the service sectors.

In summary, these findings suggest that these trend and movements of such elasticity of substitution may be produced by not only the business cycle but also the new technologies such as information and communication technology and substitution of computer-intensive machinery for workers, and moreover the structural changes and globalization such as the declining manufacturing mainly in the US and the rising service sector due to restructuring and merger in retail trade sectors mainly in Japan.

4. Concluding Remarks

Focusing on the ten-year average series data in the motor vehicles manufacturing and the retail trade sector in the U.S. and Japanese economy from 2001 to 2017, we analyzed the medium-run trend and movement in the elasticity of substitution in both countries. We showed that in both industries, the value of elasticity of substitution in the US economy is likely to be larger than unity, while the average elasticity of substitution in Japanese economy is likely to be lower than unity. We also showed that the movement of elasticity of substitution has the industry-specific feature, particularly after the Lehman shock, the elasticity of substitution in the US motor vehicles industry tends to be large and to fluctuate more. In contrast, the elasticity of substitution in the Japanese retail trade tend to become larger and to fluctuate more. These implies that the trend and movements of such elasticity of substitution may be produced by not only the business cycle but also

[12] See Autor et al. (2017), and De Loecker and Eeckhout (2017).
[13] See Teulings and Baldwin (2014).
[14] See Fukao and Pergini (2018).
[15] See Baily and Bosworth (2014).

the new technologies, and moreover the structural changes such as the declining manufacturing mainly in the US and the rising service sector in retail trade sectors mainly in Japan. However, the empirical analysis in the more profound data are needed and the widespread data analysis across OECD countries are also required. These are to be deal with in the future research.

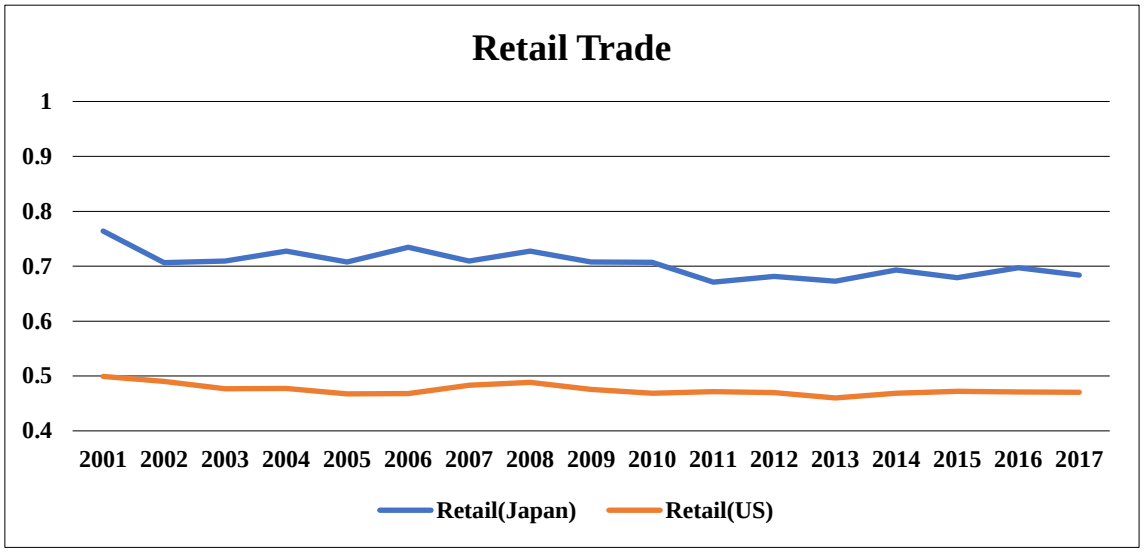
Table 1: Labor Share: Retail Trade Sector and Motor Vehicles in the U.S. and Japan

	Labor Share			
	Retail Trade (US)	**Retail Trade (Japan)**	**Motor Vehicles (US)**	**Motor Vehicles (Japan)**
2001	0.499	0.764	0.587	0.707
2002	0.490	0.707	0.546	0.683
2003	0.477	0.710	0.528	0.700
2004	0.478	0.727	0.548	0.707
2005	0.467	0.706	0.554	0.675
2006	0.468	0.735	0.562	0.680
200o7	0.483	0.709	0.580	0.669
2008	0.488	0.727	0.705	1
2009	0.475	0.708	1	0.931
2010	0.468	0.707	0.548	0.831
2011	0.471	0.671	0.504	0.869
2012	0.470	0.681	0.493	0.744
2013	0.460	0.673	0.483	0.639
2014	0.468	0.693	0.490	0.659
2015	0.471	0.679	0.480	0.666
2016	0.470	0.697	0.472	0.715
2017	0.470	0.683	0.477	0.672

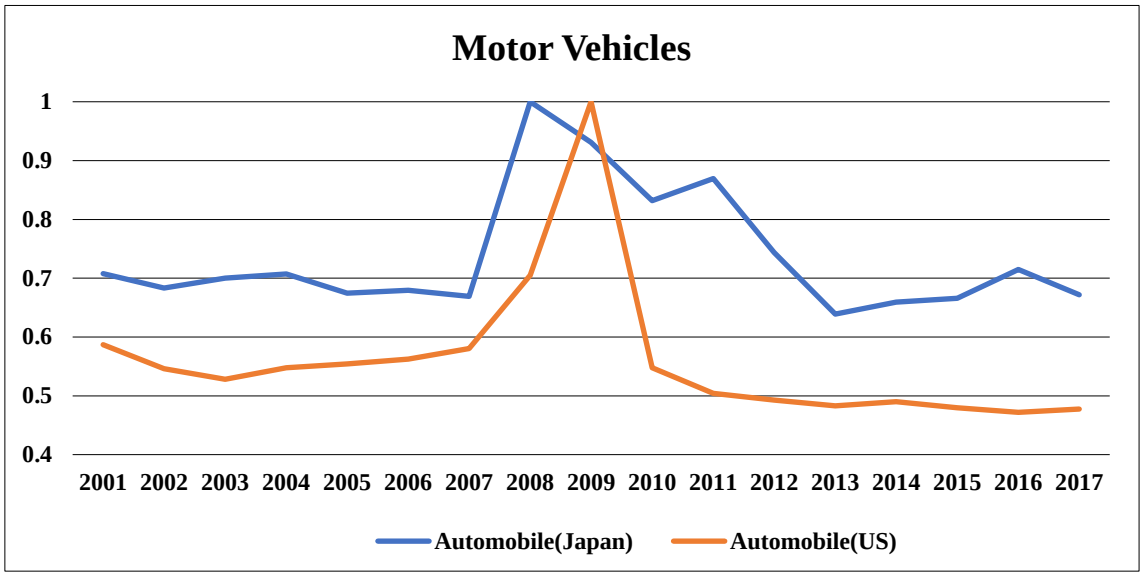
Sources: US: US Bureau of Economic Analysis, Japan: Financial Statements Statistics of Corporations by Industry

Figure 1

Labor Share: Retail Trade in the U.S. and Japan



Labor Share: Motor Vehicles in the U.S. and Japan



Sources: US Bureau of Economic Analysis, Financial Statements Statistics of Corporations by Industry

Table 2: Sigma σ (= $(G_K - G_L)/(G_w - G_r)$): Retail Trade in the U.S. and Japan

Retail Trade (US)

	G_w	G_r	G_K	G_L	σ
2001-2011	1.923	0.217	2.422	-0.426	1.669
2002-2012	1.992	1.541	1.042	-0.259	2.882
2003-2013	1.869	0.109	2.339	-0.115	1.394
2004-2014	1.884	0.295	1.926	-0.042	1.239
2005-2015	2.009	3.766	-1.893	0.059	1.111
2006-2016	1.899	8.303	-6.433	0.073	1.016
2007-2017	1.796	9.320	-6.808	0.191	0.930
					$\overline{\sigma}$ = 1.463

Retail Trade (Japan)

	G_w	G_r	G_K	G_L	σ
2001-2011	-0.564	5.399	-1.813	-0.529	0.215
2002-2012	-1.529	1.037	-1.776	-0.39	0.540
2003-2013	-1.382	2.994	-3.023	-0.362	0.608
2004-2014	1.029	3.653	-1.312	-0.393	0.350
2005-2015	0.747	0.332	1.531	-0.237	4.259
2006-2016	-0.987	-0.356	1.049	-0.167	-1.925
2007-2017	0.886	0.084	1.993	-0.049	2.541
					$\overline{\sigma}$ = 0.941

Table 3: Sigma σ (= $(G_K - G_L)/(G_w - G_r)$): Motor Vehicles in the U.S. and Japan

Motor Vehicles (US)

	G_w	G_r	G_K	G_L	σ
2001-2011	1.436	-4.931	4.940	-4.718	1.517
2002-2012	0.916	-5.710	5.220	-3.496	1.315
2003-2013	0.280	-6.932	6.309	-2.678	1.246
2004-2014	0.511	-3.151	3.845	-2.134	1.633
2005-2015	0.625	-0.559	2.808	-1.38	3.536
2006-2016	0.286	-1.682	4.978	-0.679	2.876
2007-2017	0.366	1.973	2.730	0.087	-1.645
					$\overline{\sigma}$ = 1.497

Motor Vehicles (Japan)

	G_w	G_r	G_K	G_L	σ
2001-2011	1.938	-9.203	1.433	0.128	0.117
2002-2012	1.497	-2.098	1.268	0.652	0.171
2003-2013	0.235	2.759	0.849	0.536	-0.124
2004-2014	0.555	2.926	0.334	0.435	0.042
2005-2015	0.803	1.223	0.286	0.315	0.069
2006-2016	0.974	-1.094	0.465	0.070	0.191
2007-2017	0.886	0.445	0.583	0.287	0.669
					$\overline{\sigma}$ = 0.162

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