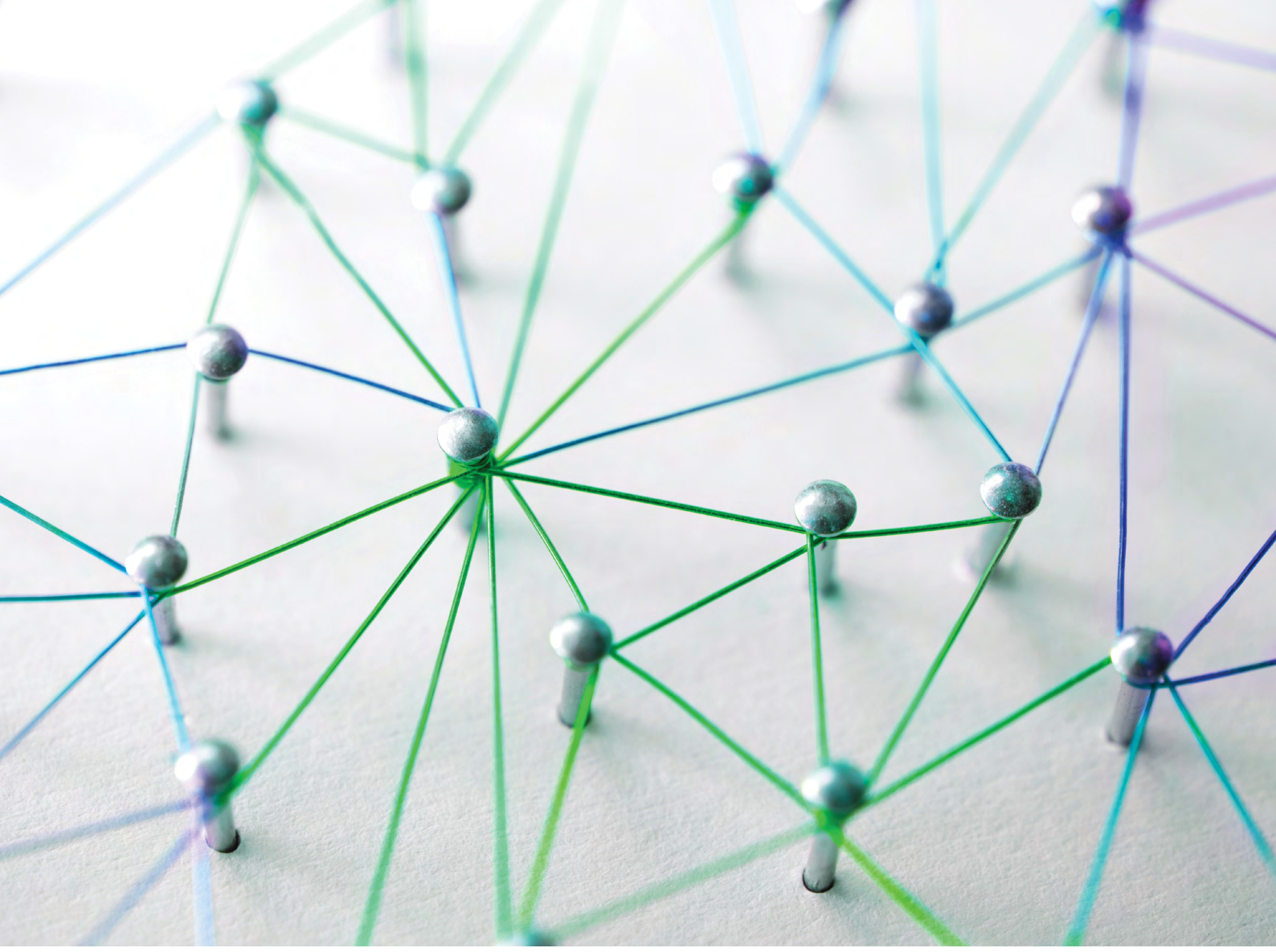

The economic contribution of Facebook data centres in Denmark, Ireland, and Sweden

September **2019**

IHS Markit®

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Introduction

To provide the level of service expected by its 2.1 billion daily active users[1] and 2.7 billion monthly active users[2], Facebook must ensure that its core infrastructure can deliver every photo, video, like, comment, message, group, or business page reliably and quickly. As Facebook and its family of products — which most notably include Instagram, WhatsApp, Messenger, and Oculus— continue to grow, the demand for server and network capacity continues to increase. To meet the business needs of its growing product offerings, Facebook has been expanding its infrastructure footprint and now has fifteen (15) data centre locations globally, with three (3) located in the European Union:

Odense, Denmark **Clonee, Ireland** **Luleå, Sweden**

Facebook commissioned IHS Markit to evaluate the economic contribution of Facebook's European data centres on their respective countries from 2011 through 2018. The study focused on how Facebook stimulated economic contributions to the Danish, Irish, and Swedish economies through its capital expenditures (i.e., construction and equipment), operational expenses, and direct wages. Although not part of the IHS Markit core quantitative analysis, the narrative of this report also provides insights on other contributions Facebook makes through its renewable energy targets including Power Purchase Agreements (PPAs), which support the development of new additional renewable energy projects on the same electricity grid as the data centres, and its Community Action Grant Programme, which provides grants to local projects that address a range of community needs — most notably improving local STEM education.

1. Average for June 2019
2. As of June 30, 2019; https://newsroom.fb.com/company-info

Table 1

Facebook cumulative economic contributions in Denmark, Ireland, and Sweden, 2011-18 (millions)

	Sales activity	Contribution to GDP	Labour income	Employment per year
Sweden	€ 2,352	€ 1,160	€ 520	1,461
Ireland	€ 1,549	€ 602	€ 359	661
Denmark	€ 1,195	€ 520	€ 316	695
Total	**€ 5,096**	**€ 2,281**	**€ 1,195**	**2,816**

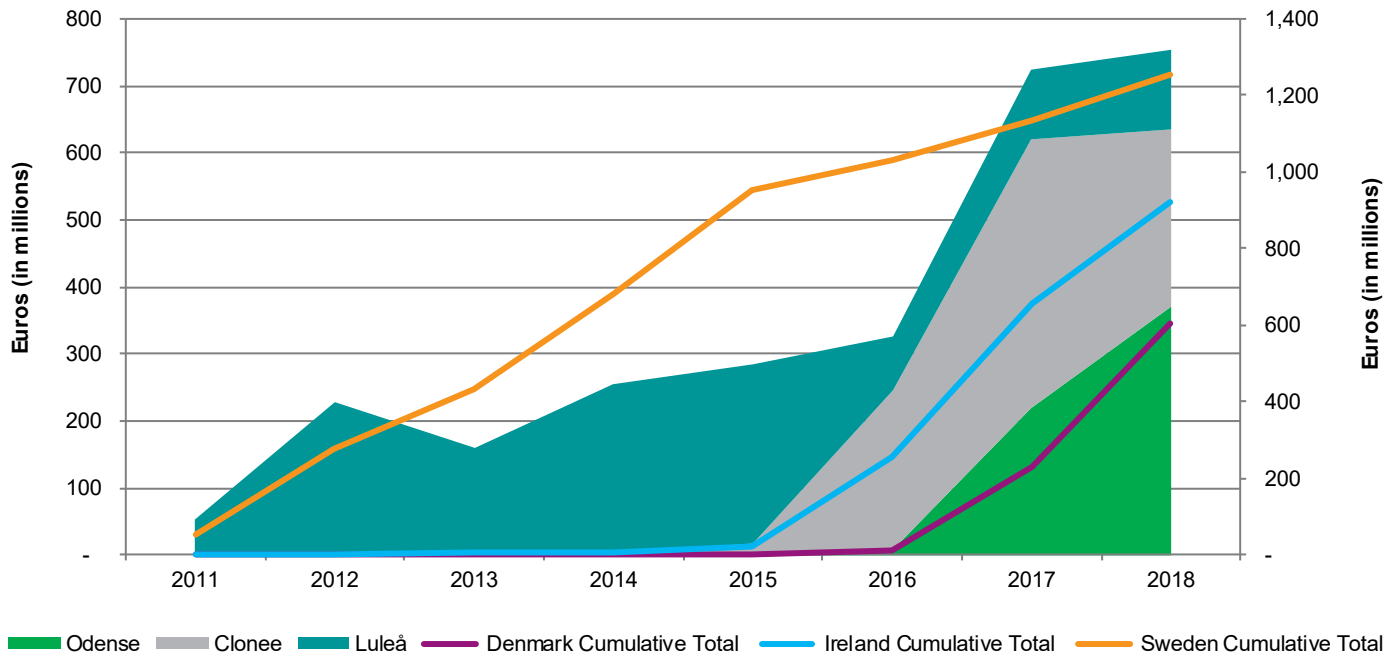
Note: These figures include data centre supply chain activities from 2011-2018 in Luleå that occur prior to construction and operation in Denmark (2016-2018) and Ireland (2015-2018). The figures in this table represent cumulative total economic contributions and average employment per year over the extended time frame and will not match the country-level tables presented in country chapters, which are estimated only over a shorter construction and operation time frames.

Source: IHS Markit

From 2011 through 2018, Facebook directly sourced expenditures totalling €2.8 billion of goods and services across Denmark, Ireland, and Sweden — an annual average of €348.6 million. These expenditures generated an additional €2.3 billion in sales and supported 2,816 jobs annually within the three countries.

Figure 1

Spending timeline for Facebook's European data centres



Source: IHS Markit

Facebook's contributions to Denmark, Ireland, and Sweden go beyond the economic benefits quantified in this report. For example, Facebook's renewable energy initiatives — such as the Nordic wind energy solution announced in 2018 — combined with its local Community Action Grant Programme have generated additional local and regional economic activity while forging collaborative community partnerships that add value in qualitative ways.

From 2011 to 2018, Facebook directly sourced a total of €2.8 billion of goods and services across Denmark, Ireland, and Sweden – an annual average of €348.6 million. These expenditures generated an additional €2.3 billion in sales and supported 2,816 jobs annually within the three countries.

Our approach

Since 2011, Facebook has initiated the addition of three European facilities to its global fleet of data centres: Odense, Denmark; Clonee, Ireland; and Luleå, Sweden. Luleå Data Centre has been operational and serving traffic since 2013, Clonee came online in 2018, and Odense is expected to come online in 2019. Today, construction is ongoing at all three of Facebook's European data centres. The combined economic effect of Facebook's multi-country data centre developments is felt across the European Union. Facebook's direct spending on capital investment, construction, and operations initiated follow-on supplier activity, generating greater economic activity than a single location studied in isolation. IHS Markit was commissioned by Facebook to evaluate the economic contributions the three data centres make to the three host countries for the period of 2011 to 2018.

IHS Markit worked closely with Facebook in the design and implementation of the economic contribution study to ensure that Facebook's data were incorporated accurately with IHS Markit methodology. Facebook supplied IHS Markit with detailed direct purchasing data for each of the European data centres for the years 2011 through 2018. The data set included a description of the vendor, its origination city, the transaction amount, and details on the types of purchases made. IHS Markit then classified each vendor to an industry based on 2-digit *International Standard Industrial Classification of All Economic Activities, Revision 4 code* (afterwards referred to as ISIC Rev4. codes). Countries of origin were determined using Hoovers, web search, or by Facebook via purchasing order search. We then aggregated Facebook's purchasing activity by industry and country, and used this data to generate core inputs for its economic impact models.

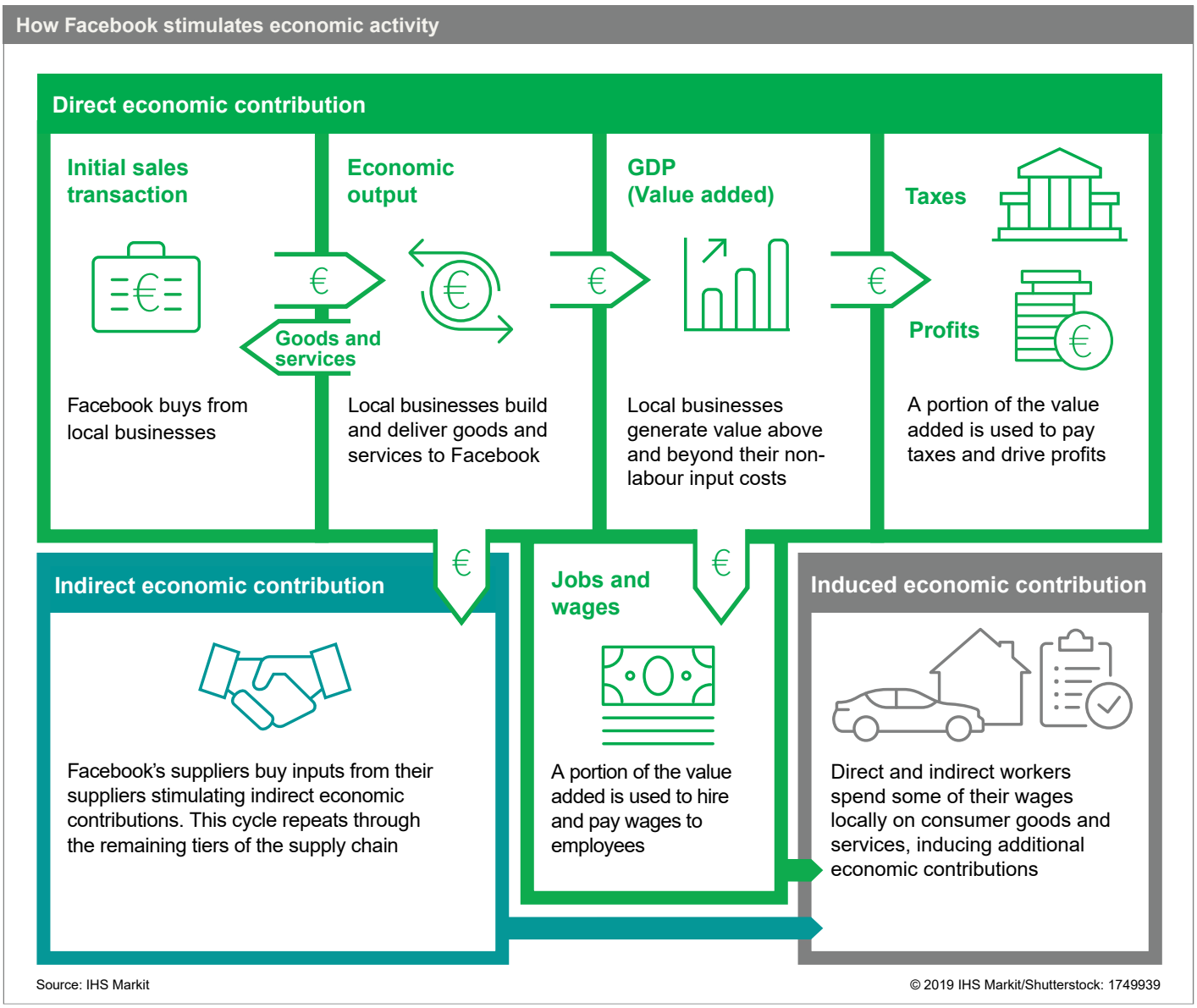
Purchases made from vendors in Denmark, Ireland, and Sweden were converted into a common currency, US dollars, using an average annual exchange rate for comparative and modelling purposes. All country and industry classifications were reviewed by Facebook for accuracy. Facebook also provided data on the number of Facebook employees and total wages paid for each data centre location, which IHS Markit then classified into ISIC Rev4. Code 62 (Computer programming, consultancy, and related activities); wages were also converted into a common currency, US dollars.

IHS Markit used an enhanced input-output (I-O) modelling approach to determine Facebook's contributions to the Danish, Irish, and Swedish economies. I-O frameworks capture the inter-industry linkages required to trace how capital expenditures and operational expenses flow through an economy. IHS Markit constructed unlinked I-O models for Denmark, Ireland, and Sweden using the most recently available I-O data from the World Input-Output database (WIOD) . While each country provides input-output data on their respective national statistical websites, IHS Markit chose to build the models using the WIOD data as the common industry classification scheme, level of detail, and currency of analysis (US dollars) to ensure comparability and consistency between each nation's contribution assessment. IHS Markit enhanced the standard I-O modelling approach by incorporating the social account matrices for each country from the WIOD[3] databases to capture induced (labour income and wage-related) impacts.

3. "World Input Output Database." Last modified 22 August 2019. http://www.wiod.org/home.

The following graphic shows how the three levels of economic contribution interact. The first level, known as **direct economic contribution**, occurs when Facebook directly engages companies in a local economy, e.g., contracting a construction firm who hires locally to build a data centre facility. The money Facebook pays to the construction firm allows it to buy inputs from its suppliers (more on that shortly). With the remaining money (known as value added in economics parlance), the construction firm can hire and pay workers, pay taxes, and derive profits. In the **indirect economic contribution** layer, the construction firm's suppliers repeat the same cycle through multiple tiers of the supply chain. Finally, in the **induced economic contribution** layer, direct and indirect workers spend some of their wages locally, inducing additional contribution cycles. The metrics typically assessed in an economic contribution analysis include sales activity, contribution to GDP, employment, and wages. A detailed description of the structure and function of an economic contribution model is provided in Appendix A.

Figure 2



All vendor expenditures identified as Facebook's direct spending for the Denmark, Ireland, and Sweden data centres were modelled on a year-by-year basis from 2011 through 2018. Direct, indirect (or supply chain expenditures), and induced results were summarised by industry and country for each year and later converted to euros for presentation.

The following were excluded from the IHS Markit quantitative analysis:

- Direct expenditures from European vendors located outside of Denmark, Ireland, and Sweden were aggregated for analytical purposes and their values were converted to a common currency, but were not included in the economic modelling. Thus, the total economic contribution of Facebook's European data centres across the entire EU are greater than the aggregate results for Denmark, Ireland, and Sweden
- Direct expenditures related to servers
- Direct expenditures related to land acquisitions and leasing
- Monetary economic contributions related to Power Purchasing Agreements (PPAs), which are best considered as indirect expenditures in several construction and utility industry classifications
- Community Action Grant Programmes disbursements
- Monetary economic contributions related to heat recovery project at Odense, Denmark.

Getty Images/Marcus Lindstrom:1633194

Sweden
Luleå Data Centre

About Luleå, Norrbotten County

Hosting Facebook's first data centre located outside of the United States, Luleå is located on the northern coast of Sweden, some 900 kilometres from Stockholm. Luleå is the capital of Norrbotten county, Sweden's northernmost and largest county by area, and home to Luleå's University of Technology. Thus, Luleå's economy is more research and service-oriented than other nearby inland municipalities. Luleå's population of 77,832[4] makes it a population centre for northern Sweden.

Connectivity and use of social media have become increasingly embedded in the Swedish economy. Based on 2017 data from Statistics Sweden, 63% of businesses use social media, primarily for marketing and recruiting purposes[5]. Information and telecommunications companies dominated business use of social media with nearly 85% utilisation, while retail trade, hotel, and restaurant businesses also participated in social media at rates above 75%[6]. Among Swedish consumers, 66% of Swedes participated in social media in 2017, and 74% of social media

4. Statistics Sweden. "Population in the country, counties and municipalities on 31 December 2018 and population change in October–December 2018". https://www.scb.se/en/finding-statistics/statistics-by-subject-area/population/population-composition/population-statistics/pong/tables-and-graphs/quarterly-population-statistics--municipalities-counties-and-the-whole-country/quarter-4-2018/

5. Statistics Sweden. "Share of enterprises using social media, by purpose". 29 November 2017. https://www.scb.se/en/finding-statistics/statistics-by-subject-area/business-activities/structure-of-the-business-sector/ict-usage-in-enterprises/pong/tables-and-graphs/use-of-social-media/share-of-enterprises-using-social-media-by-purpose/

6. Statistics Sweden. "Proportion of companies using social networks", 29 November 2017. <https://www.scb.se/hitta-statistik/statistik-efter-amne/naringsverksamhet/naringslivets-struktur/it-anvandning-i-foretag/pong/tabell-och-diagram/sociala-medier/andel-foretag-som-anvander-sociala-natverk/>

users access Facebook[7]. Telecommunication, data, and information services sectors accounted for 7% of Swedish GDP in 2018 and accounted for more than 20% of Swedish 2018 exports, or €12.9 billion (SEK132 billion)[8].

Facebook spending in Sweden

Facebook announced its plan to construct a major data centre located in Luleå in 2011, breaking ground later that year. Coming online in 2013, the campus expanded with the construction of a second building commencing in 2014, followed by the announcement of constructing a third building in 2018. By this time, Facebook had spent €367 million on construction services from Swedish companies, averaging €46 million annually. Most of the Swedish-provided construction services occurred from 2011 through 2013 and in 2015.

From 2011 through 2018, Facebook Luleå purchased €632 million in equipment (manufactured goods and wholesale goods) from Swedish vendors, averaging €79 million annually. An additional €105 million in goods and services, such as legal and managerial services, were purchased from Swedish vendors, averaging €13.2 million per year. Plus, Swedish vendors fulfilled a cumulative €62 million in sales for Facebook's data centres located in Ireland and Denmark. On average, Swedish companies realised €157 million annually during the study period.

The Luleå data centre began serving live traffic in 2013. The campus supported 85 local data centre workers when it came online in 2013, gradually increasing to 343 by 2018. Wages generated from these jobs generated additional economic benefit through purchases made by workers in Luleå's local economy.

Table 2

Luleå Data Centre expenditure timeline

(millions of Euros)	2011	2012	2013	2014	2015	2016	2017	2018	Average
Construction	33	85	70	46	86	14	14	23	46
Equipment	11	140	52	178	153	19	33	50	79
Other	6	1	17	14	8	18	27	14	13
Operations	1	1	15	15	20	30	28	32	18
Total	**51**	**227**	**154**	**252**	**268**	**81**	**103**	**119**	**157**

Source: IHS Markit

Overall, Facebook's three European data centres have directly purchased €1.2 billion worth of goods and services from Swedish suppliers through the company's direct spending on construction, investment, and operational activities from 2011 through 2018.

Facebook's European data centres have directly purchased €1.2 billion worth of Swedish goods and services through direct spending on construction, investment, and operational activities from 2011 through 2018.

7. Internetstiftelsen. "The internet habits of Swedes in the report Swedes and the internet 2017". 19 November 2017. https://internetstiftelsen.se/press-english/the-internet-habits-of-swedes-in-the-report-swedes-and-the-internet-2017/

8. Statistics Sweden."GDP Production Approach (ESA2010)". 29 May 2019.

Luleå's contribution finding

IHS Markit analysed Facebook's direct local spending through its economic modelling system. IHS Markit estimates that the €1.2 billion Facebook spent to build and operate the Luleå data centre from 2011 through 2018 supported, on average, 1,461 jobs a year, stimulated a total of €1.16 billion of GDP (average of €145 million annually), and generated €520 million of labour income.

Table 3

Facebook cumulative economic contributions in Sweden, 2011–18 (millions of euros)

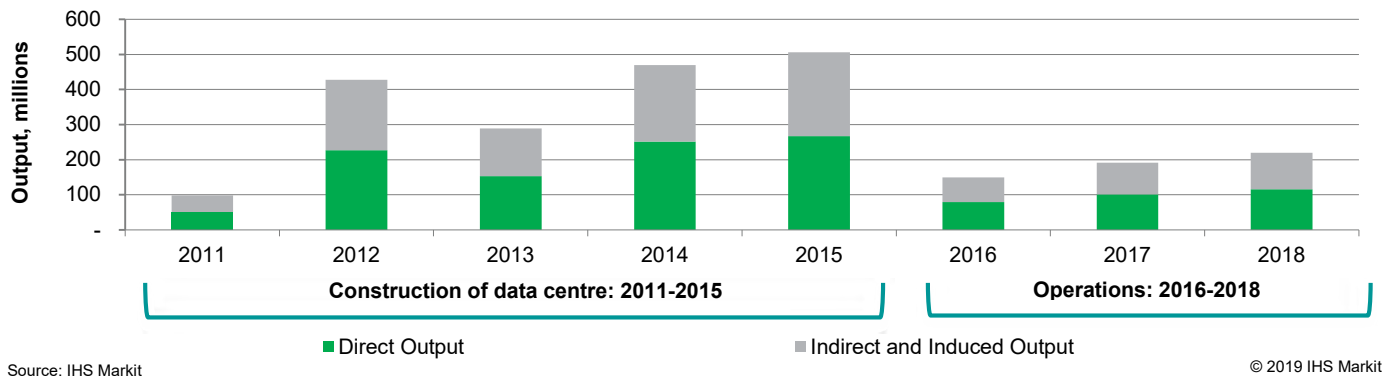
	Sales activity	Contribution to GDP	Labour income	Employment per year
Direct	€ 1,246	€ 613	€ 288	782
Indirect	€ 700	€ 337	€ 151	430
Induced	€ 406	€ 210	€ 82	249
Total	**€ 2,352**	**€ 1,160**	**€ 520**	**1,461**

Source: IHS Markit

Of the total €2.3 billion contribution in sales activity, nearly 30% – or €700 million – was supported through additional supply chain activity within Sweden (indirect effects). For every €100 Facebook spent in Sweden on construction and operations, €93 of additional GDP was stimulated in the Swedish economy.

Figure 3

Facebook data centre's impact on output (sales activity) in Sweden, euros



Source: IHS Markit

Workers also benefitted from Facebook's presence. Labour income, which includes all forms of employment income, wages, and benefits, expanded by a combined total of €520 million from 2011 to 2018. On an average annual basis, Facebook stimulated €65 million of labour income and supported 1,461 jobs per year in the study period. Facebook-stimulated jobs earned an average labour income of €44,500, which is 1.4 times greater than the average annual pay of €32,352 earned by "manual workers"[9] in Sweden in 2011–18.

9. Both "manual" and "non-manual" data come from employment definitions provided by Statistics Sweden at statistikdatabasen.scb.se.

Table 4

Facebook economic impacts in Sweden by industry, 2011–18

	Sales activity	Contribution to GDP	Labour income	Employment per year
Manufacturing	€ 557	€ 198	€ 84	254
Construction	€ 431	€ 200	€ 108	309
Wholesale and retail trade; repair of motor vehicles and motorcycles	€ 397	€ 244	€ 119	306
Information and communication	€ 168	€ 86	€ 39	76
Professional, scientific and technical activities	€ 168	€ 91	€ 50	113
All other industries	€ 631	€ 342	€ 121	402
Total	**€ 2,352**	**€ 1,160**	**€ 520**	**1,461**

Source: IHS Markit

The top three industries that benefited most from Facebook's Luleå data centre were construction, manufacturing, and wholesale/retail trade:

- The construction industry received much of the economic benefit, as during the construction peak of 2012–15,467 construction jobs per year were supported. Between 2011 and 2018, construction of Facebook's Luleå data centre stimulated a total of €431 million of sales activity in the construction sector, which contributed €200 million to Swedish GDP. The annual salary for the construction jobs averaged €43,526 in 2011–18, which is 1.2 times higher than the national construction industry averages for manual workers.[10]

- The manufacturing sector also benefited owing to the increased demand for machinery and equipment. Facebook's spending stimulated 254 jobs annually, with cumulative contributions of €557 million to sales, €198 million to GDP, and €84 million to labour income.

- Facebook's spending ultimately stimulated €397 million of cumulative sales activity and supported 306 jobs per year in the wholesale and retail trade sector. The wholesale activity is an indirect response to Facebook's spending as companies with whom Facebook directly engages need to source inputs and supplies. For example, construction firms hired by Facebook spent approximately €54 million in the wholesale trade sector in 2011–18. This means that for every €100 Facebook directly spent on construction, €14 was re-spent by construction firms with Swedish wholesalers.

10. Short-term statistics, wages and salaries, private sector (KLP), SCB, 29 May 2019.

Getty Images/wildwave4-163395

Ireland
Clonee Data Centre

About Clonee, County Meath

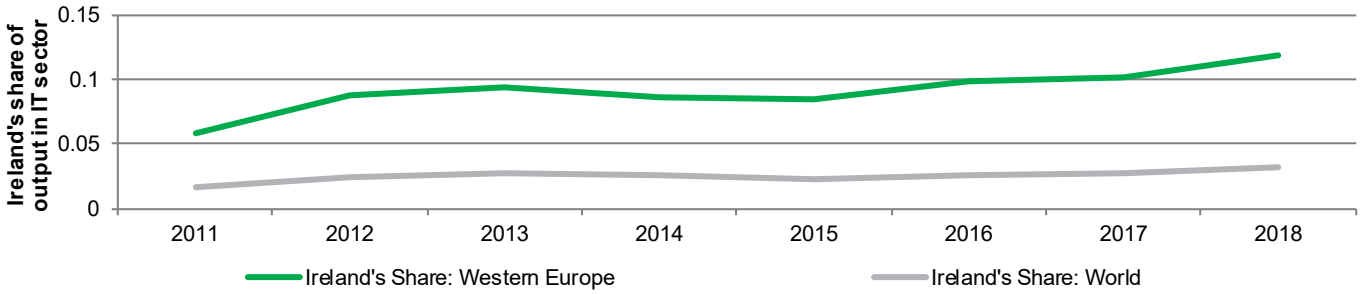
In 2009, Facebook established its international headquarters in Dublin. Ireland's concentration in information services has expanded 170% in 2011–18, translating to a 13% compound annual growth rate (CAGR) that has outpaced regional and global trends. As a share of the total output in Western Europe, information services in Ireland has increased from 5.8% in 2011 to 11.9% in 2018. In the same period, Ireland has increased its global share of sales output from 1.7% to 3.2%[11]. Employment in Ireland's information services sector has grown from 48,500 in 2011 to 83,000 in 2018 (a CAGR of 8%). In the same period, IT jobs as a share of all jobs in Ireland has increased from 2.5% to 3.6%[12].

In January 2016, Facebook announced its plan to expand its presence in Ireland and open a data centre near the village of Clonee in County Meath, approximately 16 km outside of Dublin. The addition of the Clonee data centre has added to the already vibrant and growing information services industry in the country. Facebook's presence also adds to the economic growth that County Meath has experienced in recent years. In 2011–16, the population in the county grew by 5.9%, slightly higher than neighbouring County Dublin (5.7%). Ireland has the youngest population in the EU – its 2017 population growth was five times higher than the EU, which has helped to provide a reliable labour market in the country. Employment in County Meath increased by 6.1%, while unemployment figures have decreased by 35.0% from 2011 through 2016[13].

11. Comparative Industry Service, IHS Markit 18 April 2019
12. Cso.ie StatBank: Persons aged 15 years or over in employment by NACE
13. Cso.ie StatBank: Population aged 15 years and over (Number) by Sex, Province County or City, Principal Economic Status and Census Year

Figure 4

Ireland's output in IT sector relative to Western Europe and World, 2011–18



Source: IHS Markit

Facebook spending in Ireland and its economic contribution

Table 5

Clonee Data Centre expenditure timeline

(millions of euros)	2015	2016	2017	2018	Average
Construction	2	134	229	231	149
Equipment	0	6	102	2	27
Other	11	91	63	17	45
Operations	1	5	7	14	7
Total	**15**	**236**	**401**	**264**	**229**

Source: IHS Markit

Construction on Facebook's Clonee Data Centre began in 2015. The site became operational in 2018 and in 2019, Facebook announced its plans to nearly double the size of the Clonee campus. As of 2018, Facebook supported 500 full-time workers at its Clonee campus. Facebook's Clonee campus directly spent €912 million on Irish-sourced goods and services, supporting a total 1,316 jobs[14] per year in Ireland.

- From 2015 through 2018, Facebook spent €596 million on construction activities, averaging €149 million a year.
- Clonee Data Centre purchased €108 million in equipment from Irish vendors during the construction period.
- Purchases of additional supporting goods and services totalled €209 million.

Facebook directly spent €912 million on Irish-sourced goods and services, supporting a total of 1,316 jobs per year in Ireland.

14. 1,316 jobs are data centre supported only and do not include any contributions related to the Dublin headquarters' activities.

Table 6

Facebook cumulative economic contributions in Ireland, 2015-18 (millions of euros)

	Sales activity	Contribution to GDP	Labour income	Employment per year
Direct	€ 912	€ 303	€ 217	669
Indirect	€ 424	€ 177	€ 97	373
Induced	€ 204	€ 118	€ 44	274
Total	**€ 1,541**	**€ 599**	**€ 358**	**1,316**

Source: IHS Markit

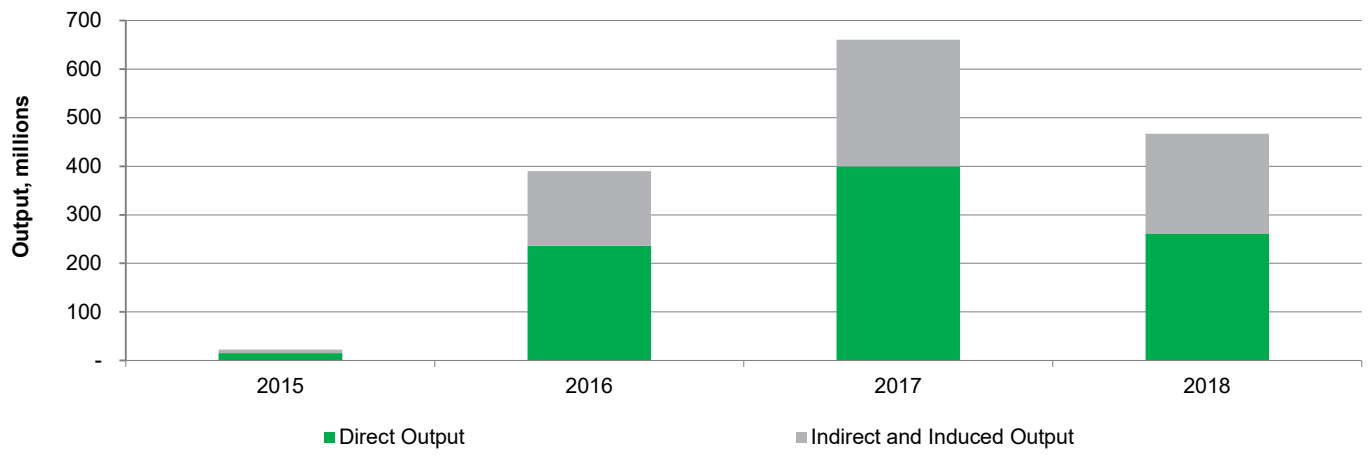
Facebook's direct expenditures stimulated a total of €599 million of Irish GDP and €358 million of labour income from 2015 through 2018.

In 2015–18, Facebook's total spending of €912 million led to an additional €628 million of indirect and induced sales. The total of €1.5 billion indicates a multiplier of 1.7 relative to Facebook's direct spending.

- During the same period, Facebook stimulated contributions of €599 million to Irish GDP (an annual average of €150 million). Thus, nearly two-thirds of Facebook's direct spending was eventually converted to Irish GDP.
- The direct and follow-on economic activity attributable to Facebook helped support 1,316 jobs annually. These workers earned an approximate average annual wage of €68,002 in 2015–18 – 1.7 times more than the 2018 countrywide average annual earnings of €38,871[15]. The high average earnings were driven by Facebook's transactions with industries like manufacturing and legal and accounting activities, where workers typically earned higher wages.
- Facebook employees' salaries were 2.1 times higher than the national average.
- Irish businesses also benefited from the construction and operations of Facebook's Swedish and Danish data centres, supplying €107.9 million in goods and services to Facebook's other European facilities.

Figure 5

Facebook data centres' impact on output (sales activity) in Ireland, euros



Source: IHS Markit

15. Central Statistics Office, Average Annual Earnings and Other Labour Costs by NACE Rev 2 Economic by Sector, Type of Employment, Statistical Indicator and Year

Construction and wholesale trade experienced the most economic benefit from Facebook's spending activity in Ireland:

- Facebook spending stimulated a total of €721 million of sales activity and €188 million of GDP in the construction sector[16]. This spending supported an annual average of 548 jobs paying an average salary of €85,303 – more than double the national average in the construction sector . In 2017, Facebook-related construction activity accounted for 2% of all sales in the Irish construction sector[17].

- In the wholesale and retail trade sector, Facebook spending drove €210 million of sales activity, €79 million of GDP, and €40 million of labour income. For every €100 Facebook spent in Ireland, approximately €19 of sales activity occurred in the wholesale trade sector.

In 2017, Facebook related construction activity accounted for 2% of all sales in the Irish construction sector.

Table 7

Facebook economic impacts in Ireland by industry, 2015–18

	Sales activity	Contribution to GDP	Labour income	Employment per year
Construction	€ 721	€ 188	€ 187	548
Manufacturing	€ 210	€ 79	€ 40	110
Wholesale and retail trade; repair of motor vehicles and motorcycles	€ 175	€ 81	€ 33	193
Professional, scientific and technical activities	€ 78	€ 55	€ 33	112
Real estate activites	€ 65	€ 44	€ 1	5
All other Industries	€ 292	€ 151	€ 64	347
Total	**€ 1,541**	**€ 599**	**€ 358**	**1,316**

Source: IHS Markit

16. Central Statistics Office, Average Earnings, Hours Worked, Employment and Labour Costs by Type of Employee, Economic Sector
17. Central Statistics Office, Average Earnings, Hours Worked, Employment and Labour Costs by Type of Employee, Economic Sector

Shutterstock/badahos: 1633196

Denmark
Odense Data Centre

About Odense

In January of 2017, Facebook announced its decision to locate a data centre in Odense, Denmark, the country's third-largest city with a 2018 population of 202,300. Located in the region of Syddanmark and the province of Fyn (Funen), Odense is an important commercial centre in a region that is rich in history and culture. In the past decade, employment in the Odense region has grown at a slightly faster pace than Denmark as a whole. In 2017, three major industry groups accounted for 73% of jobs in Odense: public administration, education, and health (37%); trade and transport (25%); and other business services (12%).

Odense is a city in transition. Once the largest employer in the city, the Odense Steel Shipyard – where many of the worlds' largest containerships were built – closed in 2009. Since then, the city has focused on transitioning from its industrial heritage towards a high-technology economic base, including robotics, health technologies, and information services[18]. By 2017, information and communication services accounted for 4.4% of jobs in the region compared with 3.7% for all of Denmark. The higher concentration of information talent in Odense made it a logical choice to locate a Danish data centre.

18. http://investinodense.dk/

Facebook spending in Denmark and its economic contribution

Facebook announced breaking ground at its Odense Data Centre in 2017. Between 2016 and 2018, Facebook spent €554 million on construction services from Danish businesses, averaging €185 million a year. Danish vendors benefitted from a total of €17.3 million in wholesale and equipment sales associated with all three of Facebook's European data centres from 2013 to 2018, averaging €2.9 million per year. Approximately 22.5% of those sales (a total of €3.9 million) were for goods and services used for the Swedish and Irish data centres. An additional €19.6 million in goods and services, such as legal and managerial services, were purchased from Danish vendors for the Odense campus, averaging €6.5 million per year.

Of the total €599 million Facebook directly spent for Danish goods and services for its Odense campus, Facebook stimulated €1.2 billion of combined direct, indirect and induced sales activity in Denmark in 2016–2018, a multiplier of about 2.0.

Table 8

Odense Data Centre expenditure timeline

(millions of euros)	2016	2017	2018	Average
Construction	0	196	358	185
Equipment	2	11	1	5
Other	1	12	6	7
Operations	5	1	6	4
Total	**8**	**220**	**371**	**200**

Source: IHS Markit

While Odense Data Centre is not yet serving traffic, by year-end 2018, Facebook's total local expenditures on construction, equipment, and services from Danish vendors came to €599 million and the campus supported 179 on-site workers.

Of the total €599 million Facebook directly spent for Danish goods and services for its Odense campus, Facebook stimulated €1.2 billion of combined direct, indirect, and induced sales activity in Denmark in 2016–18, a multiplier of about 2.0. Of this, indirect spending, also known as supply chain spending, totalled €362 million from 2016 through 2018. The economic activity stimulated by Facebook ultimately drove a cumulative €517 million of Danish GDP, €315 million of labour income, and supported 1,843 jobs per year.

In 2016–18, Facebook stimulated an average of €172 million of GDP per year.

- In the same time frame, Facebook drove an annual average of €105 million of labour income and supported more than 1,800 jobs per year.
- Jobs stimulated by Facebook spending earned wages of €56,923 on average in 2011–18 – 2.3 times higher than the 2017 national average and 2.6 times higher than the average in Odense in 2017[19].

19. INDKP101: Income for people (14 years +) by region, unit, sex and type of income, statistikbanken.dk

Table 9

Facebook cumulative economic contributions in Denmark, 2016-18 (millions of euros)

	Sales activity	Contribution to GDP	Labour income	Employment per year
Direct	€ 599	€ 223	€ 157	905
Indirect	€ 362	€ 171	€ 102	557
Induced	€ 228	€ 123	€ 55	381
Total	**€ 1,189**	**€ 517**	**€ 315**	**1,843**

Source: IHS Markit

As the campus is still in its infancy, the bulk of economic contributions for the Odense data centre are strongest in the construction industry and its supply chain industries, including wholesale and retail trade and manufacturing.

- Facebook's 2016–18 spending in Denmark drove a total of €583 million of sales activity and €212 million of GDP in the construction sector. Facebook's demand for construction services accounted for 1.1% of all sales activity in Denmark's construction sector in 2018[20].

- Cumulative sales activity in the wholesale and retail trade sector totalled €126 million and stimulated €67 million of GDP and €42 million of labour income. The interdependence between construction and wholesale trade is strong in Denmark. For every €100 Facebook spent with construction suppliers in Denmark, €10 was re-spent in the wholesale and retail trade sector on locally sourced inputs and supplies. Construction firms spent a total of approximately €54 million with the wholesale trade sector to fulfil Facebook's orders.

- Manufacturers benefitted from Facebook-driven construction activity. Sourcing of Danish fabricated metals, machinery, equipment, and electronics products by Facebook and its vendors lead to €108 million of sales activity in 2016–18. These sales stimulated €38 million of GDP and supported 131 manufacturing jobs per year on average.

Table 10

Facebook economic impacts in Denmark by industry, 2016–18

	Sales activity	Contribution to GDP	Labour income	Employment per year
Construction	€ 583	€ 212	€ 154	894
Wholesale and retail trade; repair of motor vehicles and motorcycles	€ 126	€ 67	€ 42	298
Manufacturing	€ 108	€ 38	€ 24	131
Professional, scientific and technical activities	€ 85	€ 42	€ 32	136
Real estate activites	€ 65	€ 43	€ 4	21
All other Industries	€ 223	€ 115	€ 59	364
Total	**€ 1,189**	**€ 517**	**€ 315**	**1,843**

Source: IHS Markit

20. Comparative Industry Service, IHS Markit, 17 January 2019

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Facebook's sustainability impact

Partnerships for sustainable solutions

Facebook's company mission is to give people the power to build community and bring the world closer together. Facebook's approach to sustainability is to minimise the impact of its energy usage, water usage, and emissions as it strives to create and maintain partnerships with others to achieve its sustainability goals.

Facebook invests in operational and market-based solutions to reduce its overall energy footprint, and add renewable energy capacity to the grids surrounding each of its data centres, and prioritise water stewardship.

All of Facebook's European data centres earn LEED Gold certification, a globally recognised standard for sustainability.

Climate change

As climate change dominates global conversations on challenges for the future, Facebook has undertaken major efforts to reduce its own impact on greenhouse gas emissions. The company has set a science-based target to reduce its global greenhouse gas emissions by 75% in 2020, which corresponds with the EU's 2020 and 2030 targets to cut emissions by 20% and 40%, respectively, from 1990 levels. Worldwide, Facebook reduced its greenhouse gas emissions by 44% between 2017 and 2018.

All of Facebook's European data centres earn LEED Gold certification, a globally recognised standard for sustainability.

Power usage effectiveness (PUE)

"…is defined as the ratio of total data centre input power to IT load power...The ideal case is [a] value [is] 1, which indicates the maximum attainable efficiency with no overhead energy." The ideal case is not attainable at present due to the consumption of electricity by UPS, fans, pumps, transformers, lighting and other auxiliary equipment in addition to the consuming IT Load."

—European Commission JTC

Energy efficiency

Facebook has made continuous efforts to optimise its annual data centre power usage effectiveness (PUE) and reported a global average PUE of 1.11 across all operating data centres. Facebook utilises two types of cooling technologies in its European data centres: direct air cooling in its Luleå Data Centre and indirect adiabatic cooling in Clonee and Odense Data Centres. Facebook's Odense Data Centre uses an indirect air cooling system that is also fitted with heat recovery infrastructure[21], so it can operate in either indirect air cooling mode or heat recovery mode.

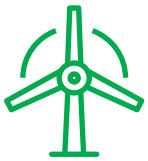
Renewable energy approach

Facebook is investing in energy solutions across its operations to reduce its energy footprint. The company was one of the first tech companies to support its facilities with renewable energy and has set an aggressive goal to support its operations with 100% renewable energy in 2020. Facebook has already made significant strides in achieving this goal. In 2018, the company achieved 75% renewable energy of final energy consumption – in line with the EU's overall 2020 and 2030 targets to achieve 20% and at least 32%, respectively, of final energy consumption from renewable energy. To achieve these renewable energy goals, Facebook has engaged in long-term (more than 10 years) commercial commitments – mainly in the form of PPAs – thereby enabling the addition of new renewable energy capacity to the same electric grid used by each new data centre. This commitment has ensured that Facebook's European data centres are 100% supported by clean and renewable energy.

In 2018, Facebook was the largest corporate buyer of renewables in the world, accounting for 19.4% of corporate worldwide clean-power deals[22].

21. The heat recovery project is unique to Odense. It was made possible due to a close collaboration between the local district heating company Fjernvarme Fyn, its existing district heating network, and Facebook.

22. https://www.bloomberg.com/news/articles/2019-01-28/corporations-hunger-for-clean-power-has-never-been-bigger



Facebook European data centres are supported 100% by clean and renewable energy.

Regional energy solutions

Facebook's European data centres are 100% supported by clean and renewable energy, ranging from wind farms in Ireland to hydroelectric facilities in Sweden.

Facebook ensures that the data centres are supported by renewable energy by purchasing electricity within the same grid region as each campus. For example, the Nordic electric grid and associated Nord Pool market, which includes the Baltics, Denmark, Finland, Norway, and Sweden, is a mature and highly liquid market with high levels of interconnection resulting in an efficient regional network and market. Purchasing renewable energy within this market ensures that generation resources are optimised across countries to the benefit of all consumers and the environment.

A Nordic example: powering Odense and Luleå with renewable resources

A recent Facebook commitment enabled Luxcara, an asset management firm, to investment in two wind farms in Norway as part of Facebook's Nordic Renewable Energy Solution. To support renewable power at its facilities in Odense and a portion of Luleå facilities, Facebook entered 15-year power purchase agreements to receive 100% of the energy from the two new wind projects, Eikeland-Steinsland and Gravdal Skinansfjellet. The two wind power projects are known collectively as the Bjerkreim cluster and will add 294MW of renewable capacity to the Nordic grid[23].

Facebook's commitment in the form of two long-term power purchase agreements enabled the financing, construction, and long-term operation of a €400-million investment in the Bjerkreim cluster. The Bjerkreim cluster is expected to be fully online by first quarter 2020 and output will be allocated to provide 100% renewable energy to Facebook's newest data centre buildings.

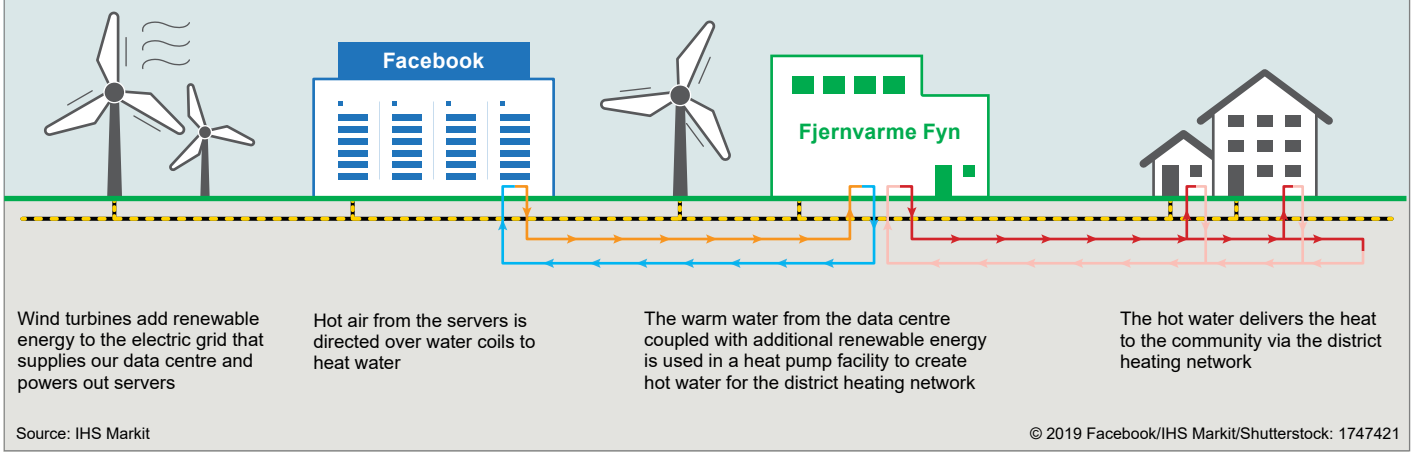
Clonee's green power purchase agreements

In 2016, Facebook entered into a long-term renewable energy supply agreement with Brookfield Renewable Ireland. Brookfield agreed to supply Facebook's Clonee Data Centre and Facebook's Ireland offices, which also include Facebook's international headquarters in Dublin, with a 100% renewable energy supply. Brookfield's Irish operational portfolio consists of 378MW of onshore wind located in the Republic of Ireland, which enables Facebook to power its Irish sites with 100% renewable locally sourced energy [24]

23. Reference details: https://www.facebook.com/notes/lule%C3%A5-data-centre/facebooks-newest-nordic-renewable-energy-solution/1597617336973615/
24. Reference: https://www.rte.ie/news/ireland/2018/0914/993768-facebook-data-centre/

Figure 5

Odense Data Centre: Heat recovery process



Source: IHS Markit

Heat recovery

In addition to its renewable power purchases, Facebook is collaborating with the district heating company, local to Odense, Denmark, to develop heat recovery infrastructure. The goal of the heat recovery infrastructure is to recover excess heat from Facebook's data centre in Odense and donate the recycled heat back to the community. Energy will be recovered from Facebook's servers and upgraded by a newly constructed heat pump facility. The heat recovery infrastructure is anticipated to enable the recovery of 100,000 MWh of energy per year – enough heat to warm 6,900 homes. The Bjerkreim wind project will also provide sufficient electricity generation to support the heat pump facility.

Water stewardship

Facebook prioritises water stewardship across its operations and the many communities it serves. Its data centres are among the most water-efficient in the world and the company makes its water efficiency data publicly available for all its data centre sites. Facebook invests in circular systems that reuse water as many times as possible before discharging it to wastewater treatment plants. In 2018 alone, the company avoided 1.5 billion gallons of water use worldwide as a result of its data centre cooling designs – the equivalent of saving 18.5 million bathtubs of water.

Facebook: 1633198

Facebook's community impact

Supporting local communities

Facebook strives to support and invest in the long-term vitality of the communities in which it is located. Major community-oriented initiatives have been developed in its two operational European sites – Luleå and Clonee – which include an annual grant-giving programme that Facebook operates at all its sites globally. The Community Action Grant Programme provides grants for high-impact projects that address a range of needs within the communities where Facebook locates its data centres. The programme's goal is "to address needs in the communities by putting the power of technology to use for community benefit, connecting people online or off, and improving STEM education". The Facebook Community Action Grants Programme commences as each data centre campus comes online.

Luleå Community Action Grants Programme

49 Grants awarded totalling €428,466 (2014–18)

The Luleå grants programme is the most mature of the European programmes, having been operational annually since 2014. Since then, Facebook has provided grants for public and private non-profit projects in the Luleå municipality. Since the inception of the Luleå programme, Facebook has provided 49 grants to groups such as Luleå Makerspace, Teknikens Hus, and Ung Scen Norr, as well as many local schools. Between 2014 and 2018, Facebook awarded €428,466 (SEK4 million) in grants.

Several grant recipients are highlighted below:

Luleå Makerspace

Luleå Makerspace is an independent community for kids to create and manifest ideas using technology. Coding is described as a tool to realise the idea, rather than the core rationale being to "teach code". Makerspace first applied for the first Community Action Grants in 2014 and has been awarded a total of €54,006 (SEK443,775) by Facebook to date. Grants received by Luleå Makerspace were used to test different forms of activities and arrangements to increase young people's interest in digital creation and programming. The organisation has a special focus on finding activities to attract girls to the program, such as combining traditional crafts with digital technology, with a long-term goal of encouraging more girls to consider the technology industry. The grants were used to purchase tools and computers for student use.

VildaKidz (Wild Kids)

VildaKidz is a non-profit association that creates activity days for children in one of four areas: technology, environment, culture, and nature. Examples of activities include technology learning days, snowmobile safaris, trips to the cinema, and visits to Facebook facilities. Children who participate in this program come from a variety of backgrounds, with 50% prioritised inclusion of children from sick, disabled, or otherwise vulnerable backgrounds. VildaKidz has received funding from Facebook since 2017 and grants have helped the organisation reach more than 20,000 children since its inception in 2015. To date, VildaKidz has received €66,933 (SEK550,000) in Community Action Grant funds. VildaKidz has received several national awards over the years.

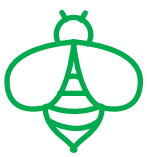
Teknikens Hus

Teknikens Hus is a science centre for children located in Luleå, founded by Luleå University of Technology to promote science and technology at an early age. The organisation provides education to children and adults, collaborating with Luleå Technical University to provide teacher training, as well as family friendly learning activities. Teknikens Hus creates a learning environment that helps children and adults solve complex technology and science-based problems. Facebook's Community Action Grant has provided a total of €92,624 (SEK 761,112) for its Science Club after-school programming courses since 2014. As one of the core industries in the region, Facebook also partners with the Science Centre on a physical display of the Luleå Data Centre facilities, which are seen by more than 100,000 visitors per year as part of the permanent exhibition.

Clonee pollinator initiative

Facebook's approximately 200-hectare Clonee data centre campus is peripherally located to a farming area in County Meath, Ireland. During construction in 2016 and 2017, Facebook learned that one-third of Ireland's bee species were being threatened with extinction because of the reduced availability of food sources and safe nesting sites. In support of the local community and Ireland's National Biodiversity Data Centre's Pollinator Plan, Facebook initiated an expansion of local native plant diversity on-site and implemented an on-site beekeeper program.

Facebook's beekeeper program now includes 10 hives and houses more than 500,000 bees. Each hive is tended to by at least three employees and outreach training encourages employees, contingent workers, and vendors to set up their own bee hives. In a nation-wide effort to increase pollinators' presence to benefit local farmers' crop yields, Facebook received accreditation as a business supporter of the All-Ireland Pollinator Plan.



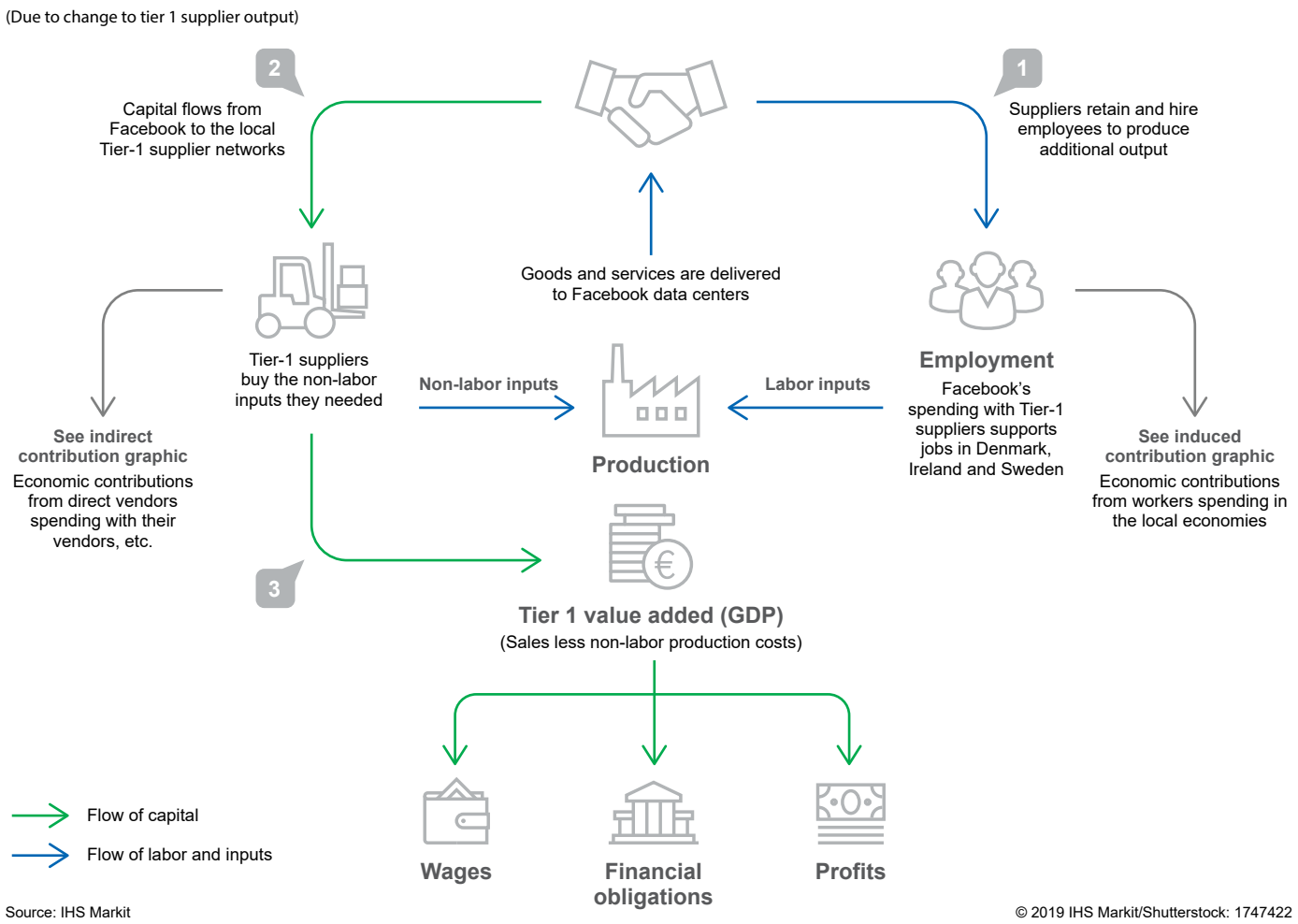
Clonee Pollinator Initiative
10 hives & 500,000 bees

Appendix A
Methodology statement

Economic Contribution Analysis methodology

The goal of this Economic Contribution Analysis study was to comprehensively assess how Facebook's construction and ongoing operations of its data centres affect the broader economies of three European countries: Denmark, Ireland, and Sweden. IHS Markit assessed Facebook's economic contributions within three domains. The first domain focused on the value generated by Facebook's direct construction and services-related activities in the three countries. The second domain assessed the supply chain effects that were stimulated by Facebook's direct transactions with local suppliers and service providers, which initiated a cascade of activity known as indirect impacts. The third domain captured contributions that were induced by Facebook employees and supply chain workers spending portions of their incomes in the local economy. These three domains, when combined, quantify the contribution of Facebook to the Danish, Irish, and Swedish economies.

The tier 1 contribution cycle



Domain 1: The Contribution of Facebook's spending with local suppliers

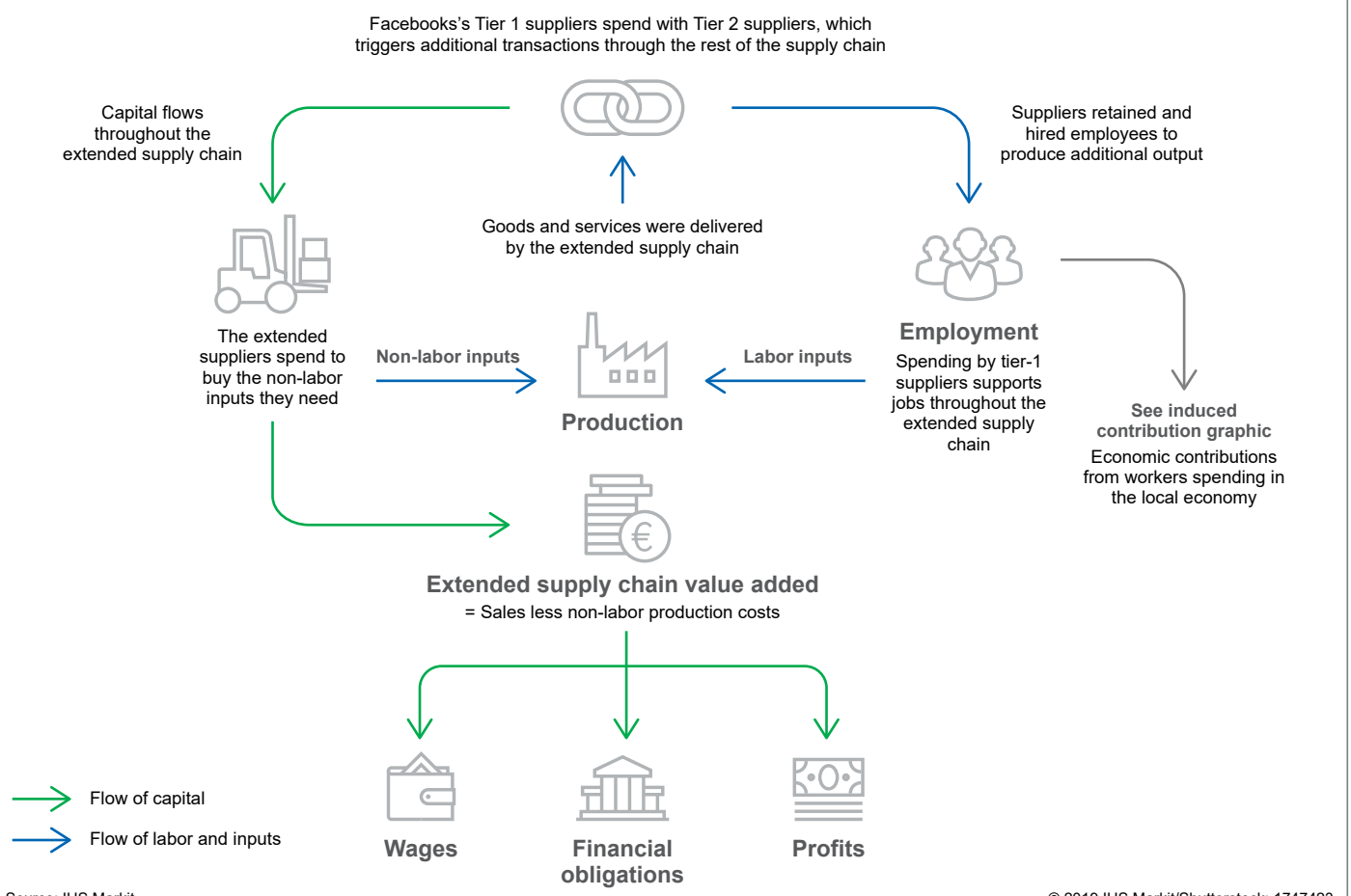
Facebook's business transactions with local suppliers and service providers serve as catalysts that trigger a flurry of economic activity throughout extended supply chains in each country. For example, when a supplier sells a product or service to Facebook, that supplier needs to hire employees to transform inputs (raw materials, energy, intellectual capital, etc.) into the final product or service for which Facebook has paid. The supplier must also source required inputs from other suppliers.

The models developed by IHS Markit assessed Facebook's tier 1 and extended supply chain economic footprint across 56 industry sectors (please refer to industry sector table in the Model Specifications section). The model was built using data from the World Input-Output database (WIOD), which is a research initiative sponsored under the European Commission's Seventh Framework Programme. The WIOD data was supplemented by employment, value added, and wage data from the WIOD's Socio-economic Accounts (SEA). The IHS Markit model was built using input-output techniques that link the flow of inter-industry and consumer transactions in a social accounting matrix. This structure provides a foundation upon which the models were built that traced how sales in one industry sector stimulate sales and economic activity across an array of supplying sectors.

Domain 2: Extended supply chain effects

The extended supply chain contribution cycle

(Due to change to extended supply chain output)



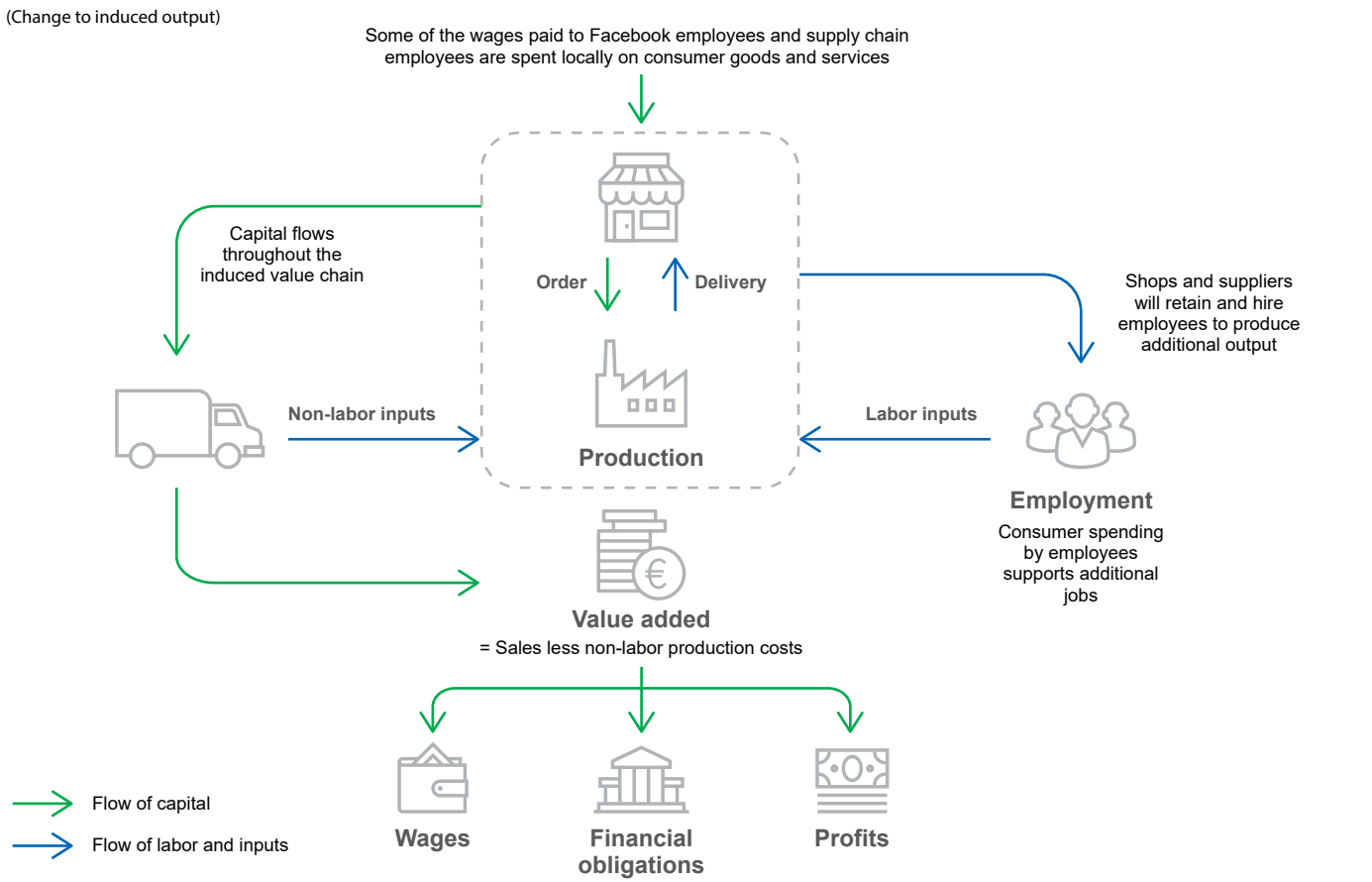
Source: IHS Markit

Tier-1 suppliers must source the inputs required to produce the products or services ordered by Facebook, thereby invoking additional rounds of economic impact. Referring to the graphic above when a tier-1 supplier makes a sale to Facebook, that supplier must then purchase the inputs (supplies and services) needed to produce the final product. Some purchases made for the construction and operations of its data centres are imported from outside the economies of Denmark, Ireland, and Sweden, and as such, were excluded from the analysis. The remaining purchases, which represent sales for local businesses, remain within the three economies. To produce goods and services for Facebook, each supplier must hire employees and source additional inputs from its suppliers. This dynamic occurs repeatedly throughout Facebook's extended local supply chain. Because this activity was not the result of any direct transactions between Facebook and its tier-1 suppliers, they were classified as "indirect" impacts.

Domain 3: Induced contributions

Finally, employees of Facebook, the tier-1 suppliers, and the extended suppliers spend a portion of their salaries in the local economy on consumer goods and services. This stimulates additional rounds of economic activity, which results in "induced" impacts on employment, value added, and so on. IHS Markit assumed the marginal household consumption pattern would be consistent with the distribution of household final demand by industry sector as reported in the WIOD data. Using the WIOD SEA productivity data, IHS Markit determined the corresponding number of employees supported by this consumer activity within each industry sector.

Wage effects contribution cycle: induced sales transactions



Source: IHS Markit

Industry sectors included in the IHS Markit Economic Impact Model

Code	ISIC Rev. 4	Description
1	A01	Crop and animal production, hunting and related service activities
2	A02	Forestry and logging
3	A03	Fishing and aquaculture
4	B	Mining and quarrying
5	C10-C12	Manufacture of food products, beverages and tobacco products
6	C13-C15	Manufacture of textiles, wearing apparel and leather products
7	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
8	C17	Manufacture of paper and paper products
9	C18	Printing and reproduction of recorded media
10	C19	Manufacture of coke and refined petroleum products
11	C20	Manufacture of chemicals and chemical products
12	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
13	C22	Manufacture of rubber and plastic products
14	C23	Manufacture of other non-metallic mineral products
15	C24	Manufacture of basic metals
16	C25	Manufacture of fabricated metal products, except machinery and equipment
17	C26	Manufacture of computer, electronic and optical products
18	C27	Manufacture of electrical equipment
19	C28	Manufacture of machinery and equipment n.e.c.
20	C29	Manufacture of motor vehicles, trailers and semi-trailers
21	C30	Manufacture of other transport equipment
22	C31_C32	Manufacture of furniture; other manufacturing
23	C33	Repair and installation of machinery and equipment
24	D35	Electricity, gas, steam and air conditioning supply
25	E36	Water collection, treatment and supply
26	E37-E39	Sewerage; waste collection, treatment and disposal activities; materials recovery, other waste management services
27	F	Construction
28	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
29	G46	Wholesale trade, except of motor vehicles and motorcycles
30	G47	Retail trade, except of motor vehicles and motorcycles
31	H49	Land transport and transport via pipelines
32	H50	Water transport
33	H51	Air transport
34	H52	Warehousing and support activities for transportation
35	H53	Postal and courier activities
36	I	Accommodation and food service activities
37	J58	Publishing activities
38	J59_J60	Motion picture, video and television programme production, sound recording/music publishing activities; programming/broadcasting activities
39	J61	Telecommunications
40	J62_J63	Computer programming, consultancy and related activities; information service activities
41	K64	Financial service activities, except insurance and pension funding
42	K65	Insurance, reinsurance and pension funding, except compulsory social security
43	K66	Activities auxiliary to financial services and insurance activities
44	L68	Real estate activities

Table continued overleaf

Continued: Industry sectors included in the IHS Markit Economic Impact Model

Code	ISIC Rev. 4	Description
45	M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities
46	M71	Architectural and engineering activities; technical testing and analysis
47	M72	Scientific research and development
48	M73	Advertising and market research
49	M74_M75	Other professional, scientific and technical activities; veterinary activities
50	N	Administrative and support service activities
51	O84	Public administration and defence; compulsory social security
52	P85	Education
53	Q	Human health and social work activities
54	R_S	Other service activities
55	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
56	U	Activities of extraterritorial organisations and bodies

Source: IHS Markit

Similarly, value-added and labour income was calculated by industry sector.

Model specifications

The WIOD transactional data is organised into an input-output (I-O) table. This is essentially a 56 X 56 matrix that organises the supply chain transactions for 56 sectors of the economy as follows:

- The 56 sectors are listed as the headers of each row and each column.
- The data in each column corresponds to the level of expenditures (on supply chain products and services as well as sectoral wages) that define a given industry sector's production function. For example, the column Sector 17 (International Standard Industrial Classification Revision 4 Code C26) shows the supply chain spending and wage expenses required for the aggregate production of Sector 17 (manufacture of computer, electronic, and optical products).
- The rows capture the income flowing into a given sector. Thus, the row for Sector 17 captures the amount that each sector spends on manufacturing of computer, electronic, and optical products. In other words, the row for Sector 17 captures the income that flows to that sector.

Using techniques that ultimately earned economist Wassily Leontief the 1973 Nobel Prize in Economics, IHS Markit transformed the I-O table into the core of the models used for the analysis. An equation for the total sales activity, or output, of an economy can be expressed as:

Total Output* = *Intermediate Purchases* + *Final Demand

- Or -

$X = AX + D$

Where:

- X represents a 56-by-1 matrix of the sectoral sales (output);
- A represents a 56-by-56 Direct Requirements Matrix (explained later in this section);

- D represents a 56-by-1 matrix of Final Demand by sector.

Solving the above equation for X yields:

$$X = (I - A)^{-1} D$$

Where:

- ***I*** represents a 56-by-56 identity matrix;
- $(I - A)^{-1}$ represents the inverse matrix of $(I - A)$.

When assessing how Facebook data centres stimulate the broader economies of Denmark, Ireland, and Sweden, the input-output approach measures how changes in Final Demand due to Facebook's purchases with local suppliers results in changes in output across multiple sectors. As shown below, the I-O table is a matrix where expenditure Xi,j represents the intermediate purchases by Sector i of inputs produced by Sector j. In addition, the I-O table provides information on the value-added factors of production (wages, capital, etc.) required to convert the intermediate inputs into final products. Thus, the sum of each column represents the total output of a given sector.

Input-Output Table

Input-Output

		Output			
		Sector 1	**Sector 2**	**...**	**Sector 56**
Income	Sector 1	$X_{1,1}$	$X_{1,2}$		$X_{1,56}$
	Sector 2	$X_{2,1}$	$X_{2,2}$	...	$X_{2,56}$
	...	...	...	...	...
	Sector 56	$X_{56,1}$	$X_{56,2}$		$X_{56,56}$
	Total output	$\sum_{i=1}^{56} X_{i,1}$	$\sum_{i=1}^{56} X_{i,2}$		$\sum_{i=1}^{56} X_{i,56}$

Source: IHS Markit

The I-O table is transformed into the Inverse Matrix in three steps. The first step is normalising the intermediate purchases portion of the I-O table. This is done by dividing each intermediate purchase cell in a given column of the I-O table by the total output of that column. The creates a Direct Input Requirements Matrix (also known as the A Matrix) that specifies the portion of a sector's output that is spent on intermediate purchases across all sectors. Thus, for every dollar of a given sector's output, the A Matrix specifies how much is spent on the required intermediate purchases by sector.

The structure of the A Matrix is shown below:

Direct Requirements Matrix (the A Matrix)

	Sector 1	Sector 2	...	Sector 56
Sector 1	$\frac{X_{1,1}}{\sum_{i=1}^{56} X_{i,1}}$	$\frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,2}}$		$\frac{X_{1,56}}{\sum_{i=1}^{56} X_{i,56}}$
Sector 2	$\frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,1}}$	$\frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,2}}$		$\frac{X_{1,56}}{\sum_{i=1}^{56} X_{i,56}}$
...				
Section 56	$\frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,1}}$	$\frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,2}}$		$\frac{X_{1,56}}{\sum_{i=1}^{56} X_{i,56}}$

Source: IHS Markit

The second step is to create the (I-A) Matrix using matrix subtraction techniques. Specifically, the A Matrix is subtracted from an Identity Matrix (a matrix in which all cells in the upper-left to lower-right diagonal are equal to "1", all others are equal to "0"). The structure of the (I-A) Matrix is shown below:

(I-A) Matrix

	Sector 1	Sector 2	...	Sector 56
Sector 1	$1 - \frac{X_{1,1}}{\sum_{i=1}^{56} X_{i,1}}$	$- \frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,2}}$		$- \frac{X_{1,56}}{\sum_{i=1}^{56} X_{i,56}}$
Sector 2	$- \frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,1}}$	$1 - \frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,2}}$		$- \frac{X_{1,56}}{\sum_{i=1}^{56} X_{i,56}}$
...				
Section 56	$- \frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,1}}$	$- \frac{X_{1,2}}{\sum_{i=1}^{56} X_{i,2}}$		$1 - \frac{X_{1,56}}{\sum_{i=1}^{56} X_{i,56}}$

Source: IHS Markit

Finally, the (I-A) matrix is inverted to create the Inverse Matrix. Given its large size, the Inverse Matrix is generated in either the IHS Markit EViews environment or in Microsoft Excel. The Inverse Matrix provides a matrix of coefficients by which changes in Final Demand by sector are matrix-multiplied to derive the corresponding changes in sector output. For this reason, the Inverse Matrix is sometimes referred to as the Coefficients Matrix.

Snapshots showing partial details of the Input-Output Table, Direct Requirements Matrix, (I-A) Matrix, and Inverse Matrix used in the economic impact models are shown on the following page.

Partial detail of the WIOD Input-Output table for Denmark

Input Output Table		1	2	3	4	5	6	7
Sector	**ISIC Code**	**A01**	**A02**	**A03**	**B**	**C10-C12**	**C13-C15**	**C16**
1	A01	1,478	12	4	0	5,102	19	2
2	A02	94	308	0	0	16	0	81
3	A03	0	0	0	0	13	0	0
4	B	35	0	0	218	97	3	1
5	C10-C12	1,180	1	46	2	3,529	70	1
6	C13-C15	5	0	0	0	14	2	0
7	C16	6	5	0	1	20	1	133

Source: Data sourced from the WIOD Programme for Denmark

Partial detail of the Direct Requirements Matrix (The A Matrix)

Direct Requirements		1	2	3	4	5	6	7
Sector	**ISIC Code**	**A01**	**A02**	**A03**	**B**	**C10-C12**	**C13-C15**	**C16**
1	A01	0.11070	0.01154	0.00495	0.00002	0.19346	0.00969	0.00079
2	A02	0.00703	0.30160	0.00001	0.00001	0.00060	0.00006	0.03969
3	A03	0.00001	0.00000	0.00013	0.00000	0.00048	0.00000	0.00000
4	B	0.00260	0.00001	0.00001	0.02467	0.00367	0.00156	0.00070
5	C10-C12	0.08836	0.00071	0.05926	0.00018	0.13382	0.03640	0.00043
6	C13-C15	0.00037	0.00004	0.00028	0.00002	0.00054	0.00080	0.00009
7	C16	0.00047	0.00529	0.00022	0.00015	0.00077	0.00055	0.06484

Note: Each sector column of the IO table is normalized using total sectoral output

Source: Data sourced from the WIOD Programme for Denmark

Partial Detail of the (I-A) Matrix

(I-A) Matrix		1	2	3	4	5	6	7
Sector	**ISIC Code**	**A01**	**A02**	**A03**	**B**	**C10-C12**	**C13-C15**	**C16**
1	A01	0.88930	-0.01154	-0.00495	-0.00002	-0.19346	-0.00969	-0.00079
2	A02	-0.00703	0.69840	-0.00001	-0.00001	-0.00060	-0.00006	-0.03969
3	A03	-0.00001	0.00000	0.99987	0.00000	-0.00048	0.00000	0.00000
4	B	-0.00260	-0.00001	-0.00001	0.97533	-0.00367	-0.00156	-0.00070
5	C10-C12	-0.08836	-0.00071	-0.05926	-0.00018	0.86618	-0.03640	-0.00043
6	C13-C15	-0.00037	-0.00004	-0.00028	-0.00002	-0.00054	0.99920	-0.00009
7	C16	-0.00047	-0.00529	-0.00022	-0.00015	-0.00077	-0.00055	0.93516

Note: A Matrix in subtracted from the Identity Matrix

Source: Data sourced from the WIOD Programme for Denmark

Partial Detail of the Inverse Matrix (Coefficients Matrix)

Inverse Matrix		1	2	3	4	5	6	7
Sector	ISIC Code	A01	A02	A03	B	C10-C12	C13-C15	C16
1	A01	1.15088	0.02049	0.02156	0.00026	0.25761	0.02107	0.00271
2	A02	0.01186	1.43265	0.00045	0.00006	0.00377	0.00045	0.06099
3	A03	0.00007	0.00001	1.00017	0.00000	0.00058	0.00002	0.00000
4	B	0.00973	0.00412	0.01412	1.02713	0.00918	0.00449	0.00503
5	C10-C12	0.11846	0.00506	0.07159	0.00043	1.18193	0.04510	0.00223
6	C13-C15	0.00051	0.00009	0.00035	0.00002	0.00075	1.00085	0.00012
7	C16	0.00166	0.00873	0.00138	0.00041	0.00174	0.00111	1.07055

Note: A Matrix in subtracted from the Identity Matrix

Source: Data sourced from the WIOD Programme for Denmark

To generate the tier 1 and extended supply chain economic contribution results, the changes in Final Demand, D, correspond with Facebook's direct spending with tier-1 suppliers. The changes in sectoral output that are calculated via matrix multiplication, known and the Type I effects, include the combined tier-1 and extended supply chain effects. Therefore, to isolate the sectoral extended supply chain results, the tier-1 results (that is, Facebook's direct spending by sector) must be subtracted from the Type 1 sectoral results. The induced effects were calculated in an iterative process that assumed a portion of the wages generated by each round of economic stimulus would re-enter the local economy with a pattern that was consistent with the sectoral distribution of household final demand reported in the WIOD data.

The WIOD SEA data provide the relationship between sector output and other key economic metrics such as employment, wages, and total-value added. The results, changes in direct, indirect, and induced sector output are multiplied by the corresponding sector ratio to generate the employment, labour income, and total value-added results.

Appendix B

Exchange rates

Exchange rates, average annual								
Currency	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
SEK/USD	6.50	6.78	6.51	6.86	8.43	8.56	8.55	8.69
DKK/USD	5.36	5.79	5.62	5.62	6.73	6.73	6.60	6.31
EUR/USD	0.72	0.78	0.75	0.75	0.90	0.90	0.89	0.85
GBP/USD	0.62	0.63	0.64	0.61	0.65	0.74	0.78	0.75
DKK/EUR	7.45	7.44	7.46	7.45	7.46	7.45	7.44	7.45
SEK/EUR	9.03	8.71	8.65	9.10	9.35	9.47	9.63	10.26
GBP/EUR	0.87	0.81	0.85	0.81	0.73	0.82	0.88	0.88

Note: IHS Markit calculation using data from IHS Markit

Source: IHS Markit Country Exchange Rate and CPI Tables

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