IMPACT OF TECHNOLOGY ON INFLATION:ANALYSIS OF INDIA

Written By: Kareena Satia Supervisor: Dr.Tushar Poddar

Abstract

Since 2013, India has witnessed a sharp decline in inflation as headline CPI declined from 12.1% year-on-year growth in November 2013 to a record low of 4.3% in December 2014. A usual suspect for disinflation in developed countries has been technology. In recent years, India has observed deeper technological penetration and arrival of tech companies (Uber, Amazon). In the paper, I attempt an empirical investigation of the linkages between low inflation and high technological growth in India. I do a state and sector analysis. I employ a difference-in-difference approach to estimate the impact of technology on inflation by comparing five technologically advanced states (treatment group) and five technologically backward states (control group) in India. I find that there is no statistically significant difference between the treatment and control group. Next, I look at the price index of four sectors most impacted by technology in India and compare it with the General Index. I find that the price level of three of the four items to be statistically lower than the price level of the General Index.

I Introduction:

In the recent years, particularly after the global financial crisis, advanced economies (USA, Canada, Switzerland), have witnessed a slowdown in inflation. Moreover, certain countries like Japan, are witnessing deflation. It seems that advanced economies are also following the path of Japan – or are becoming victims of the phenomenon - "Japanification". This is despite the fact that these advanced economies are displaying strong economic performance and experiencing low unemployment in the recent years. This global trend coincides with another major emerging trend around the world – Digitalization and Rise of E-commerce.

This dissertation is going to look at the for and against arguments of the impact of technology on inflation – global and India-specific. A lot of interest has been generated on the coincidence of low inflation and increasing digitalization in advanced economies. Yet, since this is a new phenomenon, the mystery of low inflation has not been exactly resolved. In emerging economies, like India, there has been a dearth of research on this topic. In the last 5 years, India has been experiencing a decreasing rate of inflation – 3.05% as of May 2019. Therefore, there is a reason to believe that the contagion of low inflation has been spreading to emerging economies as well.

In India, inflation has always remained a contentious subject as inflation hurts the poor. Moreover, India is a rapidly growing economy with a high debt-to-GDP ratio, leading us to worry about the inflation dynamics in India. The underlying factors that are driving inflation in India is important to study as the drivers of inflation in other countries are not similar to India. India has many idiosyncratic institutional structures and a different e-commerce structure which needs to be taken into account as well. In the paper, I do a state-analysis and a sector-analysis. Using descriptive statistics, I estimate the impact of technology on inflation by comparing inflation in 4 technologically advanced states and 4 technologically undeveloped states of India. I use internet penetration (internet subscribers per 100 population) as the proxy for technological advancement and the year 2013 as the intervention year. My hypothesis is that inflation in technologically advanced states should be statistically lower than the inflation in technologically undeveloped states after the intervention year. I employ a difference-in-difference approach to assess the difference in inflation (pre-intervention

and post-intervention). I find no statistically significant difference between the inflation in technologically advanced states and technologically undeveloped states.

In the second part of my analysis, I estimate the impact of technology on four items (most impacted by technology) in the Consumer Price Index (CPI) of India and compare it with the General Index (contains all the items) using descriptive statistics. I find the price level of three of the four items to be statistically lower than the price level of the General Index. Specifically, I find that after 2013, three of these four items have largely remained at the same price level until 2018.

The paper unfolds as follows: Section II contains the literature review (divided into three parts). The first part comprises of the channels through which technology affects inflation, the second part states other factors responsible for low inflation and the third part contains India's inflation story in detail with specific emphasis on India's idiosyncratic institutional structures, drivers of inflation in India and a distinctive effect of e-commerce compared to other economies. Section III contains my own analysis (state and sector) and results. Section IV contains the limitations of my research and some of the plausible reasons for not finding strong evidence in state-wise comparison of inflation. Section V contains the conclusion and scope for further research in this topic.

Section II: Literature Review

The current body of knowledge can be divided into three major parts:

1. Channels through which technology impacts inflation

2. Other factors that affect inflation

3. India's inflation story

Section 2.1: Channels through which technology impacts inflation

For the month of May 2019 (OECD Data), inflation in advanced countries stand as follows: Canada (2.40 percent), Germany (1.44 percent), Japan (0.70 percent), Sweden (2.16 percent) and United States (1.79 percent). The trend of low inflation has worried central banks in advanced economies. The Monetary Authority of Singapore, European Central Bank, Sveriges Riksbank (Sweden), Deutsche Bundesbank (Germany) and Bank of Canada have published reports on the impact of technology on prices. This sub-section will mainly recount the identified channels through which technology has impacted prices as stated by these major central banks.

In the Monetary Policy Report (February 2015), Sveriges Riksbank (Sweden) has provided a framework of the channels through which digitalization affects prices.

1) **Effects through automation and technological innovations**: Technological innovations allow firms to produce goods and services at lower costs. As Dong, Fudurich & Suchanek (2017) state, firms are adopting technologies at a record rate - there is an adoption of digital technologies to some extent in almost all of the 42 firms (wholesale, retail and logistics) included in their study. A third of the firms surveyed adopted technology extensively. More than half of the firms, largely in wholesale and logistics, adopted digital tracking and product handling. About half of the firms have adopted big data analytics, digital platforms (mostly logistics) and e-commerce. The two main motivations behind adopting technology, among many, is enhancing operational efficiencies and revenue (lowering costs). Although the paper has interviewed firms in different sectors like wholesale, retail and logistics, the sample size (42 firms) is still extremely low to make a conclusive statement on firm behaviour in Canada.

Firms are able to arrive at lower costs through two main channels: Automation (AI, Robotics) and higher productivity. These two channels are also interconnected as automation leads to a three-fold effect: decrease in wages, decrease in costs and increase in productivity. All of these factors, then, leads to lower costs for the firm. There is also an incentive for firms to undertake costly investments in automation. After China's entry into WTO, China has been able to heavily export goods to the world at low prices. Domestic firms in many advanced economies have faced severe competition on that account. Therefore, to withstand the increasing import competition from China, many firms find it profitable to invest in automated capital. Kromann & Sørensen (2019) call this the "trade-induced automation hypothesis". Specifically, they document that firms which produce goods of the same type in which China has a comparative advantage also invest more in automated capital as compared to others. In 2017, China was named as the largest exporter in the world – exporting 2.41 trillion dollars' worth of goods. Its main trading partners are some of the most advanced economies and technology leaders in the world (US, Germany, Hong Kong and Japan). This demonstrates how important China is in the economic landscape as well as in introducing technological change in some of the most advanced countries.

Vermeulen, Kesselhut, Pyka, & Saviotti (2018) state in their paper that automation only impacts jobs containing routine tasks, but not necessarily low-skilled. Jobs which cannot be automated due to restrictions in codifying the required work do not face the dangers of automation. Their paper is comprehensive as it builds a framework to estimate the impact of automation on a variety of sectors. It is extremely detailed in its classification of the various kinds of jobs and provides projections for growing and declining occupations. D'Souza & Williams (2017) state that jobs which require social skills (persuasion, negotiation) or working in social environments are safe from automation. For example, education, healthcare, sports, arts et cetera. Therefore, the automation channel only affects certain jobs, yet those jobs are sizable. Frey & Osborne (2017) find that close to 47% jobs in the US are highly at risk of being completely automated over the next two decades. Particularly, PWC's Report (February 2018) identifies financial services as the sector with the highest risk of job automation, closely followed by transport. On the other hand, sectors like healthcare are less likely to be in the danger of job automation. The report also states that jobs which require high education are much more immune to job automation in the long run as compared to low and medium educational levels.

The new wave of technological innovations does not merely complement labor but also substitute them. Brynjolfsson & McAfee (2014) explore in their book that we are approaching the era of the second machine age where machines will replace many of the tasks done by humans. Contrary to Vermeulen's paper, Brynjolfsson & McAfee (2011) in their other book propose that non-routine jobs are in danger as well. Levy and Murnane (2004) state that machines could never replace drivers as it is difficult to codify a driver's behavior. Yet, Brynjolfsson & McAfee argue that Google announced several Toyota Prius (cars) to be autonomous. They are trying to put forward the idea that the future is truly unknowable. Tasks which can't be imagined to be done without human perception or skill can also be automated in the future by superior technology. This is unlike the First Machine Age where machines and humans were complementary. The thing worth noting from the book is also that automation of tasks is not very simple – even for small changes, the machine will have to be re-programmed. But, as people are increasingly being replaced by robots/machines, wages have taken a hit. The low wages translate into lower costs for the company. Brynjolfsson & McAfee are proposing something which is insightful and eye-opening. Whereas some researchers are stating that certain jobs are free from risk of automation, they are putting forward a proposition that almost all jobs are in danger.

The counter-argument as presented by Dong, Fudurich & Suchanek is that although some jobs have become obsolete, a new set of jobs have also been created. The tasks in these new jobs entail work in the IT and Computers sector. This phenomenon of the spurt in new kind of jobs is useful to counter worries on long-term "technological unemployment" – structural change in the economy. The concept is itself nothing new. John Maynard Keynes defined technological unemployment in the 1930s as "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". But this concept is much more pertinent today than it ever was. Similarly, Acemoglu & Restrepo (2018) also state that the displacement effect created by the abolition of labor in many jobs could be counteracted with the introduction of new jobs and tasks in which labor has a significant comparative advantage over machines. They further expand by stating that the replacement of labor by capital will decrease the cost of producing automated tasks but will increase labor demand in non-automated tasks. Bessen (2015) documented that bank tellers increased in number even after the introduction of ATMs. This is counter-intuitive. Bessen provides an answer to this puzzling fact by stating that the introduction of ATMs reduced costs for banks to operate branches. This induced banks to expand branches which led to the increase in employment of

bank tellers. Now, bank tellers could be hired in jobs at banks in other tasks. Such countervailing effects will soften the blow of automation on jobs. Overall, the net effect is ambiguous and it is a little pre-mature to arrive at a conclusion with respect to effects on jobs.

The effect of productivity on inflation (the second channel) is largely dependent on the anticipation of productivity changes by the central banks. There is a need for demand to keep up with the rise in productivity. If demand stays the same, and the production capacity of the overall economy rises, then we will witness a slowdown in inflation or depressed prices. In the same paper, Kromann & Sørensen find that increased use of automation by firms results in higher productivity and profits for the firm.

Ark (2016) states that the economy is yet to reap the benefits of ICT investments. He argues that although there is an emergence of a "New Digital Economy", this new phenomenon is only in its installation phase. In the installation phase, the productivity gains are limited to only certain sectors and geographies. This phase is followed by a period of "frenzy" and crisis. Then, there is a re-adjustment period, which is followed by the deployment phase. In the deployment phase, technology become ubiquitous and the benefits of growth are widespread. These phases have been witnessed throughout history in various technological revolutions[1]. He puts forward his point by drawing on evidence from a survey of 550 companies in United States and Europe. Despite being the most advanced continents in the world, there has been very little adoption of big data analytics – 28% in North America and 16% in Europe. Both of these channels lead to lower costs, and therefore, lower prices of goods and services. The profits accrued by firms on account of lower costs have to be necessarily passed on to consumers in the face of competition.

2) **Effects through e-commerce**: Amazon was launched in the United States in 1994. Currently, Amazon operates in almost all of the major countries. In India, Amazon was launched in June 2013. According to Grant (2018), E-commerce will be the largest retail channel around the world by 2021. In the United States, e-commerce sales have consistently increased over the past decade. US consumers have spent $513.61 billion online in 2018, leading to a 14.3% share of the total retail sales. Under the category of e-commerce, Amazon has a 40% share in total sales. Across the world, in 2018, consumers spent $2.86 trillion online with a growth rate of 18%. According to the report by

[1] The Industrial Revolution, Age of Steam and Railways, Age of Steel and Heavy Engineering, Age of Oil, Autos and Mass Production and The ICT Revolution (Neumann, 2015) .

Riksbank (2015), e-commerce has led to increased matching between producers and consumers. As consumers are increasingly switching over to online sources, they are benefited as they can easily do a simple price comparison before placing an order. Therefore, stores and companies are not only competing with firms in their immediate vicinity, but also with firms across the globe. The increased competition between firms leaves them with very little market pricing power. This, then means that there is little price dispersion. This a demand-side phenomenon where the behaviour of consumers is putting a downward pressure on retail prices.

On the supplier side, the usage of e-commerce also allows the possibility of dynamic pricing. Depending on the location of the IP-Address and the frequency of visiting the website, firms can charge different prices to different consumers. Online firms can change their prices at low or zero costs. This cannot be done by offline firms which would need to relabel goods (menu costs) and that would cost them quite an amount as well. Therefore, offline stores are already facing the heat of competition. According to Richter (2018), sales of brick and mortar stores have fallen by 36% since 2001. Brynjolfsson and Smith (2000) find evidence that there are differences in relative price levels across online and offline stores. Moreover, their data suggests that online stores make small and frequent changes to their prices as opposed to offline stores. Yet, they could not find evidence for lower price dispersion because of lower search costs. The paper, published in 2000, is particularly farsighted as it lays out many of the effects of e-commerce which we are witnessing even after 20 years. But it needs to be noted that the paper is limited in documenting only books and CDs as goods available online.

DellaVigna and Gentzkow (2017) also state that there is uniform pricing in chains across stores irrespective of the store location's consumer demographics (rich vs poor areas) and level of competition in the area. Apart from incurring costs for frequent price changes, the paper identifies other reasons for uniform pricing in retail stores. They point out that primarily there is an existence of managerial inertia. Managers do not want to experiment for fear of failure, facing barriers and limited awareness about the potential gains in optimizing prices. Secondly, firms fear the negative responses they might gather on account of differential pricing across stores. This might tarnish the brand's image and lead to less demand for their products.

On the other hand, Cavallo (2016) suggests that there is little price difference between online and offline stores. Although, there is a difference with respect to identical prices (online and offline)

across sectors, on average, the percentage of identical prices across countries was around 72%. Online prices behave similarly to offline prices. Therefore, this paper rejects that there is any proof of dynamic pricing. Cavallo has collected data from 10 countries and the largest multi-channel retailers, making his findings quite significant. Moreover, he not only estimates the similarity of prices (online and offline) but also computes the frequency and sizes of price changes. Additionally, his paper is unique as it also estimates within-retail dispersion in prices depending on zip codes.

The advent of e-commerce has also led to many changes in the market structure. According to Charbonneau, Evans, Sarker & Suchanek (2017), internet has allowed many small firms to also enter the e-commerce market. Before e-commerce, only firms with sufficient amount of capital could compete as it would involve costs like setting up the store et cetera. But these capital expenses are no longer necessary. This phenomenon prevents monopoly or oligopoly and leads to further competition. Charbonneau, Evans, Sarker & Suchanek (2017) see this as a "democratizing force" that allows a level playing field for all the firms. On the other hand, the opposing argument is that network effects lead to the dominance of few "superstar firms" only in the e-commerce market. Bijnens & Konings (2018) document that industries which used ICT products intensively display a strong decline in business dynamism after the mid-1990s in Belgium. ICT-intensive firms became huge and pushed out the smaller firms out of the market. The dominance of these few "superstar firms" could give them much more pricing power in the market which would not lead to lower prices. That is, it leads to a higher mark-up for the few firms. De Loecker and Eeckhout (2017) document that firms are charging 67% above marginal cost in 2014 as opposed to 18% in 1980.

Also, already there are signs that business dynamism – the phenomenon of constant entry and exit of firms in the market – has significantly reduced. Decker A., Haltiwanger C., Jarmin S., & Miranda (2018) document that workers are reallocating at a much less rate among different employers, reflecting lower business dynamism. Another sign is the decreasing number of startups as a share of total firms from 13% in the early 1980s to 8% in 2012 as documented by Pugsley & Sahin (2014). Maarten De Ridder (2019) proposes that the fall in business dynamism is due to the increasing use of intangible inputs into the production process. Firms which use intangible inputs enjoy a significant advantage over other firms who do not. The costs for the firms in incurring the production now changes from variable to fixed costs. Further, he also mentions that this phenomenon could have

negative impact on economic growth. He presents a paradox – increased use of intangible inputs (born out of innovation) actually leads to lower levels of creative destruction and innovation.

3) **Direct Channel through changes in CPI**: ICT products like communications; digital computing equipment and devices; home entertainment equipment, parts and services; video and audio subscription services and reading materials (excluding textbooks) have witnessed a declining trend in prices. Costs of production of processors which are used in the manufacturing of mobile phones and computers have reduced significantly over the years. Byrne & Corrado (2017) document the fall in high-tech products over several periods. For the recent period, 2004-2014, decline of price has been in the effect of – cell networking by 18.4%, computer servers by 26.1%, personal computers by 23.7% and cell phones by 15.9.%.

Haskel & Westlake (2017) state that in the past several years companies are moving from investments in physical capital (machinery, land) to intangible assets (software, branding). Maarten De Ridder (2019) provides some statistics. He states that software comprises of 17% of all US corporate investments. Already, in the US and the UK, investments in intangible assets exceed those of tangible assets. The important difference between physical and intangible investments is that software can be duplicated at zero marginal cost. For example, once a company produces a gaming application, it hardly costs the company if the game is downloaded a hundred times or one-lakh times. This has important implications for inflation. In our economics textbooks, we learn that when demand increases, companies will need to necessarily increase prices when the economy reaches full capacity. But this is not true for intangible economies. If demand for the gaming application increases, the company has little incentive to increase prices as it is not incurring any extra costs in scaling.

Another marked trend is the change from physical to digital distribution of goods like films, newspapers and books. Again, the Amazon effect plays out here as well. E-commerce companies like Amazon has started providing e-books at cheap costs and films or TV-shows at low yearly subscription rates (Amazon Prime). As of 2018, Amazon Prime members are close to 100 million in the United States. Book sales through online retail channels has amounted to $8.03 billion surpassing book sales through physical retail at $6.90 billion in 2018. E-books constituted 24.5% of publisher's sales to e-commerce channels in 2018. Another new trend of audio-books is fast catching up as well –

amounting to 13.7% of share in 2018. Digital versions of newspapers are available through Google Play Store and Apple Store applications which are mostly free or low of cost.

This feature is not true for all the countries. Sveriges Riksbank has documented this in Europe but Bank of Canada does not find this applicable for Canada. But the absence of decline in prices in Canada is due to other reasons like few competitors in the telecommunications sector et cetera. Although in the late 1990s and early 2000s even Canada witnessed a decline in prices of ICT products, the recent trend has shown close to zero decline. So, overall, the net impact on the prices of ICT products has been zero. Even in Sweden, according to Sveriges Riksbank, this same phenomenon is noticed. Prices have declined sharply over the last 15 years; but the recent years haven't seen much decline in prices. As ICT products are a significant component of the CPI (determines the inflation rate), the dampening of prices of ICT products will result in lowering of inflation.

Using this framework, Buchheim & Kedert (2016), have tried to construct an econometric model, by using data of 17 European countries. By controlling for output gap, explanatory variables – Better Informed Consumers, E-Commerce, Automation and ICT-Products, are used in the regression to test for impact on CPI. The authors have constructed 5 models containing individual models with just one explanatory variable and a combined model containing all the explanatory variables. Automation, E-Commerce and Better-Informed Consumers display a negative and statistically significant relationship with inflation. The ICT variable showcases a positive relationship with inflation. The relationship holds true even for the combined model.

Section 2.2: Other factors affecting inflation

In this section, I'm looking at other factors that might be responsible for low inflation in advanced economies.

1. **Global economic slack**: Global economic slack refers to a period where the resources in the economy are not utilized to the full extent. That is, capital and labor, are left idle. That is, the production capacity of the economy has diminished. During such a period, there are many people who are looking for a job. As unemployment increases in the economy, there is little pressure on wages to rise. As wages remain steady, the costs incurred by firms also drop. Therefore, in such an economy, inflation can be controlled or remains below target. In the case of a booming economy, the

opposite occurs. The economy is operating at its highest production capacity, and therefore unemployment is kept low. As unemployment remains low, wages start to increase. The rise in wages translate into higher costs for the firms, and these higher costs are then transferred to prices. Hence, there is inflation. Economic slack is usually measured in terms of output gap. That is, the difference between the actual output produced in the economy (GDP) and the potential output (the capacity of the economy to produce). If the difference between potential output and actual output is very high, then you have a case of economic slack. Since the 2008 financial crisis, the global economy is undergoing a period of economic slack.

Traditionally, only domestic slack impacted inflation. The traditional Phillips Curve was able to document the impact of domestic output gap on domestic inflation. But with the rise of globalization, global economic slack can also have a measurable impact on domestic inflation. The passage through which global economic slack could have an impact on domestic inflation is the rise of Global Value Chains (GVCs). Global Value Chains involve the fragmentation or break down of the production process, where each stage of the production process is produced in a different country. The proliferation of global value chains is substantiated by the rise in value-added trade across the globe.

This rise in global value chains also mean that the stages of production can be shifted from countries with excess demand to countries with low demand. Therefore, the relation between excess demand and inflation become flimsy. Auer, Borio & Filardo (2017) have tried to document the impact of global economic slack on inflation. By using a set of 18 countries, they have found that countries which are increasingly integrated into global value chains are more likely to show effects of global economic slack on inflation. Auer, Borio & Filardo have argued in their paper that increased domestic demand do not lead to inflation or increased prices but increase in imports. They tried to augment the traditional Phillips curve by including proxies for global economic slack, and have found considerable evidence on the impact of global economic slack on inflation.

2. **Increase in central bank credibility and independence**: Dincer & Eichengreen (2014) find that countries (advanced, emerging and developing) are moving towards greater central bank transparency and independence. Their study is very vast – comprising of 100 central banks, making their results credible. By updating their measures of transparency, they have tried to see how central bank transparency has undergone a change over the years. They also consider the impact of the 2008 financial crisis on central bank transparency. Parkin (2012) suggests that a central bank is

independent is contingent on who the final monetary policy authority (government or the central bank) is, whether government officials are members of the central bank board and whether the government appointed the members of the board. The lower the government interference in any of these factors, the greater the independence of the central bank. For a central bank to be transparent, it needs to communicate all of its important information to the general public. The way transparency is defined has undergone constant revisions. The most recent and credible measure is the one introduced by Eijffinger & Geraats (2004) where they have divided the broad category of transparency into four sub-indexes (economic transparency, political transparency, procedural transparency and policy transparency). The paper has provided a much richer measure of transparency. Dincer & Eichengreen also document a positive correlation between central bank independence and transparency. Alesina & Summers (1993) document that central bank independence leads to a decrease in the inflation level as well as reduces the variability.

Inflation in emerging economies is slowly converging to the inflation in advanced economics. A reason for that is the increased central bank credibility across emerging economies. Inflation targeting is a tool that allows the people to put faith on the central bank. It has helped to anchor inflation expectations. Bordo & Siklos (2014) document that inflation targeting countries like Canada, UK, Norway and Sweden have been successful in anchoring inflation expectations than other countries. Inflation targeting enhances transparency and credibility. In this same paper of Bordo & Siklos, they found a negative and statistically significant relationship between inflation performance and transparency (measured by a transparency index) in emerging economies. Moreover, to construct a credibility indicator for emerging economies, they define credibility as the squared difference between observed and target inflation. They show that credibility has increased in central banks with inflation targeting.

As IMF states, "a key role of central banks is to conduct monetary policy to achieve price stability (low and stable inflation) and to help manage economic fluctuations". In the Indian context, RBI has aimed to contain inflation within 4 percent with a band of (+/-) 2 percent from 2016. If people believe that the claim of central banks to maintain low inflation is credible, then inflation can be easily kept in control. Contrary to the first point about global economic slack, this phenomenon is a domestic one.

The World Economic Outlook (2018) documents the factors that determine the deviation of core inflation from target. They found that longer-term inflation expectations are the key driver of the level of inflation in emerging economies. The way inflation expectations are measured in most countries is through a survey of households. To measure the impact of anchored inflation expectations, the World Economic Report looks at how the economy responds with respect to an external shock. It uses the Taper Tantrum Episode – an announcement by the central bank to slowly pull back the quantitative easing programme (pumping money in the economy by purchasing bonds), thereby, leading to high bond yields and panic in the market – as the external shock in this exercise.

The research documents the various changes in macroeconomic variables (inflation rate, exchange rate, output and policy rate) of emerging economies in response to the external shock. They create two groups of emerging economies – the less anchored economies and the more anchored economies. There is a statistically significant and positive increase in the price levels of the less anchored economies in response to the taper tantrum. On the other hand, there was no impact on prices in the more anchored group. Moreover, the exchange rate pass through was significantly larger in the less anchored group. Conversely, the pass through of currency depreciations was lower in countries in the more anchored group. Therefore, this paper provides an interesting proof that countries with anchored inflation expectations are able to keep a lid on inflation in case of adverse external economic shocks.

3. **Demographics**: Most of the current advanced economies which are experiencing low inflation also have one thing in common – an ageing population. It is felt that these economies are set to mirror the experience of Japan – secular stagnation. Secular stagnation is defined as a period of low economic growth and low potential growth. Demographic change is a long-term, structural and sometimes an irreversible change in the economy. Therefore, this factor is particularly important as its impact is long-lasting.

Europe which has been in the limelight for low inflation across the Euro Area has a growing ageing population. According to the Ageing Report (2018), the working age population will decrease from 333 million in 2016 to 292 million in 2060. Moreover, the old-age dependency ratio (share of old-age population in working age population) is going to increase by 21.6 percentage points, from 29.6% in 2016 to 51.2% in 2070. Also, according to World Population Review (2019), Europe's population is only growing at a rate of 0.3%.

Demographic change affects economic activity through various channels. Firstly, the life-cycle hypothesis states that individuals at their working age accumulate wealth and save. When these individuals start getting older and become retired, they use these same savings to finance their consumption. Therefore, in an economy, where there is a dominance of ageing population, the savings rate will be much lower.

Another channel is through the impact on financial wealth. Older people generally sell their assets, and if these assets are sold abroad and funds are repatriated, then, on an aggregate level, the exchange rate will become more favourable for the country and will lower the costs of imports. This will lead a fall in prices in the economy.

Katagiri, Konishi & Ueda (2014) bring forth another channel through which an aging population could impact inflation. As old people are more dependent on their savings for savings, they do not prefer high inflation as that would erode the value of their savings. Therefore, on the aggregate, if there is a high number of ageing population in a country, then they can successfully wield political influence in order to contain inflation. Bobeica, Lis, Nickel & Sun (2017) document the long-term relationship between demographics and inflation. By using the methodology of co-integration analysis, they documented that the growth of working age population (used as a proxy for demographic trend) and core inflation are positively correlated. Even after controlling for short term interest rate, this relationship still holds.

4**. Global decline in oil and commodity prices**: There are two measures of inflation that are reported every month in most countries – headline inflation and core inflation. Headline Inflation is the raw figure which states the total inflation in the economy. On the other hand, core inflation is a measure which excludes food and energy prices. The need for another measure like the core inflation is because food and energy prices are extremely volatile and temporary. Unforeseen environmental conditions could affect food prices and sudden changes in oil supply by OPEC cartel could also affect oil prices. Such volatility could be distortionary. Depending on the country and its average consumer basket, it could be argued that overlooking headline inflation might be unwise. When considering inflation, oil prices are always considered to be supremely important. Oil is used as an input in many sectors – paper, aluminium and petrochemicals. An increase or decrease in the price of oil will affect manufacturing industries, transportation and petrochemicals.

According to Lutz Kilian, the Brent price of crude oil (proxy for global price of oil) fell by 44% to $49. The World Bank Report (2015) identifies four causes for the decline in oil prices: US dollar appreciation, reduced demand for oil due to slow economic growth, increase in production of oil by Saudi Arabia and absence of disruptions in oil supply from conflict-driven countries like Libya and the Middle East. The decline in oil prices does not affect inflation substantially in the case of a strong monetary policy. In fact, since the 1980s and 2000s, when inflation expectations became anchored in major economies, oil price volatility started to become less of a problem. Hooker A. (2002) suggests that oil prices affected U.S inflation before 1981 but after that the effect has been close to zero.

Alvarez et.al (2011) documented similar results for other advanced countries in the Euro Area. Similarly, using a larger set of countries (34 countries); De Gregorio, Landerretche and Neilson (2007) show that the pass-through of oil prices to inflation has declined in the world economy over the past 30 years. This phenomenon was witnessed throughout the Great Moderation Period (mid 1980s to 2007). But since the 2008 global financial crisis, there is again a strong correlation between inflation expectations and oil prices noted. Sussman and Zohar (2018) argue that global aggregate demand has a much larger influence on inflation expectations after the global financial crisis. This has led to a strong correlation between global medium-term inflation expectations and oil prices. By using the data of five-year breakeven inflation rates, they document the impact of a 10% increase in oil prices on inflation rates in USA, UK, Israel and Europe. Further, they find that both global demand and supply conditions which influence oil prices are now much correlated with inflation expectations. Although, anchoring of inflation expectations increased in the recent years in emerging economies, central banks in advanced economies started focusing more on output gap after the global financial crisis. The increased focus on output gap by the central banks was seen as a shift in their focus from meeting inflation target. Although there were disinflationary pressures seen before 2014, the fall in oil prices exacerbated this problem.

Section 2.3 India's Inflation Story

India's inflation remained controllable at around 4% in the first half of the 2000s decade. After 2006, inflation climbed on an average to 9% and stayed around that figure for seven years till 2013. India's inflation dynamics are a different category from other countries. India has a variety of institutional

structures in place which makes India an anomaly in terms of drivers of inflation. Also, India's CPI weightage scheme is a little different than advanced economies. As of May 2019 (MOSPI, India), the weightage of food and beverages in the core inflation index is 36.29 (urban) and 54.18 (rural). Fuel and Light amount to 5.58 weight (urban) and 7.94 weight (rural). Therefore, India's inflation scenario deserves a separate section.

Disinflation has not been an occurrence only in advanced economies, but since 2013 India is grappling with the same phenomenon. In November 2013, inflation in India peaked at 12.1%. A year later, December 2014, inflation dramatically fell to 4.3%.

A confluence of various factors led to a turnaround of the problem of high inflation to disinflation in the Indian economy. Chinoy, Kumar and Mishra (2016) provide reasons for the India's recent disinflation. They introduce a model where they regress headline CPI on output gap, inflation expectations (8 lags), lagged growth rates in rural wages, minimum support prices, new regime dummy (inflation targeting), rain, global food prices, other global factors (crude oil) and the exchange rate. They find that output gap, inflation expectations and the new regime (inflation targeting) are the most impactful in explaining inflation in India. Their model has correctly introduced India-specific elements like MSPs and rural wages – making this literature an important contribution to the study of inflation in India. Furthermore, it carefully explains its findings – for example, why oil prices do not explain the current disinflation in India. For the uninitiated, they also explain the interaction between MSPs, wages and inflation characteristic of India. However, they do not touch upon another emerging trend in India – technology. They haven't included technology into their model (or any other proxy like 'number of Internet subscribers') and neither do they identify the growing importance that technology or e-commerce might have currently or in the future of India's inflation.

Section 2.3.1: Technological forces shaping India's Inflation

1. **A jump-start for India's technological growth**: Uber launched its operations in India in August 2013. Currently, Uber has expanded to 31 cities and has already completed a billion trips in India. India is now looking to be the second-largest market for Uber after the United States. Amazon was launched in India in June 2013. India also has its own homegrown companies – Swiggy (food home

delivery app) launched in 2014 and Flipkart (an Indian Amazon-style shopping platform) was launched in 2007. Although, India can be regarded as an infant or a starter in the adoption of technology, India also has an advantage of a higher marginal adoption of technology as compared to other advanced economies. India, like other emerging economies, which lack expertise in the technology frontier could catch-up by simply imitating technologies innovated in advanced economies. India also holds the promise of a huge market and being the fastest growing economy in the world also makes it an attractive investment destination. W Keller (2001) has proved that foreign sources of technology are very important in a country's productivity growth. According to Inc42 DataLabs' Report (2017), 12 Indian startups (OYO, BigBasket to name a few) are in the unicorn club (billion-dollar valuation) and 34 more startups are likely to enter the unicorn club by 2020.

2. **Demographics**: India is now reaping the benefits of a demographic dividend. India has 600 million young people (under the age of 25) – close to half of the country's 1.3 billion population. This makes India the only country in the world with such a large young population. According to Taylor & Silver from Pew Research (2019), younger people are more likely to own a smartphone, use internet and be connected on social media than older generations. In India, smartphone penetration is around 27.7% (2017). Therefore, India is a viable place for further expansion of tech companies.

3. **Problem of Small Firms**: A hindrance to achieving technological penetration is the existence of small firms in India. According to Hsieh & Olken A. (2014), the average number of employees hired by an Indian firm is just a little over 2 employees. Also, the modal size is 1 employee. There is also a problem of growth in these small firms. According to a study by the International Finance Corporation (2013), the size of Indian firms declined by one-fourth over a thirty-five-year-old period. This study was in comparison with Mexico and the United States. India stands apart in these results as the size of firms in Mexico generally doubled and in the United States it even grew by 10 times. The size of firms in India is a major problem for the adoption of technology. Small firms do not have the wherewithal to borrow or even imitate technologies from abroad. This problem could lead to significant barriers in adoption of technology.

4. **E-commerce in India**: In India, the e-commerce experience is a little different. Bandi, Ngwe, Moreno & Xu (2018) explore the problems of dynamic pricing for online retailers. By using the data set of an online retail platform in India, they explore the hypothesis that dynamic pricing could lead to higher returns. It means that if the customer keeps track of price changes even after purchasing the

product and will return the product if the price has dropped or other alternative brands are offering lower prices on a close substitute. They termed this problem as "opportunistic returns". Specifically, from a marginal-effects analysis, they find that a price drop in the future will increase the probability of return from 19.3% to 19.4%. Moreover, they document that products with high prices are likely to be returned – increase in price of a product by 100 rupees will lead to an increase of 0.1% return rate, and lower discounts on a product also increases the likelihood of return – increase in the discount amount by 100 rupees will lead to a 0.2 decrease in the rate of return. Returning a product is costly for the supplier but potentially a zero-cost activity for the customer. E-commerce payment structures in India encourage such opportunistic behavior. In India, due to low penetration of credit or debit cards, most consumers use the Cash-On-Delivery (COD) option for payments – 60% of online transactions are through COD as per a study by Internet and Mobile Association of India and audit firm KPMG (Nair, 2013). This also means that consumers can deny paying for the product when the delivery shows up on their door. Moreover, India has many festivals around the end of the year which lead to dramatic discount events on e-commerce websites. This has significant cost implications for online retailers. Nair (2013) states that COD leads to a longer payment cycle and extra processes and costs which add up to 3% of additional costs or increase in cost by 30 Rs. Per transaction. In the event of a return, which leads to additional costs like round-trip transportation, collection charges by courier companies and in few cases even the damaging of a product, the costs can easily go up to 30%. Although a couple of frequent ecommerce users own some card or the other, many of them still prefer COD over card payments. COD option is a one-time click affair and unlike paying by cards does not require customers to fill out details. Another problem with card payments is the lack of trust on the part of customers.

The paper is particularly important and different as it highlights the problems of dynamic pricing for online retailers and makes a case specifically for the ecommerce structure in emerging markets like India. The existing literature on this topic have only touched upon the fall in share of sales from brick and mortar stores. In contrast, this paper looks at how ecommerce systems in emerging markets could work against online retailers and lower their profits. However, the research is based only on one shopping platform (unnamed) located in only one country (India). Although the paper states that COD is popular across emerging markets like China and Brazil, it does not provide any research or specific examples of the same opportunistic behavior replicating in other emerging economies. Yet, a conclusion is still produced in the paper that opportunistic behavior is prevalent in emerging markets.

Moreover, although the shopping platform studied in this particular research is one of the leading online retailers, it only engages in the apparel or clothing sector. Therefore, there is a lack of surety whether such behavior is witnessed in other online markets like electronics and books. A single platform dealing in only one sector is probably too micro-focused to produce conclusive results on the behavior of online shoppers.

Section 2.3.2: Other factors affecting inflation in India

1. **New Monetary Policy Framework**: By emulating the model of central banks in advanced economies (US, UK, Germany), India sought to introduce a new monetary policy framework – inflation targeting (inflation as the nominal anchor). Owing to the problems associated with WPI, Consumer Price Index (CPI) was chosen as the primary inflation indicator. India's record high rates of inflation and the highest among all G-20 countries led policy makers to immediately take action against high inflation. Inflation was starting to become problematic for India's competitiveness in trade and was simultaneously eroding the savings of households. The ex-RBI Governor – Duvvuri Subbarao (2016) had reservations about the inflation targeting framework. He believed in the multiple target framework rather than focusing on a single target. As India is a country which is prone to supply shocks, he did not think that an inflation target would be useful in containing inflation.

The Governor during the period of 2014 believed otherwise. Raghuram Rajan (2014), then Governor of the Reserve Bank of India, sought to alleviate any fears of a tradeoff between inflation and growth. In fact, he believes that taking down inflation is a pre-requisite for sustainable growth. As the inflation expectations of citizens start getting anchored, the central bank can then cut interest rates to stimulate growth. This led him to increase interest rates steadily leading to a control on inflation.

Chinoy, Kumar and Mishra (2016) introduced a dummy variable to capture the presence of a new monetary policy regime. The dummy variable also captures any "forward-looking expectations" that the public might have after the fall in global oil prices. By using the augmented Phillips curve, and regressing the dummy on headline CPI, it was found that the new regime reduced CPI by around 143 basis points at 5% statistically significant level. This makes it the second most important variable determining headline CPI in the model after inflation expectations.

2. **Minimum Support Prices**: Minimum Support Price is a characteristic Indian government interventionist policy. It is a price set by Commission for Agricultural Costs and Prices at which the Government of India purchases agricultural crops from the farmers. It is used to protect farmers from the vagaries of the open market. If market prices turn out to be low, then the Minimum Support Price will help put a ceiling on their losses.

In the same paper – What is responsible for India's sharp disinflation (2016), minimum support prices also enter as a variable in the augmented Phillips curve to explain headline CPI. The researchers found that a one percent increase in MSPs lead to 6 basis points increase in CPI, thereby, making it the third important variable in explaining inflation in India. A similar result has been documented by a couple of researchers in the past as well - Anand, Kumar and Tulin (2016). Rajan in the same speech (2014) also states MSPs as the culprit of high inflation before 2014.

Section III: Analysis

In this section, I attempt to assess any early signs of the effect of technology on India's inflation. Although technological diffusion is occurring at an unprecedented pace in India, it is still at a nascent stage (as compared to advanced economies) and it is very uneven across geographies and sectors. Therefore, I exploit this unevenness to examine any changes in the pattern of India's inflation. First, I look at 4 states with high technological penetration (Delhi, Maharashtra, Punjab and Himachal Pradesh) and 4 states with low technological penetration (Bihar, Odisha, Uttar Pradesh and Assam), and their inflation. I have used internet penetration (internet subscribers per 100 population) as the proxy for technological penetration.

Section 3.1: Data

For the state analysis, I have downloaded inflation data from the RBI's Data Warehouse Website – Database on Indian Economy (DBIE). It is a comprehensive monthly panel inflation data (Consumer Price Index) set for all states in India with separate inflation indexes for rural, urban and combined (rural + urban) sectors. The data set runs from the year 2011 to year 2018 (only till April 2018). I have completed the remaining data set by extracting inflation numbers for the states from the monthly press releases of CPI Data by Ministry of Statistics and Programme Implementation (MOSPI). I have utilized only the combined index for evaluating any changes in inflation.

For the sectoral analysis, I have downloaded inflation data from the Open Government Data Platform India (data.gov.in) which houses datasets from all ministries, departments and organizations of the Government of India. It is a monthly inflation (Consumer Price Index) panel data set containing a separate index for each of the items in the Consumer Price Index and the General Consumer Price Index for both rural and urban sectors and a combined (rural + urban) index. I only use the combined

index for evaluating any changes in inflation. The data set runs from January 2014 to December 2018.

Section 3.2: State Selection

My choice of states warrants some explanation. The Telecom Regulatory Authority of India (TRAI) published a report – The Indian Telecom Services Performance Indicators - for the month of October – December 2018. They have provided data of "Service Area wise Number of Internet Subscribers per 100 population at the end of December 2018"[2]. The data for internet subscribers per 100 population is a total of rural and urban internet subscribers. My choice of states is dictated by this dataset provided by TRAI. I chose Maharashtra first, because Maharashtra has the highest number of internet subscriptions in 2017 & 2019. Thereafter, I followed the internet subscribers per 100 population data in a descending manner to choose the other 3 technologically advanced states. My choice of states with the highest technological penetration are Delhi (150.08 – internet subscribers per 100 population), Punjab (70.47), Maharashtra (60.41), and Himachal Pradesh (68.35). This forms the treatment group. My choice of states with the lowest technological penetration are Bihar (25.28), Odisha (33.35), Uttar Pradesh (29.64) and Assam (32.18)[3]. This forms the control group.

[2] Data is available for Internet Subscribers (in million) as well, but that does not adjust for the differences in Population.
[3] Maharashtra includes Goa, Bihar includes Jharkhand, Uttar Pradesh includes Uttarakhand and Madhya Pradesh includes Chhatishgarh.

Section 3.2.1 Results: State

Table 1: Descriptive Statistics of States

Variable	High technological penetration states	Low technological penetration states	Difference	T statistic	p-value
	2018				
Average Inflation	137.0979 (2.108896)	139.3583 (3.282643)	-2.2604	4.2816	4.877e-05 T=4.2816
	2011				
Average Inflation	108.0179	109.931	-1.9131	2.6749	0.008825 T=2.6749

Table 1 displays the average inflation of high technological penetration states (Delhi, Maharashtra, Punjab, Himachal Pradesh) and low technological penetration states (Bihar, Odisha, Uttar Pradesh and Assam) for the year 2011 and 2018. Year 2011 is the pre-intervention period. Year 2018 is the post-intervention period. I choose 2013 as the year of intervention. My choice of the year 2013 is motivated by the fact that the year 2013 witnessed the arrival of Uber (August 2013) and Amazon (June 2013) in India.

In 2011, the average inflation in low technological penetration states was greater than high technological penetration states by 1.9131. In 2018, the gap between the two groups broaden to 2.2604. I used a Welch Two Sample T-test to assess if the difference between the two groups is statistically significant. The null hypothesis for the test is that there is no difference between the two groups. I run two tests for each period (2011 and 2018). The confidence interval chosen was 95%. In columns (2) & (3), I have presented the average inflation in each of these groups. In column (4), I have computed the difference in average inflation. In column (5), I note the t-statistic for both the periods after running the two-sample t-test. In column (6) of Table 1, I have listed down the p-value

of pre-intervention period and post-intervention period. As the p-values are less than 0.05, both the differences are statistically significant. I can reject the null hypothesis for both the periods – there is a statistically significant difference between the two groups in each period. The t-statistic for the post-intervention period is higher and p-value much lower than the year 2011.

I use a difference-in-difference approach to assess how inflation has changed pre-intervention and post-intervention in the two states. The difference in difference statistic is (-2.2604 + 1.9131) = -0.3473. Although post-intervention the gap between the two groups have widened with high technological penetration states having much lower inflation, the difference-in-difference result is not statistically significant.

Now I only assess the state with the highest technological penetration (Delhi – 150.08) and compare it with the state with the lowest technological penetration (Bihar – 25.28).

Table 2: Descriptive Statistics of only two states

Variable	Delhi	Bihar	Difference	p-value
2011 & 2012				
Average Inflation	113.2029	114.4033	-1.2004	0.5478
2017 & 2018				
Average Inflation	136.7417	137.9875	-1.2458	0.2346

Table 2 displays information on only two states – Delhi and Bihar (pre-intervention and post-intervention). Delhi is the treatment state and Bihar is the control state. Again, 2013 is the intervention year. Here, I have chosen two periods (2011 & 2012) before the intervention and two periods (2017 & 2018) after the intervention. The initial difference during the periods 2011 & 2012 between the two states is -1.2004. Just like the above example, I use the Welch Two Sample T-test. The null hypothesis is that there is no difference in inflation between the two states. The p-value is 0.5478. Under the 95% confidence interval, as the p-value is greater than 0.05, I fail to reject the null hypothesis. The difference is not statistically significant.

For the periods 2017 and 2018 (post-intervention), the difference between the two states is -1.2458. The null hypothesis and confidence interval remain the same. The p-value is 0.2346. Again, as the p-value is greater than 0.05, I fail to reject the null hypothesis. Similar to the previous exercise, Delhi's inflation has become lower than Bihar's inflation post-intervention, the difference is not statistically significant.

I calculate the difference-in-difference between the two states – pre and post intervention. The difference-in-difference statistic is -0.0454 (-1.2458+1.2004). This statistic shows that post-intervention Delhi's inflation has become lower compared to Bihar's inflation. Yet, the difference-in-difference statistic is not statistically significant.

Therefore, I can conclude based on both the analysis that I do not find any significant evidence of low inflation in technologically advanced states as compared to technologically undeveloped states.

Section 3.3 Sector Selection

CARE Ratings published a report called E-commerce Industry – Update and Outlook in February 2019 which displayed category-wise split of E-commerce sales. Electronics and Accessories occupies 44% of e-commerce sales in India, followed by Apparel and Lifestyle at 30%. Similarly, other reports (CARE Ratings, 2019 and India Brand Equity Foundation, 2018) also show the dominance of electronics and apparel in the e-commerce market. Therefore, based on these reports, I chose Clothing, Mobile Handset, Internet Expenses and PC/Laptop as the sectors most affected by technology.

Section 3.3.1 Results: Sector

Unlike the previous section where I bifurcated selected states of India into two categories (treatment and control), I don't assume any control group in this analysis. Instead, I try to assess the movement of these indices which I consider as most affected by technology based on published reports (Clothing, Mobile Handset, Internet Expenses and Personal Computer/Laptop) against the General Index (encompasses all the categories).

I have data for all these categories and the General Index that runs from January 2014 to December 2018. Here, again, I have chosen 2013 as the intervention year. To illustrate the differences between the indices, I have plotted a multiple line graph (Figure 1) displaying the four sub-indices (Clothing,

Mobile Handset, Internet Expenses and PC/Laptop) and the General Index. The X-axis contains the month and year in quarterly manner. The Y-axis contains the indices.

In the figure, we witness a stark difference between the three indices (Mobile Handset, Internet Expenses and Personal Computer/Laptop) and the General Index. After the technological and e-commerce intervention year (2013), the prices of mobile, internet and PC/Laptop have remained more or less the same – in graphical format, these indices almost have a straight line with little fluctuation. Even though the prices of these items might not have decreased, they have remained much lower than the general price level of the economy - as it can be seen graphically, these indices are much below the General Index. Only clothing has maintained an upward trajectory, albeit with little fluctuation. Yet, it remains above the general price level of the economy. It remains to be seen if these differences show up as statistically significant.

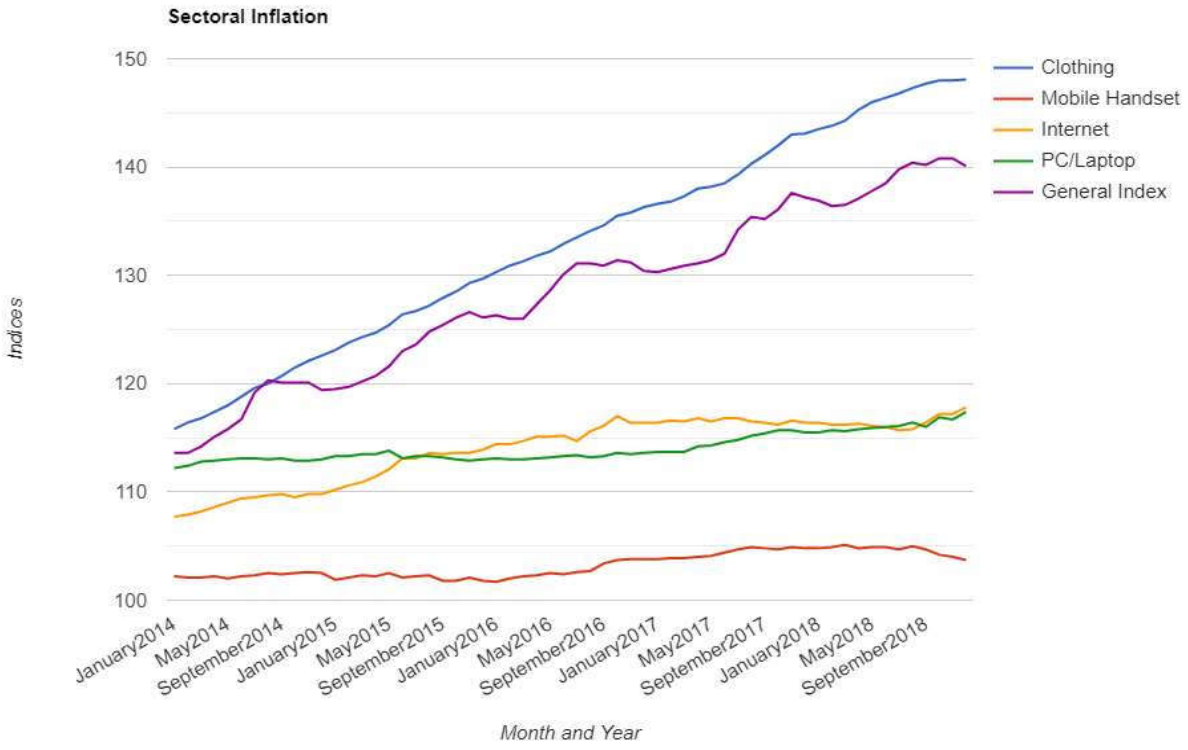

Figure 1: **Movement of Sub-Indices and the General Index from 2014 - 2018**

Similar to the state analysis, I run a two-sample Welch t-test to ascertain whether the difference between each of the indices and the general index is a statistically significant one. I run four two-sample t-test, containing 121 entries in each test, for comparing each of the sub-index to the General Index. The null hypothesis for all the four tests is that there is no true difference in mean between the specific sub-index and the general index. The data set that I used for running the test is from January 2014 to December 2018.

Table 3: Descriptive Statistics of Sectors

Indices	Mean	Difference	T-value	P-value
General	128.3867			
Clothing	132.9217	4.535	2.7769	0.006425
Mobile Handset	103.2400	-25.1467	-24.184	2.2e-16
Internet	113.9900	-14.3967	-13.093	2.2e-16
PC/Laptop		114.0567	-14.33	2.2e-16

All of the four tests display a statistically significant difference between the sub-index and the general index. Therefore, I can reject the null hypothesis in all the four tests. In Table 2, I have displayed the results. The second column contains the mean of each of the indices. The third column contains the difference in mean between the sub-index and the general index. The last column displays the P-value.

My hypothesis is that all of the sub-indices should be consistently below the General Index due to technological advancement and e-commerce sales in these particular areas. My hypothesis is disproved by only one index – the Clothing Index. Similar to the graphical method, the mean of the

clothing index is the only one higher than the General Index. By running the t-test, the difference between the Clothing Index is statistically higher than the General Index. The other three indices (Internet, PC/Laptop and Mobile Handset) are much below the General Index (as seen by the Difference column in Table 2). Moreover, the t-test result displays a strong statistically significant difference, with an extremely small p-value - 2.2e-16, between the indices and the General Index.

Section IV: Limitations of my Analysis

In this section, I will assess some of the limitations of my analysis and also some of the plausible reas ons for finding no significant evidence of low inflation in technologically advanced states as compare d to technologically undeveloped states.

1. **Simplistic analysis**: My analysis in this paper is rather simplistic in nature. To get a richer analysis and a significant causal effect, I would need to include an empirical model with sufficient control variables.

2. **Low spread of technology**: Although technology is accelerating in India, the spread of technology in India is probably still quite low. In essence, it is not as pervasive as it is in advanced economies like US, UK or Japan. Therefore, it is a still premature to find any signs of the impact of technology on inflation.

3. **Proxy Variable**: I have used internet penetration (internet subscribers per 100 population) as a proxy for technological penetration. This might not be a perfect measure for gauging technological use in a state or country. It could be that there are many people with internet but they don't use it frequently. Also, we have little idea about how internet is being used in these states – the online activities of individuals etc. Perhaps, a better measure would be the "frequency of internet use", "active internet users" or "e-commerce sales by state". These measures might serve to give a better idea of technological penetration but there are data constraints for these measures.

4. **High weightage of food and beverages in India's CPI**: The 'Food and Beverages' component comprises of 54.18% of weightage under the Consumer Price Index. This is also a component which is the least affected by technology and e-commerce in India. Therefore, the high weightage of this component dominates the final index of CPI and mutes the effect of other components that are affected by technology (Clothing/Apparel, Internet, Electronics) on CPI.

Section V: Conclusion

In the first part of my analysis, my hypothesis was that the technologically advanced states in India will replicate the pattern of low inflation in advanced countries, but I find little evidence supporting my hypothesis. In the second part of my analysis, my hypothesis was that certain sectors are more affected by technology and e-commerce, and therefore, the effect of technology should reflect in the inflation data. I do find evidence that the price level of certain items has remained stable over the past 4 years after the arrival of e-commerce in India.

My analysis in this paper is simplistic in nature, but there is scope for building an empirical model and adding control variables to assess the impact of technology on inflation in India. Moreover, with the emergence of sharing economy and gig economy, it is possible to expand research in order to assess the impact of these new systems on inflation. Further, e-commerce is expanding into new forays like the food & groceries section. Food and Beverages account for 54.18% of weightage in India's CPI, therefore, it will be interesting to conduct research over the next few years on how the rise in food e-commerce is reflecting in India's inflation.

References

(2018). *2018 Ageing Report: Policy challenges for ageing societies.* European Commission.

Acemoglu, D., & Restrepo, P. (2018). *Artificial Intelligence, Automation and Work.* Technical Report, National Bureau of Economic Research.

Alesina, A., & Summers, L. H. (1993). Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence. *Journal of Money, Credit and Banking Vol. 25, No. 2 (May, 1993), Ohio State University Press*, pp. 151-162.

Alvarez, L., Hurtado, S., Sanchez, I., & Thomas, C. (2011). The impact of oil price changes on Spanish and euro area consumer price inflation. *Economic Modelling, 2011, vol. 28, issue 1, 422-431*.

Anand, R., Kumar, N., & Tulin, V. (2016). *Understanding India's Food Inflation: The Role of Demand and Supply Factors.* IMF Working Paper No. 16/2.

Ark, B. V. (2016). *The Productivity Paradox of the New Digital Economy.* International Productivity Monitor, 2016, vol. 31, 3-18.

Auer, R., Borio, C., & Filardo, A. (2017). *The globalisation of inflation: the growing importance of global value chains.* BIS Working Papers, No 602.

Bandi, C., Moreno, A., Ngwe, D., & Xu, Z. (2018). *Opportunistic Returns and Dynamic Pricing: Empirical Evidence from Online Retailing in Emerging Markets.* Harvard Business School Marketing Unit Working Paper No. 19-030; Harvard Business School Technology & Operations Mgt. Unit Working Paper No. 19-030. Available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3266474 .

Bessen, J. E. (October 3, 2016). *How Computer Automation Affects Occupations: Technology, Jobs and Skills .* Boston Univ. School of Law, Law and Economics Research Paper No. 15-49.

Bijnens, G., & Konings, J. (2018). *Declining Business Dynamism.* CEPR Discussion Paper No. DP12615. Available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3106819.

Bordo, M., & Siklos, P. (2014). *Central Bank Credibility, Reputation and Inflation Targeting in Historical Perspective.* NBER Working Papers 20693, National Bureau of Economic Research, Inc.

Brynjolfsson, E., & McAfee, A. (2011). *Race Against the Machine.* Lexington, Mass: Digital Frontier Press.

Brynjolfsson, E., & McAfee, A. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies.* New York : W.W. Norton & Company, [2014].

Brynjolfsson, E., & Smith, M. D. (2000). *Frictionless Commerce? A Comparison of Internet and Conventional Retailers* . Management Science/Vol. 46, No. 4, April 2000.

Buchheim, V., & Kedert, M. (2016). *Digitisations effect on the inflation - An empirical analysis of possible digitisation channels* . Master of Science Thesis INDEK.

Cavallo, A. F. (2016). *Are Online and Offline Prices Similar? Evidence from Large Multi-Channel Retailers.* NBER Working Paper No. 22142.

(October 2018). *Challenges to Steady Growth.* World Economic Outlook, International Monetary Fund.

Charbonneau, K., Evans, A., Sarker, S., & Suchanek, L. (2017). *Digitalization and Inflation: A Review of the Literature.* Bank of Canada.

Chinoy, S., Kumar, P., & Mishra, P. (2016). *What is Responsible for India's Sharp Disinflation?* . International Monetary Fund, WP/16/166.

Corrado, D. B. (2017). *ICT Prices and ICT Services: What Do They Tell Us About Productivity and Technology.* International Productivity Monitor, Centre for the Study of Living Standards, vol. 33, pages 150-181, Fall.

Decker, R. A., Haltiwanger, J. C., Jarmin, R. S., & Miranda, J. (2018). *Changing Business Dynamism and Productivity: Shocks vs. Responsiveness.* NBER Working Paper No. 24236.

DellaVigna, S., & Gentzkow, M. (2017). *Uniform Pricing in U.S. Retail Chains.* DellaVigna, Stefano and Gentzkow, Matthew, Uniform Pricing in U.S. RetaiAvailable at SSRN: https://ssrn.com/abstract=3067508 or http://dx.doi.org/10.2139/ssrn.3067508.

Dincer, N. N., & Eichengreen, B. (2014). *Central Bank Transparency and Independence: Updates and New Measures.* International Journal of Central Banking, March 2014.

Dong, W., Fudurich, J., & Suchanek, L. (2017). *Digital Transformation in the Service Sector: Insights from Consultations with Firms in Wholesale, Retail and Logistics.* Staff Analytical Note, Bank of Canada.

D'Souza, C., & Williams, D. (2017). *The Digital Economy.* Bank of Canada Review.

Eijffinger, S., & Geraats, P. (2004). *How Transparent Are Central Banks? .* Cambridge Working Papers in Economics 0411, Faculty of Economics, University of Cambridge.

Elena Bobeica, E. L., Nickel, C., & Sun, Y. (2017). *Demographics and Inflation.* European Central Bank, Working Paper Series No 2006.

Europe Population 2019. (2019). Retrieved from World Population Review: http://worldpopulationreview.com/continents/europe-population/

Frey, C., & Osborne, M. A. (2017). *The future of employment: How susceptible are jobs to computerisation?* Technological Forecasting and Social Change, 2017, vol. 114, issue C, 254-280.

(2015). *Global Economic Prospects.* World Bank Group.

Grant, M. (2018, August August 14). *E-commerce Set For Global Domination -- But At Different Speeds*. Retrieved from Forbes: https://www.forbes.com/sites/michellegrant/2018/08/14/e-commerce-set-for-global-domination/#57dfe546bfaf

Gregorio, J. D., Landerretche, O., & Neilson., C. (2007). *Another Pass-Through Bites the Dust? Oil Prices and Inflation.* Working Papers Central Bank of Chile 417, Central Bank of Chile.

Haskel, J., & Westlake, S. (2017). *Capitalism without Capital The Rise of the Intangible Economy .* Princeton University Press.

Hooker, M. A. (2002). Are Oil Shocks Inflationary? Asymmetric and Nonlinear Specifications versus Changes in Regime. *Journal of Money, Credit and Banking Vol. 34, No. 2 (May, 2002)*, pp. 540-561.

Hsieh, C.-T., & Olken, B. A. (pp 89-108). The Missing "Missing Middle". *Journal of Economic Perspectives—Volume 28, Number 3—Summer 2014—*.

Inc42, T. (2018, February 15th). *34 Indian Tech Startups That Have The Potential To Enter The Unicorn Club*. Retrieved from Inc42: https://inc42.com/datalab/indian-tech-startups-unicorn/

Katagiri, M., Konishi, H., & Ueda, K. (2014). *Aging and Deflation from a Fiscal Perspective.* Globalization Institute Working Papers 218, Federal Reserve Bank of Dallas.

Keller, W. (2001). *International Technology Diffusion.* NBER Working Paper No. w8573.

Kromann, L., & Sørensen, A. (2019). *Automation, Performance, and International Competition: A Firm-Level Comparison of Process Innovation.*

Levy, F., & Murnane, R. J. (2004). *The New Division of Labor: How Computers Are Creating the Next Job Market.* Princeton University Press.

Loecker, J. D., & Eeckhout, J. (2017). *The Rise of Market Power and the Macroeconomic Implications.* NBER Working Paper No. 23687.

Nair, R. P. (2013, November 10th). *Cash-on-delivery hurts bottom line of cos like Flipkart, Snapdeal due to extra associated costs*. Retrieved from Economic Times: https://economictimes.indiatimes.com/industry/services/retail/cash-on-delivery-hurts-bottom-line-of-cos-like-flipkart-snapdeal-due-to-extra-associated-costs/articleshow/25192740.cms?from=mdr

Neumann, J. (2015, October 14th). *The Deployment Age*. Retrieved from Reaction Wheel: http://reactionwheel.net/2015/10/the-deployment-age.html

Parkin, M. (2012). *Central Bank Laws and Monetary Policy Outcomes: A Three Decade Perspective.* University of Western Ontario.

PTI. (2016, July 27th). *Former Reserve Bank governor Duvvuri Subbarao questions inflation-targeting, doubts its efficacy*. Retrieved from Economic Times: https://economictimes.indiatimes.com/news/economy/policy/former-reserve-bank-governor-duvvuri-subbarao-questions-inflation-targeting-doubts-its-efficacy/articleshow/53417761.cms?from=mdr

Pugsley, B., & Sahin, A. (2014). *Grown-up Business Cycles.* Staff Reports 707, Federal Reserve Bank of New York, revised 01 Sep 2015.

Rajan, S. b. (2014, February 26th). *Fighting Inflation.* Retrieved from FIMMDA: http://www.fimmda.org/uploads/general/Governor_Speech.pdf

Report, M. P. (2015). *Digitisation and Inflation.* Sweden: Sveriges Riksbank.

Richter, W. (2018, May 19). *Here's which brick-and-mortar retailers are getting hit the hardest*. Retrieved from Business Insider: https://www.businessinsider.com/brick-and-mortar-retailers-getting-hit-the-hardest-2018-5?IR=T

Ridder, M. D. (2019). *Market Power and Innovation in the Intangible Economy.* Cambridge Working Papers in Economics 1931, Faculty of Economics, University of Cambridge.

Sussman, N., & Zohar, O. (2018). *Has Inflation Targeting Become Less Credible? Oil Prices, Global Aggregate Demand and Inflation Expectations During the Global Financial Crisis.* BIS Working Paper No. 729. Available at SSRN: https://ssrn.com/abstract=3200712.

Taylor, K., & Silver, L. (2019). *Smartphone Ownership is Growing Rapidly Around the World, but Not Always Equally.* Pew Research Center.

Vermeulen, B., Kesselhut, J., Pyka, A., & Saviotti, P. P. (2018). *The Impact of Automation on Employment: Just the Usual Structural Change.* Sustainability, MDPI, Open Access Journal, vol. 10(5), pages 1-27, May.

(2018). *Will robots steal our jobs? .* PWC.