IARIW – CIGI 2023

IARIW – CIGI 2023

Thursday, November 2 – Friday, November 3

Data, Intangible Capital, and Economic Growth in Canada

Rupert Allen
(Canadian Heritage)

Wulong Gu
(Statistics Canada)

Ryan Macdonald
(Statistics Canada)

Paper prepared for the Conference on The Valuation of Data November 2 – November 3, 2023
Session 5: Economic Perspectives on the Value of Data and Other Intangibles
Time: Thursday, November 2, 2023 [4:45-5:15PM EST]

Data, Intangible Capital, and Economic Growth in Canada

Rupert Allen
Canadian Heritage

Wulong Gu
Economic Analysis Division, Statistics Canada

Ryan Macdonald
Economic Analysis Division, Statistics Canada

October 2023

Abstract

This paper constructed a new measure of data assets and artistic originals and updated the estimates of other intangible capital in Canada. The paper finds that the largest component of intangibles is data asset and increase in the share of investment in data assets in GDP is among the highest from 2.6% in 2000 to 3.6% in 2019. Investment in data and intangibles rose faster than investment in tangible and GDP for the period from 2000 to 2019. Including intangibles increases the estimated GDP growth and labour productivity growth slightly from 2000 to 2019 (+0.05% a year). The effect of capital deepening on labour productivity growth for the period from 2000 to 2019 increased from 0.8% per year to 0.9% per year when intangibles and data are included. Intangible capital is found to make a significant contribution to labour productivity growth, accounting for about a quarter of the total capital deepening effects in the 2000-2019 periods. Of all categories of intangible capital, data assets contributed most to the growth in labour productivity growth. The paper finds that the contribution of tangible capital to labour productivity growth was similar in the two countries for the period 2000 to 2019. But the contribution of intangible capital was much lower in Canada. Finally, investment in artistic originals which has yet to be capitalized in the Canadian national accounts is also a significant asset.

1 Introduction

Intangible assets constitute a major source of capital within modern economies, and one which is hard to quantify given the ephemeral nature of intangible investments. Ideas, stories, models, data, designs and embodied knowledge of how systems work are integral to modern production processes and economic progress. They lack physical form and market valuations which makes accounting exercises designed to value and summarize these types of assets difficult. Nevertheless, a rapid increase in these assets which coincides with the rise of digital and knowledge-based production systems is expected to affect all aspects of the economy including product provision, product development, the dynamics of firm competition and concentration, the growth of firms, industries, and countries as well as capital accumulation, productivity growth and overall economic growth.

Given the importance of intangible assets for modern economies, it is important to apply the best measurement practices available to provide the estimates for the magnitude and influence of intangible capital. This paper adds to the information on intangible capital in Canada by updating previous estimates (Gu and Macdonald 2020,), expanding the number of data-related assets under consideration and providing, for the first time for Canada, a set of estimates for artistic originals which capitalizes outputs of creative industries is examined[1]. Artistic originals include books, TV program, music and movies.

The integration of artistic originals reconciles the full set of Canadian intangible capital estimates with American intangible for the first time. The SNA 2008 recommends including artistic originals, and this is done by the BEA. However, estimates for Canada have not previously been presented, and this work offers a first comparison for the stock of these assets between the two countries.

Whether or not an item is treated as an asset in the national accounts is not an esoteric question. The definitions for what constitutes a capital asset affects the understanding of the growth process for an economy, and thus has real implications for economic policy. A broader definition for capital assets increases the scope of capital investment in the economy and affects estimates of gross fixed capital formation and the capital stock. These estimates are key for understanding economic growth and the sustainability of economic growth. Both the level and growth path of GDP are affected, as is the division of GDP between capital and labour income, estimates for consumption and estimates for saving. All of these are key concepts in the consideration of macroeconomic policies.

Appropriate definitions and measurement strategies for assets are also critical for accurately representing the ways in which capital and labour are combined for producing outputs. In industries, such as emerging industries for artificial intelligence, having assets like data sets and trained models recognized is vitally important for understanding the nature of the production process.

Currently, a suite of intangible categories are treated as gross fixed capital formation in the Canadian System of Macroeconomic Accounts (CSMA). These are software, mineral exploration and research and development (R&D). Intangible categories related to data assets, artistic originals, brand equity, firm

[1] The BEA currently capitalizes artistic originals as part of their standard national accounts estimates while Canada does not. This represents one of the largest conceptual differences between gross fixed capital formation estimates for the US compared to Canada. The exploratory estimates presented here represent a first step towards removing this difference.

organization, knowledge embedded in workers, and financial innovation are not capitalized. While acknowledged by researchers as capital assets, the measurement and data sources for these assets have not yet been sufficiently developed to be included in SNA 2008. As a result, it is necessary to make adjustments to existing national accounts values to include the missing intangible categories, and to develop satisfactory methods and data sources for estimating their capital stocks.

Much process has been made in this area in the last 15 years. Researchers and national statistical agencies have explored data sources and methods for estimating the value of intangibles and examined the effect of including them in the national accounts on macro aggregates such as GDP, investment, and productivity. Corrado, Hulten and Sichel (2005,2009) undertook seminal work in defining and estimating a range of intangible assets. These types of intangible capital estimates were subsequently explored in studies in other countries. Statistics Canada (2019a, 2019b) and the BEA (Rassier, Kornfeld, and Strassner, 2019) further explored the addition of data as an asset and the latter presented a framework for measuring data as investment along with a set of preliminary estimates.

As intangible assets are often not sold on the markets, they typically lack market valuations. In the absence of market valuation, the current practice in the national accounting is to estimate the value of the assets using the cost of inputs used to produce them. The paper adopts this sum of costs approach for estimating the value of intangibles in order to adhere as closely as possible to standard recommendations. In the process, it highlights methodological and data challenges that must be overcome for the approach to work.

The rest of the paper is organized as follows. In Section 2, the framework for integrating intangibles and data assets in the national accounts and for examining the contribution to labour productivity growth is presented. In section 3, the data sources, and methods for estimating intangible assets including data and artistic originals are presented. In Section 4, the estimates of intangible investment are examined. In Section 5, the contribution of intangible capital to labour productivity growth in Canada is illustrated. The estimates for Canada are also compared with those for the US from Corrado et al. (2022). It is important to note at the outset, however, that there are methodological difference that arise from differences in the national statistical systems used as the basis for estimation[2]. Consequently, estimates of intangibles for Canada in this paper may not be entirely comparable to the estimates for the US and evidence on Canada-US difference in intangibles should be best viewed as suggestive. Section 6 concludes and summarizes the data challenges for measuring intangible capital.

2 Intangibles as assets in the national accounts

While both tangible and intangible expenditures are viewed as creating capital assets that are used in production activities over time, intangible capital differs from tangible capital assets such as buildings. and machinery and equipment in the sense intangible assets have no physical form. Many intangible assets are associated with knowledge that is owned by economic agents and is non-rivalrous, but not

[2] A more comprehensive analysis is needed to provide a comparable analysis between Canada and the United States. One such avenue would be to develop SNA guidelines for the capitalization of these intangible assets. SNA guidelines would foster international comparability by providing national statistics agencies with a common set methodologies.

entirely excludable. Counting these assets, and valuing them, presents important challenges for the accounting community given the lack of physical representation.

The seminal work of Corrado, Hulten and Sichel (2005, 2009) categorized intangible assets into three broad classifications and these have been broadly adopted by the international community (see for example , Corrado, C, J, et al. 2022). The three broad categories of intangible assets consist of digitized information, innovative property, and economic competencies. Within these categories is a mixture of assets currently treated as assets in the SNA 2008, and those that are still not incorporated into official recommendations (Table 1)

The first category covers digitized information which includes software, data and tools derived from data. The expansion of software during the 1990s and the subsequent rise of data and tools/models with the digital economy of the 21st century makes this one of the fastest growing and most influential forms of intangible capital in the economy. While software is included in current CSMA estimates, only small fraction the data assets considered in this paper is included. Statistics Canada (2019a, b) estimated the value of data and data derived assets. This work took a conservative view and identified investment streams from activities engaged in data science in financial and marketing activities but did not include data-driven industrial and computing engineering design as in Corrado et al. (2022).

Data assets are created from economic activities referred to as the data value chain creation or data stack. The data value chain creation includes data collection (and data storage), data transformation and data science. According to the data value chain creation, a database is more closely related to data storage. But a signification part of the value created from data collection and use, including data transformation and data science, is not capitalized. Therefore, an important aspect of the economic activities associated with expenditures for producing data assets are currently expensed in the CSMA rather than being capitalized. In this paper, these values are treated as capital investments and a broader measure of the value of databases and database derived models is presented.

The second category corresponds to innovative activities or activities that improve understanding of the natural world. These cover assets included in the CSMA (research and development (R&D) and mineral exploration) and assets not currently included within the CSMA (financial innovation, architectural designs and artistic originals). These assets are related directly to the creation of new ideas, new knowledge, new products, or new processes. They are often represented by a legal construct that gives rise to a physical asset which protect the use of the idea in Western legal systems. For example, R&D often leads to patents that protect the intangible asset while artistic originals produce copyrights that protect the property rights of creators.

Within this category, artistic originals merit particular attention as they have not been previously included with intangible capital estimates for Canada. The SNA 2008 recommends entertainment, literary and artistic originals be treated as capital outputs. Artistic originals are not capitalized in the CSMA. Artistic originals include original films, sound recordings, manuscripts, tapes, models, etc., on which drama performances, radio and television programming, musical performances, sporting events, literary and artistic output, etc., are recorded or embodied. Such works are frequently developed on own account. Subsequently they may be sold outright or by means of licenses.

OECD (2010) outlined practical guidelines on the treatment of artistic originals and other intellectual property products as assets in the SNA 2008. For an item to be considered an entertainment, literary or

artistic original it should satisfy the following criteria: 1. The item must be covered by copyright. 2. The work should have primary artistic intent. This means that the original should be produced with the original itself as the end-product, not as an interim part of the production process of another product or asset. 3. The item must satisfy the capitalization criteria, as for any capital item to be included as gross fixed capital formation. That is, the 2008 SNA requirement that a capital asset must be intended to be used in the process of production repeatedly or continuously for more than one year. 4. The item is not covered elsewhere in the national accounts. Entertainment, literary and artistic originals should be defined to include at a minimum: 1. films; 2. TV and radio stock programs that excludes radio and TV news, sports events; 3. literary works that excludes magazine, newspapers; and 4. musical works.

The third category related to economic competencies. These assets relate to brand equity, firm organizational structures, and knowledge or human capital embedded in workers. These assets are among the more difficult to measure but are also important to understand as they relate directly to a firm's ability to organize itself and compete in markets. These are critical capacities for any business that will succeed over time.

2.1 Data and intangibles in expanded national accounts

In the SNA 2008 and the CSMA, the three approaches to estimating GDP are integrated. This means changing the treatment of an intangible asset to become gross fixed capital formation (GFCF) requires a series of adjustments across the value added, final expenditure and income approaches to measuring GDP. It also means that the saving and capital accumulation accounts as well as the national balance sheet must be adjusted to reflect the higher saving / GFCF that occurs as well as the increase in national net worth from the new assets. There are three ways that adjustments are made when capitalizing intangibles.

Case 1 – Intangible assets currently classified as final consumption

In cases where an intangible asset is produced and sold on markets, but is classified as final consumption, the adjustment through the sequence of accounts is the most straightforward. These adjustments begin with the GDP at the total economy level. The value of the asset in consumption is re-classified as gross fixed capital formation. This leaves total GDP unaffected, but the composition of GDP changes. Since consumption falls, saving rises, and does so by the same amount as the increase in GFCF which maintains the saving = investment identity. The value of the capital asset is added to the national balance sheet and the value of its depreciation is added to consumption of fixed capital. There is no change to the income-based estimate of GDP or to value added calculations.

Case 2 – Intangible assets currently classified as intermediate inputs

When the intangible asset is classified as an intermediate input, reclassifying it as GFCF raises GDP, saving and national net worth. This is reflected in an increase in GFCF in the final demand GDP estimate as well as an increase in gross operating surplus of income based GDP estimates. Value added rises because the value of gross output is unchanged but the value of intermediate inputs falls. The increase in value added / gross operating surplus leads to an increase in saving that is equal to the increase in GFCF. When the intangible category is capitalized, the asset side of the national balance sheet rises as does the estimate for the consumption of fixed capital.

Case 3 – Intangible assets not currently included in CSMA

When an asset is not currently included in the CSMA, the value of the estimated investment stream of the asset is added to the gross output of the industries producing it. Since, by assumption, this asset is being created using current inputs but is not recognized, this change increases value added because gross output rises but intermediate inputs do not. Gross operating surplus rises in the industries with the new outputs, as does GFCF. Saving rises by the same amount at gross operating surplus / GFCF. The value of assets on the national balance sheets increases to reflect the new asset and consumption of fixed capital rises to reflect its depreciation.

Own account and purchased intangibles

Intangible assets can be produced for own use and for sale to other industries as intermediate consumption and to governments and households as final consumption. When intangibles are used for own production, capitalization adds intangible assets as additional output to the industry. Both industry gross output and value added will increase as a result intermediate input is unchanged.

When intangibles are produced for sale, capitalization will impact output and inputs for both upstream production industries and downstream users that include industries, households and governments. For upstream industries, the effect is same as the one from the capitalization of own account intangibles: industry gross output and value added will increase by the amount equal to the value of intangibles, and intermediate input is unchanged. For downstream users, intangibles are added to the capital stock, and this capital stock then returns a flow of services.

General effects of the changes

In general, treating intangibles as capital will tend to induce similar changes regardless of the case. First, the share of labour income in GDP is expected to decline while the share of capital income is expected to increase due to the expanded capital base. Second, the growth of output is expected to be higher as investment in intangibles often increases at a higher rate than consumption and investment in tangible capital. Third, the saving rate/investment rate for the economy will be higher and fourth, the share of consumption in GDP will decline while the share of GFCF will rise.

2.2 Growth accounting with data and intangibles

The effects of capitalizing intangible go beyond raising measured GDP, investment, capital stock, and income. The capitalization of intangibles will affect analysis of the sources of real output growth and sources of labour productivity growth. Under the growth accounting framework, growth in labour productivity is defined as the change in output per hour worked, and is decomposed into three main sources: increases in capital intensity or the capital deepening effect, increases in intermediate input intensity when gross output is used to measure output of a sector, increases in skills of labour input, and growth in multifactor productivity that captures the efficiency with which the inputs are used in production from technological change, organizational change or economies of scale.

When the expanded set of intangibles are capitalized, the effect of capital deepening on the growth in labour productivity growth is expected to increase. This is because the growth in intangible capital is often faster than the growth in tangible capital. Capital expanded to include the full set of intangibles will increase as a faster rate and thus increase the contribution of capital deepening to labour productivity growth.

The estimated growth in MFP will also change. The change in estimated MFP growth depends on two effects: the increase in measured labour productivity growth from including the fast-growing intangible as investment output, and the increase in the component of labour productivity growth allocated to capital deepening effects.

The rest of the section summarizes the growth accounting framework with intangibles. A detailed discussion of that framework can be found in Corrado, Hulten and Sichel (2005, 2009) and Baldwin, Gu and Macdonald (2012).

For the growth accounting with intangibles, nominal investment in intangibles is deflated to estimate investment in intangibles in constant prices. The investment in intangibles in constant prices is then accumulated to arrive at an estimate for the capital stock of intangibles using the perpetual inventory method (PIM). The PIM is a model that accounts for the depreciation and the decline in the efficiency of intangibles in the production process over time.

Finally, the nominal value and volume of the flow of capital services from intangibles together with that from tangibles are to be estimated. The nominal value of capital service from capital assets is estimated using the user cost of capital formula where the flow of service from capital or the user cost of capital is equal to the sum of real rate of return plus depreciation minus capital gains of the asset, with adjustments for the effects of corporate taxes and capital consumption.

A main parameter for estimating the capital service of intangible capital and implanting the growth accounting with intangibles is the rate of return to an asset. Two main alternatives have been used for estimating the rate of return on capital and the user cost of capital for intangible assets: endogenous rate of returns that are calculated from capital income or exogenous rates of returns that are chosen from observed market rates such as a government bond rate, a corporate debt rate, or a weighted average of corporate debt and corporate equity rates. The endogenous rate of return is solved using the equation that the sum of capital costs across all capital assets is equal to total capital income. For example, Corrado, Hulten and Sichel (2009) used endogenous rates of return to calculate the user cost of intangible capital for the United States and the United Kingdom. Rooijen-Horsten et al. (2008) used exogenous rates of returns for Netherlands. For practical purposes, the choice of those alternative methods has little effect on estimated MFP growth at the broad sector levels. But it may impact the estimates at the detailed industry level.

3 Methods and data sources for valuing data and other intangible assets

This section summarizes the methods for estimating intangible capital and data sources used to estimate intangibles. In general, there are three methods for valuing assets including both tangible and intangible assets. When there are markets for an asset, the market price will be used. This method is used to value most, if not all, tangible assets for M&E and buildings and structures. But for intangible assets, there are limited market transactions, and the market price of most intangibles does not exist. As a result, an alternative sum of costs approach is used[3].

[3] There are two widely used alternative methods for valuing an asset. One is the sum-of-costs approach which uses the production costs (labour, capital, intermediate inputs) to value the assets. The other is the income-based approach which calculates the net present value of the stream of income from the asset.

The sum of costs approach is used for estimating most types of intangible assets such as software, R&D, mineral exploration that are already capitalized in the CSMA. It is also used to estimate intangibles that have not been capitalized in the national accounts in most previous research. It typically starts with estimating the payroll of workers that are engaged in the production of intangible assets. The costs are then scaled up to include non-labour costs including capital input costs and intermediate input costs when non-labour costs are available.

Here, the sum of costs approach is also be used for estimating data assets not currently included in the CSMA and for estimating the capital stock of artistic originals. For data assets, the occupations involved in the three stages of the data value chain creation are identified. The share of time spent in producing the asset by workers in those occupations is assumed. The hours and labour compensation of workers in those occupation are estimated to derive the labour cost component for the production of data assets. The labour costs are then scaled up to account for non-labour cost components (intermediate consumption and capital costs) to derive the total costs of production of data assets that will be used to value investment in data assets.

The occupation identified to produce data assets varies across studies. For example, Corrado et al. (2022) took a broader approach that covers most, if not all, forms of data intelligence and data science in the generation of virtually intangibles and knowledge assets. Statistics Canada (2019a, b) took a narrow view and identified occupations engaged in data science in financial and marketing activities but did not include data-driven industrial and computing engineering design as in Corrado et al. (2022).

Like most other intangible assets, there are few market transactions for artistic originals leading to the use of the sum-of-costs approach for estimating artistic originals. OECD (2010) recommends that the value of film, TV and radio program originals should be measured by the sum of costs approach. Production costs should include royalty payments made for the use of other originals in the production of film, TV, and radio programs.

In contrast, the value of books and music should be measured using the income approach and by modelling royalty flows over the lifetime of the assets. The authors' and musicians' royalties are the income the authors and musicians derive for the assets. The value of books and music assets is estimated as the present discount value of the royalty payments. That approach has been experimented for estimating artistic originals in the UK (Goodridge and Haskel, 2011). But the data required for implementing the income approach to estimating artistic originals are often incomplete. As a result, the sum of costs approach is adopted to estimate the value of book and music assets by Goodridge and Haskel (2011).

To implement the sum-of-costs approach, the costs for production of artistic originals need to be collected. Industry accounts and the supply use tables of Statistics Canada have information the total sales of artistic originals that are produced domestically by Canadian industries. The total sales values

---

For data assets, it can be argued that a part of, if not all the market valuation of data intensive companies is derived from the value of the data that the companies possess. But the exact part of such market valuation that can be attributed to data assets is not certain. In addition, the market valuation of companies is volatile and the changes in the market valuation of the companies may not reflect the value of the data assets in those companies. As such, the income approach is not used to value data assets in this paper.

need three adjustments to arrive at investment estimates of artistic originals. First, the value of the sales includes advertising costs and other non-art costs for selling artistic originals. They need to be removed as they either lead to double counting (advertising) or to expenditures not used for producing the intangible asset. Second, total sales represent the sales of artistic originals that were created over time and only a portion of the receipts form the sales is from the production of artistic originals in the current year. Third, TV and radio programs can be characterized as either "stock" or "flow". Stock programs include documentaries, drama, music, arts, history and education programs. Flow programs include news, sports and game show episodes. Stock programs have a longer life because they are suitable for repeat performances or replicated in different countries and they are included as artistic original assets. Flow programs have a shorter life and are unlikely to be repeated and they should not be included as artistic original assets.

To adjust sales, the ratio of investment to sales is obtained from Soloveichik and Wasshausen (2013) is used. They estimated the ratio for the United States using the industry data. The ratio is 0.4, 0.5, 0.1 and 0.5 for books, music, TV programs and movies. The low ratio of investment to sales for TV programs reflects the fact that flow programs such news and sports programs are not counted as investment assets.

4 Investment in data assets and other intangible assets

The time series estimates of intangible investment by asset types at the industry level (Naics 2 to 3 digit industries) have been developed for the total economy for the period 2000 to 2019. This section summarizes the main findings from this data for the total business sector. Detailed tables are available on request.

Nominal investment

Tables 3 and 4 present nominal investment in tangible assets and intangible assets in the business sector for the period 2000 to 2019. Table 3 divides assets into two main categories: tangible (which is further dis-aggregated into information and communication technologies or ICT and non-ICT tangible assets) and intangible assets. Table 4 presents the estimates by detailed intangible asset categories.

Nominal investment in both tangible and intangible assets increased from 2000 to 2019. In 2019, nominal investment in intangibles was valued as about $213 billion dollars. Nominal investment in tangible assets was valued at about 256 billion dollars in that year. While intangible investment was lower than investment in tangibles in that period, the ratio of nominal investment in intangibles to tangibles increased over time (Chart 1). The ratio was about 0.73 in 2000. By 2019, the ratio increased to 0.83.

The largest component of intangibles is data which was about 57 billion dollars in 2019: 54 billion dollars for own-account data assets, and 3 billion dollars for purchased data assets. The size of data assets relative to other intangible asset categories underscores the importance of data and data derived tools for modern production processes.

The industries that have largest investment in data assets include professional scientific and technical services, finance and insurance, and information & culture (Appendix table 1). Professional, scientific and technical services accounted for 41.5% of total investment in data assets in the business sector in

2019. Finance and insurance accounted for 13.9% of total investment in data assets, and information and cultural industries accounted for 7.4% of investment in data assets in that year.

Investment in artistic originals, which has not previously been capitalized in the CSMA, is also a significant asset.[4] Investment in artistic originals was about 6 billion dollars in 2019. The largest component of artistic originals is movie assets (4.5 billion dollars), followed by TV and radio programs (0.9 billion dollars), books (5.7 billion dollars) and music assets (0.1 billion dollars).

The intangible categories, R&D, software investment and mineral exploration are currently capitalized in the CSMA. The investment in these intangibles is only a small fraction of total intangible investment measured in this paper. In 2019, the intangibles that have been capitalized in the CSNA accounted for 20% of total intangible investment (Table 4).

Nominal investment as share of GDP

Chart 2 presents the nominal investment in tangible and intangible assets as a share of GDP in the Canadian business sector. The ratio of tangible investment in nominal GDP was flat at about 15% over the period 2000 to 2019, while the ratio of intangibles to GDP increased steadily over that period from 11.7 % to 13.5%

Table 5 shows the share of intangible assets in GDP by detailed asset types. The share of intangibles in GDP increased in almost all types of intangibles. The biggest increase was in software, data assets and new architecture and engineering design. For example, the share of investment in data assets in GDP increased from 2.6% in 2000 to 3.6% in 2019 (Chart 3).

For artistic originals, investment/GDP ratio increased for movie assets. For other 3 types of artistic originals assets, the share declined for books and music assets and had no changes for TV and radio program assets (Chart 4). The share of artistic originals in GDP in declined from 0.37% in 2000 to 0.30% in 2014 and it then increased after 2014 and was about 0.39% in 2019.

The share of artistic originals in GDP in Canada was lower than the estimate for the United States. Compared with nominal GDP in the total economy, the share of artistic originals was about 0.23% in Canada in 2007, while that share was 0.35% in the United States (Soloveichik, 2011).

Chart 5 presents the average annual growth in real investment in tangible and intangible assets by asset types for the period 2000 to 2019. Real investment increased for all assert types except for mineral exploration, books and musical assets. The largest increase in real investment was for software, data assets and organizational capital. The movie assets also had a large increase over this period.

5 Data, intangible capital, and labour productivity growth

In this section, the growth accounting framework is used to decompose labour productivity growth into contributions coming from capital deepening arising from tangibles and intangibles, contributions from increases in skill levels of workers (referred to here as a change in labour composition) and a contibution from all other sources—what is referred to as multifactor productivity (MFP) growth.

[4] The artistic originals have been capitalized in the United States and many other developed countries (Soloveichik, 2011)

Chart 6 presents the decomposition results when additional intangibles are capitalized. For comparison, the decomposition results using the national accounts data that only includes a small part of intangibles (R&D, software and mineral exploration) as assets.

Consistent with previous studies for Canada, the capitalization of additional intangibles is found to increase growth of real GDP and labour productivity in the Canadian business sector by about 0.05% per year from 2000 to 2019. This occurs because real intangible investment rose faster than real GDP in this period.

The capitalization of intangibles is also found to increase the estimated contribution of capital deepening to labour productivity growth. The contribution of capital deepening to labour productivity growth increased from 0.8 pps to 0.9 pps per year in the period from 2000 to 2019. However, estimated multifactor productivity growth had little changes over the period 2000 to 2019 when all intangible capital is included. MFP was virtually unchanged in that period.

The contribution of labour composition to labour productivity growth declined slightly from 0.26 pps to 0.23 pps from 2000 to 2019. This is a result of a decline in the estimated share of labour income in nominal GDP that is used to weigh the changes in labour compositional changes to derive the productivity contribution of labour composition when capital assets are expanded to include all intangible assets.

Table 5 presents the results from the decomposition of labour productivity growth in the Canadian business sector for the period 2000 to 2019 for which the contribution of capital deepening is presented separately for each asset type. Intangible capital is found to make a significant contribution to labour productivity growth, accounting for about a quarter of the total capital deepening effects in the 2000-2019 periods. Of all categories of intangible capital, data assets contributed most to the growth in labour productivity growth.

While not entirely comparable, the contribution of capital to labour productivity growth for Canada can be compared to that for the US from Corrado (2022). For the US, the contribution of tangible capital to labour productivity growth was about 0.5 pps for the period from 1995 to 2019 while the contribution in Canada was about 0.6 pps. The contribution of intangibles to labour productivity growth in the US was about 0.8 pps in that period while intangibles contributed about 0.2 pps. Given differences in methodology and the statistical systems underlying estimation when a full suite of intangibles is included, the 0.1 pps difference for tangible capital suggests that capital deepening for physical assets progressed at roughly the same rate for both countries. However, the 0.6 pps difference for intangibles suggests that the United States has developed importantly more intangible capital over the 1995 to 2019 period than did Canada.

6 Conclusion

This paper constructed a new measure of data assets and artistic originals and updated the estimates of other intangible capital in Canada so as to provide a more comprehensive measure of investment and to examine the contribution of those intangibles to labour productivity growth in the Canadian business sector industries. The results are then compared with the results for the U.S.

The largest component of intangibles is data asset which was about 57 billion dollars in 2019: 54 billion dollars for own-account data assets, and 3 billion dollars for purchased data assets. The share of investment in data assets in GDP increased from 2.6% in 2000 to 3.6% in 2019.

Investment in artistic originals which has yet to be capitalized in the Canadian national accounts and is also a significant asset. Investment in artistic originals was about 6 billion dollars in 2019. The largest component of artistic originals is movie assets (4.5 billion dollars), followed by TV and radio programs (0.9 billion dollars), books (5.7 billion dollars) and music assets (0.1 billion dollars).

For artistic originals, investment/GDP ratio increased for movie assets. For other 3 types of artistic originals assets, the share declined for books and music assets and had no changes for TV and raio program assets (Chart 4). The share of artistic originals in GDP in declined from 0.37% in 2000 to 0.30% in 2014 and it then increased after 2014 and was about 0.39% in 2019.

The share of artistic originals in GDP in Canada was lower than the estimate for the United States. Compared with nominal GDP in the total economy, the share of artistic originals was about 0.23% in Canada in 2007, while that share was 0.35% in the United States (Soloveichik, 2011).

The capitalization of intangibles is found to affect growth in GDP and labour productivity growth and affect the source of growth decomposition for labour productivity. The paper finds that investment in data and intangibles rose faster than investment in tangible and GDP for the period from 2000 to 2019. Including intangibles increases the estimated GDP growth and labour productivity growth slightly from 2000 to 2019 (+0.05% a year).

The effect of capital deepening on labour productivity growth for the period from 2000 to 2019 increased from 0.8% per year to 0.9% per year when intangibles and data are included.

Intangible capital is found to make a significant contribution to labour productivity growth, accounting for about a quarter of the total capital deepening effects in the 2000-2019 periods. Of all categories of intangible capital, data assets contributed most to the growth in labour productivity growth.

While not entirely comparable the contribution of intangible capital to labour productivity growth for Canada in this paper can be compared with that for the US from Corrado (2022). The paper finds that the contribution of tangible capital to labour productivity growth was similar in the two countries. But the contribution of intangible capital was much lower in Canada.

References

Baldwin, J.R. W. Gu, and R, Macdonald (2012), "Intangible Capital and Productivity Growth in Canada," Statistics Canada.

Gu, W. and R. Macdonald (2020), "Business Sector Intangible Capital and Sources of Labour Productivity Growth in Canada," Analytical Studies Branch research paper series, no. 442, Statistics Canada

Corrado, C., C. Hulten, and D. Sichel (2005), "Measuring Capital and Technology: An Expanded Framework," in C. Corrado, J. Haltiwanger, and D. Sichel (eds), *Measuring Capital in the New Economy*, Studies in Income and Wealth No. 65, University of Chicago Press, Chicago, IL, 11–46

Corrado, Carol, Charles Hulten, and Daniel Sichel (2009), "Intangible Capital and U.S. Economic Growth," Review of Income and Wealth, 55, 661–85.

Corrado, C, J, et al. (2022), "Data, Intangible Capital, and Productivity," paper presented to NBER/CRIW Conference on Technology, Productivity and Economic Growth.

Fay, Robert, Justin-Damien Guénette, Martin Leduc, and Louis Morel (2017), "Why Is Global Business Investment So Weak? Some Insights from Advanced Economies," *Bank of Canada Review*, 2017 Spring

Goodridge, Peter and Haskel, Jonathan E. (2011), "Film, Television & Radio, Books, Music and Art: UK Investment in Artistic Originals" Available at SSRN: https://ssrn.com/abstract=2707171 or http://dx.doi.org/10.2139/ssrn.2707171

Goodridge, P., J. Haskel, and H. Edquist (2022), "We See Data Everywhere except in the Productivity Statistics," *Review of Income and Wealth*, Vol. 68. No. 4.

OECD (2010), Handbook on Deriving Capital Measures of Intellectual Property Products," Paris , OECD.

Rassier, D. G., R. J. Kornfeld, and E. H. Strassner (2019), "Treatment of Data in National Accounts," Technical report, Paper prepared for the BEA Advisory Committee.

Rooijen-Horsten, M. van, Bergen, D. van den, Haan, M. de, Klinkers, A. and Tanriseven, M. 2008, Intangible Capital in the Netherlands: Measurement and Contribution to Economic Growth, Discussion Paper No. 08016, Statistics Netherlands, The Hague.

Soloveichik, Rachel C. (2011), "Research spotlight: artistic originals as capital assets," *Survey of Current Business*, June.

Soloveichik, Rachel C. and David Wasshausen (2013), "Copyright Protected Assets in the National Accounts" BEA

Statistics Canada (2019a), "Measuring Investment in Data, Databases and Data Science: Conceptual Framework," Technical report, Statistics Canada.

Statistic Canada (2019b), "The Value of Data in Canada: Experimental Estimates," Technical report, Statistics Canada.

Table 1. The classification of intangible assets

Categories of intangibles assets	Economic activities that produce assets	Examples of intangible assets
Digitalized information (Software and database, Data)	Software Databases development Data value creation or data stack	Digital capabilities, tools Trade secrets Data assets
Innovative properties	Research and development (R&D) Mineral exploration Entertainment, artistic, and literary originals Other new product development (e.g., design originals, new financial products)	Patents Mineral rights Licenses, contracts Copyrights Attributed designs Trademarks
Economic competency	Branding Marketing research Organizational structure/business process investment Employer-provided training	Brand equity Market insights, customer lists Operating models, processes and systems Firm-specific human capital

Source: Corrado, C, J, et al. (2022)

Table 2. Data sources and methods for estimating intangible assets

Type of intangible	Estimation	Depreciation
Digitalized information		
Software and databases	National accounts	33
Own account data	Cost approach based on compensation of data related occupation	20
Purchased data assets	Expenditures on the expenditures on data related services by other industries	20
Innovative property		
R&D	National accounts	20
Mineral exploration and evaluation	National accounts	13.4
Development costs in the financial services industry	20% of all intermediate purchases by the finance industry	20
New architecture and engineering design	50 percent of total expenditures on architectural, engineering and related services purchased by downstream industries	20
Books	Sum of costs based on sales	17.3
Music	Sum of costs based on sales	26.7
TV programs	Sum of costs based on sales	16.8
Movies	Sum of costs based on sales	9.3
Economic competencies		
Advertising	60% of total expenditures on advertising services.	60
Firm-specific human capital	The costs of training including direct firm expenses and wage & salary costs of employee time	40
Purchased organization capital	80% of total expenditures on management consulting	40
Own account organizational capital	20% of compensation of managers in the business sector	40

Source: Baldwin, Gu and Macdonald (2008) and this paper

Note: The estimates of investment in artistic original are based on sale. The ratio of investment to sales for artistic originals is obtained from Soloveichik and Wasshausen (2013). The ratio is 0.4, 0.5, 0.1 and 0.5 for books, music, TV programs and movies respectively. The relative low ratio of investment to sales for TV programs reflects the fact that TV programs such news and sports programs are not counted as investment.

Table 3. Nominal investment in tangible and intangible assets in the business sector, millions of dollars

	ICT tangible	Non-ICT tangible	All tangible	All intangible
2000	17,941	108,553	126,494	91,729
2001	17,004	111,268	128,273	98,329
2002	16,392	110,448	126,840	98,867
2003	15,881	116,112	131,992	103,615
2004	16,680	128,457	145,137	111,188
2005	17,128	146,165	163,292	121,371
2006	18,726	165,124	183,850	128,416
2007	17,600	172,425	190,025	139,436
2008	18,343	184,752	203,095	145,044
2009	15,108	151,695	166,803	137,647
2010	13,498	172,865	186,363	146,882
2011	12,995	196,848	209,843	153,797
2012	12,311	219,939	232,249	157,959
2013	12,299	234,222	246,521	162,375
2014	13,072	253,659	266,732	174,171
2015	14,691	232,979	247,670	175,030
2016	13,941	212,518	226,459	178,206
2017	14,921	217,910	232,831	187,478
2018	16,374	227,569	243,943	197,459
2019	17,404	238,747	256,151	212,729

Source: this paper

Table 4. Nominal investment by asset types in the business sector, millions of dollars

	2000	2005	2010	2015	2019
ICT tangible	17,941	17,128	13,498	14,691	17,404
Non-ICT tangible	108,553	146,165	172,865	232,979	238,747
Research and development	2,013	1,535	1,921	3,179	3,457
Own-account research and development (except software development)	5,977	9,539	9,097	9,263	10,727
General purpose software	1,828	2,022	3,293	3,074	5,226
Custom software design and development	4,838	7,496	7,352	10,018	14,771
Own-account software design and development	2,546	3,706	4,839	5,904	9,141
Mineral and oil and gas exploration	5,396	8,156	8,405	5,352	4,539
Development costs in financial industry	2,941	3,611	4,161	4,907	5,179
New architecture and engineering design	15,224	19,639	24,652	32,870	40,491
Own-account data	19,800	26,647	34,045	44,159	54,066
Purchase data	755	1,110	1,584	2,197	2,555
Advertising	8,369	9,914	11,724	12,239	13,337
Firm-specific human capital	4,063	5,027	5,881	7,246	8,231
Purchased organizational capital	6,597	9,537	13,535	17,173	19,784
Own account organizational capital	8,468	9,893	12,374	12,893	15,064
Books	885	1,032	1,014	482	572
Music	213	233	215	192	107
TV programs	452	611	800	919	946
Movies	1,365	1,664	1,991	2,965	4,536
All tangible	126,494	163,292	186,363	247,670	256,151
All intangible	91,729	121,371	146,882	175,030	212,729
Ratio of all intangibles to tangibles	0.73	0.74	0.79	0.71	0.83
Ratio of intangibles in National accounts to all intangibles	0.25	0.27	0.24	0.21	0.22

Source: this paper

Table 5. Ratio of investment to GDP by asset types in the business sector

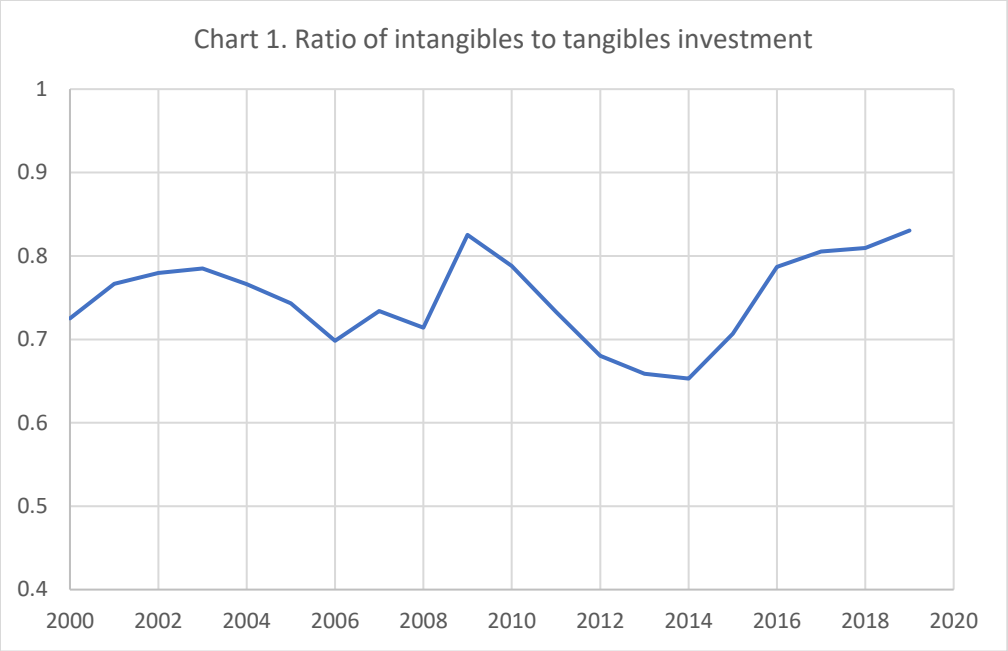
	2000	2005	2010	2015	2019
ICT tangible	2.29	1.70	1.18	1.08	1.10
Non_ICT tangible	13.88	14.53	15.10	17.15	15.10
Research and development	0.26	0.15	0.17	0.23	0.22
Own-account research and development (except software development)	0.76	0.95	0.79	0.68	0.68
General purpose software	0.23	0.20	0.29	0.23	0.33
Custom software design and development	0.62	0.75	0.64	0.74	0.93
Own-account software design and development	0.33	0.37	0.42	0.43	0.58
Mineral and oil and gas exploration	0.69	0.81	0.73	0.39	0.29
Development costs in financial industry	0.38	0.36	0.36	0.36	0.33
New architecture and engineering design	1.95	1.95	2.15	2.42	2.56
Own-account data	2.53	2.65	2.97	3.25	3.42
Purchase data	0.10	0.11	0.14	0.16	0.16
Advertising	1.07	0.99	1.02	0.90	0.84
Firm-specific human capital	0.52	0.50	0.51	0.53	0.52
Purchased organizational capital	0.84	0.95	1.18	1.26	1.25
Own account organizational capital	1.08	0.98	1.08	0.95	0.95
Books	0.11	0.10	0.09	0.04	0.04
Music	0.03	0.02	0.02	0.01	0.01
TV programs	0.06	0.06	0.07	0.07	0.06
Movies	0.17	0.17	0.17	0.22	0.29
All tangible	16.17	16.23	16.28	18.23	16.20
All intangible	11.73	12.06	12.83	12.88	13.45

Source: this paper

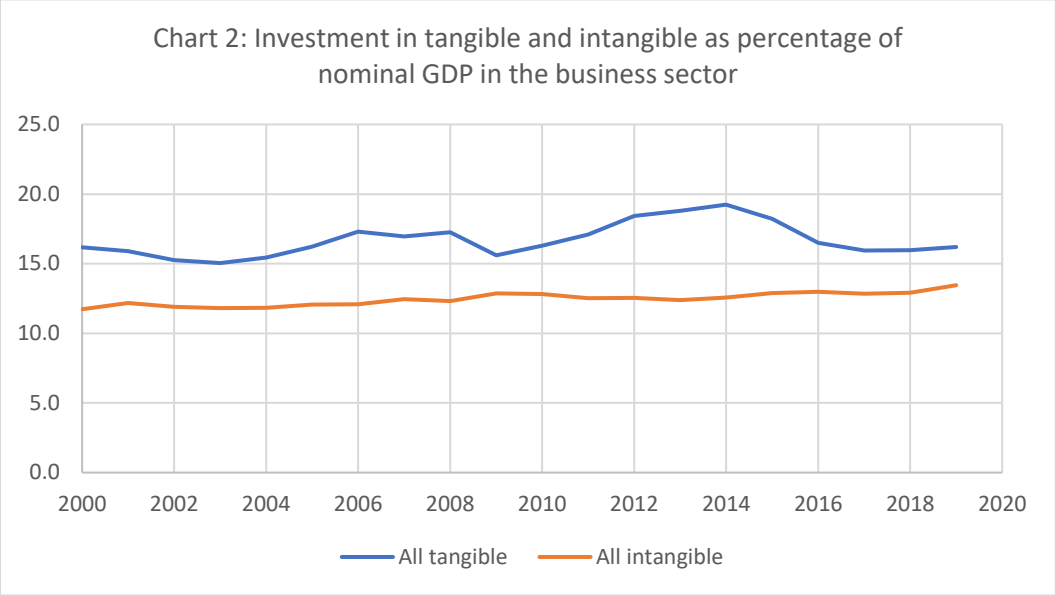
Table 6. Sources of labour productivity growth in the business sector (% per year), 2000 to 2019

Labour productivity growth	1.032
Contribution of capital deepening	
Tangible	0.637
ICT tangible	0.089
Non-ICT tangible	0.548
Intangible	0.210
Research and development	-0.010
Own-account research and development (except software development)	0.005
General purpose software	0.016
Custom software design and development	0.032
Own-account software design and development services	0.012
Mineral and oil and gas exploration	-0.036
Development costs in financial industry	0.003
New architecture and engineering design	0.050
Own-account data	0.083
Purchased data	0.007
Advertising	-0.003
Firm-specific human capital	0.006
Purchased organizational capital	0.042
Own account organizational capital	0.003
Books	-0.002
Music	-0.001
TV programs	0.002
Movies	0.000
Labour composition	0.231
MFP growth	-0.046

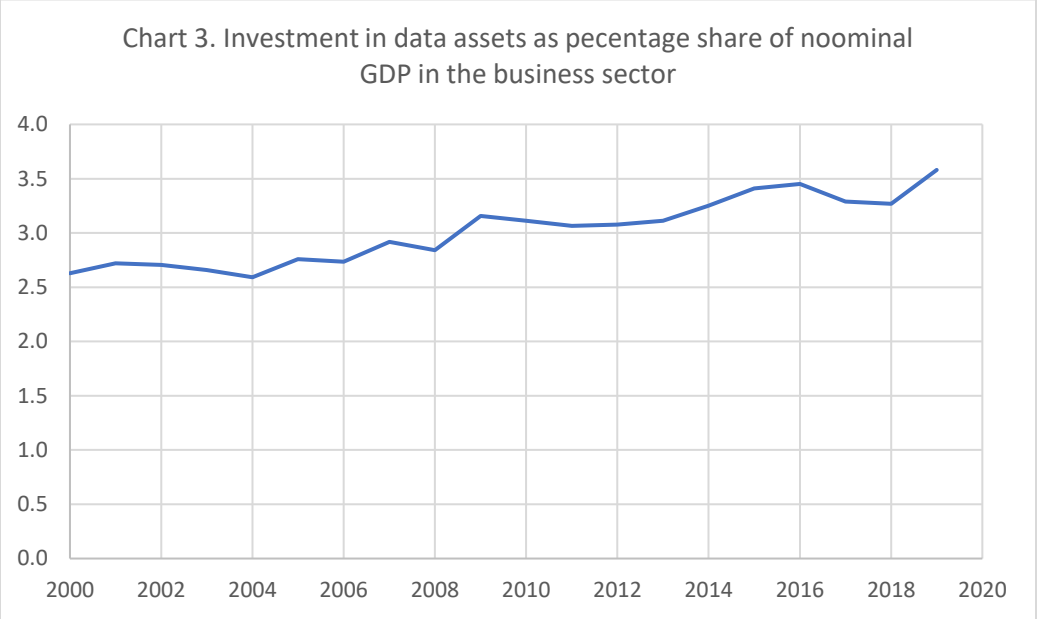
Source: this paper



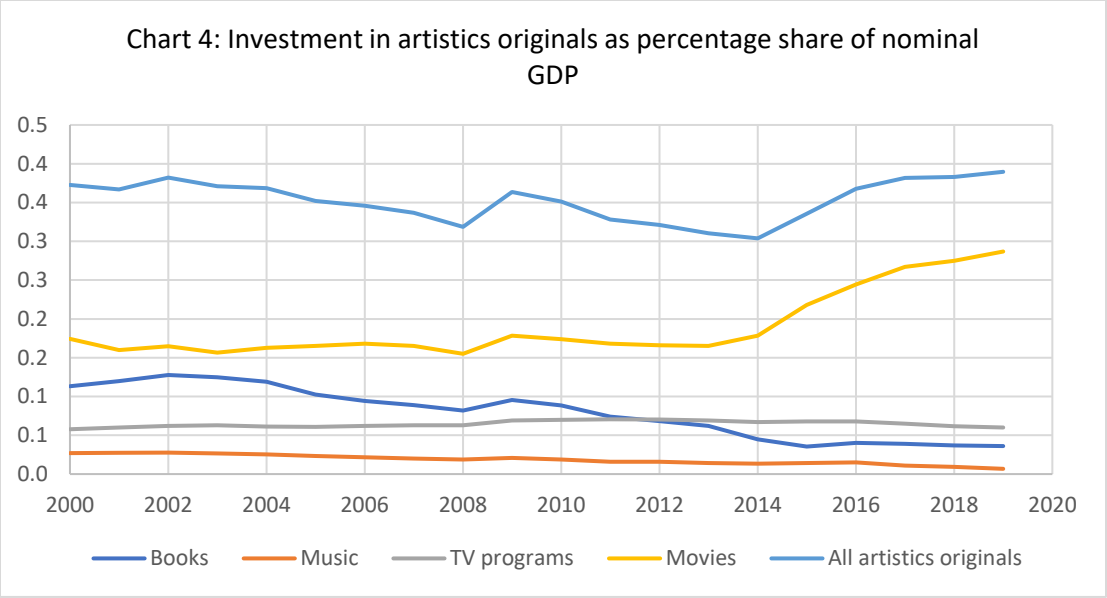
Source: this paper



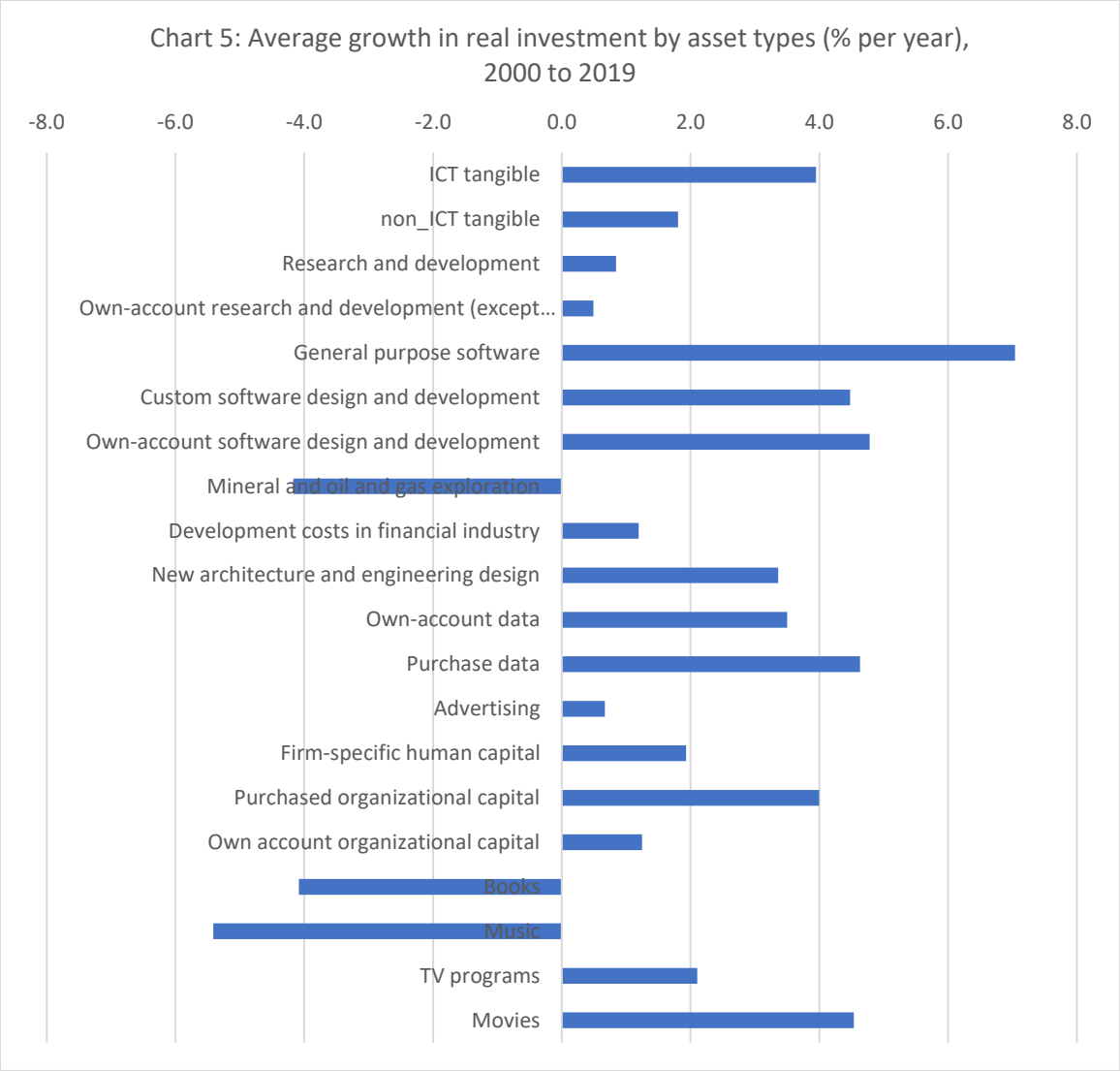
Source: this paper



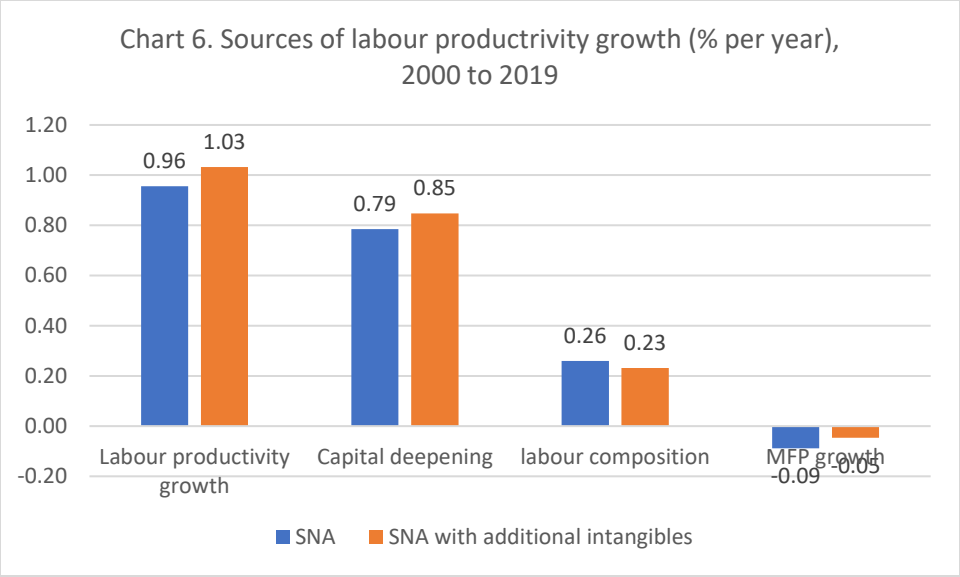
Source: this paper



Source: this paper



Source: this paper



Source: this paper

Appendix Table 1. The industries with the largest investment in data assets in 2019

Industry	Industry share of total investment in data assets (%)
Professional, scientific and technical services	41.49
Finance and insurance	13.88
Information and cultural industries	7.41
Wholesale trade	4.35
Oil and gas extraction	3.67
Administration and support, waste management and remediation services	3.47
Retail trade	3.38
Utilities	3.34
Transportation equipment manufacturing	2.92
Construction	2.65

Source: this paper