

Annex to the report: Finland's economic opportunities from data centre investments

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Appendix A

Expenditure impact analysis

Description of economic expenditure impact analysis methodology

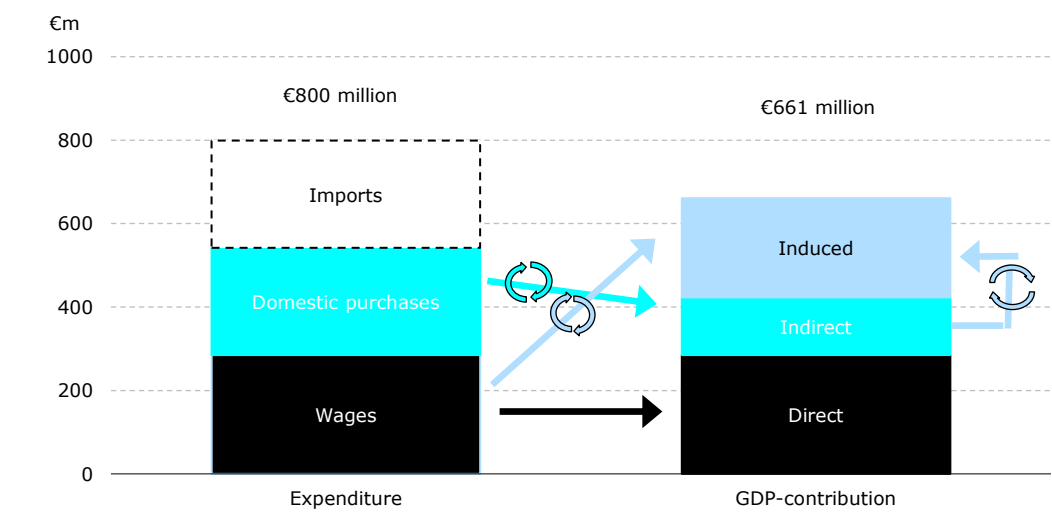
This appendix describes the approach we have applied in the quantitative analysis of the effect of Google's expenditures in Finland. Expenditure associated with data centers takes two distinct forms:

1. Construction expenditure
2. Operation expenditure

Each type of expenditure has a distinct mix of inputs and pattern of impact throughout the Finnish economy, thus we quantify the impact from each, separately. The source data for our analysis is information received from Google on expenditures and employment at the data center in Hamina. The Google data has not been sourced from audited financial statements (thus do not seek to represent a position of financial results), yet we understand it to be a precise characterisation of the magnitude of the expenditure in Finland. A further source of data is Statistics Finland, including the most recent input-output table from 2011.

We have used this data to estimate the supported GDP and employment contribution of the Google data centre to Finland. We find that Google's EUR 800 million investment in Hamina resulted in an accumulated direct, indirect and induced contribution to GDP of EUR 661 million in the period from 2009-2015, cf. Figure A.1.

Figure A.1 The accumulated impact of Google, 2009-2015



Note: The figure shows the accumulated expenditure and GDP contribution from the construction and operations from 2007-2014 measured in 2014 prices. indicate multiplier effects.

Source: Copenhagen Economics, based on data from Statistics Finland, Google and Invest in Finland

The direct effect includes the economic impact supported directly by data centres and their key construction contractors. The directly supported jobs in operations include positions in management, mechanical and electrical maintenance and repair, IT and systems technicians, plumbing and water management, and hardware operations.

The indirect effect includes the economic impact on suppliers, which is also supported by data centres' purchases of domestic goods and services. The indirectly supported jobs include positions in security, catering, cleaning and in the construction and supply industries, as well as at suppliers in upstream industries across the economy.

We refer to *the induced effect* as the supported economic impact that occurs when employees at data centres and their supplier industries spend their wages throughout the economy. The *induced jobs* are primarily service-related jobs in industries such as retail trade, transport, accommodation, restaurants, housing and finance.

Description of expenditure and effects

Google's expenditure (the left hand column) can be split between purchases of foreign and domestic goods and services and wages. With the exception of imports, each of these activities influences employment and the GDP in Finland. Wages are a part of Finland's GDP. We define these as the *direct effect* (see the right hand column).

The indirect effect reflects how the spend at the data centre site on Finnish goods and services supports a contribution to GDP and employment through increased activity up the value chain of industrial and commercial activities that indirectly benefit from demand from the data centre site.

The induced effect includes the supported economic impact when wages and salaries paid to employees at the data centre and their supplier industries is spent throughout the economy. The *induced* jobs are primarily service-related jobs in industries such as retail trade, transport, accommodation, restaurants, housing and finance. Throughout this report, we refer to induced effects as the potential amount of economic activity supported by the direct and indirect wage spend.¹

In practice, displacement in the labour force can reduce the final effect realised and this depends on the skill base and degree of openness in the economy. We have therefore provided separate reporting of the induced effects and the other effects.

The approach to build our input-output model

We estimate the indirect and induced effects using an input-output model. An input-output model reflects how national statistical agencies track the interdependency between all the sectors of the economy. In Finland, the national statistics report how each of 64 industrial sectors: i) relies on the other 63 sectors for inputs to their production; and ii) supplies its products and services to each of the remaining 63 sectors.

Input-output models provide a consistent and intuitive way of measuring the economic effects of an activity in any given industry or company in any given economy. Because of the underlying approach of this class of models, the results calculated by this method should however be regarded as approximations. Some of the assumptions are most likely to hold in the short run, and others are more appropriate for the long run.

First, we do not observe data on gross surplus (which under national counting rules is counted as part of GDP). In order to provide a conservative estimate, we do not include gross surplus in the operations when calculating the GDP contribution of the data centre.

Second, we assume that technology and resource mix (ratios for inputs and production) is the same for all firms in each industry, i.e. within each of those 64 industrial categories reported in the official Finnish national statistics input-output table. As such, our analysis describes average effects.

Third, we assume fixed production and input ratios of companies and fixed consumption shares of households. We do not include extra effects from investments or government spending.

Fourth, we assume that all the ripple effects in the economy take place within one year. Changing the timeframe would not affect the magnitude of the effects estimated.

Fifth, we assume that firms can increase their use of labour and capital as needed to meet the additional demand for their products from Google and their suppliers. Further, we assume that extra output can be produced in one area without taking resources away from

¹ In the literature, the ratio of (direct + indirect) to direct effects is called a *type 1 multiplier*, and the ratio of (direct + indirect + induced) to direct effects is called *type 2 multiplier*.

other activities. This approach to considering no supply-side constraints is equivalent to an assumption of fixed prices and wages; indeed input-output models are referred to as *fixed-price models*. We will thus refer to our estimated impact as *supported* effects, because they indicate the potential effects if the resources are readily available in Finland.

Last, we assume that the structure of the Finnish economy remains unchanged, looking as it did in 2011 (the year of the latest available input-output table). Any structural changes in the Finnish economy since 2011 will therefore lead to changes to the multipliers – which could be implemented once the Finnish official national statistics release updated input-output tables.

Description of scale-up approach

Our estimate of the economic impact on the Finnish economy, arising from the expenditure from the Finnish data centre industry relies on three complementary sources.

First, we have relied on data from Statistics Finland and World Input Output Database on the input / output table which details how supply chains are integrated across the Finnish economy – reflecting the pattern of economic activity across industries in Finland.

Second, we have taken as starting point the information relative to the expenditure at Google's Hamina data centre. We have then calculated the GDP and employment contribution associated with it, as described in the previous pages.

Third, we have gathered information from Invest in Finland on the Finnish data centre industry, its scale, composition and evolution. Based on this information (in order to proxy capacity), we have estimated the relationship between the entire data centre industry and the data centre analysed in our detailed case study of economic impact (Google at Hamina). The data centres included in the analysis comprise public and private data centres (as described in Figure 14 of the main report). This relationship underpins our quantification of the effects of the expenditure associated with the overall Finnish data centre industry.

Upon assessing the direct employment impact of operational expenditure, we have taken a conservative approach and scaled in a less than proportional way the direct employment impact of the Hamina data centre, given the specificity and complexity of that facility, which is not necessarily matched across the data centre industry.

When quantifying the yearly impact of construction activities, we have focused on the year 2016. First, we have taken as a starting point the estimate of the construction expenditure related to the entire current stock of Finnish data centres. Second, we have relied on the industry trend of 10% growth (applying this to the private data centres), leading to a corresponding increase in the stock of data centres per year – which translates into expected construction expenditure on average across the Finnish data centre industry for the year 2016.

Appendix B

Quantification of ripple effects

Description of the method used to quantify the ripple effects

This appendix describes the approach we have applied in the quantitative analysis of the ripple effects of the data centres to the Finnish economy. The quantification of additional ripple gains associated with data centres is based on two channels:

1. Growth in the data centre industry
2. Enhanced local sourcing

Through these two channels we are able to quantify the ripple effects by combining our estimates for the size of the Finnish data centre industry obtained in the footprint analysis with other evidence on the impacts of data centres to the overall economy.

Firstly, we use estimates for growth in the private data centre industry by IDC (2014b), Gartner (2013) and BroadGroup (2014), which are referenced in BCG (2014). They estimate it to be growing by 10 per cent annually towards 2020. We assume that this trend will continue beyond 2020 to 2025. The growth estimates are used to quantify impacts of increased productivity of Finnish suppliers that are expected to help Finland maintain its current share of the global data centre industry (i.e. the Finnish data centre industry also grows by 10 per cent per year) as well as impacts of signalling that are expected to help Finland expand its market share (i.e. the Finnish data centre industry grows by 15 per cent instead of 10 per cent). These growth effects provide a potential towards 2025, which is quantified both in terms of economic contribution and jobs.

Secondly, we utilise the fact that Google in the construction of the data centre in Hamina used a lower share of domestic labour and materials in the than was the case in comparable data centres, as for instance Google's data centre in Belgium and Facebook's data centre in Sweden. To quantify the potential of enhanced local sourcing, we thus use data from comparable data centres in Europe, as this enable us to quantify what the impact would have been had the extent of the local sourcing and the employment multipliers been as in these comparable data centres.

Appendix C

Interview evidence: data centre suppliers and skills base development

We analyse below several examples of outreach programs carried out by Google at the Hamina data centre.

Table 1 Overview of interviews conducted

Box 1	Domestic data centres provide great opportunity to learn from the best
Box 2	Internship is an enriching experience
Box 3	Mini data centre facilitates ICT skills in Finnish college
Box 4	Local company contributed to the Hamina reconstruction
Box 5	Google actively searches for local suppliers
Box 6	Potential for increased internationalisation of local suppliers– Fiber Highway
Box 7	Potential for increased exports to other data centres – Kerabit Pro
Box 8	Better possibilities to brand Finland as an attractive investment location – Cursor

Source: Copenhagen Economics

Box 1 Domestic data centres provide great opportunity to learn from the best

Antti Saarela works at the Google Hamina data centre as a hardware operations engineer. Antti has a technical degree in electronics and information technology from a local vocational college in the Kotka region. When he finished his degree in 2006 there were no job opportunities within this line of work in the region, and Antti took up a job as a structural line worker in a bread factory and spent some time travelling and working in Australia.

Five and a half years ago he then started working at the Google data centre. Initially he started in a non-technical position as a data centre assistant, where his main tasks involved replacing broken items from various machines in the data centre and assisting technicians with e.g. network deployments etc. While working in his initial position at the data centre, he was studying Linux and networking in his spare time, and after three years as a data centre assistant, he started as a hardware operations engineer.

Throughout his time at Google, Antti has learnt a lot within a fast changing environment, which means that there is always something new to learn. Antti also notes that his colleagues are highly qualified professionals in their field, which means that there is always great opportunity to learn from the best. The broader digital skills, which Antti has acquired at the google data centre are skills that are applicable both within and outside of the data centre industry.

Source: *Interview with Antti Saarela, Hardware operations engineer. The interview was conducted on the 11th July 2016*

Box 2 Internship is an enriching experience

Santeri Väre is 23 years and recently started working full time at the Google data centre in Hamina as an operations facility technician. During his university studies, Santeri did a four month internship at the data centre. During his internship, he worked on different projects related to cooling systems and tracking of heat emissions.

Throughout his internship, Santeri worked with highly experienced colleagues and was assigned tasks that helped him towards accomplishing his goal of becoming an engineer. The internship also led to Santeri becoming a full-time employee at Google following the recent completion of his studies. However, his training is not over. As a full time Google employee Santeri will undertake a range of training courses, most of which are technical training courses.

The emphasis that Google places on training is one of the factors which Santeri believes makes the working environment at the data centre unique. Combined with the knowledge gained from working alongside highly experience colleagues, Santeri is in no doubt that his jobs at Google are teaching him many new skills that can be employed both within and outside of the data centre industry.

Source: *Interview with Santeri Väre, Associate Data centre Operations Facility Technician, LPP. The interview was conducted on the 12th July 2016*

Box 3 Mini data centre facilitates ICT skills in Finnish college

South Kymenlaakso Vocational College (EKAMI) is a multi-disciplinary education institution with over 7,000 students. As a local actor, the college focuses on educating people to those sectors in which investments are being made through the region's labour and commercial policies.

As a response to a growing demand in the region for a workforce with high ICT skills and knowledge about data centre operations, the college wanted to create a special learning environment for data centre competences and an e-learning environment for ICT and computing training. With financial support from Google, the college constructed a mini data centre on its Hamina campus. The data centre is built by students and is planned and tailored around the needs of data centre employers as well as other industry. The data centre is now in full operation and is operated by the students.

The mini data centre is used actively for teaching purposes and plays an important part in the learning process, as students can benefit from working and studying in a real life data centre environment. In this environment, students learn ICT skills such as hosting web sites and e-shops and can also practice with the virtual networks, computers and different re-mote controllers. The mini data centre thus plays an important role in preparing students to enter a working environment that is increasingly characterised by digitalisation and rapid technology development.

Currently EKAMI is the only school in Finland, which provides education in data centre competence studies with this kind of learning environment. The mini data centre therefore also helps attract students from the region to the college.

Source: *Interview with Sami Tikkanen, Principal, Kymenlaakso Vocational College, EKAMI. The interview was conducted on the 16.08.2016*

Box 4 Local company contributed to the Hamina reconstruction

Sakki has been engaged at the Google data centre for the last three years, where it has undertaken ground works for new buildings and diamond drilling. In 2010, the company was also engaged at the site for about a year doing demolition works. During the time the company has worked at the Google data centre, they have become familiar with e.g. the US health and safety procedures used at the Google site.

As a result of the experience gained from working at the Google data centre, the company is now in a better position to serve other large clients in the area, as they are now familiar with the processes and standard requirements in a big multinational company such as Google. Finally, it has also put the company in a better position to undertake future work for other data centres, as it has gained an understanding of the volume of materials required for a data centre, useful to plan and price new projects.

Source: *Interview with Mr. Jyri Vainikka, Project Manager at Sakki. The interview was conducted on the 21st July 2016*

Box 5 Google actively searches for local suppliers

Google likes to use local service companies (e.g. maintenance and repair companies, security, catering, cable and diving companies). In cooperation with Cursor, Regional Development Company for the Kotka-Hamina region, Google have therefore arranged events, where local companies interested in becoming a subcontractor to Google can come and present what they do. The first of series of these events was held in December 2013 and in January – February 2014, where 64 companies attended. The event has since then been repeated.

Source: *Interview with Harri Eela, Sales Director at Cursor. The interview was conducted on the 15th July 2016*

Box 6 Potential for increased internationalisation of local suppliers – Fiber Highway

Fiber Highway is a small Finnish telecommunications company with offices in Hamina and Porvoo. Fiber Highway currently does most of its business in Finland but has also consulted on projects in other countries, although on a small scale. In January 2016, the company started working at the Google data centre in Hamina, where its main task until now has been fiber cable expansions, required in order to expand the centre's data traffic capacity. As a result of its work at the Google data centre, the company has tripled in size from five to 15 employees. Fiber Highway has furthermore become specialised in delivering solutions to data centres, and the experience has thus opened a new market for the company.

Working at the Google data centre has made the company familiar with a range of technical quality standards (testing protocols) that differ from the standards that it has used in the Finnish market. This experience will make it easier for the company to work with other international companies in the future. Similarly, the company has gained valuable communication skills and learned a range of industry-specific terminology and standard international definitions, which make it easier to operate in an international environment. Google has also invested in a training course in order for Fiber Highway employees to become certified in specific testing methods.

Fiber Highway expects that the skills learned will result in further work in the Finnish data centre industry and help them export their services abroad.

Source: *Interview with Mr. Antti Ansas, CEO and founder of Fiber Highway. The interview was conducted on the 11th July 2016*

Box 7 Potential for increased exports to other data centres – Kerabit Pro

Kerabit Pro (part of the Nordic Waterproofing group) is the leading roofing and waterproofing contractor in Finland. It works across the whole of Finland and provides services to customers in other parts of Scandinavia. The company has worked at the Google data centre in Hamina for just over two and a half years, starting in 2014. Kerabit Pro has undertaken the entire roofing and insulation works for part of the data centre and has also been involved in refurbishments of other elements.

While roofing a data centre is standard, the technical demands posed by cooling towers is somewhat specific. Furthermore, the company has also become familiar with internationally applicable health and safety procedures and has also learned complex procedures to meet the client's needs. This makes it easier to go abroad and work in the future on similar projects for other data centres including for Google.

Source: *Interview with Mr. Mikko Kahelin, former Kerabit Pro project manager at the Google data centre. Currently self-employed entrepreneur and consultant for Kerabit Pro. The interview was conducted on the 11th July 2016*

Box 8 Better possibilities to brand Finland as an attractive investment location – Cursor

Cursor is a development company owned by the region's five municipalities (Kotka, Hamina, Pyhtää, Virolahti and Miehikkälä) together with industrial enterprises and financial institutions in the region. Cursor's main task is to develop and attract new businesses to the Kotka-Hamina region, including FDI. According to Sales Director, Mr. Harri Eela, having a company such as Google in the region is very important in terms of attracting new international companies to the region, as it sends a strong signal. Per agreement with Google, Cursor therefore also uses Google as a showcase to brand the region.

Furthermore, Harri Eela also notes that local suppliers to Google have shown that they can adapt to the conditions of working for large international companies, which may include using English as a working language, making more complex contracts than they are used to from working with Finnish firms or complying with different standards etc. These firms can easily work for other international companies too, which helps increase the attractiveness of the region.

Source: Cursors website and an interview with Harri Eela, Sales Director at Cursor. The interview was conducted on the 15th July 2016

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