

**Economic and Social Council**Distr.: General
25 April 2018

Original: English

Economic Commission for Europe**Conference of European Statisticians****Group of Experts on National Accounts****Seventeenth session**

Geneva, 22-25 May 2018

Item 8 of the provisional agenda

New Sources and Innovations in Constructing National and International Accounts**An overview of recent developments undertaken by the
Australian Bureau of Statistics that enhance the Australian
National Accounts****Prepared by the Australian Bureau of Statistics¹***Summary*

The Australian Bureau of Statistics has undertaken enhancements with a particular focus on labour and price inputs, the use of transactions data and constrained optimisation. The key enhancements include the production of the Australian Labour Accounts, the use of retail industry transactions data and the utilisation of an optimisation tool in Supply-Use balancing the National Accounts. This paper examines these enhancements within the Australian National Accounts, and how they position Australia to maintain and enhance the quality of the National Accounts, to ensure the continued focus on meeting the contemporary and emerging needs of government, business and the community.

¹ Prepared by Kayla McIntosh and Katrina Richardson.

I. Introduction

1. The Australian Bureau of Statistics (ABS) has undertaken enhancements to maintain and improve the quality in the Australian National Accounts, with a particular focus on labour and price inputs, the use of transactions data and constrained optimisation. These enhancements will position the ABS to meet the contemporary and emerging needs of government, business and the community.

2. In 2017, the first Annual Australian Labour Accounts were published for 2010-11 to 2015-16. The data includes: jobs, persons, time and income and costs at an industry level. These are compiled by confronting data from various sources. As labour data are used extensively in National Accounts, the Labour Accounts are an important data source. Work is now underway to develop and publish quarterly Labour Accounts with the intention that they will be published a week after quarterly National Accounts.

3. Increasing importance has been placed on the use of administrative data within the Australian National Accounts. Transactions data are now utilised as a quarterly indicator for Household Final Consumption Expenditure (HFCE) Cigarettes and tobacco, as well as in the price deflation of HFCE.

4. The Consumer Price Index (CPI) is re-weighted primarily using data from of the Household Expenditure Survey (HES), which is currently conducted every six years. The use of expenditure aggregates from HFCE will expand to be utilised to annually re-weight the CPI in the inter-HES years. The increased frequency of re-weighting the CPI will result in greater accuracy, increasing the quality of the National Accounts chain volume estimates.

5. Australia is also embarking upon the use of constrained optimisation to balance the National Accounts. This technique was trialed on the Supply-Use tables and the Input-Output tables, with the intention to implement more broadly across the accounts. This high performance tool will deliver benefits that include reducing the balancing workload to allow staff to focus on expert analyses.

II. The ABS has developed the Australian Labour Account

6. The ABS publishes a range of labour market related statistical publications; however, they are unique in methodology, scope, coverage, periodicity and concept. These processes result in different statistics that can, at times, appear incoherent. These differences can be further compounded by employment statistics from ABS business surveys presenting an alternative view of Australia's labour market. Accounting for and better understanding these differences are a priority for policy makers, businesses, academics, productivity analysts and labour market researchers. Bringing together these different views under a system that was harmonised with the Australian System of National Accounts (ASNA) was a priority to ensure consistency and comparability across the suite of macro-economic statistics.

7. While there are no specific international standards on how to compile a Labour Account, the ABS followed guidance provided by the International Labour Organization (ILO) on how to develop a Labour Account. The ILO lists six central elements to a Labour Account:

- employed persons and jobs,
- unemployed and underemployed persons,
- job vacancies,

- hours of work and full-time equivalents,
- income from employment and labour costs, and
- organisation of the labour market.²

8. The Australian Labour Account covers these elements, with the exception of full-time equivalents and organisation of the labour market. However, the Australian Labour Account specifically incorporates underutilised persons and unmet labour demand.

9. The Australian Labour Account is consistent with the ASNA and its production boundary (therefore domestic duties and voluntary work outside institutional settings are excluded). This consistency allows for direct comparability with other macro-economic aggregates, and also allows for improved multi-factor productivity analysis.

10. Experimental estimates of the Australian Labour Account were published in June 2017 with a time series from 2010-11 to 2015-16. The Australian Labour Account consists of four quadrants:

- Jobs - this quadrant provides data on the number of filled and vacant jobs,
- People - this quadrant provides data on persons employed, persons looking for employment and persons with potential for further employment,
- Time - this quadrant provides information on the relationship between hours of labour supplied and hours of labour utilised by business,
- Income and costs - this quadrant provides information on the total labour costs to business and the total labour income received by workers.³

11. Each of these items are published at the total Australia, all industry level, and Australia by industry and are based on identity relationships, as shown in Appendix 1.

12. These Accounts are compiled within a framework that compares and confronts data from household surveys, business surveys and administrative sources to present a coherent picture of Australia's labour market. Results from the various quadrants balanced at the industry level in the Australian Labour Account can be used to confront quarterly estimates of compensation of employees and gross mixed income in particular. The suite of information also provides a useful lens for confronting quarterly gross value added estimates by industry.

13. Expanding the scope of the Australian Labour Account to include a state dimension; as well as investigations on how to incorporate full-time equivalents and organisation of the labour market are still being considered. These would give additional opportunities for the Labour Accounts to be incorporated as a data source and confrontation tool in the Australian National Accounts.

14. Further work is currently underway to assess the feasibility of implementing the Australian Labour Account as a part of the ABS' regular suite of quarterly macro-economic releases, with a goal to publish a week following the release of the quarterly National Accounts. The emphasis on harmonising the Australian Labour Account with ASNA, as well as the proposed timing on the data availability, presents an opportunity for the Labour Account information to be utilised within the current quarterly National Accounts balancing process.

² Buhmann et al.

³ Australian Bureau of Statistics. (2017). *Information Paper: Australian Labour Account, July 2017 (First Issue)*

III. The ABS has increased the use of administrative data to improve the quality of the Australian National Accounts

15. The ABS is focused on continuing to unlock the potential use of administrative data. The benefit of using these data are fundamental to meeting the goals of the ABS including reducing costs of ABS statistical operations, reducing time to market, reducing statistical risk and growing the business. The ABS has significantly increased the use of transactional data, particularly in the compilation of the CPI, which benefits the production of the National Accounts. The Australian National Accounts has also implemented the direct use of transactions data as a superior quarterly indicator for the household consumption of cigarettes and tobacco.

16. The CPI has significantly increased the use of transactions data from the December quarter 2017 and applied a multilateral index methodology⁴. This approach enables all the products available in the datasets (rather than a sample of products) and weighting products by their economic importance (rather than using unweighted price indexes). The major benefit of this approach is an enhancement to the accuracy of the CPI. Transactions data are currently used to price products that represent approximately 25% of the weight of the CPI.⁵ The CPI is particularly important for household final consumption expenditure (HFCE) estimates, which make up approximately 55% of the Gross Domestic Product expenditure approach in the National Accounts. The use of transactions data has led to improved accuracy in the price indexes, therefore improving the quality of the price deflators and chain volumes measures.

17. The ABS estimates HFCE on Cigarettes and tobacco on both a quarterly and annual basis. Although Cigarettes and tobacco only account for a relatively small proportion of total household expenditure, comprising only 2 per cent in 2016-17, it remains of strong interest for our users.

18. Currently the HES collect the only direct measure of household consumption on cigarettes and tobacco. As this survey is infrequent and cigarettes and tobacco are typically underreported, the estimation of HFCE Cigarettes and tobacco are measured indirectly. The quarterly household consumption was historically estimated as a residual of production plus imports less exports. This production based approach was always considered an imprecise indicator for household consumption on a quarterly basis, however recently policy eroded the quality of the relationship between tobacco production and consumption.

19. The Australian government increased taxation of cigarette and tobacco products as part of its policy to reduce tobacco consumption. Repeated tobacco excise increases changed the behaviour and timing associated with the production, imports and inventories of cigarettes and tobacco. These changes created volatility in the seasonal patterns and eventually led to structural change in this part of the economy. Domestic production of cigarettes and tobacco ceased, with companies operating within Australia on the production of tobacco reclassifying their operations to Basic Material Wholesaling. The behaviour of the domestic operations, including stockpiling prior to excise increases and changing

⁴ Australian Bureau of Statistics. (2017). *Information Paper: An Implementation Plan to Maximise the Use of Transactions Data in the CPI*, June 2017

⁵ Australian Bureau of Statistics. (2016). *Information Paper: Increasing the frequency of CPI Expenditure Class Weight Updates*, July 2016

patterns in imports made it difficult to ascertain a relationship to consumption, particularly on a quarterly basis.

20. National Accounts leveraged the work conducted in CPI to utilise transactions data from the retail industry. The transactions data contains a product code, product descriptions, prices, quantities and retail outlet metadata. The data are reshaped to incorporate the required temporal and spatial dimensions for National Accounts. Transactions sales data by state by type are aggregated to derive a current price total for Australian retail expenditure, representing purchases of cigarettes and tobacco by households. These current price estimates are price deflated using the CPI for tobacco to create coherent chain volume measures. HES estimates continue to be utilised to apportion the National estimate across states and territories, primarily due to high volatility of transactions data in small jurisdictions.

21. Transactions data accounts for every point-of-sale transaction from a selection of Australian Retailers and is considered a solid indicator of household consumption of cigarettes and tobacco. Transactions data better align with quarterly household consumption patterns when compared to wholesale, excise data or imports. This improvement has increased the quality of the National Accounts HFCE Cigarette and tobacco estimates. There is a strong commitment to continue to explore and effectively maximise the use of administrative data to enhance the Australian National Accounts.

IV. The ABS will annually re-weight the CPI using Australian National Accounts HFCE estimates

22. The ABS maintains a program of periodic reviews of the CPI to ensure it continues to meet the user needs. The ABS recently proposed annually re-weighting the Australian CPI using HFCE data from the Australian National Accounts. This proposal described the use of HFCE data, irrespective of the frequency of the HES, as an opportunity for the CPI to enhance accuracy and remain relevant. The research conducted in the ABS found empirical support for the theory that higher frequency re-weighting of the CPI at the Expenditure Class (EC) level better captures consumers' substitution effects.⁶

23. The availability of annual HFCE data from the National Accounts provides the ABS with the opportunity to update CPI EC level weights more frequently. The ILO endorses the use of HFCE data from the National Accounts when the time interval between household surveys is large, concluding that "household expenditure data in the national accounts may provide the best estimates of aggregate household expenditures" (ILO 2004, p.28).

24. The latest release of the HES is for the 2015-16 reference period. This release was the principal data source for updating the CPI weights in the December quarter 2017. The CPI weights will now be updated annually in the December quarter reference periods. The HES will continue to be the principal data source for updating the weights when it is available. The principal data source for updating the weights for the inter-HES years will be HFCE data from the National Accounts.

25. As well as the major input for re-weighting the CPI, the HES are used as a major benchmark in the compilation of the annual HFCE. Conceptually, the measurement of HFCE aligns closely with the HES as both cover expenditure by Australian households only and exclude expenditure by non-residents in Australia. HFCE measures expenditure by resident households on goods and services, whether the expenditure is made within the

⁶ Australian Bureau of Statistics. (2016). *Information Paper: An implementation plan to Annually Reweight the Australian CPI, 2017*

domestic territory or by Australian residents abroad, and expenditure by Non-Profit Institutions Serving Households (NPISH).⁷

26. HFCE data are available across a range of classifications that are differentiated by their level of aggregation. The CPI will utilise annual HFCE data at the Supply-Use level. The compilation of Supply-Use tables allow for the annual balancing of the production, income and expenditure estimates of Gross Domestic Product (GDP). A large number of data sources are utilised including business activity surveys, household expenditure surveys, investment surveys, foreign trade statistics, government finance statistics and administrative data. The use of less frequent (higher quality) data sources are used in the compilation of Supply-Use to validate more frequent measures and provide quality detailed dimensions. The HES is the most detailed household survey utilised in the compilation of HFCE benchmarks.

27. The majority of HFCE data align seamlessly into the CPI weight structure, however some challenges do exist due to conceptual, data source and coverage differences. These challenges arise because the CPI and HFCE estimates are produced for different purposes and use different data sources. The overarching challenges, including classification, scope, coverage, and revision challenges, as well as specific EC challenges have all been addressed. The December quarter 2018 will be the first update to weights using HFCE data. The use of HFCE data for CPI weights has many potential benefits for both internal and external users of inflation statistics and National Accounts. These include the following:

- improved accuracy with more representative weights while at the same time aligning with international recommendations,
- the use of HFCE data will ensure the continued production of a robust CPI, and
- the benefits to the CPI directly impact on quality improvements in the National Accounts and provide greater coherence across macro-economic statistics within the ABS.⁸

V. How ABS is utilising constrained optimisation

28. The ABS is currently undertaking a program of transformation. This initiative applies to all ABS business, the operations, the way statistics are produced, the infrastructure that are utilised and how stakeholders are engaged. This transformation agenda has given the Australian National Accounts the opportunity for considerable change, particularly with regard to Supply-Use processes and the production of statistics, in order to achieve improved efficiency.

29. Since 1998, the ABS has utilised the Supply-Use framework to produce balanced estimates of Australia's GDP, in both current price and volume terms. Under this framework, balanced estimates of GDP are available from 1994-95 to $t-1$ with each annual cycle allowing for $t-1$, $t-2$ and $t-3$, to be open for balancing. Unbalanced estimates are available from 1959-60 to 1993-94. Intermittently, the National Accounts undertake historical reviews where all Supply-Use years are open for balancing.

30. The Supply-Use process is resource intensive and reliant on software that is inflexible and dated. Staff are required to perform a significant amount of manual

⁷ Australian Bureau of Statistics. (2016). *Information Paper: Increasing the frequency of CPI Expenditure Class Weight Updates, July 2016*

⁸ Australian Bureau of Statistics. (2016). *Information Paper: Increasing the frequency of CPI Expenditure Class Weight Updates, July 2016*

intervention in the balancing process to produce quality estimates. This method is iterative and often repetitive, making it a time consuming process. While there is a high degree of manual processing, there are a number of automated balancing and benchmarking techniques incorporated to remove discrepancies. A weakness of the current method and tools is that they are inherently inflexible. For example, there may be an assumption or business rule that lower-level components that contribute to a published estimate equal that estimate when they are summed. In the absence of manual intervention, this rule is not always met. Given the number of examples like this, as well as other examples where manual intervention is required, adopting a modern optimisation tool was seen as an opportunity to create efficiency as it will reduce manual intervention and provide consistency in balancing Australia's National Accounts.

31. Australia has opted for an optimisation method based on Weighted Least Squares (WLS) which allowed for commercial-off-the-shelf (COTS) software to be used and configured for Australia's Supply-Use process, as well as other ABS applications. Most importantly, the use of WLS is expected to reduce the need for manual intervention through the presence of a more efficient adjustment process.

32. Following selection of the COTS product, the next step was to define the major components within the optimisation method in order to develop a prototype suitable for testing. These components were:

- the decision variables - a set of variables that represent decisions to be made,
- the constraints - restrictions on possible values for the decision variables,
- the objective function - a function of the decision variables, which measures the quality of any proposed solution.

33. Defining the components allowed for the automation, or computation, of the balancing process, with the best solution applied based on the parameters in the program. The greater the complexity and number of constraints, the more difficulty there is in resolving imbalances.

34. A significant amount of testing, including sensitivity analysis, was undertaken in 2017. This testing resulted in the refinement of constraints and further elimination of objective function techniques that were not appropriate or compatible with the new infrastructure that would be rolled out across the organisation. The final Supply-Use prototype included 74 high level constraints, with a mix of constraints specific to a particular industry and constraints that are applied to all industries or component specific constraints. There are both "hard constraints", which are rules that must be exactly satisfied, and "soft constraints", which should be approximately satisfied. In addition to the constraints, there are a number of other business rules that need to be satisfied, as well as the capability to balance concurrently in current prices and previous year's prices. The final prototype program is able to fully balance four years of Supply-Use data in 1 minute, with an additional 3 minutes for controlled rounding. These results will provide a significant saving in resources as historically staff spent weeks balancing the tables.

35. Given the close relationship between Supply-Use tables and Input-Output tables, scope and testing work completed through the Supply-Use balancing prototype was able to be further applied to the production of Australia's Input-Output Tables.

36. Australia's Input-Output Tables are published annually for the period $t-2$ and are published at the Input-Output Product Classification (IOPC) by Input-Output Industry Group (IOIG) level and contain 918 products and 114 industries. These tables provide structural detail of the economy but only for that given point in time as Input-Output tables are not revised, nor do they form part of a time-series. Consistent with Australia's Supply-

Use balancing, the process of producing Input-Output tables was similarly resource intensive.

37. As the Input-Output process is already constrained by the final Supply-Use tables there were already a number of rules that needed to be satisfied in completing this process. Additionally, it was identified that while there are 918 products that are analysed through the Input-Output process, the top 100 contributed to 70% of total Supply. By using Constrained Optimisation, analysts are able to better focus on these top 100 products and apply Constrained Optimisation techniques to balance the smaller products. There were 59 higher level constraints developed for Input-Output processing, with a number of other rules needing to be satisfied through the process. Similarly, the constraints are a mix of “hard constraints” and “soft constraints” with some rules being applied to all products, while others may be product specific. As with the Supply-Use prototype, there has been a significant amount of testing undertaken for the Input-Output process, including reconciliation between the Constrained Optimisation method with published data, scenario analysis, sensitivity analysis and changing reliability ratings. The results have shown that the tables are able to produce what was previously published, but with a significant saving on time and resources.

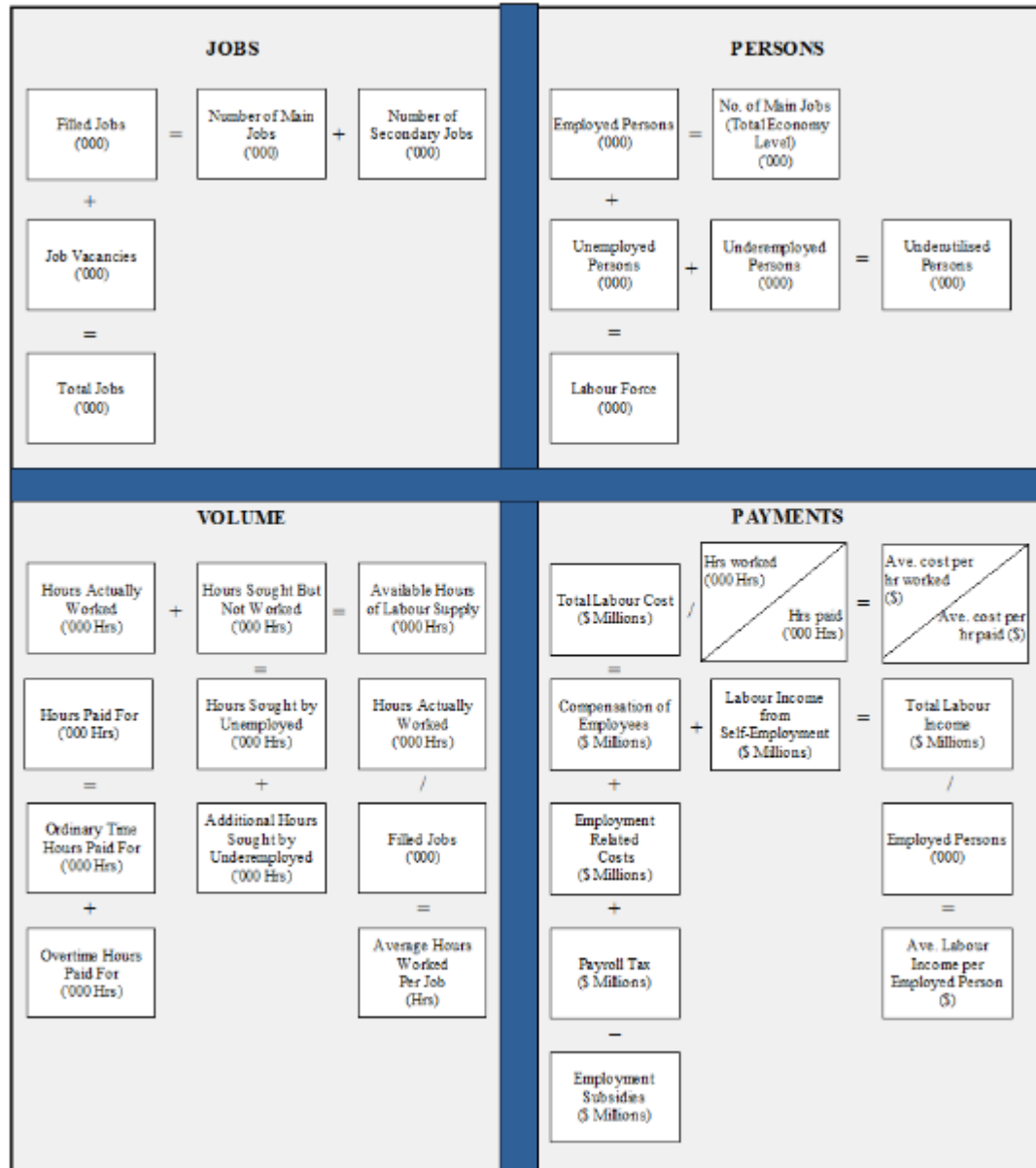
38. The efficiencies from automating parts of the Input-Output process mean that there is more time for staff to scrutinise and analyse the data. It also means that effort can potentially be redirected to revisiting the timeliness and completeness of Australia’s Input-Output tables. The savings that have been achieved could possibly allow for Input-Output tables to be produced in *t-1*, to be developed as a time-series and allow for revisions.

VI. Conclusion

39. The Australian National Accounts have capitalised on recent enhancements undertaken within the ABS to improve the quality of output. The annual Australian Labour Accounts have been published with the quarterly accounts under development, providing a useful additional data source and confrontation tool in the Australian National Accounts. Enhancements undertaken in CPI improve the quality of price deflation in National Accounts. The use of transactions data has led to improved quarterly estimation of HFCE on Cigarettes and tobacco and increased use of administrative data continues to be a focus for the ABS. The use of constrained optimisation will improve efficiency in compiling National Accounts and allow for increased time for analysis and research. Overall, these enhancements improve the quality of the National Accounts with a continued focus on meeting the contemporary and emerging needs of government, business and the community.

Appendix

Figure 1
Australian Labour Account identity relationships.



Source: ABS (Catalogue No. 6150.0.55.002)

References

Australian Bureau of Statistics. (2006). Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) (Catalogue No. 1292.0). Canberra.

Australian Bureau of Statistics. (2015). Enhancing the Australian CPI: A roadmap, Aug 2015 (Catalogue No. 6401.0.60.001).

<<http://www.abs.gov.au/ausstats/abs@.nsf/mf/6401.0.60.001>>

Australian Bureau of Statistics. (2015). Australian System of National Accounts: Concepts, Sources and Methods (Catalogue No. 5216.0). Canberra.

<<http://www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/5216.0?OpenDocument>>

Australian Bureau of Statistics. (2017). Information Paper: An Implementation Plan to Annually Re-weight the Australian CPI, June 2017 (First Issue) (Catalogue No. 6401.0.60.005).

<<http://www.abs.gov.au/ausstats/abs@.nsf/mf/6401.0.60.005>>

Australian Bureau of Statistics. (2016). Information Paper: Increasing the frequency of CPI Expenditure Class Weight Updates, July 2016 (Catalogue No. 6401.0.60.002)

<<http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/6401.0.60.002Main%20Features%203July%202016?opendocument&tabname=Summary&prodno=6401.0.60.002&issue=July%202016&num=&view=>>>

Australian Bureau of Statistics. (2016). Information Paper: Making Greater Use of Transactions Data to compile the Consumer Price Index (first issue) (Catalogue No. 6401.0.60.003). Australia

<<http://www.abs.gov.au/ausstats/abs@.nsf/mf/6401.0.60.003>>

Australian Bureau of Statistics. (2017). Australian Labour Account: Concepts, Sources and Methods, July 2017 (First Issue)(Catalogue No. 6150.0). Canberra.

<<http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/6150.0~July%202017~Main%20Features~Uses%20of%20an%20Australian%20Labour%20Account~5>>

Australian Bureau of Statistics. (2017). Information Paper: Australian Labour Account, July 2017 (First Issue)(Catalogue No. 6150.0.55.002). Canberra

< <http://www.abs.gov.au/ausstats/abs@.nsf/mf/6150.0.55.002>>

Australian Bureau of Statistics. (2017). Labour Account Australia Experimental Estimates, July 2017 (First Issue)(Catalogue No. 6150.0.55.001). Canberra.

<<http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/6150.0.55.001Main+Features1July%202017?OpenDocument>>

Buhmann, B. Leunis, W.P. Vuille, A. Wismer, K. International Labour Organisation (2002). Labour Accounts. A step forward to a coherent and timely description of the labour market.

< http://www.ilo.org/global/statistics-and-databases/WCMS_087916/lang--en/index.htm>

International Labour Office et al. (2004) IMF Consumer Price Index: Theory and Practice. Geneva.

United Nations et al. (2009). System of National Accounts 2008. New York.