Capital Stock Measurement of Research and Development at Chinese Manufacturing Level

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Intramural expenditure on R&D in large and medium-sized industrial enterprises is rapid growth, 23.07% percent per year from 1995 to 2014.China has proposed the strategic goal of transforming China into a world-leading manufacturing power in the 'Made in China 2025' plan. The plan focuses on enhancing the core competitiveness of Chinese manufacturing combining with the innovation driven strategy. R&D capital stock is the key indicator of measuring innovation level and knowledge accumulation. The objective of this paper measures R&D capital stock at Chinese manufacturing and compare with other developed countries. It will provide data sets for analyzing contribution of innovation to economic growth at Chinese manufacturing level.

Capital stock measurement of R&D is the process that fixed capital formation of R&D (namely R&D investment flows) in each period is accumulated and forms the R&D assets (representing the stock of knowledge). A particular difficulty in measurement is the absence of R&D related data, such as R&D investment flows, price index and depreciation. As a replacement for the R&D investment flows, expenditure on R&D was directly used to measure R&D capital stock, such as Griliches (1980), Nadiri and Schankerman (1981), Goto and Suzuki (1989), and it is critical.

The 2008 System of National Accounts (2008 SNA) adjusted R&D expenditure measurement method. R&D that provides an economic benefit to its owner should not be treated as intermediate consumption and should be recognized as part of capital formation. In so doing, the 2008 SNA as an official accounting standard follows a path that has long been pursued by official statistical institutions of some countries. They capitalized expenditure on R&D, and released R&D investment flows.

The U.S. Bureau of Economic Analysis constructed R&D capital satellite accounting (Mataloni and Moylan, 2007; Sliker, 2007). It studied on R&D capital stock measurement methods, including discussion on estimating of R&D depreciation rate (Hall, 2005; Li, 2016)and construction of the R&D asset price index(Copel, Medeiros and Robbins, 2007; Robbins, Belay,

Donahoe and Lee, 2012). Further, it provided detailed R&D capital stock data in enterprises and government departments. Manual on Measuring Research and Development in ESA 2010 was edited by Eurostat in 2014(Eurostat, 2014), and it provided the sources and methods for producing estimates of R&D for the national accounts. Growing interest in socio-economic policy issues requires R&D capital stock with regional and industrial details tailored to specific research question. In existing database, only expenditure on R&D at Chinese industrial level could be obtained. Some earlier research directly used expenditure on R&D to measure capital stock. Wu (2006) investigated the relationship between R&D and productivity by using R&D expenditure at the four-digital manufacturing industries in China. Calculating R&D investment flows are a key component on measurement of R&D capital stock.

R&D expenditure measurement method was adjusted in Chinese System of National Accounts 2016 (CSNA-2016), which was issued by the National Bureau of Statistics of the People's Republic of China in 2017. National Bureau of Statistics of the People's Republic of China measured fixed capital formation of R&D, and revised GDP data since 1952. The CSNA-2016 as an official accounting standard follows a path that has long been pursued by academic community.

Jiang and Sun (2016) estimated R&D investment flows each year, and then measured China's R&D capital stock during 1952~2014 with perpetual inventory method. Gao (2017) clarified the relationship among R&D capitalization, economic growth and GDP adjustment, and explained that GDP measurement provides platform for R&D capitalization. However, there are little researches on capital stock measurement of R&D at Chinese manufacturing level.

The objective of this paper is to measure capital stock of R&D at Chinese manufacturing level for the period 1952-2015. It covers 30 industries and uses the Industrial Classification and Codes for National Economic Activities. We construct a theoretical framework on capital stock measurement of R&D, which describes a process of transforming intramural expenditure on R&D into R&D capital stock, as shown in figure 1.

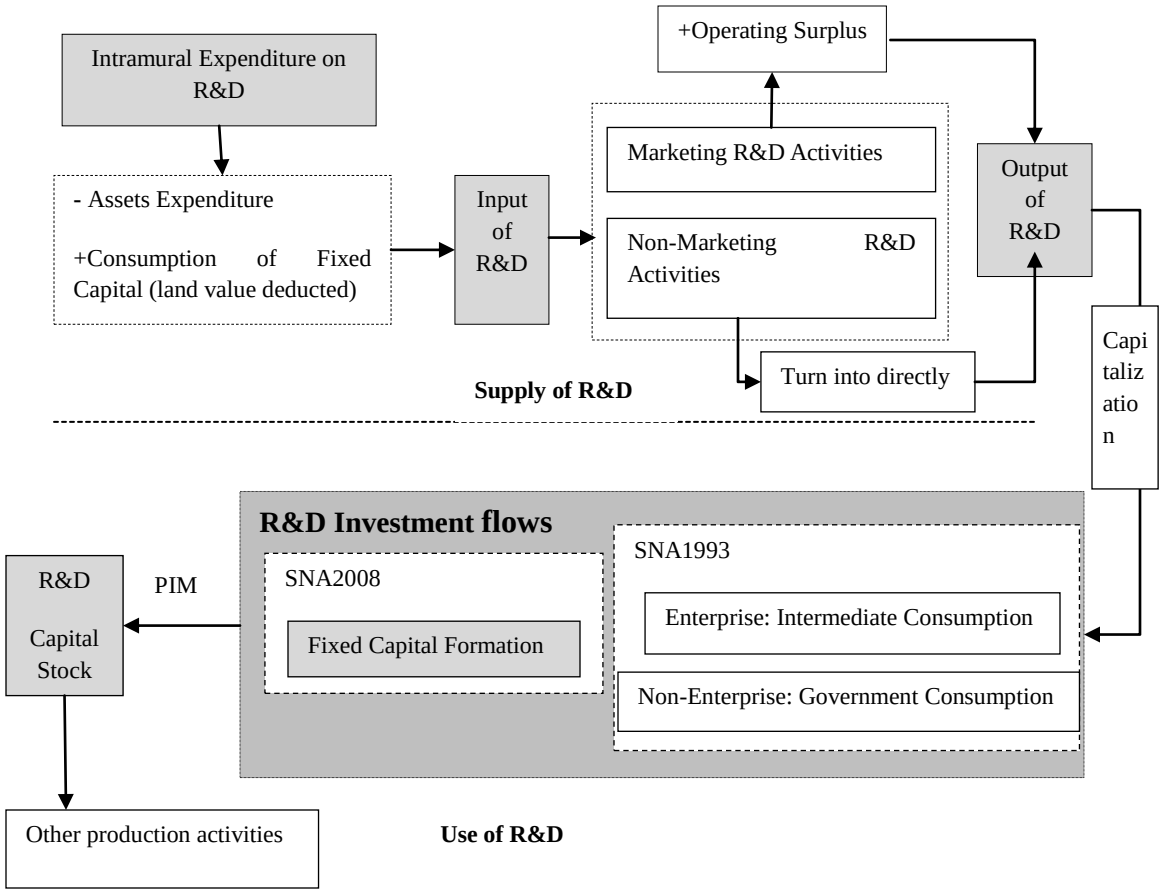

Figure 1 shows that capitalized R&D is a process of supply and use of R&D. In the supply of R&D stage, intramural expenditure on R&D is transferred to R&D input by subtracting assets expenditure and adding consumption of fixed capital, and then R&D input is transferred to the output of R&D by adding operating surplus. The output of R&D that provides an economic benefit to its owner is transferred into fixed capital formation (or R&D investment flows) in the use of R&D stage.

We estimate capital stock at Chinese manufacturing level with R&D capital stock measurement method of Bureau of Economic Analysis. Finally, we will report the results for each industry and identify some manufacturing with high innovation, which provides data foundation for making policy of improving R&D level of manufacturing.