SIZING THE VALUE OF DIGITAL TRADE

Methodological appendix

October 2018

DETAILED METHODOLOGY

This document provides a detailed methodology on the assumptions and sources of information used in the AlphaBeta research on quantifying the current and future potential value of digital trade in terms of exports and productivity benefits for domestic sectors for the following countries:

- Australia
- China
- India
- Indonesia
- Japan
- Malaysia
- Philippines
- Vietnam

This document is structured into two sections:

1. Sizing the digital trade-related economic opportunities in domestic sector
2. Estimating the value of digital exports

1. Sizing the economic benefits of digital trade to domestic sectors

A five-step methodology is used to understand the benefits created by digital trade to domestic economies in 2017 and in 2030 (Exhibit A1).

EXHIBIT A1

A five step methodology is used to understand the benefits created by digital trade to domestic economies in 2017 and in 2030

	Step 1	Step 2	Step 3	Step 4	Step 5
	Align on digital technologies	Align on focus sectors	Identify relevant technology applications in focus sectors	Understand role of digital trade	Size the value today and in 2030
Activities	Identify key digital technologies that the academic literature has shown to be important for driving business and consumer value	Identify key sectors of the economy, based on relevance of those technologies and their importance for overall jobs and GDP	Understand relevant technology applications in focus sectors, including sources of value (e.g. application of internet of things technology to the agriculture supply chain to reduce wastage)	Assess importance of digital trade for those digital applications, and short-list applications to be sized	Estimate the value (in local currency terms) of these technology applications in each sector, in 2017 (based on current adoption) and in 2030 (based on assessed potential linked to benchmarks)
Methodology	Industry reports – e.g., McKinsey Global Institute, WEF Digital 4.0	Technology reports to identify sector-impact of technologies; local country data for importance of sectors to GDP, jobs	Review of sector-level technology reports	Based on criteria for assessing importance of digital trade given nature of technology application	Case studies, with top-down “sanity check” based on comparison to other research reports on overall value of technologies

Step 1: Align on digital technologies

Several existing research reports on current and emerging digital technologies were reviewed to identify the most relevant technologies to focus on for this analysis in terms of their potential economic impact. For example, McKinsey Global Institute (MGI) has identified 12 disruptive technologies, of which six (mobile internet, cloud technology, internet of things, automation of knowledge work, advanced robotics, and 3D printing) have a strong digital component.[1]

Step 2: Align on focus sectors

To understand the current and potential economic of these digital technologies, a set of focus sectors need to be identified. Sectors were selected based on three criteria:

1. Importance for GDP (proxied by the sector's share of national GDP in the focus countries);
2. Importance for employment (proxied by the sector's share of employment in the focus countries); and
3. Relevance for digital technologies (based on past research quantifying the potential sector benefits of these digital technologies in the focus countries).[2]

Based on these criteria, 8 sectors were identified:

- Infrastructure (including utilities such as energy and water)
- Food and agriculture (including food manufacturing)
- Consumer and retail services
- Manufacturing (other than food)
- Financial services
- Healthcare
- Education and training
- Resources (including mining and oil & gas)

"Transport and logistics" (which are covered under infrastructure and manufacturing) and "Media, telecommunications, and technology" (which cut across many sectors) were excluded as focus sectors given the technology applications of relevance to those sectors overlap with many other sectors.

Step 3: Identify relevant technology applications in focus sectors

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[1] McKinsey Global Institute (2013), *Disruptive technologies: Advances that will transform life, business, and the global economy*. Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies

[2] This was based on a range of reports. See for example, McKinsey Global Institute (2014), *Southeast Asia at the crossroads: Three paths to prosperity* (Available at: https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Asia%20Pacific/Three%20paths%20to%20sustained%20economic%20growth%20in%20Southeast%20Asia/MGI%20SE%20Asia_Executive%20summary_November%202014.ashx); and McKinsey Global Institute (2014), *India's tech opportunity: Transforming work, empowering people* (Available at: https://www.mckinsey.com/industries/high-tech/our-insights/indias-tech-opportunity-transforming-work-empowering-people).

Relevant technology applications in the focus sectors and their sources of value (e.g. reduced wastage in production, enhanced consumer offerings) were identified based on a detailed review of the academic literature for each of the focus technologies. These technology applications include tangible drivers of business value, such as the use of remote patient monitoring to enable hospital-level care in homes through use of advanced sensors, smart medical devices, and robotics. A list of these technology applications is shown below in Exhibit A2.

EXHIBIT A2

A range of technology applications were identified across the focus sectors

Longlist of technology applications by sector

FINANCIAL SERVICES	**Big data analytics** improving lending risk assessment, particularly to SMEs	**Financial inclusion:** Mobile Internet supporting digital financial inclusion	**Digitizing marketing, distribution, and service:** Through internet, reducing costs and improving service delivery	**Reg tech:** AI and machine learning can enable the automation of document review, and other repetitive administrative compliance tasks			
MINING AND OIL & GAS	**Smart exploration** : Use of big data to analyse large amounts of geoscience and drilling data in order to proactively and efficiently locate probable deposits	**Predictive safety:** Wearables (hats, glasses, wristbands etc.) with in-built advanced sensors and electronic technologies can improve productivity and safety by monitoring fatigue, location, atmosphere and vitals.	**Autonomous mining equipment:** Automation of extraction and transport	**Performance monitoring:** Cloud, IoT and AI enable the prediction of production failures, detection of environmental concerns, and the optimization of asset performance,			
AGRICULTURE & FOOD	**Precision farming:** Data driven optimisation of crop and meat production	**Supply chain management:** IoT technology to help reduce supply chain waste	**Real-time market info:** Provision of real-time market information on prices	**Food safety:** Using data monitoring and analysis technique to ensure the biosecurity of food products and predict when concerns may arise			
HEALTH	**Robot assisted surgeries:** Improving the success, quality and access to surgeries with advanced robotics that have improved vision and flexibility.	**Remote patient monitoring:** Enabling hospital level care in homes through use of advanced sensors, smart medical devices and robotics.	**Telehealth:** Use of digital technologies to provide healthcare solutions in remote regions	**Data-based public health Interventions:** Use of analytics to direct highly targeted health interventions for at-risk populations	**Detection of counterfeit drugs:** Use of IoT and advanced analytics to detect counterfeit drugs	**Smart medical devices:** Analysing data across connected implants, smart medical devices and wearables can lead to personalised and predictive care.	
CONSUMER & RETAIL	**Digitizing channels:** Productivity gain of delivering retail goods through digital channel reducing labour, inventory, and real estate costs	**Inventory management:** Use of IoT to reduce stock outs					
INFRASTRUCTURE	**Smart grids:** Using digital communications technology to detect, react and optimise electricity networks.	**5D BIM and project management technologies**	**Automated construction:** The use of drone, robotics and intelligent systems to automate construction processes	**Predictive maintenance:** Using data from sensors to ensure prompt and predictive maintenance, minimising downtime.	**Smart buildings:** In response to increasing environmental pressures; physical sensor networks, energy storage and data analysis will improve the resource efficiency of buildings.	**Smart roads:** Data analytics to support dynamic road pricing	**Smart ports:** Use of IoT to enhance port efficiency
MANUFACTURING	**Big data analytics:** Use of big data analytics n demand forecasting/shaping, and supply planning	**Additive manufacturing:** Use of dynamic, resource efficient 3D printing and related technologies to enable 'on-time' manufacturing & rapid manufacturing.	**Supply chain management** : Savings in operating costs from IoT enabling supply chain management and distribution network management				
EDUCATION & TRAINING	**E-career centres and digital jobs platform:** Online platforms where job openings are posted and compatible candidate profiles are matched to available jobs based on algorithms	**Personalized learning:** Use of digital technologies to provide personalized and remote learning opportunities for students	**Online retraining programmes:** Lifelong learning opportunities delivered in digital format to help individuals gain new skills				

SOURCE: Business & Sustainable Development Commission; McKinsey Global Institute; AlphaBeta analysis

Step 4: Understand role of digital trade

The importance of digital trade for these technology applications was then assessed. This was based on four criteria:

- *Volume of data generated.* High data generation is more likely to lead to cross-border flows, in part due to storage requirements.
- *Scale requirements to draw insights.* Some forms of data (e.g. health data, mining exploration) can benefit from pooling to increase the sample of analysis.
- *Complexity of activity.* Some activities may be particularly complex, and the sharing of data across borders enables better access to the critical talent. This could include analytical talent for the analysis of data or it could relate to the use of human-guided robotics. For example, remote robotic surgery allows complex operations to be completed even when those surgeons may not be in the same country.

- *Cross-border activity.* When the activity to which the technology is being applied is itself cross-border in nature. For example, IoT monitoring of the transit of goods across countries, or the use of digital file sharing to support collaboration across countries.

The assessment was based on desktop research for each of the technology applications, complemented by expert interviews. A three-point scale was used to classify technology applications based on these four criteria:

- *Highly enabled by digital trade.* Two or more of the four criteria are relevant for the technology application.
- *Somewhat enabled.* One of the four criteria is relevant for the technology application.
- *Not enabled.* None of the four criteria are relevant for the technology application.

An assessment of the technology applications against the criteria is shown below (Exhibit A3).

EXHIBIT A3

Importance of digital trade for technology applications

■ Relevant criteria

		Criteria				
Sector	Technology application	Volume of data generated	Scale requirements	Complexity of analysis	Cross-border activity	Degree of enablement by digital trade
Health	Data-based public health interventions	■	■	■		Highly enabled
	Detection of counterfeit drugs				■	Somewhat enabled
	Smart medical devices	■	■	■	■	Highly enabled
	Robo-assisted surgeries					Not enabled
	Remote patient monitoring	■	■	■		Highly enabled
	Telehealth	■	■	■		Highly enabled
Finance	Big data analytics	■		■		Highly enabled
	Reg tech	■		■		Highly enabled
	Financial inclusion	■				Somewhat enabled
	Digitising marketing & distribution	■		■		Highly enabled
Agriculture	Precision farming	■	■	■		Highly enabled
	Supply chain management (IoT)	■			■	Highly enabled
	Food safety	■			■	Highly enabled
	Real-time market info	■	■		■	Highly enabled
Education	E-career centres & digital jobs platforms	■	■		■	Highly enabled
	Personalised learning	■	■	■	■	Highly enabled
	Online retraining programmes				■	Somewhat enabled
Consumer & Retail	Inventory management	■		■	■	Highly enabled
	Digitising channels (e-commerce)	■	■	■	■	Highly enabled
Resources	Predictive safety	■				Highly enabled
	Predictive maintenance	■		■		Somewhat enabled
	Operations management (Smart exploration & automation)	■		■		Highly enabled
Manufacturing	IoT in supply chain	■			■	Highly enabled
	Big data analytics (in forecasting)	■		■		Highly enabled
	Additive manufacturing	■			■	Highly enabled
	Robotics & automation	■		■	■	Highly enabled
Infrastructure	Predictive maintenance	■		■		Highly enabled
	Smart ports	■			■	Highly enabled
	5D BIM	■		■		Highly enabled
	Smart grids	■		■		Highly enabled
	Smart buildings	■		■		Highly enabled
	Smart roads	■		■		Highly enabled
	Automated construction					Not enabled

Step 5: Size the value today and in 2030

The value (in local currency terms) of these technology applications in each sector was then quantified in 2017 (based on current adoption) and in 2030 (based on assessed potential linked to benchmarks). A series of international and country-specific case studies were used for each technology application in the sizing. A "sanity check" of the results was then done by comparing the overall sector and economy-wide estimates with other research reports.

An example of the sizing approach for Vietnam in one technology application is shown below to illustrate the approach (Exhibit A4).[3]

EXHIBIT A4

Example: Sizing the business impact of big data applied to SME lending in Vietnam

ILLUSTRATIVE

Sector: Finance

Application: Increased revenue from higher lending to SMEs at greater margins due to the use of big data

What was measured?

- Sized based on the cost savings from lower default rates due to higher accuracy of analytics tools, as well as additional revenue through increased lending to SMEs at higher margins

Variable	Value (2017)	Value (2030)	Source/ comments
A. Total lending to SMEs	₫1,000 trillion	₫2,000 trillion	Central Bank statistics; 2030 based on growth in SME lending
B. Penetration of big data analytics in decision-making	5%	50%	Based on a FinTech adoption index developed by Ernst and Young (2017)
C. % increase in lending to SMEs due to big data analytics improving risk assessment capabilities	16%	33%	Assumptions taken from MGI report: China's digital transformation
E. % increase in margins of lending to SMEs (Post-risk)	1.4%	1.8%	Assumptions taken from MGI report: China's digital transformation
Total	**~₫100 billion**	**~₫6 trillion**	

Source: Desk research; AlphaBeta analysis

The specific assumptions and sources of information used to size each technology application in each country are shown below. The 2017 technology adoption rates for each country were estimated using a range of publicly-available sources for each country[4], from which the penetration of technology applications in different sectors was assessed. With regards to 2030 adoption rates, three criteria were used to assess the potential improvement from 2017 levels. These criteria include: the maturity of the technology currently, the degree of fragmentation in the industry landscape (which affects the technology penetration rate) and the extent of potential benefits to be reaped from digital technologies with respect to the industry status quo.

[3] Note: the numbers used in this example are illustrative and not the actual numbers used in the sizing for Vietnam.

[4] An example is the *Australian Digitisation Index* developed by MGI (2017), which examines the adoption of digital technologies in different sectors across the economy.

Health

Description	*Sizing assumptions*	*Sources*
Remote patient monitoring		
Application of remote monitoring systems to improve patient care	**2017:** Sized based on cost savings to the healthcare system through reduced hospital visits, length of patients' stays and medical procedures. MGI (2013) suggests 10-20% savings to the healthcare system from the resultant reduced hospital visits, length of patients' stays and number of procedures relating to chronic diseases. Country-level estimates based on total healthcare spend based on OECD data and the share of spend on chronic diseases and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with healthcare expenditure growing at national forecast population growth rate, and GDP growing at forecast national rates by the International Monetary Fund (IMF).	MGI (2013)[5] OECD[6] IMF[7]

[5] McKinsey Global Institute (2013), *Disruptive technologies: Advances that will transform life, business, and the global economy.* Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies

[6] OECD Health Statistics. Available at: http://www.oecd.org/els/health-systems/health-data.htm

[7] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

Description	*Sizing assumptions*	*Sources*
Telehealth		
Increasing use of internet and mobile technologies for medical consultations	**2017:** Sized based on cost savings to the healthcare system through reduced doctor visits. Goldman Sachs (2015) suggests US$100 billion savings to US healthcare from telehealth. Country-level estimates based on relative national healthcare expenditure and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with healthcare expenditure growing at national forecast population growth rate, and GDP growing at forecast national rates by the International Monetary Fund (IMF).	Goldman Sachs (2015)[8] OECD[9] IMF[10]

[8] Goldman Sachs (2015), *The digital revolution comes to US healthcare*. Available at: https://www.wur.nl/upload_mm/0/f/3/8fe8684c-2a84-4965-9dce-50584aae48c_Internet%20of%20Things%205%20-%20Digital%20Revolution%20Comes%20to%20US%20Healtcare.pdf

[9] OECD Health Statistics. Available at: http://www.oecd.org/els/health-systems/health-data.htm

[10] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

Description	*Sizing assumptions*	*Sources*
Data-based public health interventions		
Use of analytics to direct highly targeted health interventions for at-risk populations	**2017:** Sized based on the economic value of reduced disability-adjusted life years (DALYs) due to timely public health interventions. MGI (2018) indicates that the most significant and measurable impacts are on maternal and child health, as well as public sanitation and hygiene. It estimates a 0.4% reduction in DALYs for high-income countries, and 3.6% for other countries. Classification of high-income countries based on World Bank's definition. Economic value is taken to be this multiplied by GDP per capita, and is estimated based on the proportion of population suffering from chronic diseases. Country-level estimates based on national population sizes, GDP per capita and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with population growing at forecast national rate, and GDP growing at forecast national rates by the International Monetary Fund.	MGI (2018)[11] UN Population Division (2018)[12] IMF[13] World Bank[14]

[11] McKinsey Global Institute (2018), *Smart cities: Digital solutions for a more livable future.* Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future

[12] UN Population Division (2018). Available at: https://esa.un.org/unpd/wpp/DataQuery/

[13] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

[14] World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications

Description	*Sizing assumptions*	*Sources*
Detection of counterfeit drugs		
Use of IoT and advanced analytics to detect counterfeit drugs	**2017:** Sized based on the cost savings from reduced counterfeit drugs in the country due to a higher rate of detection. EU IPO (2016) estimates that the annual cost of counterfeit drugs to Europe's pharmaceutical industry is €10 billion. MGI (2013) also assesses that 30-50% of all drugs sold are addressable by this technology, and that its success rate is 80-100%. Country-level estimates of the national cost of counterfeit drugs based on the country's relative healthcare expenditure and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with healthcare spending growing at national GDP growth rates forecast by the International Monetary Fund (IMF).	EU Intellectual Property Office (2016)[15] MGI (2013)[16] OECD[17]

[15] EU Intellectual Property Office (2016), *The economic cost of IPR infringement in the pharmaceutical industry.* Available at: https://euipo.europa.eu/ohimportal/en/web/observatory/ipr-infringement-pharmaceutical-sector

[16] McKinsey Global Institute (2013), *Disruptive technologies: Advances that will transform life, business, and the global economy.* Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies

[17] OECD Health Statistics. Available at: http://www.oecd.org/els/health-systems/health-data.htm

Description	Sizing assumptions	Sources
Smart medical devices		
Analysing data across connected implants, smart medical devices and wearables can lead to personalised and predictive care	**2017:** Sized based on the economic value of reduced disability-adjusted life years (DALYs) due to health improvement measures prompted by data from such devices. MGI (2018) indicates a 1% reduction in DALYs for high-income countries, and 0.6% for other countries. Economic value is taken to be this multiplied by GDP per capita. Classification of high-income countries based on World Bank's definition. Country-level estimates based on national population sizes and GDP per capita, and is estimated based on the proportion of population suffering from chronic diseases. National estimates also differ based on technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with population growing at forecast national rate, and GDP growing at forecast national rates by the International Monetary Fund (IMF).	MGI (2018)[18] UN Population Division (2018)[19] IMF[20] World Bank[21]

Financial Services

Big data analytics

[18] McKinsey Global Institute (2018), *Smart cities: Digital solutions for a more livable future.* Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future

[19] UN Population Division (2018). Available at: https://esa.un.org/unpd/wpp/DataQuery/

[20] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

[21] World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications

Description	*Sizing assumptions*	*Sources*
Increased lending to SMEs at higher margins due to the use of big data	**2017:** Sized based on additional revenue through increased lending to SMEs at higher margins. MGI (2014) suggests lending to SMEs increases by 16-33%, with increased margins between 1.4-1.8%. Country-level estimates based on annual total lending to SMEs and technology adoption rate. **2030:** 2030 estimate based on same assumptions, with total lending to SMEs growing at constant rate.	World Bank[22] MGI (2014)[23]

[22] World Bank. Available at: https://data.worldbank.org/indicator/FS.AST.PRVT.GD.ZS

[23] McKinsey Global Institute (2014), *China's digital transformation: The Internet's impact on productivity and growth.* Available at: https://www.mckinsey.com/industries/high-tech/our-insights/chinas-digital-transformation

Description	*Sizing assumptions*	*Sources*
Financial inclusion		
Mobile Internet supporting digital financial inclusion	**2017:** Sized based on the number of persons who became financially included due to mobile money as of 2017. MGI (2014) suggests that individuals gain a 15% increase in their wages due to financial inclusion, with this wage being gauged at the country's minimum wage rate as such individuals typically come from lower-income backgrounds. Country-level estimates based on the country's financially-included population (ages 15+), the proportion of them who became financially included due to mobile money, and annual minimum wage. **2030:** 2030 estimate based on same assumptions, but with the growth in the proportion of financially-included individuals who gained financial inclusion due to mobile money projected based on historical growth rates, as well as the projected growth rate of population ages 15+, based on UN Population Division's estimates. Annual minimum wage in 2030 is projected based on projected growth in GDP per capita by IMF.	MGI (2014)[24] World Bank Global Findex Database[25] UN Population Division (2018)[26] IMF[27]

[24] McKinsey Global Institute (2014), *India's technology opportunity: Transforming work, empowering people.* Available at: https://www.mckinsey.com/industries/high-tech/our-insights/indias-tech-opportunity-transforming-work-empowering-people

[25] World Bank Global Findex Database. Available at: https://globalfindex.worldbank.org/

[26] UN Population Division (2018). Available at: https://esa.un.org/unpd/wpp/DataQuery/

[27] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

Description	Sizing assumptions	Sources
Digitising marketing, distribution, and service		
Internet and mobile technologies that reduce operational and risk costs and improve service delivery	**2017:** Sized based on the cost savings from digitisation such as the electronic onboarding of clients, leveraging machine learning and robotics to create operational improvements and the use of public cloud infrastructure to reduce processing capacity. MGI (2017) estimates that the potential savings from retail banking operational costs and risk costs are 20-30% and 10-30% respectively. Country-level cost savings based on estimates of domestic banking sector costs and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic banking sector costs growing at forecast national GDP rates by the International Monetary Fund (IMF).	MGI (2017)[28] World Bank[29] IMF[30]

[28] McKinsey Global Institute (2017), *Digital Australia: Seizing opportunities from the fourth industrial revolution.* Available at: https://www.mckinsey.com/featured-insights/asia-pacific/digital-australia-seizing-opportunity-from-the-fourth-industrial-revolution

[29] World Bank. Available at: https://data.worldbank.org/indicator/NV.IND.TOTL.ZS

[30] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

Description	Sizing assumptions	Sources
Reg Tech		
AI and machine learning which enable automation of document review, risk analysis and other repetitive compliance tasks	**2017:** Sized based on the cost savings in compliance expenditure due to the increased efficiency brought about by these technologies. Juniper Research (2017) suggests up to 50% reduction in compliance expenditure. KPMG (2013) indicates that compliance expenditure is on average 10% of banks' operating costs. Country-level estimates of efficiency savings based on domestic banking sector costs and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with GDP growing at forecast national rates by the International Monetary Fund (IMF).	Juniper Research (2017)[31] KPMG (2013)[32] IMF[33]

Agriculture and Food

Precision farming		
Data-driven optimisation of crop and meat production	**2017:** Sized based on the productivity gains from increased yield, as well as cost savings from use of less resources in farming. Country-level estimates based on the effectiveness of the technology within the context of the country's agricultural landscape, its agricultural sector GDP and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with the amount of agricultural land in each country changing at constant rates.	World Bank[34]

[31] Juniper Research (2017), *How Regtech can save banks billions.* Available at: https://www.juniperresearch.com/document-library/white-papers/how-regtech-can-save-banks-billions

[32] KPMG (2013), *The cost of compliance*. Available at: https://home.kpmg.com/content/dam/kpmg/pdf/2014/07/Cost-of-Compliance.pdf

[33] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

[34] World Bank. Available at: https://data.worldbank.org/indicator/AG.LND.ARBL.HA

Description	*Sizing assumptions*	*Sources*
Supply chain management		
IoT technology to help reduce supply chain waste	**2017:** Sized based on the additional revenues from reduced food losses that occur in the supply chain. MGI (2014) estimates 10-15% of all food waste throughout the supply chain is recoverable from technology-enabled supply chain management. Country-level estimates based on annual food waste from the supply chain and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with annual food waste growing at constant rates.	MGI (2014)[35] World Bank[36] IMF[37]
Real-time market information		
Provision of real-time market information on prices	**2017:** Sized based on increased farmers' revenues from access to real-time information. MGI (2014) estimates this positive impact to be 10-15% of agricultural GDP. Country-level estimates based on the country's agriculture sector GDP and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with GDP growing at forecast national rates by the International Monetary Fund (IMF).	MGI (2014)[38] World Bank[39] IMF[40]

35 McKinsey Global Institute (2014), Southeast Asia at the crossroads: Three paths to prosperity. Available at: https://www.mckinsey.com/featured-insights/asia-pacific/three-paths-to-sustained-economic-growth-in-southeast-asia

36 World Bank. Available at: https://data.worldbank.org/indicator/AG.LND.ARBL.HA

37 IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

38 McKinsey Global Institute (2014), *Southeast Asia at the crossroads: Three paths to prosperity*. Available at: https://www.mckinsey.com/featured-insights/asia-pacific/three-paths-to-sustained-economic-growth-in-southeast-asia

39 World Bank. Available at: https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS

40 IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

Description	Sizing assumptions	Sources
Food safety		
Using sensors, data monitoring and analysis technique to ensure the biosecurity of food products and predict when concerns may arise	**2017:** Sized based on cost savings from reduced food contamination losses. Fast Company (2017) reports that improving food traceability via sensing, tracking and data monitoring technologies could allow an improvement in the percentage of food that arrives at the retailers' premises with target freshness, from 30% to 90%. PWC (2014) estimates the global cost of food fraud, proxied by lost sales due to adverse health consequences, to be between US$30-40 billion a year. Country-level estimates of food contamination losses based on the relative share of global GDP and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with GDP growing at forecast national rates by the International Monetary Fund (IMF).	Fast Company (2017)[41] PWC (2014)[42] World Bank[43] IMF[44]

Education and training

[41] Fast Company (2017), *These high-tech sensors track exactly how fresh our produce is so we stop wasting food.* Available at: https://www.fastcompany.com/40424163/these-high-tech-sensors-track-exactly-how-fresh-our-produce-is-so-we-stop-wasting-food

[42] PricewaterhouseCoopers (2015), *Food fraud vulnerability assessment.* Available at: https://www.pwc.com/sg/en/industries/assets/food-fraud-vulnerability-assessment.pdf

[43] World Bank. Available at: https://data.worldbank.org/indicator/NV.IND.TOTL.ZS

[44] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

E-career centres and digital jobs platform		
Online platforms where job openings are posted and compatible candidate profiles are matched to available jobs based on algorithms	**2017:** Sized based on GDP contributions from increased employment rates. MGI (2018) estimates the impact on employment rates on different countries, stating that these are different for each country, depending on its labour market characteristics, education and income levels and demographic trends. Country-level estimates based on national employment rate, labour force, GDP per capita and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with labour force growing at forecast national rate and GDP growing at forecast national rates by the International Monetary Fund (IMF).	MGI (2015)[45] IMF[46]
Personalised learning		
Use of digital technologies to provide personalised and remote learning opportunities for students	**2017:** Sized based on increased GDP from increased employment. MGI (2018) estimates that these levers would lead to an increase in employment rate by 0.5% in high-income countries, and 0.9% in other countries. Classification of high-income countries based on World Bank's definition. Country-level estimates based on national employment rate, labour force, GDP per capita and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with population and labour force growing at forecast national rates and GDP growing at forecast national rates by the International Monetary Fund (IMF).	MGI (2018)[47] World Bank[48] IMF[49]

[45] McKinsey Global Institute (2015), *A labor market that works: Connecting talent with opportunity in the digital age*. Available at: https://www.mckinsey.com/featured-insights/employment-and-growth/connecting-talent-with-opportunity-in-the-digital-age

[46] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

[47] McKinsey Global Institute (2018), Smart cities: Digital solutions for a more livable future. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future

[48] World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications

[49] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

Online retraining programmes		
Lifelong learning opportunities delivered in digital format to help individuals gain new skills	**2017:** Sized based on increased GDP from higher employment. MGI (2018) estimates that these levers would lead to an increase in employment rate by 0.1% in high-income countries, and 0.3% in low-income countries. Classification of high-income countries based on World Bank's definition. Country-level estimates based on national employment rate, labour force, GDP per capita and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with labour force growing at forecast national rate and GDP growing at forecast national rates by the International Monetary Fund (IMF).	MGI (2018)[50] World Bank[51] IMF[52]

Consumer and retail

[50] McKinsey Global Institute (2018), Smart cities: Digital solutions for a more livable future. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future

[51] World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications

[52] IMF Data Mapper (2018). Available at: http://www.imf.org/external/datamapper/

Digitising channels		
Productivity gain of delivering retail goods through digital channel reducing labour, inventory, and real estate costs	**2017:** Sized based on productivity gains from delivering goods digitally**.** MGI (2013) estimates that the productivity gains from selling goods through digital channels to range from 6% to 15%, based on reduced labour requirements, inventory efficiencies and lower real estate costs. Country-level estimates based on domestic e-commerce retail sales and operating costs. **2030:** 2030 estimate based on same assumptions, but with retail sector operating costs growing at constant rate.	McKinsey & Company (2017)[53]
Inventory management		
Use of IoT to reduce stock outs	**2017:** Sized based on increased revenues from avoidance of sales lost due to stock outs. MGI (2013) estimates that 4% of retail sales are lost due to stock outs, and that 35-40% of this value may be recaptured using IoT. Country-level estimates based on domestic retail sales and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic retail sales growing at projected national rates.	MGI (2013)[54]

Resources

[53] McKinsey & Company (2017), *Digital Australia: Seizing the opportunity from the fourth industrial revolution.* Available at: https://www.mckinsey.com/featured-insights/asia-pacific/digital-australia-seizing-opportunity-from-the-fourth-industrial-revolution

[54] McKinsey Global Institute (2013), *Disruptive technologies: Advances that will transform life, business, and the global economy.* Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies

Operations management: Smart exploration & autonomous mining equipment		
Use of big data to analyse large amounts of geoscience and drilling data to proactively and efficiently locate probable deposits, and automation of extraction and transport	**2017:** Sized based on the potential global economic value of such technologies in mining. McKinsey & Company (2015) estimates this to be US$250 billion, based on an 80% adoption rate scenario. Country-level estimates based on relative share of global mining sector GDP, and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic mining sector GDP growing at projected national rate.	McKinsey & Company (2015)[55]
Predictive safety		
Technologies that improve productivity and safety such as wearables with in-built sensors that monitor fatigue, location, atmosphere and vitals, and augmented reality interfaces that improve human-machine interaction	**2017:** Sized based on the potential global economic value of such technologies in mining. McKinsey & Company (2015) estimates this to be US$15 billion, based on a 100% adoption rate scenario. Country-level estimates based on relative share of global mining sector GDP, and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic mining sector GDP growing at projected national rate.	McKinsey & Company (2015)[56]

[55] McKinsey & Company (2015), *How digital innovation can improve mining productivity.* Available at: https://www.mckinsey.com/industries/metals-and-mining/our-insights/how-digital-innovation-can-improve-mining-productivity

[56] McKinsey & Company (2015), *How digital innovation can improve mining productivity.* Available at: https://www.mckinsey.com/industries/metals-and-mining/our-insights/how-digital-innovation-can-improve-mining-productivity

Predictive maintenance		
Remote operations centres and data-collecting sensors on mining equipment which help improve failure anticipation, reduce unscheduled breakdowns and increase equipment life	**2017:** Sized based on the potential global economic value of such technologies in mining. McKinsey & Company (2015) estimates this to be US$105 billion, based on a 100% adoption rate scenario. Country-level estimates based on relative share of global mining sector GDP, and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic mining sector GDP growing at projected national rate.	McKinsey & Company (2015)[57]

Manufacturing

Big data analytics		
Use of big data analytics in demand forecasting/shaping, and supply planning	**2017:** Sized based on increased revenue from more accurate demand-supply matching leading to increased sales. MGI (2011) suggests a 2.5-3% increase in profit margin. Country-level estimates based on domestic manufacturing sector GDP and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic manufacturing sector GDP growing at projected national rate.	MGI (2011)[58]

[57] McKinsey & Company (2015), *How digital innovation can improve mining productivity.* Available at: https://www.mckinsey.com/industries/metals-and-mining/our-insights/how-digital-innovation-can-improve-mining-productivity

[58] McKinsey Global Institute (2011), Big data: The next frontier for innovation, competition and productivity. Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation

Additive manufacturing		
Use of dynamic, resource efficient 3D printing and related technologies to enable 'on-time' manufacturing & rapid manufacturing.	**2017:** Sized based on the incremental economic value of faster time-to-market thanks to quicker prototyping and design adjustments, reduced production time, higher material productivity as well as more efficient sales process due to product customisation. McKinsey & Company (2017) estimates that the global economic value of this could reach to between US$100 billion and US$250 billion by 2025. Current economic value is calculated based on today's global manufacturing sector GDP, and assuming constant growth rate. Country-level estimates based on domestic manufacturing sector GDP as a share of the global figure, and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic manufacturing sector GDP and the projected global value of additive manufacturing growing at constant rates.	McKinsey & Company (2017)[59]
Supply chain management		
Savings in operating costs from IoT-enabled supply chain management and distribution network management	**2017:** Sized based on increased revenue from more accurate demand-supply matching leading to increased sales. MGI (2011) suggests a 2.5-5% savings in distribution and supply chain operating costs, and that these costs make up 2-6% of manufacturing sales. Country-level estimates based on domestic manufacturing sector operating costs and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic manufacturing sector GDP changing at global real GDP growth rate.	MGI (2011)[60]

[59] McKinsey & Company (2017), *Additive manufacturing: A long-term game changer for manufacturers.* Available at: https://www.mckinsey.com/business-functions/operations/our-insights/additive-manufacturing-a-long-term-game-changer-for-manufacturers

[60] McKinsey Global Institute (2011), *Big data: The next frontier for innovation, competition and productivity.* Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation

Automation and robotics		
Productivity boost from automating mundane and repetitive production tasks	**2017:** Sized based on productivity boost to manufacturing processes from robots performing mundane and repetitive tasks. World Economic Forum and AT Kearney (2017) estimates 10% increased production. Country-level estimates based on domestic manufacturing sales and technology adoption rate derived from industrial robot density data by the International Federation of Robotics. **2030:** 2030 estimate based on same assumptions, but with 20% increased productivity from automation and robotics and domestic manufacturing sales growing at projected national rate.	World Economic Forum and AT Kearney (2017)[61] International Federation of Robotics (2017)[62]

Infrastructure

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[61] World Economic Forum and AT Kearney (2017), *Technology and innovation for the future of production: Accelerating value creation.* Available at: http://www3.weforum.org/docs/WEF_White_Paper_Technology_Innovation_Future_of_Production_2017.pdf

[62] International Federation of Robotics (2017), *2017 World robot statistics*. Available at: https://ifr.org/ifr-press-releases/news/robot-density-rises-globally

Smart grids		
Using digital communications technology to detect, react and optimise electricity networks	**2017:** Sized based on cost savings from energy savings due to lower consumption and efficiency improvements. Smart Energy Consumer Collaborative (2018) estimates 5-10% energy savings. Country-level estimates based on total electricity consumption and technology adoption rate. Business and Sustainable Development Commission (2017) suggests that the global average wholesale price of electricity is US$100/Mwh. **2030:** 2030 estimate based on same assumptions, but with electricity consumption growing at projected rate.	Smart Energy Consumer Collaborative [63] World Bank[64] Business and Sustainable Development Commission (2017)[65]
5D BIM and project management technologies		
Integrated modelling platforms simulating construction cost and timeline impacts of decisions in project planning, design, construction, operations, and maintenance	**2017:** Sized based on cost reductions from improved coordination between different development parameters, as well as the continuous insight provided on project costs. MGI (2013) suggests that streamlining project delivery could bring about 15% savings to infrastructure cost, with 15-25% of these savings coming from 5D BIM technologies. Country-level estimates based on domestic construction sector costs and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic construction sector GDP growing at projected rate.	MGI (2013)[66]

[63] Smart Energy Consumer Collaborative. Available at: http://www.whatissmartgrid.org/faqs/what-are-the-benefits-of-the-smart-grid

[64] World Bank. Available at: https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC

[65] Business and Sustainable Development Commission (2017), *Valuing the SDG prize: Unlocking business opportunities to accelerate sustainable and inclusive growth*. Available at: http://businesscommission.org/our-work/valuing-the-sdg-prize-unlocking-business-opportunities-to-accelerate-sustainable-and-inclusive-growth

[66] McKinsey Global Institute (2013), *Infrastructure productivity: How to save $1 trillion a year.* Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/infrastructure-productivity

Predictive maintenance		
Using data from sensors to ensure prompt and predictive maintenance, minimising downtime	**2017:** Sized based on the economic value of benefits from sizeable applications including the predictive maintenance of public transit systems and water leakage detection and control. MGI (2018) estimates 5.2% reduction in average commuting time from predictive transit for high-income countries, and 2.5% for other countries. Average commuting time by country derived from Dalia Research. On water leakage detection and control, MGI (2018) estimates 1.4% reduction in water consumption for high-income countries, and 17.4% for other countries. Classification of high-income countries based on World Bank's definition. Business and Sustainable Development Commission (2017) suggests that the global average price of water is US$0.90/$m^3$. Country-level estimates based on average commuting time, population, GDP per capita, domestic water consumption and adoption rates. **2030:** 2030 estimate based on same assumptions, but with GDP per capita and population growing at the forecast national rates.	MGI (2018)[67] Dalia Research[68] World Bank[69] OECD[70] Statista[71] Business and Sustainable Development Commission (2017)[72]

67 McKinsey Global Institute (2018), Smart cities: Digital solutions for a more livable future. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future

68 Dalia Research. Available at: https://daliaresearch.com/the-countries-with-the-longest-and-shortest-commutes/

69 World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications

70 OECD. Available at: https://data.oecd.org/earnwage/average-wages.htm

71 Statista. Available at: https://www.statista.com/statistics/263156/water-consumption-in-selected-countries/

72 Business and Sustainable Development Commission (2017), *Valuing the SDG prize: Unlocking business opportunities to accelerate sustainable and inclusive growth*.

Smart buildings		
Physical sensor networks, energy storage and data analytics which help improve resource efficiency of buildings and reduce energy and water consumption, as well as carbon emissions	**2017:** Sized based on the economic value of the reduction in greenhouse gas emissions (GHG) and water consumption by building automation systems. MGI (2018) estimates 2.9% reduction in GHG emissions and 1.7% reduction in water consumption for high-income countries. The corresponding figures for other countries are 1.4% and 1.1%. Classification of high-income countries based on World Bank's definition. Country-level estimates based on greenhouse gas emissions and water consumption from buildings, and technology adoption rates. GHG price is valued at US$50/ton (a global proxy price that equates roughly to the financial incentives needed to achieve carbon emissions consistent with a 2-degree pathway). **2030:** 2030 estimate based on same assumptions, but with domestic water consumption and building energy consumption growing at national forecast population growth rate.	MGI (2018)[73] Cao (2016)[74] World Bank[75]

[73] McKinsey Global Institute (2018), Smart cities: Digital solutions for a more livable future. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future

[74] Cao Xiaodong (2016), *Building energy-consumption status worldwide and the state-of-the-art technologies for zero-energy buildings during the past decade*. Available at: https://www.sciencedirect.com/science/article/pii/S0378778816305783

[75] World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications

Smart roads

Real-time public transit information, intelligent traffic signals and real-time road navigation which reduce commuting time	**2017:** Sized based on the economic value of real-time public transit information, intelligent traffic signals and real-time road navigation. MGI (2018) estimates 8.4% reduction in average commuting time for high-income countries, and 10.6% for other countries. Classification of high-income countries based on World Bank's definition. Country-level estimates based on average commuting time, population, GDP per capita and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with GDP per capita and population growing at the forecast national rates.	MGI (2018)[76] Dalia Research[77] World Bank[78] OECD[79]

[76] McKinsey Global Institute (2018), *Smart cities: Digital solutions for a more livable future.* Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future

[77] Dalia Research. Available at: https://daliaresearch.com/the-countries-with-the-longest-and-shortest-commutes/

[78] World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications

[79] OECD. Available at: https://data.oecd.org/earnwage/average-wages.htm

Smart ports		
Use of IoT to enhance port efficiency	**2017:** Sized based on cost savings from reduced logistics costs due to IoT-enabled data collection and monitoring, as well as intelligent decision-making capabilities. Accenture and SIPG (2016) suggest 3.6% savings in logistics costs. Country-level estimates based on logistics sector costs (based on indicated percentages of the country's GDP), and technology adoption rate. **2030:** 2030 estimate based on same assumptions, but with domestic manufacturing sector GDP growing at constant rate.	Accenture and SIPG (2016)[80] Council of Supply Chain Management Professionals (2013) [81] World Bank (2016)[82]

[80] Accenture and Shanghai International Port Group (2016), *Connected ports: Driving future trade.* Available at: https://www.accenture.com/t20161012T003018Z__w__/us-en/_acnmedia/PDF-29/accenture-connected-ports-driving-future-trade.pdf

[81] Council of Supply Chain Management Professionals (2013), *State of logistics report*. Available at: http://www.scdigest.com/assets/newsviews/13-06-20-2.php?cid=7168&ctype=content

[82] World Bank (2016), *Logistics performance index: Ranking by countries*. Available at: https://lpi.worldbank.org/international/global

2. Estimating the value of digital exports

Part of what makes defining digital trade difficult is the rapidly changing nature of the digital economy. Different definitions are used by various organizations. In the World Trade Organization (WTO), the term "electronic commerce" has generally been employed rather than "digital trade" and understood to mean "the production, distribution, marketing, sale or delivery of goods and services by electronic means".[83] The definition used by the United States International Trade Commission (USITC) includes the provision of e-commerce platforms and related services, but excludes the value of sales of physical goods ordered online, as well as physical goods that have a digital counterpart (such as books, movies, music, and software sold on CDs or DVDs).[84] UNESCAP takes a broad approach to measuring the value of digital exports, seeking to capture digital infrastructure related to exports, as well as digital goods and services.[85]

Three broad categories of digital trade are sized in this analysis:[86]

i. **Digitally-enabled products.** These refer to "content" products, such as software, books, music, films, and games that can be traded in a physical form but are now traded electronically via the Internet, as well as apps and e-commerce.

ii. **Digitally-enabled services.** These refer to services provided by digital technologies. This is a large category because most services currently have adopted digital technologies and are selling e-services to varying degrees. For example, this includes online advertising (viewed from abroad), and the export of data processing and online software consultancy services. It also includes other direct e-service exports such as online booking and electronic banking, however these categories are currently not able to be measured.

iii. **Indirect digital services (embedded in other exports).** These refer to imported digital services that get used in the export of products and services. Examples include telecommunication services such as email, video conferencing, digital file sharing, and Voice Over Internet Protocol (VOIP) services that get used by a mining company when exporting overseas.

Digitally-enabled products

This is separated into two components[87]:

1. *Cross-border e-commerce.* Despite its growing significance, the literature on cross-border e-commerce flows is surprisingly scarce. As a result, the value of this component is estimated using a 'bottom-up' approach. The approach employs four major data points: 1) the number of firms in the economy; 2) the share of firms engaged in e-commerce; 3) the share of firms

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[83] UNESCAP (2016), *Internal trade in a digital age*. Available at: http://www.unescap.org/sites/default/files/aptir-2016-ch7.pdf

[84] U.S. International Trade Commission (2017), *Global Digital Trade 1: Market Opportunities and Key Foreign Trade Restrictions*. Available at: https://www.usitc.gov/publications/332/pub4716.pdf.

[85] UNESCAP (2016), *Internal trade in a digital age*. Available at: http://www.unescap.org/sites/default/files/aptir-2016-ch7.pdf

[86] "Digital infrastructure goods" are excluded from the scope of analysis as this category is considered an enabler of digital trade, rather than digital trade itself.

[87] The sizing of digitsed products does not include a detailed breakdown for products such as ebooks, OTT videos, or non-mobile video games as they are often either not reported within current international trade databases or aggregated with other categories.

engaged in e-commerce which export; and 4) the value of exports. To obtain these data points, many local and foreign data sources (e.g. National statistics departments, OECD, IMF, business surveys, e-commerce industry reports) are used to understand the number of firms engaged in e-commerce, and their average revenues from exporting. The analysis focuses on exports in the manufacturing of Fast-Moving Consumer Goods (FMCG), as this is a main component of e-commerce goods, and data on other types of e-commerce goods are incomplete. As a result, this is likely to be a very conservative estimate of the overall value of cross-border e-commerce. The estimates are computed from mostly domestic data sources, and checked against World Trade Organization (WTO) data to ensure consistency.[88] Estimates of businesses' propensity to engage in e-commerce are derived from business surveys,[89], and the propensity of such firms to export is derived from relevant proxies in industry reports of e-commerce companies such as eBay.[90] Finally, the computed estimates are cross-checked against existing estimates of cross-border e-commerce (in the few instances where these are available), as well as the size of the domestic e-commerce market.

2. *Digital apps.* This refers to revenues from smartphone applications (both gaming and non-gaming) earned by domestic publishers in major foreign markets. The sizes of major app markets are obtained from industry data from Newzoo.[91] These market revenue figures are then broken down into domestically-generated revenue (via local app developers) and foreign revenue (via foreign app developers). Caribou Digital provides data on revenue generated, by country of origin, in the world's largest 37 app markets.[92] This data allows for total app export revenues for the focus countries to be estimated.

Digitally-enabled services

The challenge with measuring digitally-enabled services is that export statistics do not distinguish digitally-enabled and non-digitally-enabled exports. For example, COMTRADE's classification of education services (under the "personal, cultural and recreational services category") comprises "services relating to all levels of education whether delivered through correspondence courses, via television, satellite, or the Internet, or by teachers, among others, who supply services directly in host economies."[93] The challenge with this definition is that there is a lack of robust data sources which distinguish the share of these education services done through digital channels versus teachers working abroad. A similar challenge occurs in other key areas of service exports, such as health, legal, professional services, and travel.

To address these issues, focus is limited to only those sectors that are likely to have a large share of exports being digitally-enabled. This includes the *direct exports of digital infrastructure services* as well as the important and growing area of *local content creator revenues.*

[88] We were unable to use WTO data directly due to a lack of disaggregation and timely reporting.

[89] Where such estimates were not available the propensity across all industries was used as a proxy.

[90] eBay (2016), *Small Online Business Growth Report*. Available at: https://www.ebaymainstreet.com/sites/default/files/ebay_global-report_2016-4_0.pdf

[91] Newzoo (2016), *2016 Global Mobile Market Report*

[92] Caribou Digital – Mozilla (2016), *Winners & Losers in the Global App Economy*

[93] United Nations (2016), *2016 International Trade Statistics Yearbook (Volume I: Trade by Country)*. Available at: https://comtrade.un.org/ITSY2016VolI.pdf

1. *Direct exports in digital infrastructure services.* This includes the export of digital services such as VOIP, email or cloud computing solutions. Telecommunications and computer-related services are used as proxies.[94] This data is sourced from the OECD-WTO Trade in Value-Added (TiVA) database (December 2016 version).[95] From the TiVA database, historical data on gross exports is obtained for the relevant industries. Forecasts are based on IMF data for domestic and global trade flow.[96]

2. *Local content creator revenues from online video advertising.* This refers to revenues earned by local content creators from online advertising (e.g., blog posts, YouTube videos). Driven by data availability, the focus of the analysis is on online video advertising. The online video advertising revenue from exports is computed using a bottom-up approach. Key data inputs consist of: the number of views of each country's 250 major YouTube channels (available from SocialBlade), the average cost per view paid by advertisers (relying on a variety of industry reports) and estimates of the foreign share of viewership for top channels (based on a combination of media, industry reports and direct interviews with content creators).

   In China, local content creator revenues derived from advertising were not sized. This is due to four key reasons:

   1. Youtube, Vimeo, and other mainstream video hosting sites are prohibited in China;
   2. China's three main video-streaming companies – iQiyi, Tencent Video, and Youku Tudou – rely on a mixture of advertising revenue as well as paid premium content/memberships for revenue. This makes it difficult to size advertising revenues;[97]
   3. Advertising spend in China is shifting away from longer-form videos (like those traditionally hosted on video-streaming sites) to short snippets (similar to those seen on Weibo);[98] and
   4. China' video-streaming companies have placed geo-restrictions on users outside of China, making the content they host inconvenient to access as foreign users would have to find technical "workarounds".

Indirect digital services (embedded in other exports)

The previous category of digitally-enabled services sizes the direct exports of digital services. Yet, it fails to account for digital services (imported from abroad) that are embedded in the exports of other goods and services. Data from digital imports that are used in exports of goods and services is provided from analysis of the OECD TiVA database.

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[94] This follows the approach taken by UNESCAP (2016), *Internal trade in a digital age*.

[95] Available at: https://stats.oecd.org/index.aspx?queryid=75537. Data was used for the following industries: 'C64: Post and Telecommunications' and 'C72: Computer and related activities' (Numbers refer to the International Standard Industrial Classification of All Economic Activities (ISIC) 3rd revision)

[96] IMF data mapper Available at: http://www.imf.org/external/datamapper/NGDP_RPCH@WEO/OEMDC/ADVEC/WEOWORLD

[97] South China Morning Post (2018), "China's consumers are paying to watch movies online, but foreign streaming giants are missing out". Accessible at: https://www.scmp.com/tech/article/2137870/chinas-consumers-are-paying-watch-movies-online-foreign-streaming-giants-are

[98] Financial Times (2017), "Youku Tudou loses out as luxury advertisers shift focus". Accessible at: https://www.ft.com/content/f9b4791c-4a56-11e7-a3f4-c742b9791d43

Most of the literature has largely ignored this indirect component and therefore has potentially significantly underestimated the contribution of digital trade to a country's exports (in some countries, this component accounts for up to 40 percent of the value of total digital exports). Where attempts have been made to proxy for this indirect component in the past literature, the analysis has often failed to distinguish between the sources of such services by domestic and foreign origins. By including the value-added by domestic production of digital infrastructure services, this approach would overestimate the value of a country's exports that is directly facilitated by digital trade.

The TiVA database provides data on the contributions of value added by imports - broken down by source country and source industry - to gross exports – broken down by exporting country and exporting industry. This data allows us to compute the indirect value-added impact that imports in the relevant industries have on the gross exports of the focus countries. However, some double-counting will occur as some of the value of direct exports of these industries (i.e. telecommunications and computer-related services) calculated in the component "Digitally-enabled services" (discussed earlier in this document), will originate from imports in those industries. To avoid this, the indirect value-added sourced from imports in the telecommunications and computer-related services on exports is removed.