GSMA Intelligence

Estimating the economic impact of mobile technologies

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Introduction

This note explains the methodology behind the economic impact estimates in the GSMA Mobile Economy reports[1] and the Economic growth and the digital transformation of enterprises report.[2]

In the first part we present our empirical model to capture the contribution of mobile technologies to economic progress. In the second part we break down the impact by direct, indirect and productivity effects. Finally, we present the fiscal contribution and employment impacts.

[1] https://www.gsma.com/mobileeconomy/
[2] Economic growth and the digital transformation of enterprises, GSMA Intelligence, 2025

How connectivity and digital transformation shape the economy

The economic impacts of connectivity are well documented. There is a very significant body of research that establishes the link between ICT and growth, a subset of which is focused on mobile technology and the internet specifically. These studies are typically based on econometric (regression) analysis and try to isolate the effect of mobile usage as a factor that drives GDP. A list of relevant references is provided at the end of this note.

Previous GSMA Intelligence research finds that on average a 10% increase in mobile adoption increases GDP by 1%, with the effect increasing by approximately 15% when connections upgrade from one mobile network technology to another.[3] As a consequence, the higher the mobile technology adoption, the higher the benefit with respect to GDP. These gains arise because digital technologies enable a more efficient allocation of resources within firms and markets, which improves productivity.

However, the broader effects of digital transformation across enterprises in different sectors remain less understood.[4] We address this by providing empirical evidence on how the latest wave of digital technologies influences economic growth. Some relevant applications based on faster and reliable connectivity are cloud computing, network slicing, augmented and virtual reality, industrial automation, connected vehicles and the integration of IoT and AI applications and services.

Our approach to economic growth is based on the theory of production to determine what factors account for the observed growth in the economy and to what extent. In our model the factors that explain real output are fixed capital, human capital and digital technologies – including mobile and fixed broadband, as well as 5G, IoT and AI. This framework is consistent with the traditional approach employed in the existing literature that has previously assessed the macroeconomic impacts of information and communication technologies on growth.[5]

[3] Mobile technology: two decades driving economic growth, GSMA, 2020.
[4] See for example Acemoglu (2025), Edquist et al. (2021) and Tiutiunyk et al. (2021).
[5] See for example Czernich et al. (2011), Gruber et al. (2014), Koutroumpis (2019), ITU (2020) and Briglauer et al. (2022).

Data

To estimate the effect of mobile technologies on GDP we use linear panel data models with fixed effects on 195 countries during the 2010–2023 period. Table 1 sets out the main data sources.

Table 1: Datasets used to estimate the impact of mobile technologies on the economy

Outcome variable	Independent variable	Controls
GDP GDP by industry	Mobile adoption (GSMA Intelligence, 2024)	Investment (IMF-WEO, 2024) Labour (WB-WDI, 2024) Schooling years (UN, 2024) Fixed broadband (ITU, 2024)
	IoT connections per inhabitant IoT manufacturing IoT construction IoT automotive IoT enterprise others IoT others (GSMA Intelligence, 2024)	Investment (IMF-WEO, 2024) Labour (WB-WDI, 2024) Schooling years (UN, 2024) Fixed broadband (ITU, 2024) Mobile adoption (GSMA Intelligence, 2024) Income level (WB, 2024)

Source: GSMA Intelligence

Empirical strategy

In our empirical specification, the output of a country i at time t (GDP_{it}) depends on its physical capital (K_{it}), labour force participation (L_{it}) and mean years of schooling $(schooling_{it})$ as a proxy for human capital. The variables of interest are mobile adoption $(Mobile_{it})$ and IoT adoption (IoT_{it}). The former refers to the effects of connectivity and the latter to the digital transformation of the economy as a consequence of the adoption of more advanced technologies (IoT, AI, cloud computing, network slicing etc.) and their interaction in the digital ecosystem. As a control we also include fixed broadband adoption $(Fixed\_BB_{it})$.[6]

The terms μ_i and θ_t are parameters for country and time (year) fixed effects. The former captures any time-invariant heterogeneity at the country level (such as geographic characteristics), while the latter controls for time-bounded macroeconomic shocks that impact every country at the same time (such as the Covid-19 pandemic). Equation 1 becomes our two-way fixed effects (TW-FE) estimator:

$$\log(GDP_{it}) = \beta_0 + \beta_1 \log(K_{it}) + \beta_2 \log(L_{it}) + \beta_3 \log(schooling_{it}) + \beta_4 \log(FixedBB_{it}) + \beta_5 \log(Mobile_{it}) + \beta_6 log(IoT_{it}) + \mu_i + \theta_t + \varepsilon_{it} \quad (1)$$

Equation 1 presents the effects of mobile technologies on the economy of a country. However, these benefits can be unevenly spread across industries, meaning that some sectors can benefit more than others due to their greater ability to incorporate digital technologies. To account for this fact, Equation 2 replaces the dependent variable total GDP by the GDP for each industry. We define eight industries, in line with the UN's value added by industries classification (see Appendix 1).[7] The variable GDP_{ist} represents the GDP of country i in the industry s at time t:

$$log(GDP_{ist}) = \beta_0 + \beta_1 log(K_{it}) + \beta_2 log(L_{it}) + \beta_3 log(schooling_{it}) + \beta_4 log(FixedBB_{it}) + \beta_5 log(Mobile_{it}) + \beta_6 log(IoT_{it}) + \mu_i + \theta_t + \varepsilon_{it} \quad (2)$$

Based on the type of IoT connections we were able to identify five verticals defined as manufacturing, construction, automotive, enterprise others and consumer others. The types of IoT connections included in each category are presented in Appendix 2. Using this data, we estimate the impact of each IoT vertical on sectoral GDP. Equation 3 presents this strategy. The variable $IoT\_vertical_{ivt}$ represents the IoT connections per capita of country i in the vertical v at time t:

$$\log(GDP_{ist}) = \beta_0 + \beta_1 \log(K_{it}) + \beta_2 \log(L_{it}) + \beta_3 \log(schooling_{it}) + \beta_4 \log(FixedBB_{it}) + \beta_5 \log(Mobile_{it}) + \beta_6 log(IoT\_vetical_{ivt}) + \mu_i + \theta_t + \varepsilon_{it} \quad (3)$$

Results

The impact on a sector was calculated by taking the average value of the coefficients that were statistically significant in equation 3. Table 2 presents the coefficients by industry.

Across all sectors, a 10% increase in IoT connections per inhabitant increases GDP by 0.16%, on average. We find that the industries that benefited the most in relative terms from the increasing digitalisation measured by the number of IoT connections per capita are ICT, agriculture, manufacturing and financial services.

[6] Given that AI and the latest wave of digital technologies are in the early years of adoption we were not able to identify a time series of data across countries with enough length that can be use in our models, being IoT the only variable for which we obtained enough data to conduct empirical analysis based on asymptotic assumptions.

[7] The data was downloaded in October 2024 from: https://data.un.org/Data.aspx?d=SNA&f=group_code%3A204

Table 2: Impact coefficient of IoT connections on GDP by industry

Industry	IoT Increase	Result
Accommodation and food service activities	10%	0.12%
Agriculture, forestry and fishing	10%	0.20%
Construction and real estate	10%	0.09%
Financial and insurance activities	10%	0.16%
Information and communication	10%	0.28%
Manufacturing	10%	0.16%
Public administration and defence; compulsory social security	10%	0.11%
Services	10%	0.11%

Source: GSMA Intelligence

Limitations

The presence of endogeneity is frequently observed in economic production processes, meaning that the effect of the independent variable on the outcome cannot be casually interpreted.[8]

Endogeneity may arise due to three possible reasons in our analysis. The first possible reason is the omission of variables that can affect GDP growth and at the same time be related to digital transformation. Considering that we control for physical and human capital, the rollout of fixed and mobile broadband plus the inclusion of country and year fixed effects, this should not be a major concern in our case.

Second, there may be a simultaneity relation (reverse causation) between economic growth and digitalisation. This means that productivity should rise in sectors adopting digital technologies, but it is possible that this occurs more rapidly in already highly productive and technological sectors (OECD (2008)). A natural experiment or instrumental variable would be ideal in this case; however, we were not able to identify such an exogenous event or policy in our horizon of analysis or an appropriate set of instruments. In Aquije, Bahia and Castells (2024), we use dynamic panel models, including multiple lags of GDP as instruments and obtain similar results to our main specification using the two-way fixed effects estimator.

Third, there may be measurement errors, such as misreporting or erroneous data, which should not be a factor in our case as we rely on information maintained by international organisations (IMF, World Bank, UN, among others) and GSMA Intelligence data for mobile and IoT

[8] Endogeneity refers to a situation where a predictor variable and the error term of the outcome variable are correlated, leading to bias estimates.

connections. Moreover, if there is any bias, it would arguably be randomly generated so would not affect our results.

Estimating the impact of mobile technology

To estimate the economic contribution of mobile technologies we combine data on the adoption of mobile technologies (both historical and forecast) with the parameters obtained in the empirical models. Formally, the total benefit of a country i on the industry s at time t is defined as the sum of two components:

- For connectivity, the output in the previous year ($GDP_{i,s,t-1}$) is multiplied by the expected change in the mobile technology penetration rate for 2G, 3G, 4G and 5G technologies ($\propto_{i,t} - \alpha_{i,t-1}$) and the productivity parameter impact for each technology ($\beta_{i,t}^{G}$).
- For digital transformation driven by enterprises, the output in the previous year ($GDP_{i,s,t-1}$) is multiplied by the expected change in IoT connections per capita ($\delta_{i,t} - \delta_{i,t-1}$) and the productivity parameter impact for each technology by industry ($\gamma_{i,s,t}$).

The coefficients for connectivity and digital transformation are then adjusted according to the country's level of development $\rho_{i,t}$ based on the World Bank's historical income classification.[9] Low-income countries are expected to see higher additional benefits as there is more room for improvement and efficiency gains, in line with the convergence hypothesis (Mankiw, Romer and Weil (1992), Johnson and Papageorgiou (2020)) as well as empirical evidence on the impact of mobile technologies (see for example ITU (2020)) and our econometric results. Informed by these studies, we apply an uplift of 1.3 for the low-income economies and a downgrade of 0.5 for the high-income economies:

$$\sum_{s=1}^{n} Economic\_Benefit_{i,s,t} = \sum_{s=1}^{n} GDP_{i,s,t-1} * \rho_{i,t}\left[\left(\propto_{i,t} - \alpha_{i,t-1}\right) * \beta_{i,t}^{G} + \left(\delta_{i,t} - \delta_{i,t-1}\right) * \gamma_{i,s,t}\right]$$

Finally, to obtain the total benefits for a country on a given year we aggregate the results. In the case of connectivity, we consider the period since the introduction of the first mobile generation until 2030. For enterprise digital transformation (proxied by the number of IoT connections), given that it is a more recent phenomenon growing at a fast pace, we conservatively only consider the effect from 2024 to 2030:

$$Total\_Benefit_{i,t} = \sum_{t=1980}^{2030} Connectivity_{i,t} + \sum_{t=2024}^{2030} Digital\_transformation_{i,t}$$

[9] Downloaded on December 2024 from https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

Distribution of the economic benefits

Direct, indirect and productivity impacts

Three elements contribute to the overall economic impact of the mobile industry: direct, indirect and productivity impacts.

The direct impact considers the contribution of the mobile ecosystem to the economy. In our definition, this is formed by three categories: mobile operators; infrastructure and equipment; and content and services. The infrastructure and equipment category encompasses network equipment providers, device manufacturers and IoT companies. Meanwhile, the content and services category encompasses content, mobile application and service providers, distributors and retailers and mobile cloud services. We explicitly exclude any economic value generated through mobile commerce, as in that case mobile technology and services are typically a contributor but not the key driver of the value that is generated.

To calculate the direct economic contribution of the mobile ecosystem, we follow the value-added approach to GDP accounting, also known as the production approach. This method calculates value added as the difference between the sales made by the sector and the direct cost of making those sales. Firstly, we measure the revenues associated with each of the industries that make up the mobile ecosystem, as well as the direct cost of making those sales. Secondly, we calculate the direct economic contribution by adding the value added generated by companies operating in the ecosystem across approximately 240 countries and territories.

Revenue data for the ecosystem industries is obtained from GSMA Intelligence and a range of industry sources (a full list is provided at the end of this note). We analyse companies' financial accounts across the ecosystem to understand the proportion of revenues that should be accounted for as value added in each country. Where data is not available, modelling techniques are used to estimate and predict values. Where data at the country level is not available, we use industry market values (historical and forecast) from multiple sources at a more aggregate level. Data from international organisations such as the World Bank, the IMF and the UN are used to further support and calibrate the analysis.

As mobile operators and the ecosystem purchase inputs and services from their providers in the supply chain, an indirect effect is generated, producing sales and value added in other sectors and industries. A mobile network operator, for example, needs to contract energy and construction services and is hence indirectly generating economic activity elsewhere in the economy. We calculate this indirect or 'multiplier' effect from input-output tables, which are produced by national, and sometimes supranational, statistical authorities. These are a detailed account of how the outputs from an industry are used as inputs in all other industries and vice versa. We further adjust the values of the multipliers to avoid any potential double-counting arising from the multiplier for one ecosystem industry including the indirect effect on other ecosystem industries that are already accounted for in our direct impact analysis.

Finally, the usage of mobile phones and mobile internet applications by consumers and businesses allows more efficient ways to access information, accelerates processes and communications, and allows greater productivity, boosting GDP. In the model the productivity is calculated as the difference between the impact of mobile technologies on GDP and the direct and indirect contribution. We identify two ways in which this takes effect:

(i) The first is the use of basic mobile voice and text services, which allows workers and firms to communicate more efficiently and effectively (e.g. reducing unproductive travel time).

(ii) The second is the use of mobile broadband (3G, 4G and 5G), which allows workers and firms to use internet services – for example, allowing them greater access to market information. The impact of broadband materialises through deployment of 3G networks. 4G technology has provided improved mobile broadband services, with faster speeds and, therefore, greater economic impacts. 5G provides significant improvements to current mobile services' speeds, signal response delays and massive communications capabilities, powering the digital transformation of the economy.

Estimating the impact on jobs

We examine the employment and revenue figures for a sample of companies in the ecosystem. Revenues per employee are calculated and used to derive estimates per country and region and globally.

Further to the employment sustained within the ecosystem, additional jobs are also indirectly supported as the economic activity in the ecosystem generates demand and jobs in other sectors. We estimate the number of indirect jobs by combining data on value added per worker in the broader economy, obtained from international organisations, with our own estimates of indirect value added generated by the mobile ecosystem.

Estimating the contribution to public funding

A significant element of the GDP contribution of the mobile ecosystem is through general taxation. For most countries this includes value added and corporation tax, as well as income tax and social security paid by mobile ecosystem employees. We calculate the value of these by applying the applicable tax rate in the country to the tax base which is the subject of taxation. For example, to calculate value-added taxes, the VAT rate in the country is multiplied by the total value of sales generated by the ecosystem industries.

Data used for the model

The model incorporates data gathered from various sources, which can be categorised into the three primary components delineating the economic impact: direct, indirect, and productivity.

The direct impact corresponds to the mobile ecosystem and is formed by three categories: mobile operators; infrastructure and equipment; and content and services. Table 3 presents the data sources for each category and its components.

Table 3: Direct impact data sources

Category	Component	Source
Mobile operators	Total revenues	GSMA Intelligence
	Direct costs	GSMA Intelligence
Infrastructure and equipment	Network equipment providers	GSMA Intelligence and EY-Parthenon
	Device manufacturers	Counterpoint
	IoT	GSMA Intelligence research
Content and services	Content, apps and services revenues	data.ai, GSMA Intelligence
	Distributors and retailers	Counterpoint, TechInsights and Euromonitor
	Mobile cloud services	GSMA Intelligence research

Source: GSMA Intelligence

The indirect impact comes from applying a multiplier to the direct impact. Table 4 presents the sources.

Table 4: Indirect impact data sources

Category	Source
Input-output tables	OECD, national statistics offices

Source: GSMA Intelligence

The productivity impact is calculated as the residual between the total impact, and the sum of the direct and indirect contributions. The data used to calculate the total impact and therefore estimate the productivity contribution is presented in Table 5.

Table 5: Productivity impact data sources

Category	Source
Mobile technology impact on GDP	GSMA Intelligence
Market penetration by technology (2G, 3G, 4G, 5G)	GSMA Intelligence
IoT connections per inhabitant	GSMA Intelligence
Historic GDP	IMF World Economic Outlook (October 2024)
Real GDP long-term forecast	IMF World Economic Outlook (October 2024) and OECD
Historic GDP by industry	UN Table 2.4 Value added by industries at current prices (ISIC Rev. 4)
World Bank Country and Lending Groups	World Bank

Source: GSMA Intelligence

There are additional sources used for employment modelling and public funding contribution. Table 6 presents these additional sources.

Table 6: Employment and tax data sources

Category	Source
Employment	ILOSTAT
Population	UN
Human Development Index	UNDP
Taxes	GSMA Intelligence

Source: GSMA Intelligence

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Appendix

Appendix 1: Industries

Table A1 presents the link between the United Nations value added by industries and the industries considered in the study.

Table A1: Correspondence between United Nations Industries and economic sectors

United Nations Industries (item code)	United Nations Industries (item)	Industries considered by the GSMA
A	Agriculture, forestry and fishing	Agriculture, forestry and fishing
B+C+D+E	Manufacturing, mining and quarrying and other industrial activities	Manufacturing
F	Construction	Construction and real estate
L	Real estate activities	
G+H+I	Wholesale and retail trade, transportation and storage, accommodation and food service activities	Accommodation and food service activities
J	Information and communication	Information and communication
K	Financial and insurance activities	Financial and insurance activities
M+N	Professional, scientific, technical, administrative and support service activities	Services
R+S+T	Other service activities	
O+P+Q	Public administration and defence, education, human health and social work activities	Public administration and defence; compulsory social security

Source: UN Table 2.4 Value added by industries at current prices (ISIC Rev. 4)

Appendix 2: IoT connections by vertical

Table A2 sets out the IoT connections by vertical and the components of each category.

Table A2: IoT connections by vertical

Vertical	**Category**	**Subcategory**
Manufacturing	Smart manufacturing	Inventory tracking, monitoring and diagnostics, warehouse management
Construction	Smart buildings	Heating and air con, security, lighting, hot desks, office equipment, home infrastructure
	Smart city	Public transport, surveillance, electric vehicle charging, street lighting, parking, waste management
Automotive	Smart vehicles	Embedded telematics, aftermarket telematics, in-car entertainment, connected bikes
Enterprise others	Enterprise others	Fleet management, asset tracking, applications in agriculture, oil and gas, mining, construction
Consumer others	Consumer electronics	Smart TV, home entertainment (games consoles, DVD players), personal entertainment (MP3 players, portable gaming devices), set-top boxes, streaming devices, smart speakers
	Smart home	Home appliances (fridges, washing machines), home infrastructure (routers), home security (alarms), energy monitoring (thermostats)
	Wearables	Fitness trackers and smart watches
	Consumer others	Children/elderly/pet trackers, drones, robots, AR/VR headsets, wireless headphones/earphones, non-prescribed health devices
	Smart utilities	Energy, water and gas smart metering, smart grid
	Smart retail	Point of sale (PoS), digital signage, vending machines, ATMs, beacons and stock control devices
	Smart health	Professionally prescribed health devices, remote monitoring of medical devices, emergency vehicle infrastructure

Source: GSMA Intelligence

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