NEW ZEALAND
PRODUCTIVITY COMMISSION
Te Kōmihana Whai Hua o Aotearoa

The Labour Income Share in New Zealand: An Update

Research Note 2018/1

March 2018

Author: Huon Fraser

The New Zealand Productivity Commission Research Note: The Labour Income Share in New Zealand: An Update

Te Kōmihana Whai Hua o Aotearoa[1]

How to cite this document: Fraser, H. (2018) *The Labour Income Share in New Zealand: An Update* New Zealand Productivity Commission Staff Research Note 2018/1

Date: March 2018

Author: Huon Fraser

JEL classification:

ISBN: 978-1-98-851905-0 (online only)

Acknowledgements: I would like to thank Patrick Nolan and Paul Conway from the Productivity Commission as well as Norman Gemmell from Victoria University, for their feedback and guidance on this project. This note has also benefited from conversations and feedback from John Janssen and Simon McLoughlin from the Treasury and Bill Rosenberg from the Council of Trade Unions.

The Commission – an independent Crown entity – completes in depth inquiry reports on topics selected by the Government, carries out productivity related research and promotes understanding of productivity issues. The Commission aims to provide insightful, well –formed and accessible advice that leads to the best possible improvement in the wellbeing of New Zealanders. The New Zealand Productivity Commission Act 2010 guides and binds the Commission.

Information on the Productivity Commission can be found on www.productivity.govt.nz or by contacting +64 4 903 5150

[1] The Commission that pursues abundance for New Zealand

Abstract

Earlier work by the New Zealand Productivity Commission investigated changes in the labour income share across the "former measured sector" part of the New Zealand economy between 1978 and 2010. This paper updates this earlier work by including additional data points for 2011-2016 and by increasing the scope of coverage to more industries in the economy. Focus is given to the decomposition of changes in the labour income share into growth in productivity and real wages. Findings are interpreted both within and outside an economic framework and are related to broad changes in technology and policy across the observed period.

Contents

Figures

1 Introduction

In recent years there has been much interest in inequality (e.g., Piketty, 2014). One aspect of this has been growth in real wages falling behind growth in productivity in a number of countries, indicating that "labours' share" of the income gains from productivity growth has been falling (Rosenberg, 2010). While the relationship between changes in gross wages and the distribution of final (net) incomes is not straightforward (Nolan, forthcoming), understanding changes in the labour income share can illustrate one potential driver of inequality in the distribution of gross incomes (which is a feature of a "pre-distribution agenda").

More formally, the labour income share (LIS) is a measure of the returns to labour (wages, salaries, etc.) divided by the total income of a nation. This is based on a view of production where outputs are exclusively produced by capital and labour. In other words, the labour income share measures how the "income pie" is split between labour and capital[2].

Another way to look at the LIS is as the ratio of average real wages to average labour productivity (Equation 1.1). This decomposition can be used to illustrate the extent to which growth in labour productivity has translated into (and will lead to) growth in real wages. For instance, if productivity grows at a higher rate than real wages, labour's "share of the pie" will shrink, even though labour may be better off in absolute terms (through higher wages).

(Equation 1.1) $LIS = \frac{Labour's\ Income}{National\ Income} = \frac{Labour's\ Income}{Labour\ Inputs}\frac{Labour\ Inputs}{National\ Income} = \frac{Real\ Wages}{Labour\ Procuctivity}$

Within the context of inequality in gross incomes, the LIS is important. All else equal, a decrease in the labour income share could increase inequality in gross incomes, as income from capital tends to be distributed less evenly across people than income from labour (due to a relative concentration of capital ownership (ILO et al., 2015)). However, this is not the only possible source of changes in net income inequality. For instance, an increase in CEO incomes or the introduction of less progressive tax policies would increase net income inequality without having any direct impact on the LIS.

Neoclassical economic theory provides a framework for considering how the LIS could be influenced by various economic shocks. Section 2 outlines this framework, using the example of a Cobb Douglas production model, to analyse how the LIS, real wages, and labour productivity change in the process of technological change.

Earlier work by the New Zealand Productivity Commission (NZPC) (Conway et al, 2015) studied the LIS in New Zealand. The focus was on understanding how productivity growth affects the income share of labour and capital. The scope of this work was on the former measured sector, MS-11[3], part of the economy between 1978 and 2010. A summary of this earlier work is presented in section 3.

An update to the earlier NZPC work is presented in sections 4 and 5. Additional data points are included for 2011-2016, which have become available since the publication of the previous study. Additionally, the scope of the economy covered is increased by also providing results for MS-16[4] – known as the measured sector – from 1996 to 2016. Changes to the LIS are discussed in section 4. Section 5 looks at the decompositions of the LIS; in particular the changes to real wages and productivity and section 6 discusses the observed changes to the LIS within the context of related policy and technology factors.

[2] Income for self-employed businesses is distributed between labour and capital. For a discussion of this issue see page 12 of Conway et al. (2015).

[3] The MS-11 includes the following sectors: Agriculture, Electricity, Gas, Water and Waste Services, Construction, Wholesale Trade, Retail Trade, Accommodation and Food Services, Transport, Postal and Warehousing, Information, Media, and Telecommunications, and Financial and Insurance Services.

[4] The, MS-16 includes the sectors in the MS-11 as well as: Rental, Hiring, and Real Estate, Professional, Scientific and Technical Services, Administrative and Support Services, Arts and Recreation Services, and Other Services.

2 The Neoclassical Model

The neoclassical economic model can provide insights into how the LIS behaves under certain conditions. This model offers a framework for assessing firm level behaviour; and under the right conditions, link firm level insights to the economy as a whole. The model assumes perfectly competitive markets with firms having a Cobb Douglas production function (Equation 2.1). The implications of such a model for the LIS are established in Appendix A and are summarised in this section[5].

(Equation 2.1) $Y = K^{\alpha}L^{1-\alpha}$

The determinants of the LIS are given in Equation 2.2. Within the Cobb Douglas model (with constant returns to scale) the sole determinant of the LIS (over the long run) is **1-α**, the marginal output elasticity of labour. This is important as, within the confines of this model, the only shocks that can change the LIS are changes to **α**; neither capital intensification or changes in input prices will affect the LIS over the long term.

(Equation 2.2) $LIS = \frac{Aggregate\ Real\ Wages}{Revenue} = \frac{MP_L L}{Y} = 1 - \alpha$

Changes to **α** occur when technological change or changes endogenous to the firm increase the output elasticity of capital (relative to the output elasticity of labour). Examples of such shocks are technological change that favours capital over labour, or firms investing in higher quality capital. As Equation 2.3 describes, such changes will increase labour's average product by more than its marginal product. A divergence of real wages and productivity is expected within these circumstances.

(Equation 2.3) $MP_L = (1 - \alpha)AP_L$

This divergence makes intuitive sense, capital enhancing technological improvements or investments can be expected to see the owners of capital take a greater return. Enhancement of the labour that works with this capital is a by-product of the change, as opposed to changes that enhances labour, where labour can be expected to capture more of the gains to productivity.

Explicit in the Cobb Douglas model is the assumption that the elasticity of substitution (between labour and capital) equals one. Relaxing this assumption gives the more general Constant Elasticity of Substitution (CES) model. Under CES models, if the elasticity of substitution is greater than one, capital intensification (say due to a fall in the price of capital) will result in a decrease in the labour income share, as opposed to the Cobb Douglas case, where changes in factor prices or quantities do not affect the LIS over the long term.

Outside of the neoclassical model, there are many factors which can influence real wages, productivity, and the LIS. Product market factors (for instance, education levels of labour, or relative bargaining power) may influence wage setting and consequently the LIS. Education enhances the quality of labour (through developing human capital) and can influence labour's ability to benefit from technological change.

3 Earlier Results

Conway et al. (2015) found that across the former measured sector of the New Zealand economy, the LIS fell from 64.6% in 1978 (the starting point of the data series used) to 56.1% in 2010, a decline of 8.5 percentage points. This fall was somewhat offset by an increase in the LIS from 2002, in contrast to the continuing falls seen in many other OECD economies (ILO et al., 2015).

Much of this decline in the LIS in New Zealand occurred over three short periods; 1982-1984, 1992-1995, and 1999-2002. The researchers argued that these periods of volatility show how sensitive the LIS can

[5] Where values are as follows: Output (Y), quantity of Labour inputs (L), quantity of Capital inputs (K), output elasticity of capital (α), output elasticity of labour (1-α), marginal product of labour (MP_L), average product of labour (AP_L).

be to changes in policy or economic shocks; the 1982-1984 fall and partial recovery in the LIS could be linked to the wage and price freeze of the time, the 1992-1995 decline to a period where strong growth in productivity was decoupled from growth in real wages, and the 1999-2002 fall and recovery in the LIS to the impact of (unanticipated) inflation.

As outlined above, the LIS can be decomposed into productivity (LP) divided by real product wages (RPW), where the RPW is a measure of wages as a cost to the producer rather than as the purchasing power of the consumer. The differences between real producer and consumer wages is discussed in Box 3.1.

Using this decomposition the researchers reached two conclusions. First, the RPW grew at a rate below that of productivity growth on average over the sample. This was consistent with the New Zealand evidence in Rosenberg (2010) and, more generally, with the experience elsewhere in the world. Secondly, real wages grew more quickly when productivity growth was higher, highlighting that despite a declining LIS, productivity growth is still a key mechanism associated with higher real wages.

The same decomposition made at the level of individual industries[6] added further support for the conclusion that real product wage growth was correlated with productivity growth, with the majority of industries seeing real product wage growth in line with (but slightly below) labour productivity growth.

The differences between industries also offered insight. In particular, Mining and Construction – a capital intensive industry with a LIS of approximately 0.2 – saw real product wage growth far below labour productivity growth. Potentially, different industry experiences can be explained by the level to which industries are exposed to better technology and the effects of policy changes.

As the authors noted, their study could be developed in a number of ways. One issue is that their conclusions were based on data for MS-11 industries only. The authors noted that if the experience of sectors not included in the MS-11 differed from those in these industries, then the experience of the LIS across all New Zealand may differ from the LIS changes observed in MS-11.

Another caveat was the use of product wages rather than consumer wages. Since 1978, the ratio of production wages to consumption wages – the measure of the value of labour for firms compared to its value for consumers – has declined for workers inside MS-11 industries relative to the same ratio for the economy as a whole[7]. This may be an example of the Baumol effect, where low productivity growth in sectors that compete for labour with high productivity growth sectors leads to wages grow above productivity in the lower productivity growth sectors[8]. Consequently, the LIS data on the MS-11 may give a false picture of what is happening to the income share across the whole economy.

Ideally, interpreting changes in the LIS from 1978 should be done in the context of data available prior to 1978. In particular, data for the period prior to 1978 shows that the LIS increased during the 1960s and 1970s (e.g., Bertram, 2000, Rosenberg, 2017). These studies use compensation of employees as a measure of income which does not take self-employed income into account and means they do not directly match the data used by Conway et al. (2015). However, such studies still provide context suggesting that the LIS observed at the start of the data series used in Conway et al. (2015) was relatively high in the broader historical context.

[6] Industries are defined by the ANZSIC classification.

[7] This is based on the assumption that the PPI measure of input prices is identical to PPI output prices. The PPI measure used here is output prices, whereas input prices reflect the cost of inputs to producers. In general, changes in output prices are matched by changes in input prices over the long term, however short term movements, or different industry experiences may cause this relationship to break down.

[8] Industries outside the MS-11 are services which generally experience lower productivity growth than non-service industries. For further discussion on the Baumol effect see page 63 of Productivity Commission (2016).

Box 1 **Real Product Wages and Consumer Wages**

Real consumer wages measure the purchasing power of wages as the amount of goods and services that can be purchased. This is the standard measure of real wages talked about in the discussion of income inequality. Real product wages differ in that they relate to the cost of labour for the firms relative to the prices firms receive for their outputs. These two measures are broadly comparable across the whole economy, as changes in real consumer prices (CPI) tend to be matched by changes in real producer prices (PPI), as Figure B.1 shows.

For LIS analysis, using real product wages over real consumer wages has a number of advantages. First, from the persepective of a firm looking to hire labour and capital to produce outputs, it is the cost of labour relative to both the cost of capital and intermediate inputs and the price of outputs that are important in deciding on the quantity of labour hired. Second, different industries may experience different cost pressures or different changes in the prices of the goods and services they sell, with implications for real product wages. As Figure B.2 shows, the PPI for the MS-11 sector has grown less than the whole economy PPI since 1978, indicating that since 1978 the shift in the relative value of labour differs across different sectors of the economy.

Figure B.1 CPI and PPI

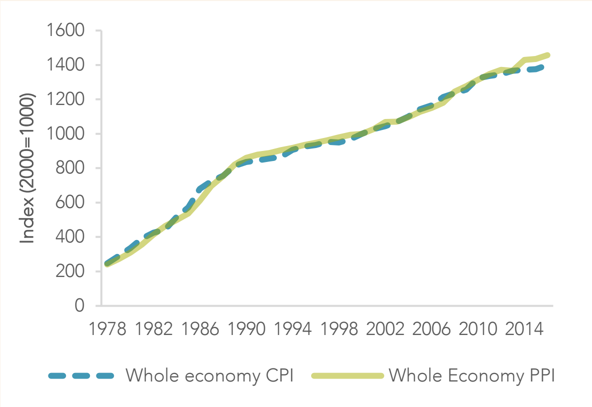
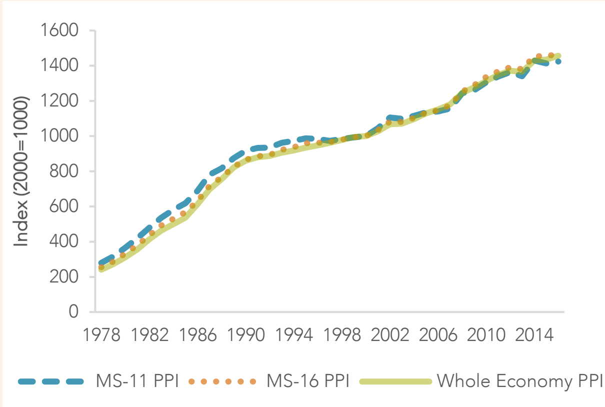


Figure B.2 PPI across sectors



4 Updated Results for the LIS

Between 2010 and 2016 the LIS fell from 56.3% to 55.5% across the MS-11, a decline of 0.8 percentage points (Figure 4.1a). This fall somewhat reversed the gain in the LIS in the early 2000s identified by Conway et al. (2015). Adding this period to earlier years, the total fall in the LIS since 1978 (the starting point of the data available) was 8.3 percentage points[9]. Overall, the addition of six more years to the series is consistent with the narrative of three periods of sharp and partly temporary declines in the LIS against a background of gradual decline.

The trends in the LIS observed for the MS-16 part of the economy are similar to those seen in the MS-11. Figure 4.1 b shows a gradual downward trend in the LIS for the MS-16 from 1996 to 2016, with a fall from 57.4% to 55.6% (minus 1.8 percentage points). This is a broadly similar level of decline to that seen across the MS-11 over the same period from 58.0% to 55.5% (minus 2.5 percentage points).

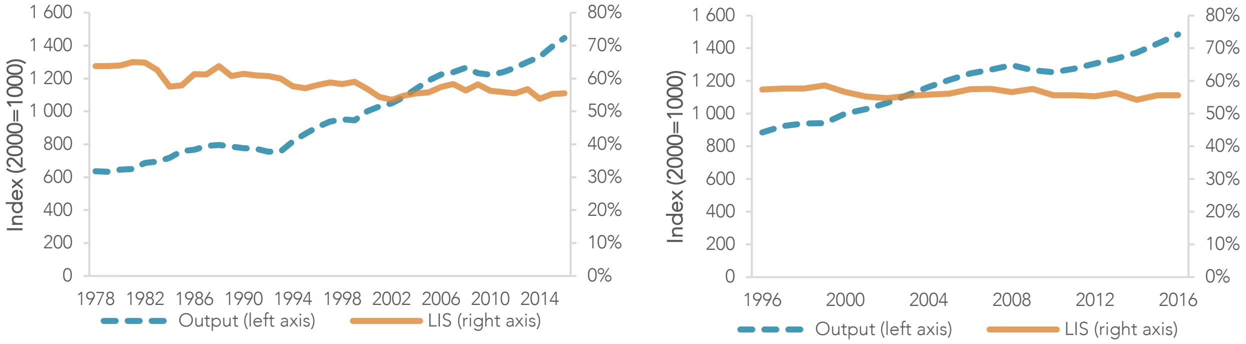
Looking at the LIS for the MS-11 and the MS-16 side by side, figure 4.2 shows that the level of the LIS is similar at the start and end of the period for which the data series overlap. Furthermore, the two series

[9] Note that the 2010 data point for the labour income share has been revised in the 2017 StatsNZ productivity release, creating a slight incongruence between the numbers in Conway et a. (2015) and those this study. Similar measurement issues can have a significant effect on the LIS.

move more or less in tandem across business cycles, with peaks and troughs being observed at the same time for both series.

Figure 4.1 Output and labour income share

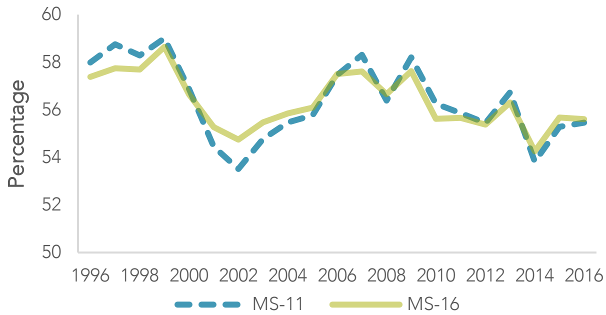
a. MS-11 **b. MS-16**



Source: StatsNZ, Authors Calculations

Figure 4.2 Comparing MS-11 and MS-16

a. LIS



Source: *StatsNZ, Authors Calculations*

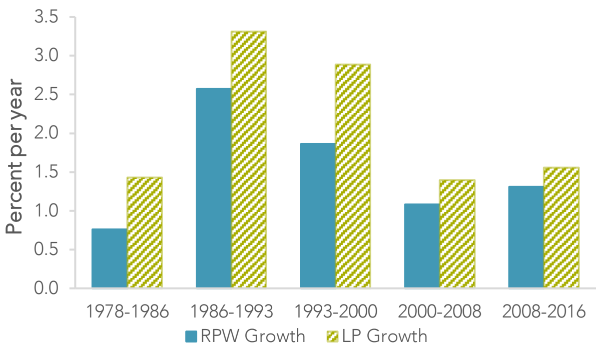
5 Productivity and Wages

The conclusions in Conway et al. (2015) on the decomposition of the LIS into real product wages and labour productivity hold up over the longer period and the larger section of the economy studied here. The addition of data for 2011-2016 in Figure 5.1 shows another time period in which productivity grew more quickly than real wages and for which higher productivity growth is correlated with higher growth in real wages[10]. However, the gap between growth in labour productivity and real product wages is smaller over the 2000s compared to previous decades, consistent with the essentially flat profile of the LIS over this period. Notwithstanding more limited historical data for MS-16, the same findings are true for that part of the economy, as seen in Figure 5.1 b.

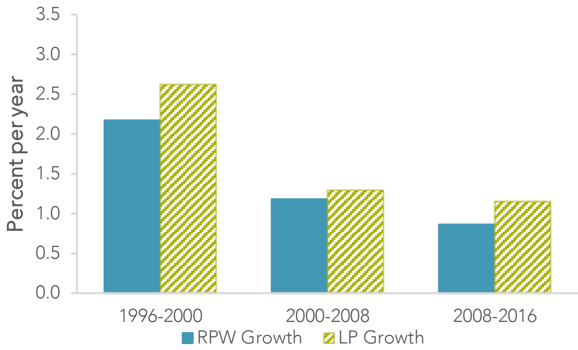
[10] The LIS moves over a business cycle (Conway et al., 2015). As 2010 to 2016 is not a complete business cycle it may not be directly comparable to the other periods of time shown in these graphs. In general, care needs to be taken in comparing the LIS across time, given the cyclical nature of with the LIS.

Figure 5.1 Growth in real product wages and labour productivity

a. MS-11



b. MS-16



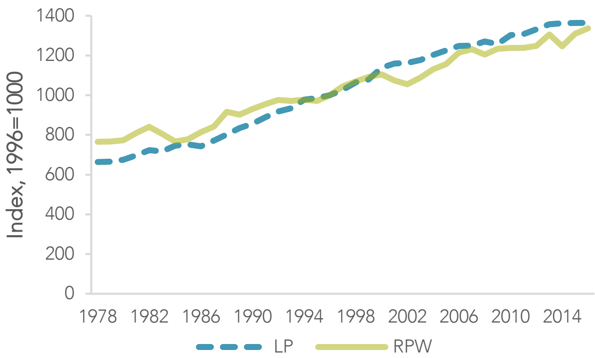
Source: StatsNZ, Authors Calculations

Notes:

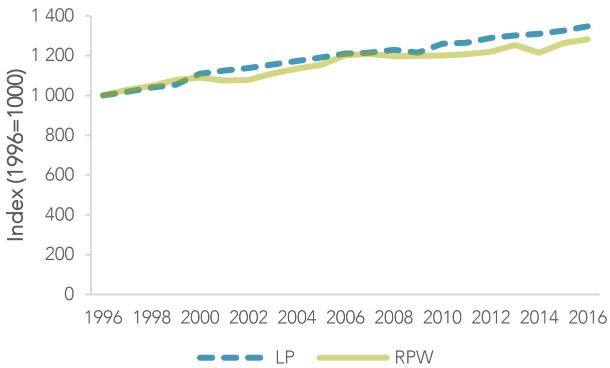
1. The time periods for these graphs correspond to complete business cycles for the New Zealand economy, with the exceptions of the most recent period and 1996-2000 for the ms-16

Figure 5.2 Divergence in real product wages and labour productivity

a. MS-11



b. MS-16



Source: StatsNZ, Authors Calculations

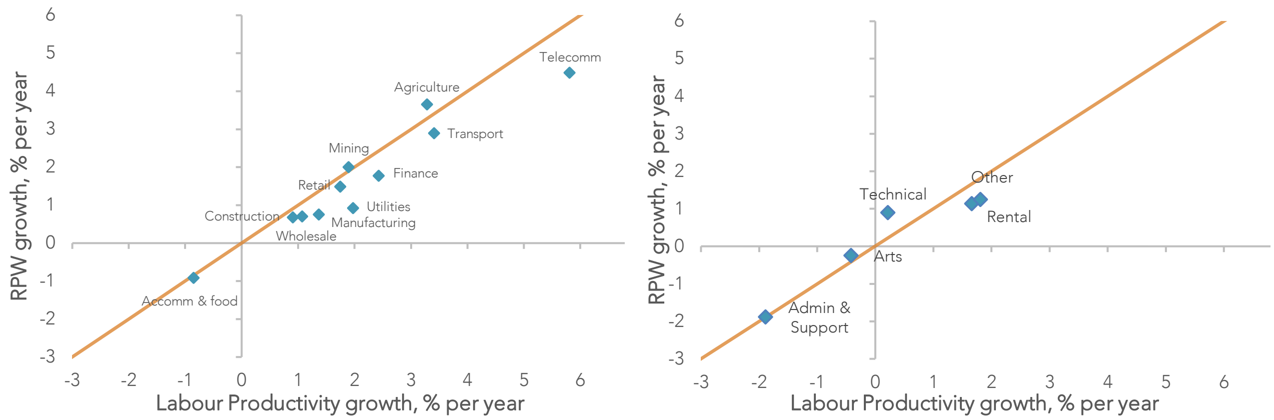
Industry-level analysis also shows a link between growth in labour productivity and in the real product wage (Figure 5.3a). So the evidence shows that the real wages firms pay their workers increase more rapidly when productivity growth is strong and that higher real wage increases are more likely in high-productivity growth industries. These results indicate reasonably good coordination between product and factor markets across industries in the New Zealand economy, which will be beneficial for resource allocation.

Industries that belong to MS-16 but not MS-11 are service industries with productivity growth below that of MS-11 industries (on average). Non MS-11 industries (with lower overall productivity growth), experienced higher wage growth relative to productivity (compared to MS-11 industries) suggesting the incidence of Baumol-like effects in certain industries (Figure 5.3b). This is consistent with the analysis of Conway et al. (2015) regarding the potential incidence of a Baumol effect leading to a divergence in the MS-11 PPI compared to the whole economy PPI or CPI. Furthermore, the real product wage-labour productivity decomposition at the industry level (Figure 5.3) showed that low productivity growth industries such as Administration and Support services, Arts, and Technical, Professional, and

Scientific services had slightly higher levels of real product wage growth than labour productivity growth, further evidence for the Baumol effect hypothesis[11].

Figure 5.3 Real product wages and labour productivity, industry level

a. MS-11, 1978-2016 **b. MS-16 minus MS-11, 1996-2016**



Source: StatsNZ, Authors Calculations

6 Technology and Policy

Changes to the LIS can be attributed to myriad economic, political, and technological factors, with emphasis often placed on technological change, globalisation and policy changes. Conway et al. (2015) noted the role played by policy or economic shocks, as well as technological change, in driving the fall in the LIS. They argued that much of the decline in the LIS occurred over several small periods where such shocks led to large changes in the LIS.

Rosenberg (2017) argued that policy-related effects dominated technological change, in particular employment law, patterns of industrial disputes and government actions, in addition to the impact of changes in the terms of trade. Rosenberg cited the International Labour Organization (2013) which found that only 10% of the decline in the LIS across OECD countries was due to technology change, as compared to 25% being due to the loss of employee bargaining power, de-unionisation, and falling government spending.

The International Monetary Fund (2017) argued differently; stating that approximately 50% of the fall in the LIS across OECD countries can be attributed to the impact of technological change , as evidenced by a fall in the relative (and absolute) price of investment goods. Furthermore, the IMF argued that such technological changes have a polarising effect on the labour market; increasing the LIS of high skill labour, while lowering the LIS of medium and low skill labour.

Another perspective is given by Bridgman and Greenway (2016), who linked the observed falls in the LIS in New Zealand to the privatisation of formerly public owned companies, with large, often monopolistic firms replacing "fair wage" deals with mandates to return profits. This is consistent with the first principles argument that markets that are competitive, rather than rent seeking, may lead to a higher LIS (Appendix A)[12].

The additional data on the LIS presented in this note, along with the decomposition showing the divergence in labour productivity and real wages, suggest a slow constant decline in the LIS, with

[11] Some of the industries in which the RPW kept up with LP – particularly Accommodation and Food; Retail; and Administration and Support Services – have significant proportions of workers on or near the minimum wage, which has risen considerably faster than average hourly wages since 2000.

[12]

occasional large and partly temporary shocks. The first principles model given in Section 2 outlined the result that these observations can be explained by technological progress favouring capital over labour, suggesting that technological change could be an important driver in the falling LIS.

That is not to say that policy is not important. Even within the hypothesis of technological change, the gradual decline in the labour income share may also reflect weaker bargaining power of labour (relative to 1978). In addition, limited progress in the "race between education and technology" in New Zealand may be polarising the labour market and allowing capital to capture a more than proportional share of the benefits of technological change. The incidence of such phenomena would increase the returns of capital relative to that of labour for a given level of productivity (growth). It is probable that a mix of political, technological, and other factors is causing the declining labour income share, all of which have complex flow on effects that need to be considered in any policy around the LIS.

Whatever mix of factors is influencing the LIS, the structural make up of New Zealand relative to the world economy and of individual industries relative to each other have an important role in determining the level of exposure to these changes and their flow on effects. In particular, the elasticity of substitution (between labour and capital) and the extent to which capital substitutes or complements different types of labour will affect the exposure of New Zealand's economy to technological change, globalisation or policy changes. If the elasticity of substitution is greater than one, then capital intensification will decrease the LIS. Steenkamp (2016) estimated that the elasticity of substitution differed significantly from one for nearly every industry in New Zealand, meaning that capital intensification, or technological change affecting capital will have a different impact (on the LIS) for different industries. This matches the international evidence of the IMF (2017), who found that the elasticity of substitution varies across countries and industries, with the majority of developed nations having an elasticity of substitution greater than one.

7 Conclusion

This note updated Conway et al. (2015) by including six more years of data (bringing the period studied to 1978-2016) and by increasing the scope of the economy studied by looking at a wider number of industries (MS-16 not just MS-11). The main conclusions made by the researchers in 2015 are supported by the additional evidence in this update.

Over the full period observed (for the MS-11), 1978-2016, the LIS fell by 8.3 percentage points, while between 1996 and 2016 the LIS fell by 2.5% for the MS-16. This indicates a trend of the ratio of income-to-capital growing more quickly than that of income-to-labour, over the period observed. Another way of stating this is that growth in real product wages is falling behind growth in labour productivity, with the difference being 0.21% per year on average for the MS-11 and 0.09% per year for the MS-16[13]. Given that the data series starts during a period of volatility for the New Zealand economy, these numbers need to be interpreted with caution; the relatively high LIS observed in 1978 may be an outlier that doesn't represent the majority of New Zealand's economic history.

This divergence of labour productivity and real wages does not mean that productivity growth has contributed to the decline in the LIS or relatively low wage growth. The evidence presented here is consistent with the argument of Conway et al. (2015) that higher productivity growth contributes to higher wage growth, to the benefit of workers; growth in real wages would be expected to be lower in the absence of productivity growth.

The evidence presented here does not give any insights into the reasons that real wages have fallen behind labour productivity, nor what an appropriate LIS might be. Technological change, government policy, and economic shocks all have far-reaching and complex consequences; further research is

[13] MS-11 figures are over 1978-2016, MS-16 figures are over 1996-2016.

needed to give insight into the mechanisms which are responsible for a declining LIS and into the effects these changes are having on the economy.

Understanding the policy implications of the findings in this note requires more work on what is driving the fall in the LIS. Changing labour laws, technological change, and globalisation are all disruptive forces which present unique policy opportunities and challenges. Improving the flexibility and resilience of the economy and adapting to changes, rather than resisting them, are vital for allowing productivity growth to drive higher wages for all New Zealanders. In this role, education is of key importance in training workers to adapt to and to make the most of new technology as well as to provide new skills when old ones are displaced.

This note is the starting point of a conversation around the labour income share and inequality. The LIS is a single measure which does not include important parts of New Zealand's economy, such as education and health. One way to further this conversation would be to look at the net (as opposed to gross) labour income share[14]; calculating factor returns to labour and capital inputs after depreciation and tax are accounted for. Such a measure would give a greater understanding of how the take home income of employees compares to the profits of employers and provide further context to the changes observed in the gross LIS studied here. For example, if depreciation rates of capital have risen (say due to uptake of computer related technology with high depreciation rates), then the gross data may overstate increased corporate profits compared to the net data. Likewise, if the average tax on income has fallen, labour's income share may fall by a smaller proportion when based on a net measure of the LIS.

[14] Rosenberg (2017) finds that the LIS calculated on the basis of net income decreased more than the LIS calculated using gross income for the whole economy since the historic maximum in 1980 and since the local maximum in 2009.

References

Bertram, G. (2000). *The factor shares debate: an update,* School of Economics and Finance, Victoria University of Wellington. Wellington, New Zealand: Victoria University of Wellington

Bridgman, B., Greenaway-McGrevy, R. (2016), *The fall (and rise) of labour share in New Zealand*, The Bureau of Economic Analysis, Department of Economics, University of Auckland. Auckland, New Zealand

Conway, P., Meehan, L., & Parham, D. (2015). *Who benefits from productivity growth? – The labour income share in New Zealand*, New Zealand Productivity Commission Working Paper 2015/1. Wellington, New Zealand: Productivity Commission

International Labour Office. (2013). *Global Wage Report 2012/13: Wages and Equitable Growth* (Global Wage Reports). Geneva, Switzerland: International Labour Organization

International Labour Organization (ILO), International Monetary Fund (IMF), Organisation for Economic Co-operation and Development (OECD), World Bank Group. (2015) *Income inequality and labour income share in G20 countries: Trends, Impacts and Causes*

International Monetary Fund. (2017). *World Economic Outlook: Gaining Momentum?* Washington

Nolan, P. (forthcoming). *Effective Marginal Tax Rates: The New Zealand Case*

Piketty, T. (2014), *Capital in the Twenty-First Century*, Harvard University Press

Productivity Commission. (2016). *New models of tertiary education: Issues paper.* Wellington, New Zealand: New Zealand Productivity Commission. Available from www.productivity.govt.nz/inquiry-content/tertiary-education

Rosenberg, B. (2010). *Real wages and productivity in New Zealand.* Presented at the 14th Conference on Labour, Employment and Work in New Zealand, Wellington, New Zealand: Industrial Relations Centre, Victoria University of Wellington. Available from https://ojs.victoria.ac.nz/LEW/issue/view/170

Rosenberg, B. (2017). A brief history of labour's share of income in New Zealand 1939-2016. In G. Anderson (Ed.), Transforming Workplace Relations. Wellington, New Zealand: Victoria University Press. Available from https://www.researchgate.net/publication/317868928_A_brief_history_of_labour%27s_share_of_income_in_New_Zealand_1939-2016

Steenkamp, D. (2016), *Factor substitution and productivity in New Zealand,* Reserve Bank of New Zealand Discussion Paper series DP2016/12, Wellington, New Zealand: Reserve Bank

Appendix A Labour Income Share in a Cobb Douglas Production Model

The standard neoclassic model is often talked about in regard to the claim that real wages should grow in line with productivity. This appendix presents one such "standard neoclassical mode", a perfect competition single good, single industry economy where firms have Cobb Douglas production functions, analysing how the LIS should respond in different scenarios in such a perfect market setting.

Production Function

The Cobb Douglas production function takes the form seem in equation 1, with the level of output (Y) being a function of strictly two homogenous inputs, Labour (L) and Capital (K). α and 1-α represent the output elasticities of their respective input, that is the percentage change in output for a one percent change of the said unit $\frac{\frac{\partial Q}{\partial K}}{\frac{Q}{K}} = \alpha$.

(Equation A.1) $Y = K^{\alpha}L^{1-\alpha}$

Cost Functions

In this model cost is linear for both labour and capital, with the cost function taking the form seen in Equation 2, where w is the wage rate for a unit of labour, and r the required return on capital. As is this model is perfectly competitive, w and r are both constants set by the market. The average cost function is outlined in Equation 3, and marginal cost in Equation 4.

(Equation A.2) $Total\ Cost = wL + rK$

(Equation A.3) $Average\ Cost = \frac{wL+rK}{Y}$

(Equation A.4) $Marginal\ Cost = \frac{dTC}{dY} = \left(\frac{\partial TC}{\partial K}\right)\left(\frac{\partial K}{\partial Y}\right) + \left(\frac{\partial TC}{\partial L}\right)\left(\frac{\partial L}{\partial Y}\right) = \frac{\beta rK + \alpha wL}{\alpha(1-\alpha)K^{\alpha}L^{1-\alpha}}$

Marginal and Average Products

(Equation A.5) $MP_K = \frac{\partial \overline{Q}}{\partial K} = \alpha\left(\frac{K}{L}\right)^{1-\alpha} = \frac{r}{p}$

(Equation A.6) $MP_L = \frac{\partial \overline{Q}}{\partial L} = (1-\alpha)\left(\frac{K}{L}\right)^{\alpha} = \frac{w}{p}$

(Equation A.7) $LP = \frac{Y}{L} = \left(\frac{K}{L}\right)^{\alpha}$

(Equation A.8) $MRTS = \frac{\partial L}{\partial K} = \frac{MP_L}{MP_K} = \frac{(1-\alpha)K}{\alpha L}$

Resource Allocation

Efficient resource allocation is given by Equation 5, and the level of output for a given level of Labour (or Capital) given allocative efficiency by equation 6. Wage rates, returns to capital, and output elasticities for both outputs are all relative factors in determining the quantity of each output used.

(Equation A.9) $K(L) = \left(\frac{w}{r}\right)\left(\frac{\alpha}{1-\alpha}\right)L$

(Equation A.10) $Y(L)|Equation\ 7 = \left[\left(\frac{w}{r}\right)\left(\frac{\alpha}{1-\alpha}\right)\right]^{\alpha} L = \left[\frac{r}{w}\frac{1-\alpha}{\alpha}\right]^{1-\alpha} K$

A.1 Case 1: Perfect Competition, Constant Returns to scale

Under perfect competition, firms are price takers. This means that the price of one unit of output (p) is set by the market, giving the equation for revenue of Equation 7.Profit (π) is given by total revenue minus total costs. Firms seeking to maximize profit, will produce output at the point where MR=MC. This equates to increasing labour and capital until marginal products of each input equals marginal cost of each input; the marginal productivity of labour equals its real wages.

(Equation A.11) $Revenue = pY$

(Equation A.12) $\pi = pY - wL - rK = p\left[\left(\frac{w}{r}\right)\left(\frac{\alpha}{1-\alpha}\right)\right]^{\alpha} L - wL\left(\frac{1}{1-\alpha}\right)$

(Equation A.13) $\frac{\partial \pi}{\partial L} = \left[\left(\frac{w}{r}\right)\left(\frac{\alpha}{1-\alpha}\right)\right]^{\alpha} L - w\left(\frac{1}{1-\alpha}\right) = 0$

The Labour Income Share

In this perfect competition setting, economic profits equal zero; all revenue is distributed to labour and capital (with the return on capital representing entrepreneurial reward). Equations A.14 and A.15 show the key result of this, the LIS and KIS are set solely by the ratio of α to 1-α.

(Equation A.14) $LIS = \frac{wL}{wL+rK} = \frac{wL}{wL+r\left(\frac{w}{r}\right)\left(\frac{\alpha}{1-\alpha}\right)L} = \frac{wL}{wL}\frac{1-\alpha}{1} = 1-\alpha$

(Equation A.15) $KIS = \frac{rK}{wL+rK} = \alpha$

Result 1: In a perfectly competitive market, the LIS of a firm with a Cobb Douglas production model is set solely by the ratio of α to 1-α. Changes in input prices affect the quantity of each input and do not affect the LIS, vice versa.

Technological change improving capital

Having established that the only relevant factors for the LIS under perfect competition are α and 1-α, this next section looks at how changes to α due to technology improvements affect the LIS, wages, and productivity.

Under constant returns of scale an increase in the output elasticity of capital must be offset by a decrease in the output elasticity of labour, with an increase in multi-factor productivity as a result. Let α increase to (α+ ϕ)/(1+ ϕ), 1-α decrease to (1-α)/(1+ϕ), and A increase to A(1+ ϕ).

Over the long term, this shock increases MPL (Equation A.21) and LP (Equation A.22). Of note, MPL increases by less than LP; wages grow by less than productivity.

$$Y_1 = AK^{\alpha}L^{\alpha-1} \qquad Y_2 = (1+\varphi)AK^{\frac{\alpha+\varphi}{1+\varphi}}L^{\frac{1-\alpha}{1+\varphi}}$$

$$LP_1 = A\left(\frac{K}{L}\right)^{\alpha} \qquad LP_2 = A(1+\varphi)\left(\frac{K}{L}\right)^{\frac{\alpha+\varphi}{1+\varphi}}$$

$$MP_{L,1} = \beta K^{\alpha}L^{1-\alpha} \qquad MP_{L,2} = (1-\alpha)A\left(\frac{K}{L}\right)^{\frac{\alpha+\varphi}{1+\varphi}}$$

$$MP_{K,2} = (\alpha+\varphi)A\left(\frac{L}{K}\right)^{\frac{1-\alpha}{1+\varphi}}$$

(Equation A.21) $\%\ change\ MPL = \left(\frac{K}{L}\right)^{\frac{-\varphi(1-\alpha)}{1+\varphi}} - 1$

(Equation A.22) $\%\ LP = (1+\varphi)\left(\frac{K}{L}\right)^{\frac{\varphi(1-\alpha)}{1+\varphi}} - 1$

Result 2: Under constant returns to scale, in a perfect competition model of homogenous firms with Cobb Douglas production functions, increases in technology that enhance capital will lift the average product of labour more than the marginal product of labour.

A.2 Case 2: Cobb Douglas production under a Monopoly

A firm with a Cobb Douglas production function operating in a monopoly environment has production and cost functions identical to that of a firm operating in a perfectly competitive market. Hence equations 1 through to 7 hold here.

When it comes to revenue and cost equations, the firm is no longer a price taker (the price is no longer p). Rather the price is a result of the demand function, and is depends on the quantity produced. Revenue functions are as follows.

(Equation A.23) $p = f(Y)$

(Equation A.24) $Total\ Revenue = f(y)Y$

(Equation A.25) $Average\ Revenue = f(y)$

(Equation A.26) $Marginal\ Revenue = \frac{dTR}{dY} = f'(y)Y + f(y)$

A monopolistic firm produces at the point where marginal revenue equals marginal costs

(Equation A.22) $MR = MC \rightarrow\ f'(y)Y + f(y) - \frac{\beta rK + \alpha wL}{\alpha\beta K^{a}L^{b}} = 0$

(Equation A.23) $\pi(y) =\ f(y)Y - wL - rK = [f(y) - AC]Y$

(Equation A.24) $LIS = \frac{wL}{wL+rK+\pi(Y)} = \frac{wL}{wL+r\left(\frac{w}{r}\right)\left(\frac{\alpha}{\beta}\right)L+\pi(y)} = \frac{\beta}{\alpha+\beta+\frac{[\pi(Y)\beta]}{wL}}$

(Equation A.25) $KIS = \frac{rK+\pi(Y)}{wL+rK+\pi(Y)}$

Result 3: The LIS under imperfect competition depends on the distribution of super-normal profits. If super-normal profits are distributed proportionately between labour and capital then the LIS will be identical to that of the perfect competition case. If super-normal profits are distrusted mostly to capital, then less competition will lead to a lower LIS.