Cross-Border Data Flows

The impact of data localisation on IoT

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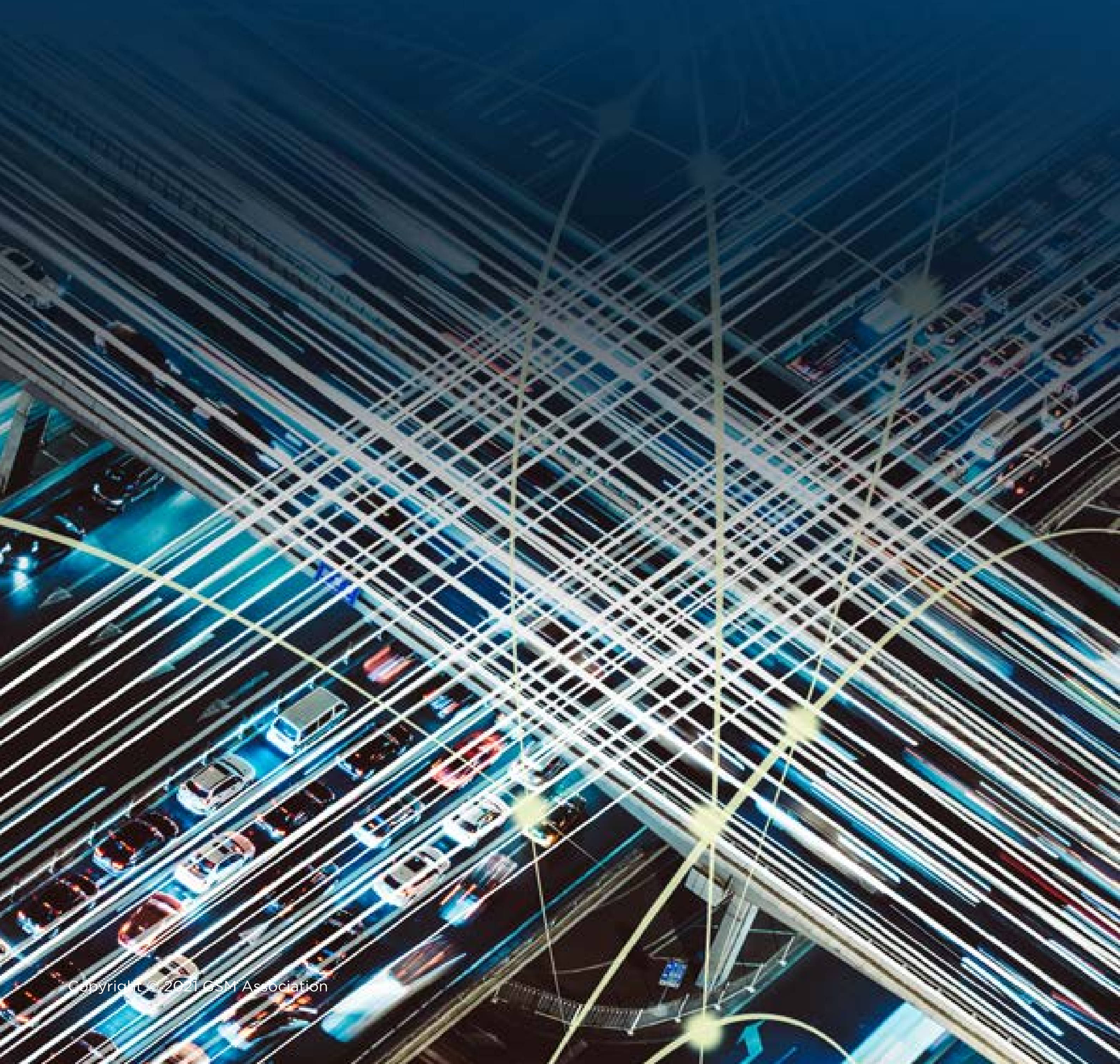

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The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators and nearly 400 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces the industry-leading MWC events held annually in Barcelona, Los Angeles and Shanghai, as well as the Mobile 360 Series of regional conferences.

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The Internet of Things (IoT) is hugely important and rapidly growing, with the potential to transform the digital economy. Its industrial use is already having a significant impact on how businesses operate, and the widespread use of 5G will only further accelerate this transformation. With IoT connections currently growing by almost 15 per cent annually, by 2025 this is set to reach approximately 25 billion - vastly outnumbering personal devices (such as phones and computers) connected to wireless networks.

Acknowledging the transformative steps that IOT can have on economic growth, GSMA's latest study explores how the adoption of Data Localisation Requirements (DLRs) could negatively impact the many gains generated to date. In does so for three emerging countries: Brazil; Indonesia; and South Africa.

Whilst the study is hypothetical, it findings do allow us to consider the negative consequences of imposing DLRs and similar restrictions on cross-border data flows and how to mitigate the impact of these measures. Acknowledging that the viability and impact of IoT is contingent on governments adopting a positive regulatory framework, the study concludes by outlining a number of actions to support growth in this sector and minimise trade restrictions.

Abstract

The Internet of Things (IoT) will have far-reaching and beneficial effects for both advanced industrialised economies and emerging economies.

- The number of IoT connections is growing by almost 15% per year and is set to reach approximately 25 billion connections by 2025. **The sectors that are heavily impacted by IoT play a crucial role in emerging economies** such as agriculture, basic manufacturing, transport, logistics, healthcare and education.

Beyond simple productivity gains, adopting IoT will produce significant dynamic effects across the entire economy.

- **IoT has already become a horizontal technology** with an impact across many sectors, including manufacturing, agriculture, mining, retail, transport, utilities, healthcare, entertainment and education.

- As the distinction between 'the economy' and 'the digital economy' fades we see the uptake of IoT and related technologies having a transformative impact on the way people live and how firms do business, meaning that **IoT gains start to produce first and second order economic effects across the whole economy.**

Data Localisation Requirements (DLRs), however, will have a significant negative impact and undermine many of the IoT gains to Gross Domestic Product (GDP) growth, employment, trade and investment.

- This study uses the well-recognised GTAP methodology to estimate the negative impact that DLRs and other restrictions on cross-border data flows have on the gains generated by IoT deployment in three emerging countries: Brazil; Indonesia; and South Africa.

- It is evident that the cost of imposing DLRs and similar restrictions on cross-border data flows will only increase in future, owing to the growing importance of data in all areas of economic activity. The model takes into account any positive impacts of data localisation when foreign suppliers are replaced by domestic competitors due to data localisation requirements.

The model estimates that DLRs and other restrictions on cross-border data flows will wipe out over half of the potential gains countries stand to make by adopting IoT.

- Data localisation **more than halves the GDP gains** of adopting IoT – by: **59% in Brazil; 61% in Indonesia; and 68% in South Africa.**

- Data localisation also has a considerable negative impact on employment, causing **job losses** of around: **205,000 in Brazil; 372,000 in Indonesia; and 182,000 in South Africa.**

Background

Investigating the impact of data localisation measures on the Internet of Things (IoT).

Thanks to its many positive productivity effects and the gains to trade that it produces, the number of IoT connections is growing by almost 15% per year and is set to reach approximately 25 billion[1] connections by 2025. The potential gains for emerging economies are expected to be far-reaching, given that sectors heavily impacted by IoT also play a crucial role in developing countries.

This study aims to fill a gap in existing literature on the impact that data localisation will have on the expected productivity gains from IoT. By using the Global Trade Analysis Project (GTAP) model – the principal analytical tool used by governments and international organisations for trade simulations – we estimate the impact of IoT and data localisation on Brazil, Indonesia and South Africa.[2]

How data localisation impacts IoT deployment.

While the deployment of IoT is highly cost efficient, data localisation restrictions (DLRs) lead to: increased costs owing to the duplication of data centre infrastructure; and higher costs for connectivity, applications and other services — alongside limited variety and lower quality — because these must be sourced from a smaller pool of domestic providers. Such cost increases are based on empirical studies.[3]

Even without the additional costs imposed by data localisation, the costs for new applications, additional data storage and connectivity already account for 47% of the deployment costs for IoT[4], but data localisation drives up the cost even more.

Unlike previous studies on DLRs and data regulation, however, these costs are not assumed to apply to a particular type of data, such as personal data due to privacy regulation. In this model, DLRs and its costs are isolated to one particular type of application (i.e. IoT usage), rather than one particular data type.

Moreover, it cannot be precluded that there are also positive effects from data localisation. Such requirements lead to import substitution, i.e. where foreign suppliers are replaced by domestic competitors. Such positive effects are fully taken into account in the model.

1. The contribution of IoT to economic growth (2019) is a survey-based study from GSMA Intelligence on the projected productivity gains to be had as a result of firms adopting IoT technologies.
2. The Global Trade Analysis Project (GTAP) is an international network of researchers (mostly from universities, international organisations, and economic and climate/resource ministries of governments) who conduct quantitative analysis of international economic policy issues, including trade policy, climate policy, and globalisation linkages to inequality and employment.
3. See Bauer, Lee-Makiyama, van der Marel and Verschelde, The Costs of Data Localisation: Friendly Fire on Economic Recovery, ECIPE Occasional Paper No. 3/2014 based on Cushman & Wakefield, Data Centre Risk index, 2016; Frost & Sullivan, Insights into Big Data and Analytics in Brazil, 2014.
4. See Peter Newman, IoT Report: How Internet of Things technology growth is reaching mainstream companies and consumers, published at: 'Business Insider', 2019.

Results

Emerging economies could reap major gains from deploying IoT.

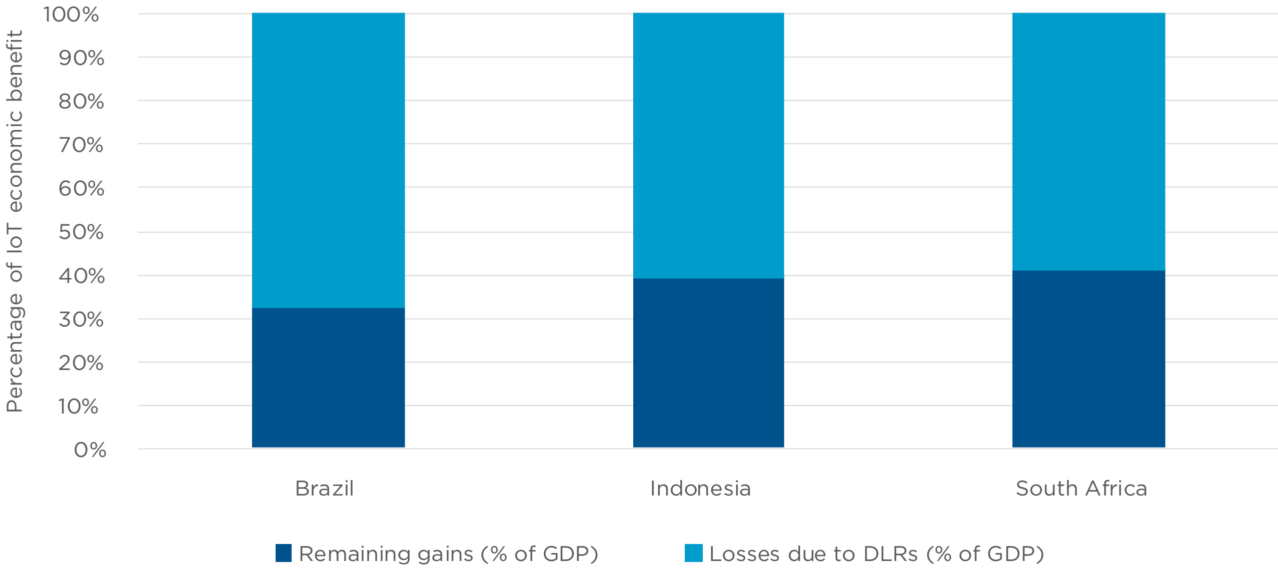
The gains accruing from IoT in emerging economies may be considerable. IoT technologies which work best under conditions of open cross-border data flows could have a considerable impact on economic output, with:

- **GDP**: up to 0.5% GDP in Brazil; up to 0.9% in Indonesia; and up to 2.6% in South Africa.
- **Exports**: up to 2.4% in Brazil, up to 2.9% in Indonesia; and up to 3.1% in South Africa.
- **Employment**: up to 0.2% in Brazil, up to 0.4% in Indonesia; and up to 1.3% in South Africa.

While IoT in South Africa is expected to have a relatively low domestic productivity effect (GSMA Intelligence, 2019), the most pronounced impact is likely to come from higher import efficiency.

Imposing DLRs and other restrictions on cross-border data flows, however, will undermine these gains by a significant margin.

The impact of data localisation reduces the economic gains (measured in GDP) from IoT by 59% for Brazil, 61% for Indonesia and 68% for South Africa. This can be depicted in simple graphic terms as follows:



- The increased costs that result from DLRs have a suppressing effect on economic activity, which our model indicates will have a considerable negative impact on jobs (causing 205,000 lost jobs in Brazil, 372,000 in Indonesia and 182,000 in South Africa)
- The negative impact on investment caused by the economic cost of DLRs is even more pronounced — with $5 billion lost in Brazil and Indonesia and $4 billion in South Africa.

Conclusions

Because the positive impact of IoT is substantial and produces dynamic effects across almost the whole economy, the economic downsides of data localisation restrictions and similar restrictions are equally pervasive.

The crucial contribution of IoT and related technologies to economic growth is found to be consistent in all the countries surveyed, despite different regions, industrial structures and industrial policies.

The cost of imposing data localisation measures and other similar restrictions on cross-border data flows (that have similar cost-raising effects to DLRs), however, will only continue to rise further as data becomes increasingly important across all areas of economic activity. International mobile roaming is not taken into account as we assume that this would be in breach of the DLR.

These increased costs result in suppressed economic activity across the entire economy — with negative impacts not just in GDP growth, but also trade flows, employment and investment.

Policymakers will want to consider the negative consequences of imposing DLRs and similar restrictions on cross-border data flows. To mitigate the impact of these measures, action should be limited to the most essential policy objectives and be imposed in a way that is minimally trade restrictive.

Technical Report

Anticipated gains from the Internet of Things (IoT) exceeds most other technologies.

Digitalisation is, without doubt, one of the biggest innovations to ever impact the global economy. As it progresses, we will see the emergence of the Internet-of-Things (IoT), of devices, sensors, infrastructure and automated systems communicating with each other.

The technology is at the nexus of wireless connectivity, automation and data-driven applications. In particular, its industrial use is already having a significant impact on how businesses operate. By deploying connected devices across the organisation, businesses can make improvements, enabling 'smart' production methods, and concepts such as 'Industry 4.0', 'Society 5.0' and 'digital manufacturing'.

Economically speaking, IoT will bring about cost reductions through efficiency gains and increased production flexibility. In addition, it will allow for shorter feedback loops between different production stages – from design, prototyping, mass-production, testing and go-to-market.

Overall, IoT leads to increased productivity,[5] enhanced energy or cost efficiencies and lower environmental impact. Given the many benefits, **the number of IoT connections is growing by almost 15% per year and is set to reach approximately 25 billion connections by 2025.** By then, the number of IoT (i.e. machine-to-machine) connections will outnumber personal devices (such as phones and computers) connected to wireless networks.

The uptake of IoT is also intricately linked to the deployment of 5G. Of course, 5G (with speeds 200 times faster than 4G) will enable mass consumer applications such as instant streaming of HD content. The economic impact of personal applications, however, is relatively modest compared to potential industrial use. IoT under 5G will benefit from 20 times shorter latencies and 1,000 times better energy efficiencies. IoT running on 5G networks will seamlessly connect sensors on industrial equipment, vehicles and infrastructure, which in turn will enable the unprecedented real-time and large-scale collection of data. This will enable big data analytics and artificial intelligence (AI) to provide feedback for the optimisation of business processes, logistics or pricing in real-time.

IoT has already become a horizontal technology impacting numerous economic sectors, including manufacturing, agriculture, mining, retail, transport, utilities, healthcare, entertainment and education.

5. Supekar et al. A Framework for Quantifying Energy and Productivity Benefits of Smart Manufacturing Technologies, published in: '26th CIRP Life Cycle Engineering (LCE) Conference' 2019, at p. 699.

The impact of IoT on emerging economies is undervalued.

Previous studies have tried to quantify the impact of IoT on economic growth, often assuming that advanced, digitised and capital-rich countries alone will reap the majority of any gains. Further, previous studies have often offered a static perspective by excluding the dynamic effects of technological change. Although historical precedence shows how mobile connectivity has allowed emerging economies to leapfrog several steps in their economic growth, the impact of IoT and 5G on emerging economies is less well known.

This report aims to fill the gaps in the existing literature by looking at Brazil, Indonesia and South Africa. These countries are not just representatives of South & Latin America, South-East Asia and Africa – but in each of these countries, there has been a public debate on the negative impact of restrictive measures on cross-border data flows. Brazil proposed (and fundamentally recast) Marco Civil da Internet until 2014, removing data localisation elements;[6] Indonesia had its Electronic Information and Transactions Law (EIT) amended in 2018;[7] and in South Africa, the conditions subject to which personal information could be transferred abroad were debated at length in the context of enacting the Protection of Personal Information (POPI) Act in 2013 and subsequent implementing acts.[8]

The potential gains for developing countries, meanwhile, are estimated to be far-reaching. Connectivity has proven to have major trade facilitating effects. The improvements that IoT technologies have brought to logistics and digital customs solutions, or cost-reductions to multinational enterprises, allow for faster and more seamless business processes, shorter product-development cycles and enhanced business intelligence. All of these benefits facilitate a more efficient exchange of goods, services and investments across borders, saving billions in transaction costs and allowing for more emerging economies to participate in, and reap the benefits of, world trade and global supply chains.

Sectors heavily impacted by IoT — in the light manufacturing (e.g. textiles, chemicals and household goods) or agri-food sectors, for example — also play a crucial role in emerging economies where the value-chains are increasingly interlinked and becoming 'smarter'.[9] IoT and related technologies will have an inordinately large impact on emerging economies because they will address supply-side constraints in sectors such as education or healthcare. Public transport is critical for connecting producers to markets, transporting workers to factories, and labour to places where it can be more productive (i.e. from rural areas to cities), and public transport networks are ripe for reaping the many benefits provided by IoT and related technologies.

6. See Cecile Zwiebach, Brazil's Internet Governance and Data Protection Legislation: A New Legal Framework Aimed at Providing Guidelines for a Rapidly Evolving Environment, published in: "Ethisphere Magazine", 2015.
7. See Kristo Molina, Indonesian Electronic Information and Transactions Law Amended, published on "White and Case / Our Thinking / Case Publications and Events", 2016.
8. See Michelle De Bruyn, The Protection of Personal Information (POPI) Act - Impact On South Africa, published in: "International Business & Economics Research Journal (IBER)" 1315 – 1339, 2014.
9. See for example Gwen Robinson, Marrian Zhou and Erwida Maulia How the death of fast fashion is transforming Asia's garment industry: New technology and demanding consumers unravel a decades-long race to the bottom published in: Nikkei Asian Review, 2019.

Data localisation requirements disproportionately hampers developing economies.

Data localisation requirements have been identified as potentially some of the most restrictive and disruptive barriers to international trade.[10] Such requirements require foreign businesses to duplicate IT infrastructure, such data centres and computing facilities. Restrictions on ICT and telecom suppliers range from making cross-border data flows conditional on certain legal conditions (e.g. personal data protection, national security, etc) or imposing data storage requirements, (e.g. a copy of the data must be stored locally, etc).[11]

Some far-reaching requirements include local processing requirements, i.e. mandating that the data must be stored and processed locally. Some countries explicitly ban data transfers outside of their jurisdiction for some types of data (typically personal information) or entities in a sensitive industry (e.g. banking, telecom, healthcare sectors, etc) or national critical or sensitive infrastructure (e.g. power generation/distribution, military, etc).

While no jurisdiction restricts transfers of IoT data specifically, IoT technologies are subject to any DLRs that impact the network services essential to IoT systems. In effect, data localisation on industrial applications can undermine the business case for adopting IoT and related technologies.

Not even the most profitable multinational enterprises can build data centres or run duplicate IT infrastructures in every country they operate in. The cost of DLRs, however, goes beyond merely building or renting data storage capacity in the implementing jurisdiction. DLRs force companies to re-conceive and realign their internal procedures in a way that can significantly drive up their operating costs, since they often require a far-reaching reconfiguration of how businesses collect, store, process and transfer data. This can represent an important operational constraint for IoT models.[12]

Previous studies point to GDP losses of up to 1.7% from data localisation requirements.

Several academic studies look to the beneficial gains of cross-border data flows and data localisation requirements:

- In a 2019 survey-based study undertaken by GSMA Intelligence on the contribution of IoT to economic growth, researchers concluded that in 2018 alone, the global economy benefitted by some $175 billion just from the productivity gains accrued to businesses thanks to IoT, and that by 2025, these gains will have risen to $370 billion or 0.34% of global GDP. The GSMA Intelligence study also concluded that businesses in the manufacturing sector reaped the majority of these gains: in developing countries, businesses can reduce costs by 4-5% simply by adopting these technologies.[13]

- Other studies look to the general impact of all usage of 5G networks, including IoT. A study by the Australian Government (Bureau of Communications and Arts Research, 2018) found that if 5G becomes a general-purpose technology (GPT), the potential benefits could result in an up to 0.3% increase in productivity, and GDP per capita could increase up to AU$ 8,400 per capita depending on the roll-out scenario.[14] Another study commissioned by Cisco concluded that the total contribution of 5G to real global GDP growth would be equivalent to the current GDP of India [$2.1 trillion].[15]

- Several studies have also analysed the economic impact of DLRs and other restrictions on cross-border data flows. Using the GTAP model, studies by ECIPE (2014) estimated that the GDP losses of economy-wide DLRs varied between 0.7% and 1.7% in Brazil, China, the EU, Indonesia, Korea, Vietnam and Russia.[16]

There is still a gap, however, in the economic literature with respect to the impact of data localisation on IoT. What's more, case studies in the business literature only provide limited information on the impact of DLRs on IoT.

10. See ECIPE (2014).
11. For example, Russia's personal data protection law, Fz-242.
12. See Hogan Lovells, Privacy, Cybersecurity, and the Internet of Things in Asia: What to Expect in 2019: Interview with Mark Parsons, published on 'Lexology', 2019.
13. See GSMA Intelligence (2019)
14. The four scenarios were: 1) lagged rollout and only incremental productivity benefits; 2) lagged rollout and greater productivity benefits (because 5G becomes a GPT); 3) expedited rollout and incremental productivity enhancements; and finally; 4) expedited rollout and greater productivity benefits. See Bureau of Communications and Arts Research, Impacts of 5G on productivity and economic growth, 2018, at p. 21.15. Bekkers, Sabbadini, Koopman and Teh, Long run trends in international trade. The impact of new technologies, 2018.
15. Campbell et al. The 5G economy: How 5G technology will contribute to the global economy, published in: 'IHS Economics and IHS Technology', 2017, at p. 19.16. See ECIPE (2014).
16. See ECIPE (2014).

Research methodology provides IoT-specific impacts as well as the missing dynamic effects.

This study aims to provide the 'indirect wider economic benefits' and 'consumer welfare benefits' that were out of scope in the GSMA Intelligence (2019) study by applying the findings into a dynamic model. For this purpose, we use a computable general equilibrium (CGE) model, a research approach that is regularly used to estimate how an economy reacts to policy or technology changes.

This study uses the standard model developed by GTAP, which includes a combination of a state-of-the-art model and data sets that are used together for a wide range of policy analysis. It is the principal analytical tool used in the vast majority of reports on the impact of economic and technological changes as well as climate change. **This modelling framework is also frequently used by governments and international organisations** like the EU, UN, World Bank, WTO and OECD — all of which are likewise members of the consortium responsible for its development.[17]

The GTAP model is a multi-regional, multisector, CGE model, characterised by perfect competition, constant returns to scale and Armington elasticities.[18] Such a model captures supply-chain effects, macro-economic aspects, economy-wide equilibrium constraints, linkages between different sectors and countries as well as the factor-use effects of various commodities. The model is also able to capture the potential substitution of one sector by another, among other aspects.

We use the most up-to-date and publicly available data from the GTAP 10 database, which contains the most recent global trade data up to 2014, including input-output tables and currently applied levels of trade protection. Before applying the shocks[19] to the model according to our scenarios, we extrapolate the GTAP dataset to the latest available year (2018) to reflect the 'best estimate' of the global economy today. The exogenous variables shocked for extrapolation include the most relevant macroeconomic variables — including population, labour force, GDP, total factor productivity[20] and capital endowment — which are available in the well-recognised database of the French Research Centre in International Economics (CEPII).[21]

The CGE modelling principally draws on findings from two studies:

- First, it relies on the GSMA Intelligence (2019) study for the productivity enhancement generated by IoT. This study surveys the cost-savings from IoT that are typical for a sector. A country-specific productivity increase is derived by adjusting for IoT adoption rate (the share of businesses in the economy that is using the technology) and the sectorial contribution to the total value-added.[22] The results of the **GSMA Intelligence (2019) study provide us with quantitative estimates of the TFP changes in the domestic economy** that have been achieved by 2025.

- Second, IoT does not just impact the productivity of the domestic economy. The use of connectivity (including IoT) also facilitates trade, investment and other cross-border economic activities. A study published by the WTO uses a CGE model (the Global Trade Model), to generate long-term projections of the potential impact of digital technologies on trade.[23] **The WTO study provides an 'ad valorem equivalent' (AVE) — or the reductions in trade cost — that result from e-commerce and broadband connectivity.**

- Moreover, the relationship between domestic productivity changes and the corresponding change 'at the border' from the WTO study provide us with the expected change in trade costs from IoT.[24]

- Previous CGE modelling exercises on data localisation (ECIPE, 2014) look to localisation that affects nearly all data objects (e.g. personal information) or sector-specific data (e.g. financial services). However, this study looks to the impact on one specific data application in isolation — namely IoT. Therefore, the cost impact of DLRs is modelled using a relative cost-based approach described in the next section.

17. Purdue University, GTAP Consortium Members. Accessed at: https://www.gtap.agecon.purdue.edu/about/consortium.asp
18. Purdue University, Global Trade Analysis Project (2018). GTAP Models: Current GTAP Model. Accessed at: https://www.gtap.agecon.purdue.edu/models/current.asp16.
19. The word "shock" here is used in a neutral manner to denote applying the scenarios we wish to observe to the existing data set.
20. Total Factor Productivity (TFP) is understood to denote a measure of productivity calculated by dividing economy-wide total production by the weighted average of inputs, i.e. labor and capital. It represents growth in real output which is in excess of the growth in inputs such as labor and capital.
21. Jean Fouré, Agnès Bénassy-Quéré & Lionel Fontagné, The Great Shift: Macroeconomic projections for the world economy at the 2050 horizon, 'CEPII Working Paper 2012- 03', 2012
22. See GSMA Intelligence (2019) at p. 20.
23. Bekkers, Sabbadini, Koopman and Teh, Long run trends in international trade. The impact of new technologies, 2018.
24. The IoT AVEs corresponds to WTO AVEs weighted by 0.95. This is based on the relationship between IoT productivity effects and domestic TFP changes derived from corresponding data points in the GSMA Intelligence study, the WTO study and Micus (2008), a survey on ICT use in enterprises that estimated the macroeconomic broadband-related productivity improvements.

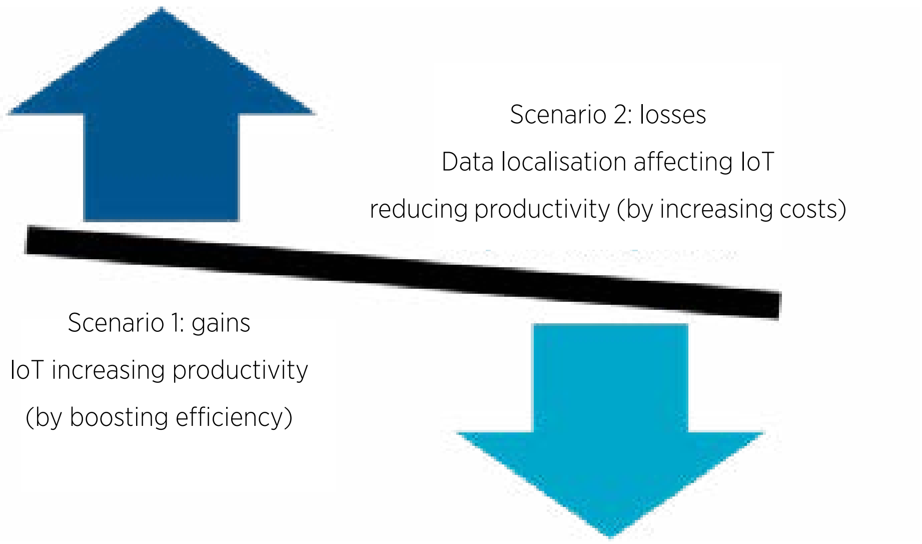
How the scenarios are defined?

A two-step approach to assess data localisation effects on IoT.

The GTAP model in this study builds on two scenarios. In the first, IoT increases the productivity of the global economy. In the second, DLRs reduce the productivity gains achieved from IoT for the countries surveyed as part of this study.

Figure 1

Schematic illustration of the scenarios in this study.
Scenario 1 introduces IoT gains, while Scenario 2 illustrates the losses from DLRs.



Scenario 1: IoT generates new gains compared to today.

There are two types of efficiency gains from IoT deployment in our model: the productivity gains within the economy; and the trade-enhancing effects when the economy trades with other economies.

In the first instance, we shock the model by using the productivity gains from GSMA Intelligence (2019) to Brazil, Indonesia, South Africa and the rest of the world that agglomerates all other economies in the model. The productivity shocks are introduced as TFP increases that apply to the domestic economy.

In other words, we assume that the global economy deploys IoT applications according to the GSMA Intelligence (2019) calculations for the year 2025. Obviously, this baseline assumes ceteris paribus for all other technologies, policy measures or economic developments aside from the extrapolation described in the previous chapter. The TFP shocks from the GSMA Intelligence study are:

Table 1

Domestic productivity increase due to IoT.
Percentage change in the respective country/region from IoT technology.

Total Factor Productivity (TFP) change (%)	
Brazil	0.27
Indonesia	0.24
South Africa	0.17
Rest of the world	0.34

In addition to the domestic shocks, we also introduce a productivity effect 'at the border' for imports of trade and services from overseas. This trade efficiency impact of IoT applies concurrently with the domestic productivity increase identified by GSMA Intelligence (2019).

The trade efficiency-enhancing effect from IoT is based on the impact of connectivity on trade which was identified in the WTO study cited above. How IoT reduces the import prices of goods and services and increase product variety is estimated for a similar point in time, i.e. after approximately seven years.[25]

Table 2

Import efficiency due to IoT.
Percentage change in the respective country/region from IoT technology.

Trade cost change: AMS (%)	
Brazil	-0.68
Indonesia	-1.88
South Africa	-4.82
Rest of the world	-0.62

25. This trade efficiency shock is denoted Aggregate Measurement of Support (AMS) shock in the GTAP model

Interestingly, the TFP shocks fall within a relatively narrow range (0.17-0.27%), whereas the trade cost reductions are quite dispersed, between 0.68-4.82% This is probably because the increasing impact that data is having on the economy is relatively uniform across the three countries surveyed, whereas their relative exposure to trade flows varies significantly depending on how acutely countries' economies are oriented towards export and how open these economies are to trade and investment.

Scenario 2: data localisation hampers IoT efficiency.

In the second set of scenarios, we examined the negative impacts that the introduction of DLRs would have on the three countries surveyed in the first scenario.

Whereas previous quantitative and experimental studies on DLRs (ECIPE, 2014) relied on the relations between regulatory indices (e.g. OECD PMRs or DTRIs) and TFP, these approaches cannot distinguish the impact on one single application — such as the use of IoT in isolation. This model is not based on an assumption that DLRs apply to a particular type of data (e.g. on personal data due to privacy regulation). Instead, this model assumes that data localisation and its costs are isolated to one particular type of application (i.e. IoT usage) in this model, regardless of what type of data (e.g. personal or business data) that are subject to data localisation requirements.

In sum, we assume that DLRs create costs according to the following:

- The original costs (prior to data localisation) of IoT deployment is based on a parity between gains and costs according to a 30% return on investment (ROI), which is based on a 2019 survey by Microsoft.[26]

- Data localisation requirements lead to: increased costs for duplicate data centre infrastructure; and higher costs for connectivity, applications and other services — with poorer variety and quality — because they must be sourced from the limited pool of domestic suppliers) These cost estimates are based on empirical observations from Brazil,[27] and extrapolated for the other countries based on industry survey data on data centre costs.[28]

- Not all aspects of the IoT deployment costs, however, are subject to a cost increase due to data localisation requirements. There are other costs that arise independent of restrictions on cross-border data flows. According to an estimate of cost breakdowns of IoT deployment based on survey data,[29] the cost of deploying mobile and web apps, the cost of obtaining data storage services and the costs of connectivity more generally account together for 47% of the deployment costs of IoT.

- These new costs lead to productivity losses since they lead to a higher cost for using technology. Return on investments in the technology becomes lower, while the new costs may have resulted in IoT becoming prohibitive for some firms in the economy. Such constraints lead to businesses being unable to achieve the same productivity gains as before.

- In this scenario, we assume that DLRs are introduced simultaneously with IoT, i.e. the productivity reductions occur from day one. We also assume that the rest of the world will not introduce any new DLRs affecting IoT deployment, which is not already included in the baseline. Further, the use of international mobile roaming (to circumvent the DLRs) is not taken into account as we assume that would be in breach of the regulations.

In sum, the TFP reductions are as follows:

26. Microsoft, IoT Signals: Summary of Research Learnings, 2019.
27. Frost & Sullivan, Insights into Big Data and Analytics in Brazil, 2014
28. Cushman & Wakefield (2016).
29. Business Insider (2019)

Table 3

Domestic productivity loss due to DLRs.
Percentage change in the respective country/region from IoT technology.

Total Factor Productivity (TFP) change (%)	
Brazil	-0.16
Indonesia	-0.14
South Africa	-0.10

In addition, we also assume that 'at the border' efficiencies for imports of trade and services are reduced proportionately to the domestic productivity shocks according to the following:

Table 4

Import efficiency loss due to DLRs.
Percentage change in the respective country/region from IoT technology.

Trade cost change: AMS (%)	
Brazil	0.39
Indonesia	1.10
South Africa	2.81

Exploring the results

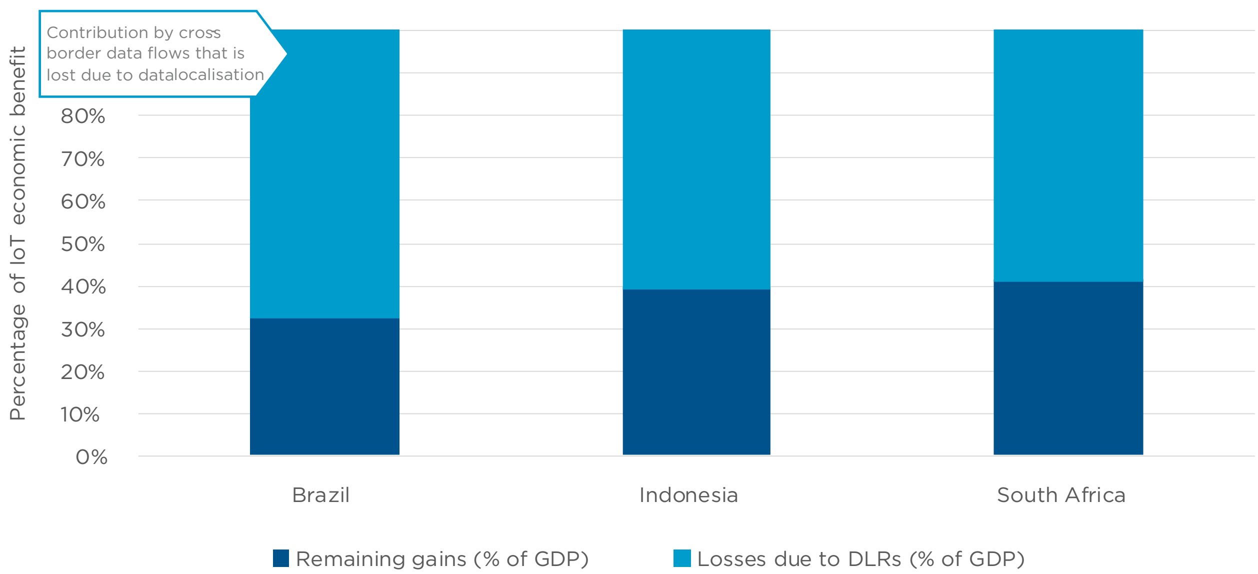
Overview: cross-border data flows accounts for up to 68% of IoT gains (which are lost due to data localisation).

The comparison between Scenario 1 (where IoT is first deployed) and then Scenario 2 (where we see reductions due to DLRs) provides us with the losses incurred by DLRs. In effect, this portion also accounts for the contribution of cross-border data flows across the IoT value chain through lower deployment costs, higher returns and better technology variety.

Since as little as 32-41% of the output gains (GDP) from IoT remain if DLRs are introduced, **between 59% and 68% of IoT GDP gains are attributable to cross-border data flows (which are lost when DLRs are imposed)**. These strongly negative results fully take into account the positive effects from data localisation that lead to import substitution, i.e. where foreign suppliers are replaced by domestic competitors of systems development, IT infrastructure and data storage.

Figure 2

The relation between gains and losses: GDP (%).
Sections in light blue are the contributions by cross-border data flows, which are lost due to data localisation



Results of Scenario 1: considerable GDP gains from IoT.

Overall, we see major increases to GDP from IoT deployment — between 0.5% to 2.2% of GDP compared to a baseline where the use of IoT in the economy is constant — compared to today. To put these numbers in context, **the gains predicted from IoT deployment are similar to those one would expect to see from implementing major policy or tax reforms, or from a free trade agreement with a major trading partner.**

These very large numbers are explained either by the productivity shocks in the GSMA Intelligence study or the AVE cuts in the WTO study. Nonetheless, the dynamic effects provided by the CGE modelling on the national output (GDP) doubles the original productivity gains. As expected, the dynamic effects from welfare increases, stronger demand, better competitiveness and greater variety of products augment the original productivity boost created by the use of IoT.

These effects can be explained in different ways. The overall GDP gains are the result of broad-based productivity increases and the dynamic effects that impact the economy as a whole since IoT technologies themselves generate both first and second-order economic effects. An example of first-order effects would be the direct impact of procuring and installing thousands of new IoT sensors, or contracting for additional data storage capacity as a result of the data these sensors will produce. An example of second-order effects would be the economic activity generated from new solutions and services that companies operating in the IoT space are able to devise and sell on the basis of the data now being captured by the newly procured and installed sensors. This is a very basic example, but it should give the reader an idea of how the productivity gains and dynamic effects interact with one another to generate gains across the economy as a whole.

Both first and second order effects can result in an uptick in exports, imports, investment and employment, depending on how IoT-related goods and services are produced and consumed.

Table 5

Comparison of GDP effects (%).
Comparison to the TFP shock introduced.

	GDP	Original TFP shocks
Brazil	0.5	0.27
Indonesia	0.9	0.24
South Africa	2.6	0.17

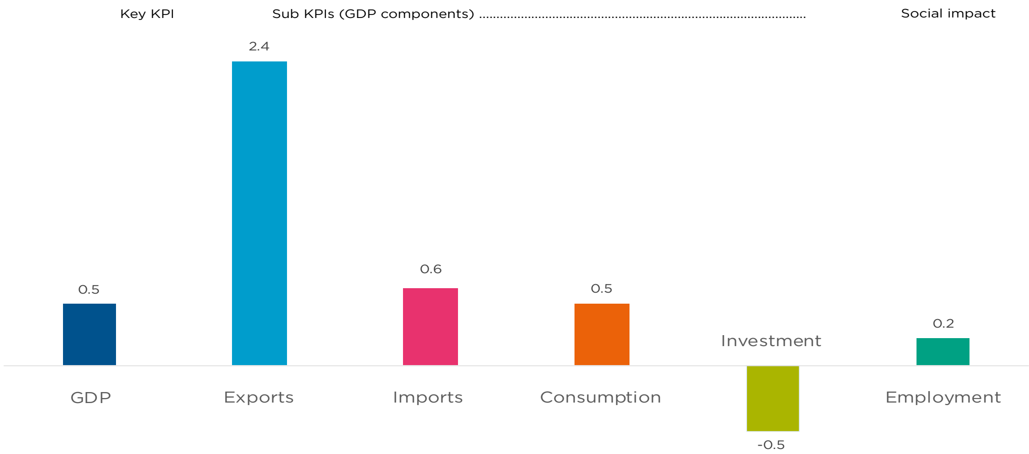
In the case of **Brazil**, introducing IoT and related technologies resulted in: annual average GDP gains of 0.5% (which is primarily derived from the improved trade balance); and an extraordinarily high boost to exports (at 2.4%), with only a modest increase in imports (presumably because the Brazilian economy already exudes strong export orientation). Other GDP components see a relatively small change compared to exports. It is recognised that strong export orientation typically results in reduced investment, and this is borne out in this case with investment in Brazil dropping by 0.5%.

It should also be noted that in 2015 the Brazilian economy suffered a major crisis (where GDP dropped by almost 4% in a single year), which likewise has a bearing on this study. The lowering of wages since the crisis facilitates a reconfiguration of economic activity towards export orientation. The economic prospects (which form the baseline) were also seriously downgraded for the short to medium term period we are examining.

Nonetheless, according to the latest International Monetary Fund (IMF) projections, the GDP gains in absolute terms are approximately $11 billion in 2025, according to the current trajectory.[30]

Figure 3.1

Contribution of IoT deployment in Brazil (%).
Increases compared to a baseline where IoT deployment is not expanded.

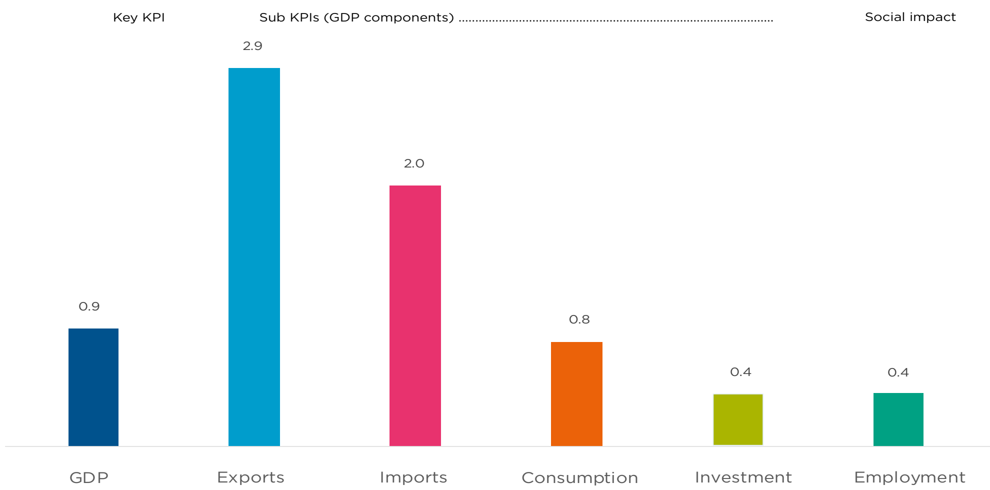


In the case of **Indonesia,** we found that introducing IoT resulted in impressive average GDP gains of 0.9% (i.e. almost a full percentage point), with a more balanced increase on exports and imports, with a positive impact on investments.

The GDP gains in this scenario are approximately **$14 billion** in absolute terms by 2025, based on GDP-growth projections published in the IMF World Economic Outlook.[31]

Figure 3.2

Contribution of IoT deployment in Indonesia (%). .
Increases compared to a baseline where IoT deployment is not expanded.



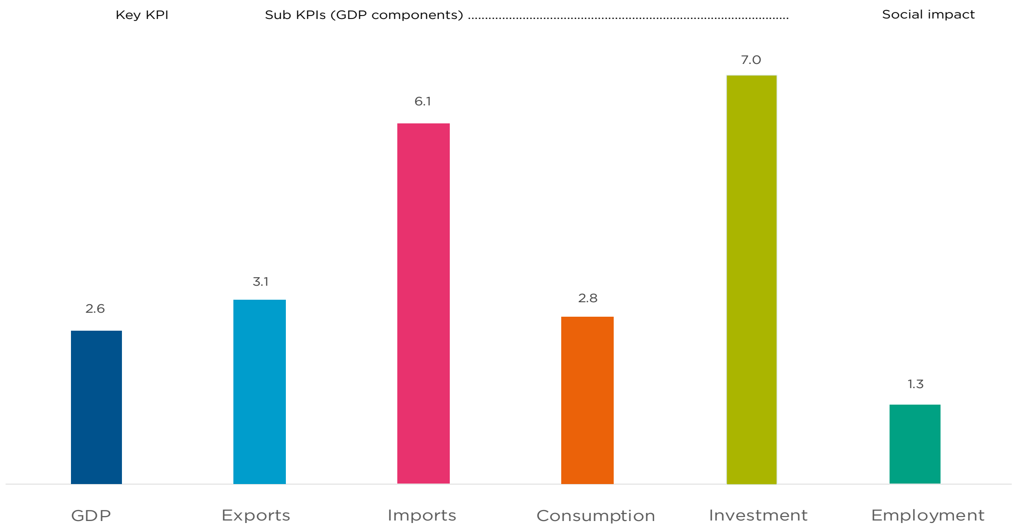
30. IMF, World Economic Outlook, October 2019
31. Ibid.

South Africa sees results where the gains are distributed differently compared to the other two countries surveyed. With a significantly larger boost to GDP of 2.6%, which is not driven by an expansion of the trade balance, but primarily consumption that boosts imports and investments. The consumption and investment-led growth contribute to GDP increases that are by far the largest of the three countries surveyed.

The GDP gains in this scenario are approximately **$11 billion** in absolute terms by 2025, based on GDP-growth projections published in the IMF World Economic Outlook. [32]

Figure 3.3

Contribution of IoT deployment in South Africa (%).
Increases compared to a baseline where IoT deployment is not expanded.



32. Ibid.

Scenario 2: cross-border data flows are an essential component of a productive IoT deployment.

Similar to how the dynamic effects augment the gains, the losses incurred by DLRs reverberate throughout the economy. In this scenario, we also assume that the country is alone in introducing new DLRs. By doing so, the country lags behind other competing economies who do not introduce new DLRs on IoT data or telecom services — and thereby benefit from diverted investments and trade. Subsequently, the rest of the world is not affected by any negative shocks in the GTAP model.

Table 6

Comparison of GDP effects (%).
Comparison to the TFP shock introduced.

	GDP	Original TFP shocks
Brazil	0.3	-0.16
Indonesia	0.6	-0.14
South Africa	-1.5	-0.10

For **Brazil**, the model estimates that DLRs result in a -0.3% change in GDP overall, with no measurable impact on exports. Brazil remains strongly oriented towards exportation. Exports, however, cannot compensate for the negative impact on domestic consumption and investment.

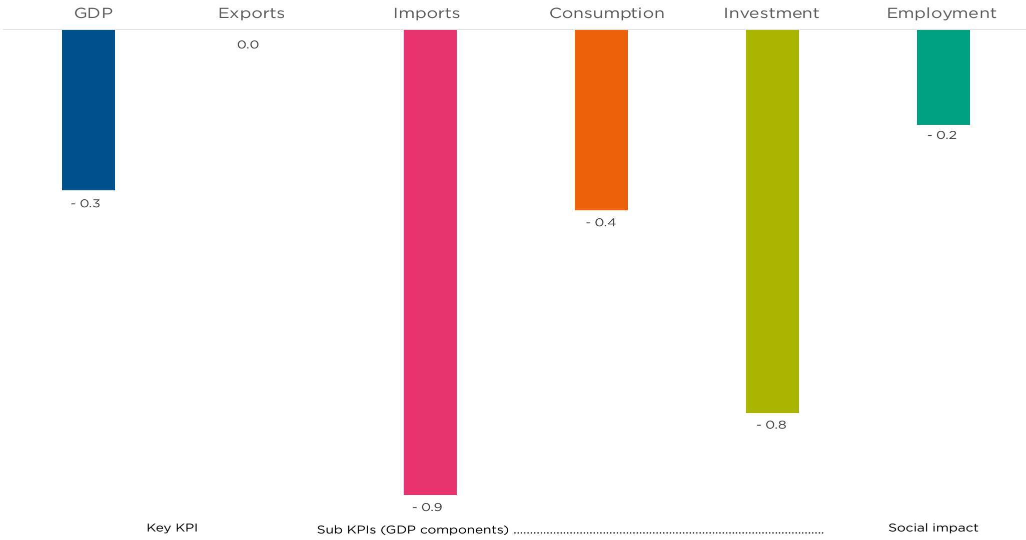
Brazil also sees the largest relative drop in GDP relative to the gains (see figure 1), which is explained by how IoT benefits are generated by demand in external markets.

- As a result of the economic contraction caused by DLRs, 205,000 jobs are lost in Brazil.
- GDP losses are approximately $7.5 billion in absolute terms by 2025, based on GDP-growth projections published in the IMF World Economic Outlook.[33]
- The loss of investment amounts to $3.2 billion, which is in addition to the investment losses caused by greater export orientation.

33. Ibid.

Figure 4.1

Losses of DLRs on IoT data in Brazil (%).
Declines compared to Scenario 1 baseline.

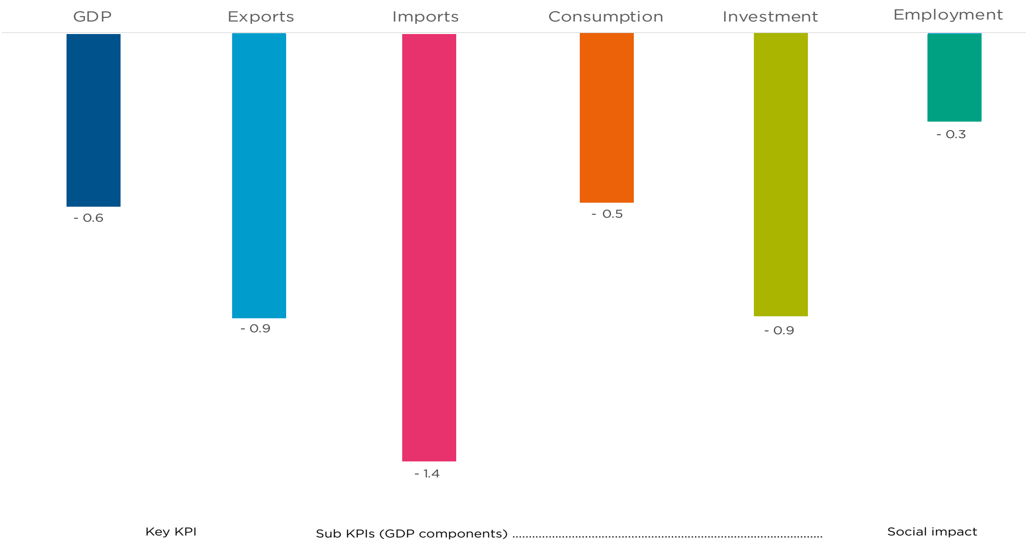


For **Indonesia,** we estimate that introducing DLRs results in an annual -0.6% change in GDP overall, from a combined effect of trade balance, consumption and investments. In fact, the effects of trade and investment diversion (where trade and investments to Indonesia are diverted to competing economies) create a larger loss than the original benefit generated from IoT. The case of Indonesia clearly illustrates how the costs of policy failure are higher in real life: no country is truly independent of competition from other countries.

- As a result of the economic contraction caused by DLRs, 372,000 jobs are lost in Indonesia.
- GDP losses are approximately $8.8 billion in absolute terms by 2025, based on GDP-growth projections published in the IMF World Economic Outlook.[34]
- The loss of investment amounts to $5 billion.

Figure 4.2

Losses of DLRs on IoT data in Indonesia (%).
Declines compared to Scenario 1 baseline.



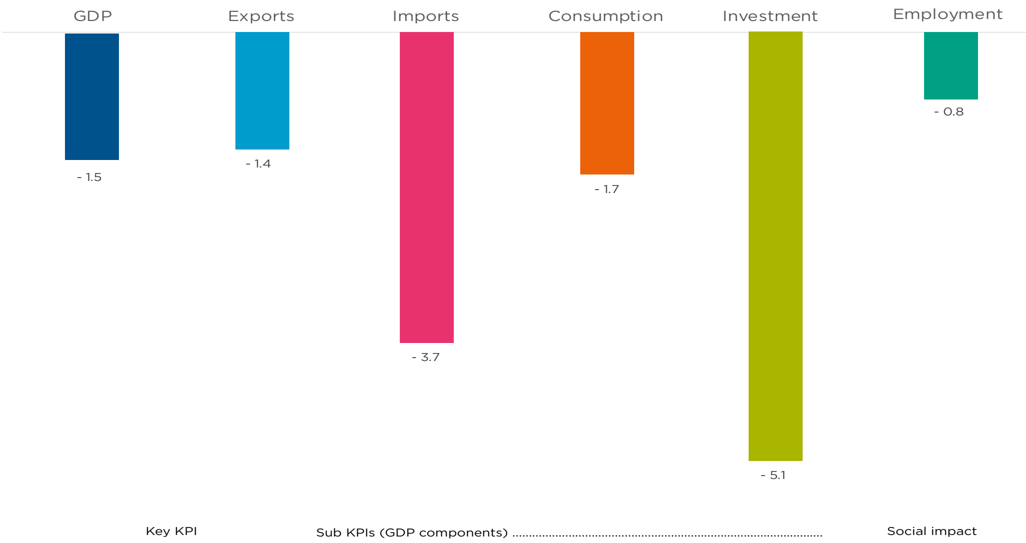
34. Ibid.

For **South Africa**, the model estimates that investments, consumption and imports are projected to decline at a greater rate if cross-border restrictions are implemented.

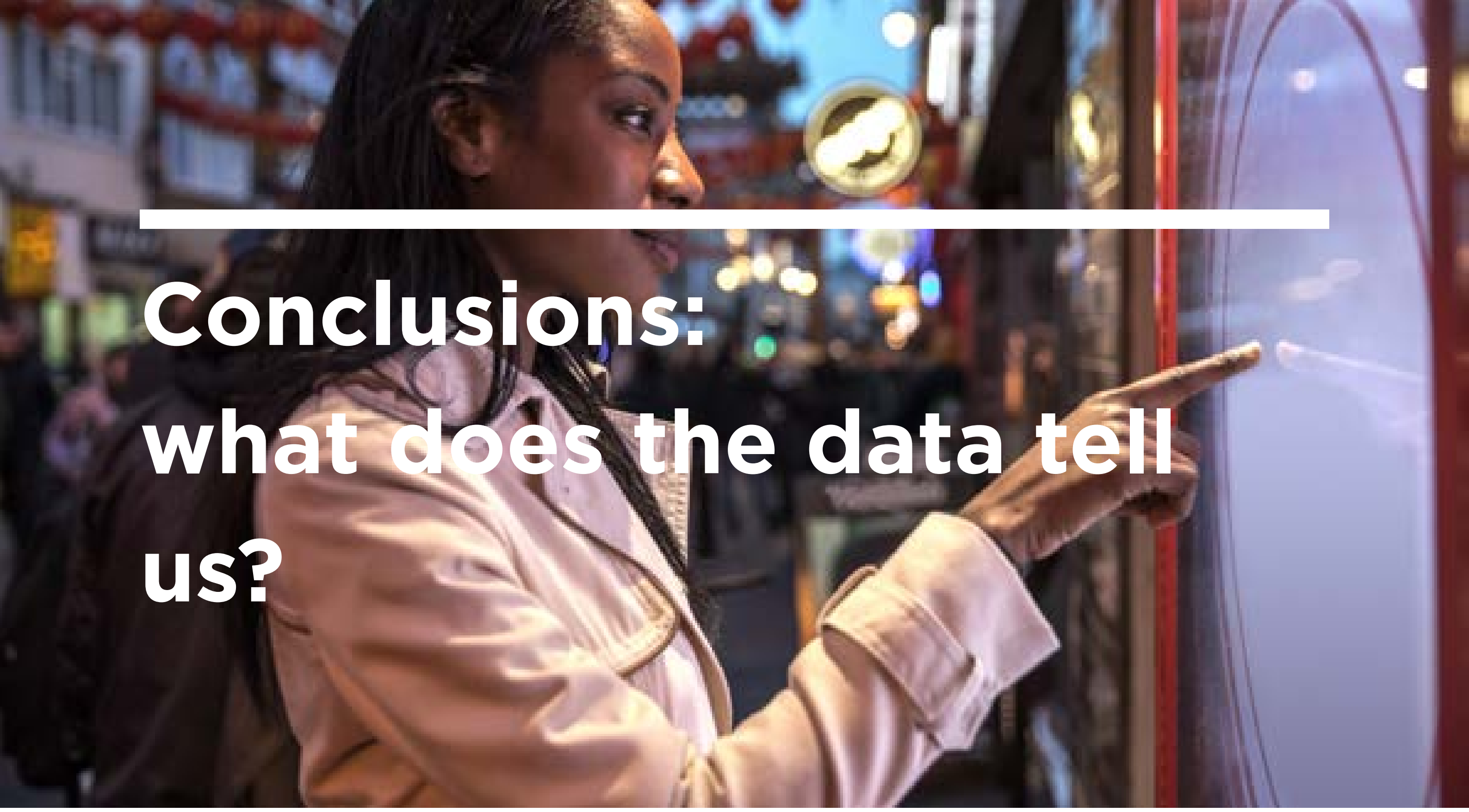
- As a result of the economic contraction caused by DLRs, 182,000 jobs are lost in South Africa.
- GDP losses are approximately $6.7 billion in absolute terms by 2025, based on GDP-growth projections published in the IMF World Economic Outlook.[35]
- The loss of investment amounts to $4 billion.

Figure 4.3

Losses of DLRs on IoT data in South Africa (%).
Declines compared to Scenario 1 baseline.



35. Ibid.



Conclusions: what does the data tell us?

The role of cross-border data flows is crucial for IoT.

In each of the three economies surveyed we find that there are substantial economic gains when IoT technologies are adopted. CGE modelling results, however, also show that these efficiency gains can be unravelled once firms have to grapple with the additional costs that the imposition of DLRs and similar restrictions on cross-border data flows inevitably bring.

In conclusion, between 59% and 68% of IoT GDP gains are attributable to cross-border data flows, which will be lost when DLRs are imposed, increasing costs for IoT system developers or network service providers.

The economic impact of network services is substantial and 'trickles down'.

The potential gains from IoT and related technologies come in various forms: improvements in TFP; continuing annual improvements to GDP; and structural changes to those economies that embrace these technologies, thereby making them more competitive. In this way, technologies such as IoT, 5G, big data analytics, machine learning, automation and the many others that will characterise this new era of the Internet of Everything (IoE) are a gift that keeps on giving to almost all sectors that are vital to an emerging economy

By the same token, DLRs and similar restrictions on cross-border data flows can significantly undermine the potential gains countries stand to reap from the adoption of IoT and related technologies. Moreover, no country exists in a vacuum: The CGE modelling shows how the divergence of export revenues and investment to regional competitors can be considerable for countries in Latin America, Sub-Saharan Africa and ASEAN.

Policymakers must not underestimate the damaging impact imposing these measures is certain to have on their economies. They should also consider the costs to businesses, consumers and the economy as a whole before imposing them.

IoT enables different paths for growth for emerging economies.

The CGE model generates interesting results across different emerging economies from the productivity increase. Whereas the adoption of IoT and related technologies was universally beneficial to GDP across all the three countries surveyed, we see export-led growth in Brazil as opposed to consumption and investment-driven growth in South Africa.

This study has deliberately focused on three emerging economies in different regions with varying industrial structures and demographics, and which find themselves on different growth trajectories. The varying paths for growth presented by IoT deployment show how the economy-wide deployment of IoT brings positive benefits to the economy regardless of region, size or growth model.

Results are consistent across all countries.

The TFP impacts derived from the GSMA Intelligence survey are considerable. They are further augmented by the dynamic effects in the economy and the 'at the border' effects implied by the WTO study, especially in the case for South Africa.

Overall, these large numbers are explained by the underlying methodology of the studies we rely on for our economic shocks, but should not affect the relative importance of cross-border data flows or the significant impact of DLRs. The results on data flow contributions (and costs of data localisation) are consistent and within a relatively close band regardless of the size or type of shock introduced in the model.

Costs of DLRs and similar restrictions are increasing.

In addition, **as IoT adoption rates increase and value chains and production networks adapt and reconfigure themselves to take advantage of these new technologies, the cost implications of imposing DLRs and similar restrictions on cross-border data flows will only increase.** Any such measures need to be carefully conceived and narrowly formulated, with a view to implementing them in such a way that is minimally disruptive to the data requirements of business and their need to collect, process and transfer data across multiple jurisdictions.

Although the significant GDP losses generated in this study are not directly comparable to previous studies on DLRs (ECIPE 2014), the results in these studies indicate substantially higher costs from DLRs due to higher data intensity in the economy brought on by IoT and 5G. The societal costs of disrupting connectivity and network provision likewise increase.

Network and regulations must be minimally trade-restrictive.

In conclusion, policymakers and business leaders cannot afford to be complacent, but need to start thinking very seriously about what steps they plan to take to facilitate and accelerate the adoption and implementation of IoT and related technologies. By the same token, they need to avoid any measures that undermine the efficiency gains and cost savings that these technologies can unleash. In particular, DLRs and other restrictions on cross-border data flows should only be applied when they are absolutely essential and implemented in a way that is minimally trade-restrictive.

Overall, the results show that DLRs and similar restrictions on cross-border data flows can significantly cut into the efficiency gains achieved by adopting and implementing IoT and related technologies. Restrictions on cross-border data flows significantly raise costs for businesses while also lowering their profitability — and the tax revenues they pay to governments.

Table of acronyms

AI	Artificial intelligence
AMS	Aggregate Measure of Support
AVE	Ad-valorem Equivalent
ASEAN	Association of Southeast Asian Nations
CBDFs	Cross-border data flows
DLRs	Data localisation requirements[36]
GDP	Gross Domestic Product
GTAP	Global Trade Analysis Project
ECIPE	European Centre for International Political Economy
IoE	Internet of Everything
IoT	Internet of Things
IMF	International Monetary Fund
OECD	Organisation for Economic Cooperation and Development
RoW	Rest of World
TFP	Total Factor Productivity
WTO	World Trade Organization

36. This paper understands DLRs to encompass mandatory regulations requiring that data can only be stored or processed locally, or that a copy must be stored locally for any data transferred. DLRs can also comprise a ban on transferring some forms of data across borders.

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