Horizon Scanning Series

The Internet of Things

Comments on draft report and economic analysis of IoT

This input paper and additional commentary was prepared by Jason Potts

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Comments on draft report, by Professor Jason Potts, RMIT Blockchain Innovation Hub, RMIT University
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Thank you for the opportunity to review the ACOLA draft report. Overall it is a substantial and well researched report that does a good job in representing the impact of IoT using the analytical frameworks developed by industry consulting reports, and by drawing on expert opinion and extrapolation of trends, particularly with respect to costs, adoption and spending.

I confine my comments entirely to economic analysis presented in the report. The basic limitation is that *no serious microeconomic analysis has been attempted* (other than aggregate spending projections drawn from consultancy reports). I make some recommendations about the sort of economic analysis that might be useful (and offer outlines of how to do it and what it might find) in order to better understand the economic impact of IoT technology adoption and innovation. These focus on considering the information economics and industrial organisation economics of IoT innovation and adoption.

However, economic analysis of the future is always fraught with difficulties and uncertainties, and the ACOLA report as it stands does a good job in setting out a broad structure through which to consider the impact of IoT technology. Its main strength is that it replicates international reports into an Australian context, focusing in spending and extrapolations of existing trends. Its main limitation is that it fails to engage with the specific *economic disruption* that IoT brings (as opposed to an engineering disruption).

From an engineering perspective, IoT brings a range of new devices and capabilities, including sensors, actuators, gateways and other digital technologies that enable things to communicate with each other, and to send data. This improves the performance of machines and the productivity of machine systems. The report has largely focused on the flows of spending that go with adoption of these technologies, and the productivity improvements to firms and industries.

Specifically, the main argument the ACOLA report represents, and does so emulating (and calibrating to Australia) the findings of various similar international reports studying IoT impact (e.g. reports by PWC, McKinsey, IDC, etc) is that IoT impacts the economy via its *productivity enhancing* effect across a range of key industries (by lowering costs), and as a second order effect via revenue enhancing improvements in services. The economic impact is quantified by estimates of business *spending* on IoT adoption, arguments that are further supported by the growth of IoT devices (i.e. capital). These arguments are represented in the ACOLA report in sections 1.3 and 1.5, in which projections of aggregate spending on IoT are drawn from international consultancy report studies. The use of these estimates for Australia is entirely legitimate, as Australian conditions are broadly similar to those in other nations. The methodology of using international estimates from quality commissioned reports to estimate the range of spending as a measure of Australian economic impact is well-founded.

An IoT enabled economy has a lot more IoT devices in it. It also has a lot more data. From an economic perspective, the main effect of IoT is not the devices but the data. In an IoT economy, the following structural effects are to be expected:

1. **Machines make more decisions.**

A shift in the locus of decision making from humans to machines (this increased automation of decision making shows up in different sectors in different ways). This shift will be by far the greatest impact on the economy, changing the types of goods and services offered, the types of firms that exist, as well as the regulatory and taxation environments needed to support this type of economy. (The new *ARC Centre of Excellence in Automated Decision Making and Society*, based at RMIT University, is an example of the sorts of research centres that are exploring the challenges this brings).

2. **Data becomes an asset.**

An increase in the quantity of data and also an increase in the value (or economic importance) of data, and therefore a corresponding increase in the demand for property rights over data. This contrasts with the industrial-era model of data as a quasi-public good that is regulated by government. This will drive the importance of data property rights (cf. data human rights, data regulation, GDPR, etc) and the emergence of data markets. Economic analysis should seek to estimate the value of data produced under different property rights regimes and under different regulatory environments. It should also be concerned with the distributional consequences of the growth of data assets.

3. **IoT adoption can be understood from the perspective of centralised or decentralised data.**

These have very different economic evolutionary consequences, with centralised data tending toward a more command economy, and decentralised data tending toward a more free market economy. IoT technology will develop along different pathways depending on whether data is centralised or distributed. Blockchain or DLT technologies pull toward decentralised data to drive a decentralised platform-based data-driven digital economy. However ML and AI technologies (such as we are observing in Nation States such as China) rely on huge pools of centralised data as inputs into centralised decision making. IoT can therefore facilitate a more centralised economic command and control model of an economy to centrally automate economic decision-making (where IoT devices feed data into a central pool), or it can facilitate a more decentralised market driven economy where IoT devices create data as a privately owned and tradable economic asset. The current legislative and regulatory settings are tilted toward the centralised model. This is unlikely to be the best mode for the entrepreneurial development of a competitive market economy. However, it does afford the State significant power and advantages. Economic analysis of this institutional-technological trade-off would be a useful way to frame the possible pathways that IoT adoption might bring.

Notes on the economic evidence and literature on economic value estimates

The economic estimates in the ACOLA report for the international impact of IoT derive from several studies, including a 2015 McKinsey forecast (Manyika et al 'The Internet of Things: Mapping the value beyond the hype') of global economic impact ($11 tr) and an International Data Corporation (2018) forecast of IoT spending growth (ACG 13%), with IoT spending focused on manufacturing and transport. The McKinsey report, which uses a bottom-up settings-based estimation methodology, emphasises that much value capture from IoT comes from integrating systems and allowing data in one setting to be reused in others, and from more and better information facilitating automated decision-making.

The economic estimates in the ACOLA report for Australia derive from the PWC report 'Australia's IoT opportunity: Driving future growth' (an ACS report)**.** Top line figure estimates for the expected annual economic value on the order of $200-300 billion over an 8-18-year window. This benefit is argued to arise from productivity improvements across a range of key sectors – this will occur through efficiency improvements of 15-40% across these key industries through adoption of internet of things technologies. This is expected to accrue to several key sectors: construction ($75-96bn); Manufacturing ($50-88bn); healthcare ($34-68bn); mining ($22-34bn); Agriculture, fishing and forestry 14-22bn). IoT use cases accrue to efficiency improvement, asset management, workplace health and safety, and sales optimization. IoT enables smart cities, smart construction sites, smart hospitals, smart factories, smart mines, etc.

The modelling strategy to estimate potential benefits used by PWC was to use estimates made in other countries (it is never explained which other countries or what econometric methodologies they used) to estimate a benefit range (a scalar) which was then adjusted (not calibrated, as no model was built) using interviews with Australian industry representatives. A generic technology adoption curve was then used to generate estimates over a range of forward years. Market size growth estimates were built using a multifactor model developed in consultation with industry experts to estimate impact assessment indexes for efficiency (cost reduction) and revenue growth.

The forecasts made for Australia have simply copied the aggregate estimates of more comprehensive forecasts made in other countries that were compiled by considering the impact on a range of expected use cases. These are not model-based approaches (e.g. using DSGE approaches or similar, which are more effective for estimating the effects of price changes or specific demand or supply shocks on an economy) but rely on working with experts through a range of different settings and possible uses and then estimating a range of effect, then summing these to a forecast. By targeting the estimates around cost reduction or revenue growth, an estimate of economic impact is derived by simulating dynamics of deviations from trend of existing revenue and cost curves. Economic forecasts of the impacts of technological change are notoriously hard to do, and this approach has the benefit of making use of current expert knowledge located in the current sectors. The weakness of this approach is that it necessarily assumes a kind of stationarity and is difficult to model the impact of entrepreneurial discovery, including new products, processes, business models or other such impacts of new technologies.

Other literature and economic analysis on emerging technologies to consider

Questions of data ownership and the implications for decentralisation are fundamental to understanding and forecasting the economic disruption and changes that IoT will bring. A proper economic analysis of IoT adoption and innovation will largely focus on this microeconomic aspect of information economics, transaction cost economics and industrial organisation rather than on spending (which is a simple macroeconomic model). Chapter 2 of the report might consider some further market structure and industrial organisation aspects of decentralisation as a new possibility afforded by wide adoption of IoT.

Novel data considerations
Goldenfein et al (2017) argue that the economic organisation of a *smart city* looks very different depending on whether the data architecture is centralised (which is the standard assumption, and which benefits incumbents with access control of data) or decentralised (which is better from a competitive and entrepreneurial perspective), which is possible using distributed ledger technology.

See - Goldenfein, J., Potts, J. Rennie, E. (2017) 'Blockchains and the Cryptocity' *Information Technology* 59(6): 285-293.

Health service delivery
Digital health data and My Health Record is an instance of centrally controlled data. Blockchain plus IoT technologies can facilitate patient owned and controlled data, which may facilitate the development of digital health wallets, data markets in health data, etc.

See – Allen, D. et al (2019) 'Blockchain and the new economics of healthcare' SSRN papers https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3396218

Freight and Logistics
IoT devices can be configured so that the write data to blockchains enabling 'proof of location' services. This is a distributed data market for witnessing events in space, which is a decentralised model for tracking, verifying movements of goods and services.

See - https://foam.space/

See – Potts et al (2019) 'Spatial institutional cryptoeconomics' SSRN https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3439911

Areas of the Australian economy likely to benefit from IoT adoption
When IoT adoption is understood as an engineering technology (as the ACOLA report does on page 25) in existing institutional systems in which data is largely centralised (and therefore access is regulated), an industry use case model is a useful approximation: e.g. mining, manufacturing, health, logistics, etc.

But when IoT adoption is understood as an economic technology that creates a vast new source of economic value (data) and new economic organisation (through automated decision making) then the main sectors that will be disrupted by IoT are households (with new capabilities and new sources of income) and business services, including accounting (new assets), law (smart contracts), management and finance (including insurance).

The ACOLA report would be better if it more clearly emphasised the structural economic disruption that is coming (and its relation to the digital technology stack of DLT, ML, etc), and not just the engineering implications for existing business (productivity growth and spending increases). It starts to do this on page 26 in the paragraph beginning ‘Through the use of sensors…’ but doesn’t then develop that important insight much further.