TECHNOLOGY AND INNOVATION

Lessons from the Dismal Science

by **Tan Boon Seng**

The Chinese dynastic history had a remarkable regularity — the population boomed then busted as a dynasty aged, but the standard of living of the general population remained close to subsistence level over time despite technological advances. This regularity is called the Malthusian trap which suggests that technological advances increase a society's supply of resources (such as food) and thereby improve the standard of living; but the resource abundance encourages population growth that eventually brings the standard of living back to near subsistence level. The Malthusian trap is often incorrectly[1] cited as the origin of economics being known as the dismal science.

Economists today know a lot more about technological innovation and economic development than Thomas Malthus. This article discusses some facets of innovation that contemporary economists know and busts a few myths along the way.

1 See http://www.theatlantic.com/business/archive/2013/12/why-economics-is-really-called-the-dismal-science/282454/

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Preamble

It is surprisingly important to have a common vocabulary before going further — the meaning of some Economic concepts differs from their definitions in the English dictionary.

For this article (and generally for economic analysis), technology refers to how capital and labour are used as inputs to produce an output (product, service or knowledge) which is potentially useful. For example, my online calendar is an output which is useful to coordinate my activities with others. It is produced using tools (capital goods), such as smartphones, computers and software, with the help of many people including myself (labour). Technology refers to how these inputs produce the output, and not the tools such as smartphones or the internet.

New technologies emerge over time through invention and innovation. Invention refers to the creation of new products or processes. Innovation refers to the widespread adoption of the invention to produce economic impacts. Inventing a better mousetrap is great, but it changes nothing until there is an innovation, i.e., until the world beats a path to your doorstep to get that better mousetrap. The latest invention sometime stirs a media frenzy only to fizzle out after a few years. Innovation requires the invention and the economic conditions for widespread adoption.

Innovation and Economic Growth

Economic growth is the central question in development policy. Economists have long recognised that while increasing inputs can expand the economy (increase the amount of output an economy produces), it gets increasingly difficult to do so as more inputs are used. This Law of Diminishing Returns ultimately causes economic development to converge to a steady state in classical economic theory, unless we get a free lunch somewhere.

That free lunch is innovation. For example, we need capital and labour to produce food, but over time we have introduced innovations such as the use of ploughs and animals, tractors, crop rotation and fertilisers, biotechnology in seeds and animal breeding, and even organisation of farms, supply chain and market for trading food. These innovations allow us to increase output (food) often using less inputs (capital and labour).

Logically, unproductive inventions have less chance of being widely adopted in a functioning market, and innovation therefore generally increases productivity. Innovation allows us to produce more output for a given combination of inputs, which is another way of saying that innovation is the source of long-run productivity growth. If we assume that the stock of knowledge is the ingredient for invention, there can

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be increasing returns for innovation with increasing stock of knowledge accumulated through research. The pace of innovation appears to have accelerated over time with the increasing knowledge base and the lower cost of sharing knowledge.

Post classical economic theories have come a long way in thinking about economic growth. The Solow-Swan model started by recognising the role of innovation as the source of long-run growth, but treated innovation as something that was unexplained by the model. In other words, this early model did not attempt to explain how innovation came about. In economics terms, we say that the Solow-Swan model assumed innovation to be exogenous. Subsequent growth models then incorporated accumulation of human capital, institutional arrangements, and entrepreneurship to explain innovation and economic growth.

Disruption, Diffusion and Economic Thinking

Mainstream economists generally view knowledge as "development-by-accumulation" of accepted facts and theories to fuel innovation. This means that knowledge increases incrementally. On the other hand, Schumpeter's heterodox view of creative destruction driving innovation is also well-known. Innovation can vary from incremental to radical in this view.

To have some clarity about the nature of how knowledge increases, we turn to Philosophy as philosophers study the theory of knowledge in a branch of philosophy called epistemology. Thomas Kuhn argued that knowledge accumulation goes through periods of conceptual continuity interrupted by periods of disruptive change.[2] Years later, Clayton Christensen coined the term disruptive technology to refer to discontinuous innovation that cause established market leaders to be replaced by start-ups.[3] Today, the term "disruptive technology" has become a buzzword in danger of being overused and ill-understood. However, armed with an understanding of market characteristics, economic reasoning helps us view disruptive technology in perspective. For example:

Peer to Peer (P2P) Lending: P2P lending appears to be a disruptive technology for banking. The basic P2P lending model is to leverage the internet to match lenders and borrowers. Potential borrowers are screened and graded using a credit reference agency. P2P companies use loan terms with standard durations and sizes to match lenders with borrowers based on interest rate and risk, and charges a fee for their service. Variations of the basic model include

2 Kuhn, T.S.1962. "The Structure of Scientific Revolutions" Chicago, IL: University of Chicago Press.

3 Christensen, C. 1997. "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail" Cambridge, MA: Harvard Business School Press.

the peer-to-business model by offering small business loans, provision fund/insurance to safeguard lenders against default, using collaterals for secured loans.

There are subtle but important differences between the economics of P2P lending and banking. P2P lenders (who provide the loanable fund) face the borrower's default, but depositors face the risk of bank default but not the borrower's default risk directly. In other words, if a borrower is unable to pay back his loan, the P2P lender suffers the loss, whereas in banking, the bank absorbs the loss and depositors are not affected (unless the bank goes bankrupt). Central banks, through regulations and other interventions, have generally tamed the risk of bank default to low levels.

Therefore, banks have lower borrowing rates, lending rates, and lending risk appetite than P2P companies. The products in P2P lending and banking serve distinct market segments and may be demand complements instead of substitutes. As complements, the rise of P2P lending instead of disrupting banking, may create a new consumer segment that was previously unable to borrow from banks to enter the market. Some of these P2P borrowers may borrow from banks (which have a lower rate) after establishing good credit history with P2P lending. Banks may invest in P2P companies to obtain preferential access to P2P borrowers with good credit history, rather than as a defence against the threat of disruption.

M-Pesa Story of Mobile Payment: Where in Kenya do you go to deposit your spare cash, transmit money, or withdraw some cash? For many people, the answer is not a bank or an automated teller machine (ATM) which is hard to find, but is what is known as mama shops in Singapore that sell prepaid mobile phone airtime. Buy some airtime credit and send it to someone just by an SMS. You can also send your existing credit to the shop owner for cash and viola you get an ATM. This financial service, known as M-Pesa, which processed transactions amounting to 43% of Kenya's gross domestic product (GDP)[4] in 2013, is not operated by any financial institution. Instead, it is operated by telecommunication operators using the extensive network of mama shops that already exist. This is a well known story of disruptive technology.

However, using airtime credit like a currency is not common in Singapore (numoni.com is a niche player targeting the unbanked foreign workers in Singapore who use it for remittance). Why is the technological disruption not universal? There are two possible reasons.

The obvious reason is the availability of alternatives such as credit cards, NETS (A nation-wide electronic payment platform formed in 1985 by a consortium of local banks), and EZ link cards; and the ease with which ATMs can be found. Complementary assets for these alternatives such as distribution and brand positioning are already well established.

The non-obvious reason is positive network externalities favouring existing payment technology. A positive network externality arises when a product becomes more valuable when there are more users. For example, being able to pay by NETS is only convenient if many places accept NETS payment. Similarly, firms being able to accept payment by NETS would only benefit if many people are NETS users who can pay by NETS. For a new payment technology, retailers often find the set

4 See http://www.forbes.com/sites/danielrunde/2015/08/12/m-pesa-and-the-rise-of-the-global-mobile-money-market/

The risk of technological unemployment is generally higher in low-skilled jobs which are easier to automate, but high-skilled jobs can also be at risk due to innovation in areas such as machine learning.

up cost for payment processing higher than the benefit from additional sales because there are few users. Since few retailers can currently process the new payment technology, there is less reason for users to adopt it. This sets off a vicious cycle that gives early movers a strong advantage, even if earlier technology is inferior.

In sum, a better invention is not always adopted by users to become an innovation, and only innovations that cause established market leaders to be replaced by new companies are disruptive technologies. Disruptive technology is the exception rather than the norm because adoption of such technology requires overcoming the advantage conferred by complementary assets to existing alternatives. Positive network externalities sometimes raise the hurdle even higher.

Innovation and Jobs

Economist John Maynard Keynes in 1933 predicted technological unemployment "due to our discovery of means of economizing the use of labor outrunning the pace at which we can find new uses for labor". There is general agreement that short-run technological unemployment is plausible but the debate on long-run effect is unsettled. The risk of technological unemployment is generally higher in low-skilled jobs which are easier to automate, but high-skilled jobs can also be at risk due to innovation in areas such as machine learning.[5]

The award-winning book by Martin Ford's "Rise of the Robots: Technology and the Threat of a Jobless Future" describes a pessimistic view that technological unemployment is inevitable. Ford states that "Ultimately, the question of whether smart machines will someday eclipse the capability of average people to perform much of the work demanded by the economy will be answered by the nature of the technology that arrives in the future — not by lessons gleaned from economic history."

Economist Herbert Simon in 1960 applied[6] the concept of comparative advantage to this question: if machines can increasingly do whatever humans can do and do it faster, why won't everything eventually be done by machines? Whether man or machines will be employed in a particular process depends not simply on their relative productivity, but on their cost as well. And cost depends on price. As machines become more productive, the prices of labour and capital will adjust such that the value of the output produced for each dollar cost of the inputs (machine or labour) is the same. Manpower will flow to those processes in which productivity per dollar of wage is higher relative to the productivity of machines per dollar of machine usage and vice versa. In more concrete terms, in jobs where machines become better than humans, the wages of job-holders will decrease and people will move into other jobs where machines cannot replace humans and therefore pay better. Eventually, an increasing

5 http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

6 Simon, Herbert A. 1960. "The corporation: Will it be managed by machines?" In Anshen, M.L. and G.L. Bach (eds.) Management and the Corporations. McGraw Hill.

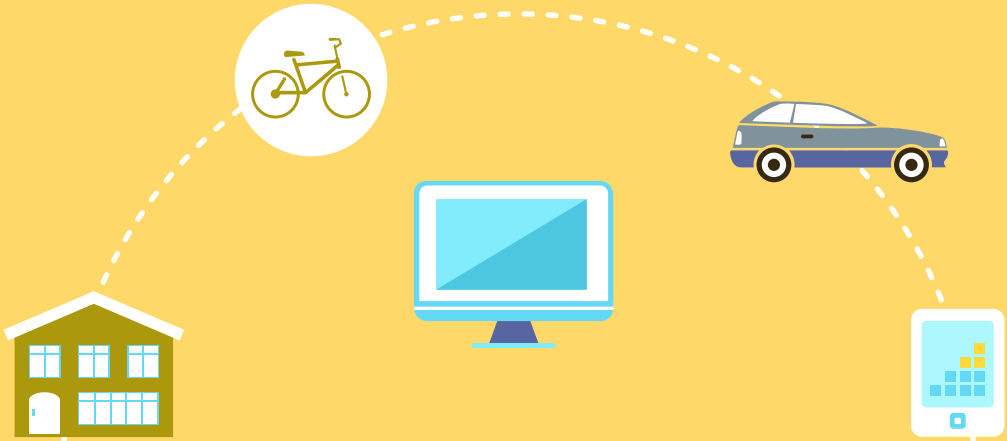
fraction of workers will be engaged in occupations where "personal service" involving face-to-face human interactions is an important part of the job.

Short-run technological unemployment can arise from a mismatch between current job skills and skills required. The long-run employment effect is more controversial. For example, consider the effects of agricultural innovations over the last few centuries. Innovations (e.g., tractor) destroy some existing jobs but create new jobs (e.g., tractor repairmen) or even industries in the creative destruction process. The higher productivity from agricultural innovations has changed skills requirements and shifted "excess" agriculture labor to manufacturing and service sector jobs. Short-run structural unemployment can occur but labour can adjust by acquiring relevant skills. Higher productivity generally raises income and reduces average working hours. Nonetheless, long-run technological unemployment can occur if labour does not adjust sufficiently by acquiring relevant skills, resulting in a divide of higher income in one group and technological unemployment in the other. In the context of agricultural innovations, the skills that became relevant to the new jobs were not related to agriculture or technology in most cases, but were skills that matched jobs in the manufacturing and service sectors. In sum, whether long-run technological unemployment will occur is an empirical question contingent on market adjustment (i.e., will people pick up new skills) and also policy intervention (e.g., how effective governments are in aiding the re-training process).

Conclusion

Technology and innovation have always influenced the evolution of human societies. The good news is that most economies appear to have escaped the Malthusian trap. The bad news is that technological unemployment is a potential future threat. Economic reasoning provides a useful framework to think about the problem, and what the unanswered questions that empirical studies should answer are.

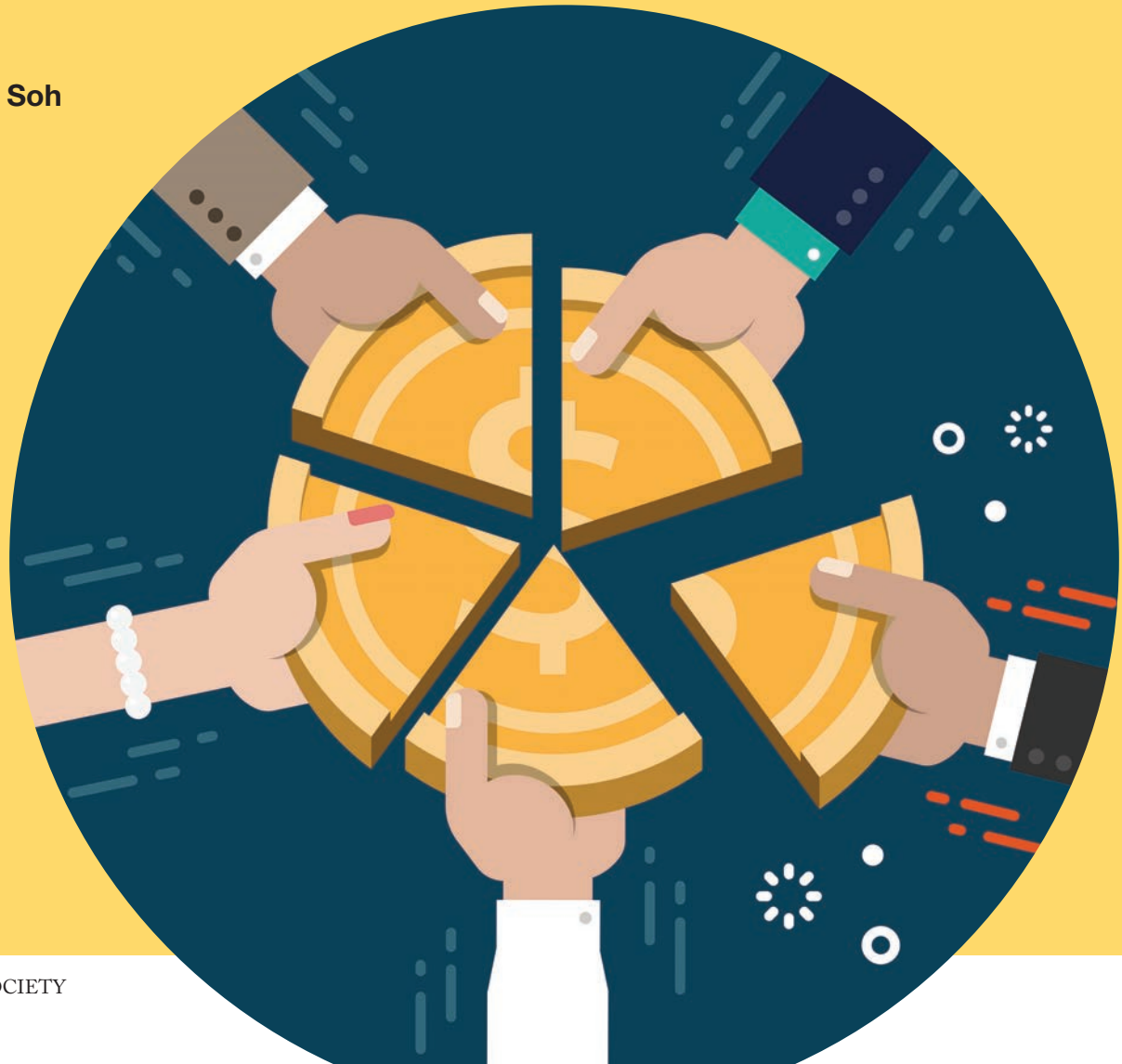
Dr Tan Boon Seng believes that economic reasoning provides a useful basis to think rigorously about societal problems including many seemingly non-economic problems. An education in Economics is therefore valuable although not everyone becomes an economist.



THE SHARING ECONOMY

Same Old Brand New Business Model?

by **Christabelle Soh**



Despite the recent buzz over the rise of the sharing economy, a closer inspection of the business of sharing reveals that it is not new. Airbnb is in the business of home rentals — an old industry; Uber and Grab are in the business of car rentals — an old industry too.

Same same but different

What is new, however, is the scale of the industry's expansion. This was precipitated by technological developments that dramatically reduced the transaction cost of renting a room or a car. In the past, while it was certainly possible for people who were going away on a holiday to rent out their homes for the period in which it would be vacant, the trouble one had to go through to locate a renter who happened to want to rent it for those days would be so much that it was not worth anyone's time to do so. This trouble that landlords and renters have to go through to find a match is what we term the transaction cost.

So, for example, if we were to look at the pre-Airbnb times, the only times when it would be worthwhile to incur the transaction cost would be the times when the period of rental was going to be a long one (i.e., it wouldn't be worth one's time to spend a great amount of effort to find a renter for one's home for just a few days, but it would be worth the time if the home was going to be vacant for six months otherwise). This explains why rentals used to be for longer time periods.

What technological development has done is to reduce this transaction cost by making it easy for demand to meet supply. Airbnb and Uber are essentially platform providers. Both companies have harnessed the spread of the internet and smartphones to create convenient spaces for sellers and buyers to meet at practically zero cost. Airbnb allows home owners to easily let potential renters know the availability of their homes and potential renters to conveniently browse through potential homes that match their needs and preferences. Uber allows people in need of a car ride to easily find out if there are drivers of private cars who happen to be available and private car drivers to easily find out where such people who need car rides are. With the reduction in the transaction cost, the rental market boomed. By one estimate, as of March 2017, approximately 23,000 bookings worldwide are made on Airbnb a month; the equivalent figure for Uber was 26 million trips for the month of July in 2016.

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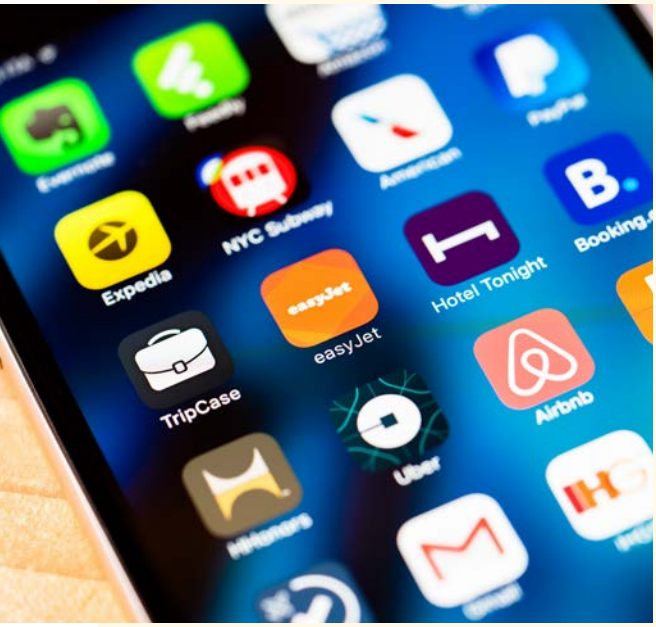
If it ain't broke, don't fix it. But if it broke...

Knowing how the "new" sharing economy differs (or not) from the "old" sharing economy allows us to systemically determine which regulations can continue to be applied, which need updating, and whether completely new regulations are required. And, to do so, we need to revisit the purpose of regulation to determine if current regulations can still serve their purposes given the increase in the scale of the sharing economy.

The first purpose of regulation is to establish property rights. This roughly translates into "duty of care" in legal speak. What this means is that the rights of the owner and the renter must be clearly established. For example, in the rental market, is the onus on the owner to replace a faulty pipe, or is it the renter's responsibility to do so? An increase in the scale of an industry ought not to have implications on the property rights framework that a country adopts for a particular industry. Thus, regulations related to the determination of property rights should simply continue to be applied, even for rentals made using platforms like Airbnb and Uber. For most countries, in the home rental



market, this would mean that renters are liable for any damage caused to the property and owners are liable for not providing accommodations as advertised. A similar principle should apply for the ride-hailing industry.

The other purpose of regulation is to correct market failure in the industry. For rental markets, one major source of market failure is information asymmetry. Owners cannot tell whether the renters are "well-behaved" renters *ex ante*, and conversely, neither can renters tell if the owners are trustworthy. In more concrete terms, home owners do not know if a potential renter will destroy their TV and escape into the night, and renters would not know if a home owner is secretly part of a human trafficking ring. This information asymmetry gives rise to market failure as risk-averse people (the majority of living homo sapiens) would both consume (rent) and produce (put up their assets for rent) at a lower frequency than is optimal. A higher amount of rental transactions would be preferred as it would bring benefits to both the owner (in the form of income) and the renter (in the form of increased utility from having a need/want met). There is also the rather salient issue of compromising the safety of owners and renters.[1]

To address this market failure, regulations are put in place to reduce the amount of information asymmetry. To own a taxi license, for example, drivers need to meet a set of qualifying criteria to ensure that they are safe drivers who can deliver passengers from points A to B. This process weeds out the unsound drivers and assures potential passengers that they would be in the hands of safe drivers. A complementary set of regulations to screen passengers does not exist. The question then, is whether this set of regulations is feasible for a much larger number of potential drivers. This then depends on the context of the country in consideration. For countries whose regulatory bodies are able to, equivalent checks should be conducted. For others, this set of regulations may need to be adjusted. What Uber and other car-sharing platforms currently use as a screening device is the passengers' rating of drivers. Regulation to prevent market failure due to information asymmetry should then be developed along the lines of regulators having sight of the car-sharing platforms' rating algorithms to ensure that it is sufficiently robust such that drivers who would not have been able to obtain taxi licenses would also be disallowed from being Uber or other car-sharing platform's drivers. This is a matter of having the correct expertise in Big Data analysis, which is not an insurmountable problem.

In the "old" sharing economy, the main source of market failure was information asymmetry. In the "new" sharing economy, however, the introduction of a platform introduces a new source of market failure — monopoly power. The reduction in transaction cost was brought about by the creation of platforms for demand to meet supply. However, significant positive network externalities exist in the use of such platforms. Network externalities refer to the benefits to other users of a network when an additional person joins a network. When an additional driver becomes an Uber driver, for example, he/she benefits all the consumers who use Uber to hail rides as they now have access to his/her services too. The presence of network externalities creates a bias towards the most

1 Technically, a compromise of safety is not a source of market failure if it is properly taken into account by the producers and consumers. Window cleaners, for example, have their safety compromised. However, that risk is taken into account in the wage and benefits negotiations and is not considered a form of market failure.

Markets will eventually adjust to account for the issues related to the rise of the sharing economy.

dominant platform for both drivers and passengers. Drivers will want to use the platform that most passengers use, and passengers will want to use the platform that most drivers use. Every additional driver and passenger to the platform creates a benefit to the existing users of the platform, which then attracts even more drivers and passengers. The natural end result of this is a platform monopoly in the market. Facebook becoming the most dominant social media platform is testament to the effects of network externalities. As with any monopoly, a platform monopoly could be a source of market failure if it exercises its market power to increase its profits. For example, if Uber becomes a platform monopoly, it could demand a larger share of every trip fare to the detriment of drivers (and passengers too, if that drives up prices). Hence, regulation may need to be introduced to minimise monopolistic behaviour.

To (let it) be, or not to (let it) be? That is the question.

The prior analysis was based on the assumption that the growth of the sharing industry would be allowed and centred around how regulators should respond to the growth of the industry.

Of course, it is also possible for regulators to disallow the growth of the industry by making it illegal for homes or cars to be rented. This could be the case if the government deems that the cost of allowing for the growth of the industry outweighs the benefits. However there are three arguments against this.

Firstly, sound regulation ought to be able to manage the costs of allowing for the growth of these industries. The section prior to this expounded on an approach to refining regulations. With sound regulation in place, it is unlikely that the costs will outweigh the benefits.

Second, preventing the growth of the industry may take more effort than regulating the industry. For example, cities that have tried to ban the use of Uber have had varied success. Uber is just a platform and does not need a physical presence in a city to operate. The only way to prevent its use is to shut down its servers (but that could also entail shutting down a number of other internet services that share the same server) or to keep posing as riders to catch the drivers using Uber and throw them into jail one at a time (but Uber may have developed algorithms to identify law enforcement officers to prevent their drivers from picking up their rides).

Third, markets will eventually adjust to account for the issues related to the rise of the sharing economy. For instance, there are current concerns from neighbours of home owners who rent out their apartments over having strangers in their estates. However, down the road, it is likely that such matters will start factoring into the prices of property. Assuming people generally prefer not having short-term renters in their estates, renter-free properties where buyers sign an agreement to not allow short-term rentals or risk eviction will probably go for a premium while others will become cheaper. Such market developments will naturally address the privacy needs of certain segments of the market.

Conclusion

In conclusion, attempts to prevent the rise of the sharing economy are likely to be unwise and futile. In light of this development, governments need to systematically relook whether existing policies are still fit for purpose and what changes, if any, need to be made. This essay presents one way of approaching the problem to allow for the benefits of the sharing economy to be reaped while managing the costs.

Christabelle's passion lies in Economics and Education. She believes in making the world a better place through raising rational and compassionate students of Economics.
