Capitalisation of Research and Development Expenditure in Gross Domestic Product

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Abstract

Research and development (R&D) is recognised as important capital investment of an economy for improving efficiency and productivity. In view of the inherent investment nature of R&D, the System of National Accounts 2008, which presents the latest international standards for the compilation of national accounts statistics, recommends recording R&D expenditure as capital formation in the Gross Domestic Product (GDP) statistics. This is to better reflect R&D as an economic asset which provides impetus to economic growth and development. While the concept of capitalising R&D expenditure is appealing, its statistical measurement is not straight-forward. The paper discusses the measurement challenges in estimating the capital formation of R&D in the GDP compilation system, and highlights the salient features of the implementation of this new development in the GDP system of Hong Kong.

Keywords: capital formation, national accounts

1. Introduction

In September 2012, the Census and Statistics Department (C&SD) of Hong Kong released the revised Gross Domestic Product (GDP) series as a result of a technical revision exercise made to GDP to incorporate the latest international standards in the 2008 version of the System of National Accounts (SNA), i.e. *2008 SNA* (1). A major feature of the technical revision is the expansion of the coverage of investment expenditure on fixed assets (2) in GDP to include research and development (R&D) as recommended in 2*008 SNA*.

According to the earlier standards in *1993 SNA*, expenditure on R&D is classified as intermediate consumption, with the whole value of expenditure considered as being used up in the process of production in the time period when the expenditure is incurred, even though it is recognised that R&D may be used for more than one year and hence bring future economic benefits. The reason for such treatment is more on practical than conceptual consideration: expenditures on R&D "do not lead to the acquisition of assets that can be easily identified, quantified and valued for balance sheet purposes" (para. 1.51, *1993 SNA*).

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(1) It is an established practice of Hong Kong to conduct technical revision exercises for enhancing national accounts statistics once every several years. The 2012 round of technical revision to GDP mainly aimed to incorporate the latest international standards presented in 2*008 SNA*, which is the latest version of the international statistical manual on the compilation of national accounts statistics. The last version is *1993 SNA*.

(2) In the SNA, fixed assets are defined as produced assets that are used repeatedly or continuously in production processes for more than one year.

Over the past years, some statistically advanced economies have been carrying out researches on the measurement of R&D expenditure and systematically addressing the difficulties in including R&D expenditure as fixed assets in national accounts. In the recent update of the statistical standards of national accounts by international organisations, the SNA has been reviewed to recognise the outputs of R&D as assets, such that the acquisition, disposal and depreciation of R&D assets would be treated in the same way as other fixed assets.

The new standards relating to the capitalisation of R&D expenditure in *2008 SNA* have been implemented in the GDP framework of Hong Kong since September 2012. This better reflects R&D as an economic asset which provides impetus to economic growth and development.

While the concept of capitalising R&D is appealing, its statistical measurement is not straight-forward. This article describes the data sources and estimation methods adopted by C&SD in compiling statistics of investment expenditure on R&D and analyses the trend of investment in R&D in Hong Kong in recent years.

2. Coverage of Research and Development

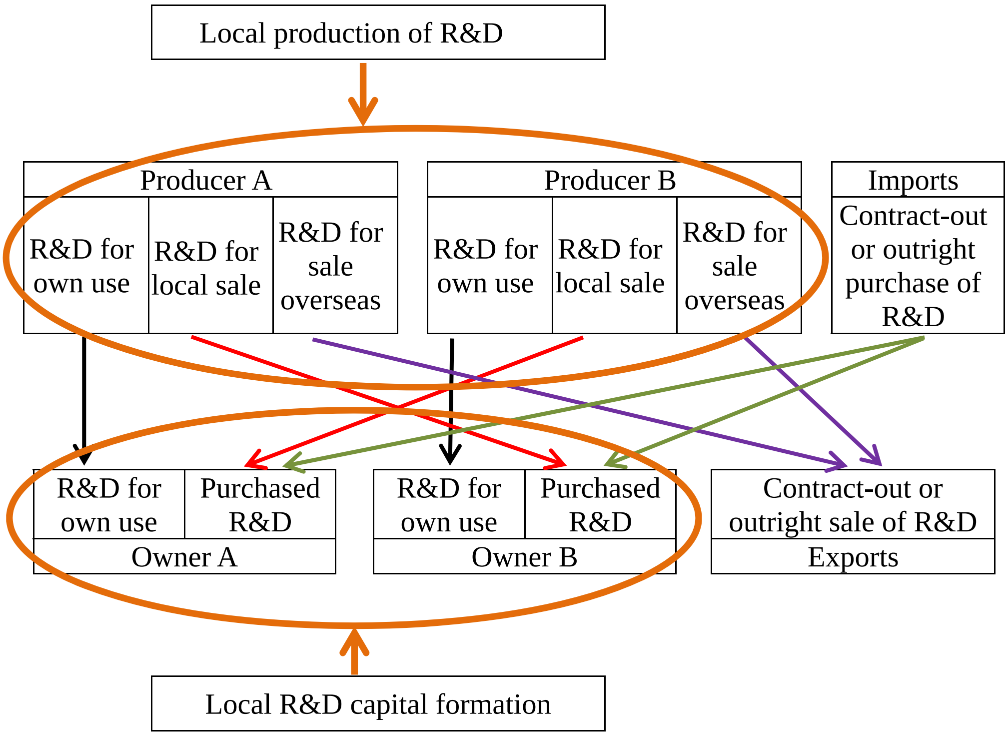
Under the statistical framework of GDP, fixed capital formation refers to investment in fixed assets. In *2008 SNA*, fixed assets cover not only traditional types of assets such as dwellings, buildings and structures, and machinery and equipment, but also intellectual property products such as computer software and R&D. Regarding R&D, the *2008 SNA* basically follows the definition in the *Frascati Manual* published by the Organisation for Economic Cooperation and Development (OECD), which defines R&D as consisting of the value of expenditures on creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and use of this stock of knowledge to devise new applications. R&D expenditure should be included in fixed capital formation if the R&D is expected to provide economic benefits in the future.

Depending on the nature of projects undertaken, R&D may be classified according to technology areas such as information technology, electrical and electronics engineering technology, manufacturing technology, biotechnology, etc. R&D may also be classified according to purposes: (i) basic research for experimental or theoretical work undertaken with no immediate practical purpose in mind; (ii) applied research that is directed primarily towards a special practical aim or objective; and (iii) experimental development work leading to new devices, products or processes. R&D also includes the provision of public services in the case of R&D acquired by government, as well as the cost of unsuccessful R&D as it may set grounds for the success of future R&D projects.

In whatever ways R&D is classified, it is distinguished from similar activities by the presence of an appreciable element of novelty or innovation and the resolution of scientific and/or technological uncertainty. As such, scientific and technical services such as medical testing of approved drugs and general-purpose data collection and marketing research are not considered as R&D.

Note that in national accounts, fixed assets are recorded upon acquisition of ownership of the assets by the institutional sectors/economies concerned, irrespective of the sectors that produce the assets. This is straight-forward for R&D that is performed in-house for own use, where the performer is also the owner of the R&D output. However, some R&D may not be developed in-house but is acquired from other institutional units, in the form of contract-out R&D projects or in the form of outright sale of R&D output (often referred to as patented entities). In that case, difference may arise between production and ownership of R&D in terms of sector classification of R&D. In the case where the producer and the owner of R&D have different residence status, imports and exports of services are also involved. The relationship between production and ownership of R&D is illustrated in Figure 1.

Figure 1: Illustration of Production and Ownership of R&D



3. Valuation of Research and Development

In principle, fixed assets are measured at market value upon acquisition if their market values are directly observable. This applies to purchases of R&D which are measured as expenditure of contract-out parties on R&D projects (irrespective of whether such contract-out projects are performed within or outside Hong Kong) and payments to parties outside Hong Kong for outright purchases of R&D output.

However, the statistical measurement is less straight-forward in most cases, because R&D activities are usually undertaken by establishments in-house as own account production and the market value of R&D output is generally not directly available from the business accounts data of the establishments. The *2008 SNA* recommends that the value of such R&D output should be estimated based on the sum of costs.

In the valuation of in-house R&D for own use, data on Gross Domestic Expenditure on R&D (GERD) are often taken as the principal inputs. GERD is defined as the total intramural expenditure on R&D performed on the national territory of an economy during a given period, according to OECD's *Frascati Manual*. Intramural expenditure on R&D, as measured by GERD, covers current costs (labour costs of R&D personnel *plus* other current costs such as water and fuel, and subscriptions to scientific societies) and capital expenditure (on land and buildings, instrument and equipment, and computer software) incurred in the period concerned.

On the other hand, in the conventional sum-of-costs approach recommended in *2008*

SNA, R&D output is measured by summing up compensation of employees, intermediate consumption, other taxes on production and gross operating surplus (GOS). The first three components are similar to the current costs component in GERD. However, the GOS in this context measures the return to capital used in the production of R&D output in the reference period, which is different from the capital expenditure component in GERD. This is because a piece of capital asset that is purchased for R&D projects in a certain period can provide a stream of economic returns during its service life for the R&D projects concerned. Hence, GOS attributable to the return to capital is to be estimated as one of the components in order to measure the value of R&D output in the fixed capital formation in GDP.

4. Compilation Methods and Data Sources in Hong Kong

The C&SD of Hong Kong has been compiling statistics on GERD which are based on the international recommendations in the *Frascati Manual*. Data on GERD also serve as important inputs for compiling figures on capital formation relating to R&D.

Data on R&D expenditure in the business sector are collected via the Survey of Innovation Activities (SIA) conducted annually by C&SD. This survey covers major industry groups including manufacturing; construction; distributive trades; transport and storage; information and communications; financing, insurance, professional and business services. It collects detailed data on different types of expenditure (e.g. compensation of employees of R&D personnel, costs of materials and supplies, royalty payments) incurred by business establishments in various industries in performing in-house R&D activities, analysed by in-house R&D for own use and in-house R&D for sale to other organisations. The GOS for in-house R&D for own use is not directly measurable. With reference to the practices of other statistically advanced economies, such GOS is estimated based on the ratio of GOS to gross output of important R&D-intensive industries in Hong Kong.

To measure the sectoral R&D from ownership prospective, data on purchases of R&D are collected. Expenditure data on contract-out R&D activities are collected via SIA, whereas data on purchases of R&D in the form of outright sale are collected separately from the Annual Survey of Imports and Exports of Services [(3)] conducted by C&SD.

As regards the government and higher education institutions, administrative data on their R&D expenditure are obtained through special enquiries made to government departments and universities.

Volume Measures of Research and Development

In addition to current price valuation, volume estimates of investment expenditure on R&D are also compiled for measuring changes in real terms. In Hong Kong, changes in real terms are measured in chain volume measures, and the volume estimates for a specific period are measures of the constant price estimates for the period concerned relative to those of the preceding year.

For purchased R&D, the deflation method is applied to derive volume estimates. The composite index compiled from the prices of various technology products in the

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[(3)] Outright sales and purchases of previously-produced R&D output (e.g. in the form of patented entities) between establishments within Hong Kong are not measured because this represents negative capital formation for the seller establishment and positive capital formation of the same amount for the buyer establishment (no transfer costs involved). Hence, there is no net effect on the overall gross capital formation of Hong Kong.

United States is adopted as the price deflator because the United States is the major producer and supplier of R&D output. The price deflator is used to discount the effect of price changes from current price estimates.

For the same reason as in the current price valuation of in-house R&D, prices for the output of in-house R&D are not directly measurable, and hence volume estimates are compiled for individual cost components. For non-labour current costs involved in in-house R&D activities, price indices of various types of cost items (e.g. rents and rates, costs of materials and supplies) are used to deflate the relevant current price estimates. As for labour costs, the method of single extrapolation by volume indicators is used whereby volume estimates of compensation of employees are extrapolated using labour inputs in R&D activities, as measured by the number of R&D personnel in full-time equivalent terms. The volume estimates of GOS are also measured in a similar way.

5. Investment Expenditure on Research and Development in Hong Kong

Table 1 presents the data series of investment expenditure on R&D in Hong Kong from 2002 to 2011.

Table 1: Investment Expenditure on R&D

Year	At current market prices (HK$Mn)			Average annual growth (%)				
				Period	Nominal terms			Real terms
	Private	Public	Total		Private	Public	Total	Total
2002	2,735	4,835	7,570					
2004	6,128	4,782	10,910	2002-2004	49.7	-0.5	20.1	26.6
2006	6,949	5,494	12,443	2004-2006	6.5	7.2	6.8	2.7
2008	7,260	6,811	14,071	2006-2008	2.2	11.3	6.3	2.7
2010	6,685	7,260	13,945	2008-2010	-4.0	3.2	-0.4	2.7
2011	7,165	7,591	14,756	2010-2011	7.2	4.6	5.8	0.8

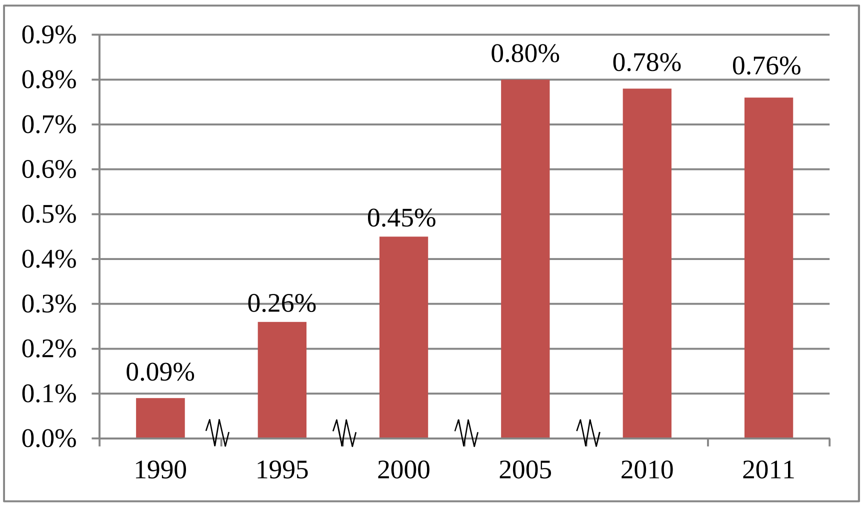
Investment expenditure on R&D amounted to HK$14,756 million in 2011, which almost doubled that in 2002. This represented an average annual growth rate of 7.7% in nominal terms and 7.4% in real terms during the period. The rapid growth in investment expenditure on R&D is in tandem with the evolution of Hong Kong into an information society which progressively improves its competitive edge and productive capability.

Investment expenditure on R&D had been growing fast in earlier years of 2000s, with an average annual growth rate of 20.1% in nominal terms and 26.6% in real terms in 2002-2004. The notable growth was likely due to the pick-up of business confidence after the economic downturns in Hong Kong in 1998 and 2001.

The investment activities in R&D were hit following the financial tsunami in 2008. The private sector was again more sensitive to economic environment, and its investment in R&D recorded a decline of 4.0% in terms of average annual nominal change in 2008-2010, which then rebounded to 7.2% growth in 2011. On the other hand, public sector investment in R&D remained steady at an average annual growth of 3-5% over the same period. Compared with 2010, the total investment expenditure on R&D recorded positive growth of 5.8% in nominal terms and 0.8% in real terms in 2011.

Figure 2 presents the ratio of investment expenditure on R&D to nominal GDP at market prices for the period from 1990 to 2011. The ratio increased from 0.09% in 1990 to 0.45% in 2000 and further to 0.80% in 2005. The ratio fell mildly to 0.76% in 2011 when the external economic environment turned difficult. Nevertheless, the general increase in the ratio over time reflects the accumulation and growing significance of knowledge-based assets for enhancing productivity of Hong Kong.

Figure 2: Ratio of Investment Expenditure on R&D to GDP



6. Conclusion

Hong Kong has been closely following the international statistical standards and has established the framework for capitalisation of R&D expenditure in GDP statistics. While the investment expenditure on R&D remains relatively small in GDP, its rapid growth in the past decade reflects the increasing importance of R&D in the economy. The C&SD would continue to keep abreast of the international development on this front and enhance its statistical framework as necessary.

References

Aspden, C (2005): *Extending the Asset Boundary to Include Research and Development*, Paper No. SNA/M1.05/20. Issue paper prepared for the meeting of the Advisory Expert Group on National Accounts, July 2005: Update of the System of National Accounts 1993 – Issue No. 9 and 10.

Census and Statistics Department (2012): *Special Report on Gross Domestic Product - September 2012*. C&SD, Hong Kong.

Census and Statistics Department (2012): *Hong Kong Innovation Activities Statistics*. C&SD, Hong Kong.

European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, and the World Bank (2009): *System of National Accounts 2008.*

Organisation for Economic Co-operation and Development (2002): *Frascati Manual – Proposed Standard Practice for Surveys on Research and Experimental Development*.