Subsidizing electronic payments to decrease the informal economy.

Yasir Khan

Department of Economics
Hanken School of Economics
Helsinki
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Abstract: The informal economy affects almost every economy around the world. The policies to control informality usually overburden the existing formal sector of the economy, hence creating an informality trap.

The government can increase electronic payments among the consumers to decrease informality, so that the businesses can not conceal their information. If the government subsidizes electronic payments, then the consumers will be willing to search for an electronic payment facility, if the sellers do not offer one.

Using Game Theory, the thesis establishes that the consumers are willing to search for electronic payment facility, if the cost of searching is less than the product of reimbursed amount and the firms providing electronic payments. The Game Theory analysis further establishes, that for sellers, it is profitable to offer electronic payment facilities, if the tax rate is below the consumer's probability of searching for another seller.

Analysing the data from EU member states, a regression analysis of tax gap on electronic payments is performed, while analysing data as individual years and as a panel data. The results of regression analysis, for cross sectional and panel data, verifies the hypothesis derived from the game theory. The electronic payments are negatively correlated with the tax gap.

Keywords:
informal economy, electronic payments, tax evasion
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1 INTRODUCTION

The existence of an informal sector, plagues almost all the economies, even in this age of information and technology. According to the United Nation’s International Labour Office (ILO) around 2 billion employed people, over the age of 15, work informally. They make up for the 61.2 percent of the world’s employment. The range of informal employment varies by region, the highest is in Africa (85.8%) and the lowest is in Europe and Central Asia (25.1%).

The report presents statistics on “Economic Units”, sum of own account owners and employers. It states that throughout the world, around 80.9 percent of economic units are informal. Africa and Arab States’ economic unit informality is at 92.4 percent and 90.8 percent, respectively. For emerging and developing countries, the share of informality among economic units is 82.5 percent.

This study investigates the statistics, factors and consequences of informality in an economy. The thesis also includes a brief breakdown of the existing policies recommended by the institutions and scholars. After that, a different perspective and an approach towards tackling informality is evaluated. The implications of the suggested policy on the micro and macro-economic level is analysed, along with the best possible ways to implement the policy. The study intends to provide the policy makers with an additional tool to tackle the menace of informality.

Prior to further analysis, one must be able to completely define “Economic Informality”. Some of the synonyms used for the informal economy are “shadow economy”, “undocumented economy”, “the underground economy” and “the black economy”. The preceded terms weren’t always followed up by “economy”, in fact the economists seldom paid heed to the activities carried outside the formal framework of the economy (Gërxhani, K. 2004).

In the 1950s and 1960s, the economic literature started to recognize informality. (Blau and Scott, 1963) and it was in 1971 that the term “informal sector” was coined by Keith Hart (Hart 1973). The “informal sector” was analysed by the ILO, in 1972, when it organized an employment mission in Kenya. Initially, the interest in the “informal sector” only existed in the under-developed or developing countries, but soon it was followed up by increasing interest in the developed economies as well.

Soon after “informal sector” was accepted as a complex phenomenon, further research into it unravelled the sheer size of it. The economists soon decided to use the term “informal economy” as they realized that it had its own way of operating. For better understanding of this phenomenon, it would be wise to define and explain what informality means.
1.1. Informal Sector/Employment Definition

ILO states that: Employment in the informal sector is an enterprise-based concept and it is defined in terms of the characteristics of the worker’s place of work. By contrast, informal employment is a job-based concept and it is defined in terms of the employment relationship and protections associated with the job of the worker.

For international comparisons, the ILO uses the following criteria to define informal sector:

They should be unregistered, not registered with relevant national institutions, private economic units, producing goods and services to sell, or barter. (Even if a portion, not all, of production is used for trade.) In addition to that, the units do not practice a formal book keeping, have less than 6 employees and doesn’t hold fixed premises.

For the informal employment, ILO defines it as:

For the economic units, which include own-account (without hired workers) and employers (with hired workers), operating in the informal sector classifies them as informal employment. Also, all contributing family workers are termed as informal employment, even if they work in the formal sector. Employees are considered informal, when there are no social security contributions being made on their behalf by their employers, and/or they aren’t entitled to paid annual or sick leaves.
2 BACKGROUND

2.1. Statistics

Many studies have been conducted to grasp the actual numbers behind informality. The task hasn’t been easy, as informality by its nature is hard to be quantified. The ILO’s effort has been by far the most detailed and widely accepted one by now. So, this thesis would rely upon the ILO for the informality statistics.

The ILO states that 2 Billion people, 61.2 percent of global employment, work informally. As shown in (figure 3.1) in Appendix 3. The section labelled "World", shows that the ratio of informal employment varies between regions. Looking at the five main regions of the World, Africa’s informal employment of 85.8 percent, is the highest. The Arab States, Asia and the Pacific region, have an almost same ratio of informal employment, around 68 percent. The Americas and Europe and Central Asia, face much lower numbers of informality, 40 percent and 25.1 percent respectively. Removing the agriculture sector, decreases the World total informal employment to 50.5 percent. However, it remains high in Africa, Arab States, Asia and the Pacific.

A look at the first two sections, of the figure 3.1 in Appendix 3, suggests that there is a positive correlation between, formality and development. Countries characterized as "Developing & Emerging" have greater proportion of informality than the "Developed" ones. The "Developed" countries, as defined by the World Bank, are high-income countries, whereas "Developing & Emerging" economies are defined as, low-income and middle-income countries.

Almost 70% of the working population in the developing and emerging countries is employed informally. For the developed countries the share is smaller than 20 percent of the employed population. Furthermore, developing and emerging countries represent 82 percent of world employment, but 93 percent of the world’s informal employment is in these countries.

Informal employment exists in the formal, informal and household sectors. Unsurprisingly, the informal sector, at global and regional level, constitutes most of the informal employment. Out of 61.2 percent global informal employment, 51.9 percent is due to the informal sector, where as 6.7 percent and 2.5 percent are due to formal and household sectors, respectively.

A statistic overview of "Economic Units" in the informal economy suggests a more severe magnitude of informality. Economic Unit include: (a) units that employ hired labour, (b) units that are owned by individuals working on their own account, either alone or with the help of contributing family workers, and (c) cooperatives and social and solidarity economy units,
according to the Recommendation 204 adopted by the International Labour Conference, in June 2015. In simple terms, the “Economic Units” are the businesses and entrepreneurial entities.

Around the world, almost four-fifth of the economic units, 80.9 percent, are informal. This is almost 33 percent higher than informal workers. The informal economic units are higher in Africa and the Arab States, more than 90 percent in both regions. The economic units in the informal sector of developing and emerging countries is almost equal to the global level, but informality in developed countries, for the economic units is 55.7 percent, smaller than the world aggregate, but still it is quite high.

The figure 3.2 in the Appendix 3, divides economic units into employers and own-account workers. The own-account workers, according to OECD glossary are the workers who, working on their own account or with one or more partners, hold the type of job defined as a self-employed job and have not engaged on a continuous basis any employees to work for them during the reference period. The figure illustrates that most of the informality is caused by own-account workers, that doesn’t come as a surprise, as own-account workers, comprise vast majority of economic units around the world.

The ILO’s report, Women and Men in the Informal Economy(2014), presents the statistical overview of informality and status in employment. It summarizes the informal and formal employment by categories of status in employment.

The report states that, all over the world, employees and own-account workers make up most of the informal employment, 36.2 percent and 45 percent respectively. Contributing family workers are, informal, hence they would only be counted in the informal section. For developing and emerging countries, the composition of employees, contributing family workers, employers and own account workers is the same as the global average. The composition varies for the developed economies, they have employees as the largest group in the informal work, at 51.3 percent.

It can be concluded that, for a policy to eradicate informal economy successfully, it must be directed towards employees and entrepreneurs, especially own account workers, simultaneously.

Next subsection, discusses the reasons behind the existence of informality and presents the point of view of different schools of thought.
2.2. Reasons for Informality

There has been an on-going debate about the nature and causes of informality. The debate has created four dominant school of thoughts, the dualists, legalists, structuralists and voluntarists (also called il-legalists).

The dualists school believes that the informal sector is comprised of marginal activities, that are not directly connected with the formal sector, they can be easily differentiated from the formal sector. This school of thought argues that, when the population growth rate, and along with it the labour supply, exceeds the economic development, more precisely the modern industrial growth, the informal sector starts to grow. The dualists further believe that informality is a consequence of a disparity between traditional labour skills and the modern economic structure. Hart (1973), Tokman (1978) and many in the ILO World Employment Mission Kenya 1972, were the main proponents of the dualists school of thought.

The legalists school of thought sees the informal sector as a combination of small entrepreneurs, who stay out of the formal sector to avoid costs, effort and responsibilities of formal registration. The legalists school of thought revolves around the hostility and complication of the legal system, which they believe, causes the self-employed to operate in the informal sector. The examples of legal complications include, licencing, registration, compliance with laws and regulations etc. This school of thought is popularized by De Soto (1989, 2000), among others.

Both, dualists and legalists, saw informality as a feature of pre-capitalists’ economy. The structuralists believe informality to be a feature of capitalist development. They argue that informality is driven by capital gains, i.e. the formal sector exploits the informal agents, to decrease costs and improve their competitiveness.

The structuralists further add that the exploitation, by subordinating, of the informal sector by large firms is a reaction to the power of organized labour, global competition, and states’ efforts to regulate economy, such as enforcement of higher minimum wages. Modern industrial techniques such as offshore industries, outsourcing and specialization also causes the formal sector to look towards informal subordinated economic units, to maintain their competitiveness. Moser (1978) and Alejandro Portes, among others, are the main proponents of the structuralists school of thought.

The voluntarists (il-legalists) school of thought focuses on the informal economic units. These economic units willingly try to avoid labour market regulations, taxes and social protections contributions, after weighing the cost and benefit of operating in the formal and informal
sector. Informality is seen as a choice, and complex registration procedures are not one of the reasons for informality. They believe that a strong welfare system would increase the opportunity cost of working in the formal sector hence the incentives to work in the informal sector increases. So, with higher unemployment benefits, a voluntarist would seek to work informally and claim unemployment benefits as well.

Martha Chen, in a working paper for WIEGO, summarized the stance of four school of thoughts by stating that as the informal economy is diverse, each school of thought holds weight in the overall share of informality. She further adds that the informal economy is however more complex than just the sum of these school of thoughts.

Hence, a holistic approach towards the reasons for informality was needed. At the turn of the century, new literature appeared with a complete framework, accounting for the different aspects of informality. At the forefront was the exact definition of informal sector and employment by The International Labour Office (ILO) in 2002, already discussed in the background section.

In 2007, The World Bank published a book: Informality: Exit and Exclusion. It was co-authored by Guillermo Perry, William F. Maloney, Omar Arias, Pablo Fajnzylber, and Jaime Saavedra. The book took a holistic approach towards the determinants of informality. The book analysed the informality in Latin America. The authors used two different views to differentiate between types of informality, Exit and Exclusion. To summarize, the “Exit” means voluntary informality and “Exclusion” means involuntary informality. Furthermore, the book segments the informal sector, in “three pairs” of economic agents, Labour, Micro-firms and Firms.

The authors describe that the labour, is excluded from the formal sector because they lack the human capital required by the employers in formal sector. Some of the labour exits the formal sector, to start their own work, enjoy more flexible hours or to earn more money by avoiding taxes.

For the micro-firms, the exit is caused by the lack of ambition or no prospects of growth, hence there is no intention to engage with the state institutions. The exclusion is due to the hindrance caused by the high barriers to entry. The firms operate in the informal sector because they may be trying to avoid taxes and regulations. They may also be partially registering their employees and sales as well.

The holistic causal theory given by the book is divided into three parts as well, “Opportunistic evasion”, “Defensive evasion and exclusion” and “Passive evasion and state irrelevance”.
Opportunistic evasion is a pure form of voluntary informality or exit. This simply includes labour or firms trying to evade taxes, involved in illegal or unregistered activities. Avoidance of labour codes due to unprotected workers or subcontracted productions is also a form of opportunistic evasion.

Defensive evasion and exclusion are a response to a burdensome or weak state. Rent seeking bureaucracy, business and labour elites create a burdensome state by not letting weaker firms and workers enjoy state benefits. Hence, they prefer to stay in the informal sector as access to state benefits is difficult. The stronghold of some groups on the political and economic areas may encourage exit or outrightly cause exclusion.

In the instance of pre-modern or the bazaar economy, or when the non-state institutions are quite strong, the passive evasion takes place. The state institutions may be presents but they might be irrelevant because they may not be tailored to local conditions, hence the firms or labour may not feel the need to be affiliated with the state by formalizing.

The chapters 2 and 3 of the book make some very interesting conclusions about the ratio of voluntary and involuntary formality. To summarize, the chapters state that majority of the independent or self-employed, in other words own-account workers, are voluntarily informal. However, a majority of informal workers are excluded from their desired formal jobs.

Concluding the causal theory debate, there are many factors that force the different segments of society towards informality. Most of the employees work informally due to the hiring practices of their employers, who maybe avoiding payroll taxes, contributions to social security and other employer related legal obligations. Whereas most of the own-account workers, self-employed and employers would want to operate under the informal sector to avoid taxes and excessive, or complex, regulations.

In the next subsection, the effects of informality on the different sectors of economy are discussed.
2.3. Effects of Informality

This subsection explains that how an economy incurs huge cost because of informality, both at the aggregate as well as individual level. Those who work in the informal sector are deprived of basic social care benefits, this might be one the most significant effect an individual would have to face while working in the informal sector. The absence of social care creates lack of protection against income shocks and basic worker protection, among many other effects. The fall in productivity or output, might be the most significant effect at the aggregate level. Below are some of the effects that the existence of informality has on the economy.

2.3.1. Fiscal Deficit

Some of the very apparent effects of informal sector can be readily identified. As the informal sector, by its definition, is not working under the ambit of law, it would obviously mean that the state would face a negative fiscal pressure. There would be low collection of taxes, hence the consequence would be fiscal deficits. The existing theory on the informal sector states that informality decreases government revenues, and subsequently causes fiscal deficit. The figure 3.3 in Appendix 3, from OECD data base, illustrates the fact.

The figure shows the Government deficit, as a percentage of their GDP for the European Union, United States, United Kingdom and China. The figure shows that, other than China, the all the countries face almost a constant fiscal deficit. The fiscal deficit illustrated in the figure shows that the major economies in the world are facing fiscal deficit. This is one of the of main consequences of informality. Decreasing informality can help cover the fiscal deficit.

Many argue that, tax evasion creates a “free rider” problem on the public goods. The informal firms and labour then congest the public infrastructure. Loayza (1996) concludes that the relative size of the informal sector is negatively correlated with the public infrastructure.

While there are countless negative effects of fiscal deficit, we would limit the discussion of these effects vis a vis informal sector. The low collection of taxes could create an “informality trap”, where the governments would not have enough revenue to spend on public goods, infrastructure development and improving bureaucratic processes, specially the revenue boards, among others. Hence, the firms who have voluntarily left the formal sector, or continue to stay informal, due to inadequate state machinery, refer to “defensive exit and exclusion” in the reasons for informality section, would have little motivation to join the formal sector. Similarly, firms practicing “opportunistic evasion”, would continue to evade taxes if the
low tax collection means weaker revenue boards. Low public expenditure reduces tax morality, the public’s attitude towards the state.

Some governments might increase the indirect taxes to cover the fiscal deficit and break the informality trap, by investing the extra taxes raised on public goods. The nature of indirect taxes is regressive, and this may eventually decrease the trust in the government, subsequently increasing the “defensive exit and exclusion”. Increasing the direct taxes, may eventually push the firms and labour in the formal sector towards informality. It may also have a determinantal effect on attracting foreign investment and multinational firms, as they are mostly formal in nature. Increasing any sort of taxes also tend to reduce tax morality.

2.3.2. Social Indicators

There are differing viewpoints about the effects of informality of social indicators. Some theories state that the informal sector is a source of earning for low skilled labour, hence it reduces poverty and unemployment and increases the standard of living. Others argue that the long-term effects of informal sector are determinantal for the social indicators such as quality of life.

Kireenko and Nevzorova (2015) investigate the impact of informal economy on the quality of life. They conclude that as the informal sector grows, the life quality indicators which reflect long and healthy life as well as access to knowledge decreases.

A UNDP National Human Development Report for informal sector in Montenegro, states that workers employed informally are more exposed to poverty as compared to formally employed workers, whereas the poverty risk rate is significantly higher for self-employed in the informal sector.

However, empirical research carried out by Suharto (2002), investigates the link between urban poverty and informality in Indonesia. Suharto states that for people working in the informal sector, 80 percent of the subjects interviewed were above the poverty line but could still be counted as poor. The rest 20 percent were counted as below poverty line. Surprisingly, for Suharto, when accounted for other HDI indicators, such as access to health care and housing, the informally employed didn’t vary statistically from the general population. Suggesting that the informality doesn’t significantly affect the social indicators.

Ibrahim and Norman (2008), while determining the causes and consequences of informality on the Arab world, conclude that informality is associated with wider spread of poverty.
The workers in the informal sector are generally paid less than those working in the formal sector. This would create an unequal income distribution. Dell’Anno (2016) states that as informal sector decreases government revenues, it subsequently decreases the government’s ability to implement income redistributive policies. This may increase informality hence, again creating an “informality trap”.

2.3.3. Corruption

Sakuhuni (2014) points out that informal sector lacks the required documents to operate in any economy, hence they would be vulnerable to corruption and harassment. This would increase the distrust in the government and state, hence any efforts of formalization would not be supported by the informal sector, in other words reduce tax morality.

Dutta, Kar and Roy (2012), and Mishraa and Ray (2011) find that corruption is positively correlated with employment in the informal sector. The informality trap can be detected in the instance of corruption as the bureaucracy can easily exploit the informal sector by their corrupt practices. This can make the informal agents lose trust in the state and any attempts to decrease informality might not be successful. The state would need to increase their revenues to implement better checks and balances on the corrupt practices, but the informal agents would not be willing to become part of the formal economy, due to exploitation by the corrupt bureaucracy and trust deficit.

2.3.4. Productivity Gap

The firms, individually, can save costs by staying informal. As De Soto (1989) argues, that by avoiding taxes and social security payments firms can gain benefits from staying in the informal sector. There other benefits such as lower hiring and firing costs, and greater freedom and flexibility in working hours and conditions.

However, staying in the informal sector usually has a lot of determinantal effects on the long-term productivity and growth of firms. The informal firms try to limit their production size, the caveat being that larger firms are easily detectable by the governments. The larger an informal firm grows, the larger is the risk of being caught.

Besides from consciously limiting their scale, the informal firms face a much harder task in hiring, or retaining, educated and better skilled labour. This limits their productive capacities, as they tend to face a higher turnover of labour. Hence the informal firms don’t tend to invest in training and capital goods.
The informal firms usually don’t have better access to courts and legal institutions. This restricts their ability to trade openly with other firms. They may also have to limit the quantity of overall transactions, or the value of a single transaction, to avoid excessive exposure to risk. This limited trading with trustworthy partners hampers any potential of growth.

Staying in the informal sector means, non-declaration of assets and transactions. This makes it incredibly hard for these firms to secure credits and loans from the formal financial sector, at least at reasonable interest rates, as they can’t use their assets for collateral. Even partially concealing their revenues could have determinantal effects on their ability to take loans as this increases the element of risk for lenders. This restriction on raising equity limits their ability to expand, or even improve their productivity by hiring new physical capital.

Besides the formal financial institutions, the informal firms cannot take advantage of programs initiated by the government targeting small and medium enterprises. These programs usually offer easy and cheaper loans, skills training to improve productivity or expert opinions and help to tackle technical problems.

Perry et al. (2007) argue that firms operating in the informal sector may be able to compete with more productive and cost-effective firms by avoiding taxes and regulations. So, despite having lower level of entrepreneurial skills, the informal firms may just be able to survive due to avoiding regulations and taxes. One of the major problems this scenario creates is it reduces the creative process, through which the highly productive firms render firms with low productivity, redundant. They further argue that strict imposition of regulations could eventually derive many firms out of business, who voluntarily stay informal, which may also affect aggregate levels of production.

The cost disadvantages faced by the formal firms, against the informal sector, can decrease their willingness and ability to carry out research and development. This may have a determinantal effect on the innovation and technological advancement, which would eventually lead to slow economic growth.

Robles (2009) concludes that, government’s limited capacity to enforce tax compliance, decreases the aggregate output by 12 percent. The effect on total factor productivity is 9 percent. The share of informal sector in the aggregate output is above 30 percent, due to poor tax enforcement. The assumption in the model used was that the larger firms have higher probability of being detected for tax evasion, hence the informal firms would optimally want to stay small.
Farrell (2004) argues, that globally, the average productivity level of informal firms is half the ratio of formal companies, in the same sector. So, the informal firms, constantly decrease the country’s overall productivity and standard of living. She also argues that informality consistently distorts competition, which in turn stops the more productive, formal firms from expanding.

Ibrahim and Norman (2008), analysing micro and small enterprises (MSEs) from four countries of Arab region conclude that, entrepreneurial and labour informality has negative marginal effects on MSEs, even after controlling for enterprise characteristics and labour attributes. They also, find that informal firms face a hard time tapping regional and international markets. Hence, it causes low economic growth and limited export potential.

Industry based research by the McKinsey Global Institute, conducted in Brazil, India, Russia and Turkey, enlist voluntary informality as one of the main reasons for perpetual low productivity in sectors such as retail, food processing, and housing construction. This obviously points to low productivity on the aggregate level as well.

In conclusion, the informal firms lose their own productivity as well as cause the productivity of formal firms to decrease. This eventually leads to a reduction in the economic growth rate and aggregate production.

2.4. Existing Policies to decrease Informality

This subsection focuses on the policies employed by different economies to tackle informality. The subsection also includes the recommendations by the ILO, to control and reduce informality. To conclude the subsection, the response of the informal agents, to the polices, is categorized.

2.4.1. Value Added Tax

Value Added Tax (VAT), introduced by Maurice Laure in 1950s, is widely known to be the simplest way of taxing the informal economy, or nudging the enterprises towards formalization. According to Investopedia, VAT is levied on the gross margin at each point in the manufacturing-distribution-sales process of an item. The tax is assessed and collected at each stage.

Understanding what a VAT can, or cannot, do is essential for assessing its rule in the economy formalizing process. Fundamentally, VAT is not simply a tax on final consumption, but it is charged on all sales, domestic and imported goods, by the registered firms. The full credit or
refund of VAT is available to registered tax payers, they were charged for their own purchases. This method is called invoice-credit method and is used in all the countries where VAT is implemented, other than Japan.

So, if the chain of crediting and refunding is unbroken, then the VAT is equivalent of tax on final consumption. However, if the chain is broken, then the trader, who breaks the chain would integrate the VAT it pays, for the purchases made from VAT compliant firms, into its input costs, as they won't be able to claim refunds from the government. The chain maybe broken due to many reasons, one of them are the unregistered traders. The unregistered firms cannot charge VAT on its sales, as their buyers cannot claim refunds from the government, for purchases made from unregistered firms, or unregistered purchases.

Hence, even if the informal sector may be able to evade income taxes, the structural characteristic of VAT ensures that they pay taxes on their inputs. This increase in input costs or the inability to transfer VAT on to its buyers may push the informal firms towards formalization. This is called the “self-enforcement” hypothesis of VAT by (Agha and Haughton, 1996).

However, Pomeranz (2015) states that the VAT mechanism breaks down at the final production stage, as final consumers do not have an incentive to demand a transaction receipt. There is therefore no “self-enforcing” effect for final transactions. She further states that if the mechanism breaks down at the final stage, it can potentially unravel from the bottom, if collusion builds up all the way from the final stage.

De Paula and Scheinkman (2010) find that, since informality is transmitted vertically, the presence of VAT causes the formal firms to trade with other formal firms, because informal firms do not generate tax credits and refunds while the formal firms can provide receipts that allow VAT deduction from input costs. Also, there is no incentive for informal firms to deal with other formal firms, because informal firms would have to pay VAT, while they themselves cannot ask for refunds.

Emran and Stiglitz (2005) and Pomeranz (2015) conclude that VAT is only effective for the formal sector. An over-reliance on VAT, for tax collection, can “increase the inter-sectorial distortions between formal and informal sectors”.

In essence, VAT may be a good tax revenue tool, but it does not necessarily help to reduce informality.
2.4.2. Tax on Cash withdrawal

Greece, India and Pakistan impose withholding tax on cash withdrawals, from bank accounts, to bolster their revenue earnings. However, Pakistan, also, uses tax on cash withdrawal to increase the number of tax return submissions, by individuals and enterprises. It discriminates between tax return filers and non-filers by the rate of tax imposed on the cash withdrawals from bank and banking transactions.

According to the Section 231A of the Income Tax Ordinance, a Cash withdrawal from a bank of 50,000 Pakistani Rupees and more would be liable for withholding tax of 0.3% for income tax filers and 0.6% for non-filers. Similarly, 231AA(1) and 231AA(2) mention banking transactions between accounts or via other banking instruments would have a withholding tax levied upon them. The discrimination between tax return filer and non-filer is maintained at 0.3% and 0.6%. This was introduced to help in better documentation of the economy.

2.4.3. India’s Demonetization

On November 8, 2016, the Indian Government embarked on an ambitious plan to reduce the informality, or emphasis on cash, in the Indian economy. It declared that 500 Indian Rupees and 1000 Indian Rupees would cease to be a legal tender.

The Reserve Bank of India, the Central Bank, announced that these notes can be deposited with any bank and obtain a credit of deposited value in their respective bank accounts. However, for immediate needs, a limit of 4,000 Indian Rupees was imposed for over the counter cash exchange.

The Government did achieve a higher rate of income tax return filing within a year of the demonetization, which subsequently means reduction in informality. The Government claimed, income tax return filing grew by 25 percent, within a year. This claim was wholeheartedly rejected by the Economic Survey 2016-17, conducted by the Finance Ministry. It claimed that the tax payers increased only by 1 percent.

The mobile wallet payers faced a huge surge in demand, the Paytm enjoyed an 106% increase of registered users in just one year. A government backed payment app, Bharat Interface for Money (BHIM), was also introduced to facilitate bank to bank transactions. This all would undoubtedly help increase transparency between transactions.

However, according to Forbes, the economy is still reeling from the effect of the demonetization, due to which the growth in the first quarter of the fiscal year 2017-2018, fell
to 5.7 percent, where as in the same quarter last year, it was 7.1 percent. That makes demonetization a very costly venture to carry out for any economy.

2.4.4. **ILO Recommendation 204**

On 12 June 2015, at its 104th session in Geneva, International Labour Organization adopted the recommendation 204, concerning the transition from informal to formal economy. Perhaps, it is the most comprehensive document of policies to curb informal economy.

The ILO, in this recommendation, initially acknowledges the high incidence of informal economy and its negative impacts. It particularly refers to public policies to speed up the transition towards formalization, specially creating a social dialogue.

The recommendation affirms that the transition towards formal economy will create inclusive development and urges all its members to take appropriate measures, on priority basis, to move labour and economic units towards formalization, or prevent them from informalization. However, the recommendations also warn about preserving and improving the existing livelihoods, income security and entrepreneurship during the transitions.

The Recommendation asks to find a balanced combination of incentives with compliance measure, while strictly preventing and penalizing the voluntary tax evasion or exit from the formal sector, to avoid social and labour laws and regulations.

For legal framework, the Recommendation points towards assessing and identifying nation specific causes and characteristics of informality. It further emphasizes the need to design, review and eventually enforce local laws to facilitate the transition towards formal economy.

The Recommendation 204 also talks about incentive, compliance and enforcement. It draws attention to take appropriate measure to prevent tax evasion, avoidance of social contribution and labour laws and regulations. It recommends eradication of corruption by improving governance, so that barriers towards formalization are removed.

For labour protection, a vigilant inspection system, which extends to all workplaces, is recommended while setting up of efficient and easily accessible complaint and appeal procedures.

The Recommendation heavily emphasizes the following steps to ensure labour formalization:

- create a comprehensive framework to allow low-income households to escape poverty. For example, appropriately designed minimum wages and social protection schemes.
• create public employment programmes and guarantees.

• enhance outreach and delivery of employment towards the informal sector.

• promote labour migration policies, that ensure decent work and protects the rights of migrant workers.

• introduce educations and skills development programs which support life-long learning, so that the labour can respond to the ever-evolving needs of the labour market and new technologies.

• accept the informal apprenticeships systems, this may broaden formal employment opportunities.

• take comprehensive steps to facilitate school-to-work transition of young people.

• allow freedom of association with any organization, federation and confederations of their own choosing.

• allow the workers, and employers, to organize and collectively bargain.

• effectively eliminate forced or compulsory labour.

• completely eradicate child labour.

• allow the workers’ and employers’ organizations to extend their memberships to those in the informal sector.

• include members of workers’ organizations into the policy designing, implementing and evaluating process.

• create relevant and up-to-date labour market information systems.

• introduce measure to promote employment for the unemployed to inactive population.

To formalize micro and small economic units, the recommendations are as follow:

• reduce costs and the length of business registrations.

• simplify taxation to reduce compliance costs.

• provide easy access to public procurements and tenders.

• create an inclusive financial sector, which provide credit and insurance services that are customized to these economic units.

• increase access to entrepreneurship training and skills development.

• improve access to social security coverage.

Eventually, the Recommendation 204 talks about the provision of information and assistance for compliance with laws and regulations, while capacity building of relevant actors, takes
place. However, it also recommends preventive and appropriate corrective measures, so that administrative, civil or penal sanctions for non-compliance are enforced, adequately and strictly. Finally, effective data collection, analysis and dissemination on a regular basis is recommended. This will help monitor and evaluate the progress towards formalization.

2.4.5. Tax Credit for Household Expenses (Finland)

In 1997, Finland implemented a new policy that targeted tax evasion. “Kotitalousvahennys” or “Household Reduction Act (728/1997)” aimed at declaring expenses incurred by a household on hired domestic help. The Tax Office (Vero) website states that the taxpayers are entitled to a tax credit for household expenses if they have household work done in their home or holiday home. Such work includes cleaning, childcare, decorating, renovations, and installation of IT equipment. Currently, the maximum tax credit available to an individual is 2400 Euros, a year. Initially, the Act was only implemented in three provinces, Etelä-Suomen, Oulu and Lapland. From the beginning of 2001, the tax model was expanded throughout the country.

2.4.6. Response to Policy

To conclude the subsection, the works of Ravi Kanbur are stated. Kanbur (2009) theorized the responses, of economic agents, to the regulation for formalization into four categories,

1) Stay within the ambit of the regulation and comply.
2) Stay within the ambit of the regulation but do not comply.
3) Adjust activity to move out of the ambit of the regulation.
4) You are outside the ambit of the regulation in the first place, so there is no need to adjust

He further states that only category 1 is formal, while all the other three categories are informal, where Category 2 is strictly “informal-illegal”. So, Ravi Kanbur (2009 & 2010), alludes to the fact that, the response to reforms for tackling informality are heterogeneous.

He concludes that, the policy makers need to recognize the complexity of the heterogeneity in this complex phenomenon and simplistic single solutions should be shunned, in favour of country specific and tailor-made policies.
3 POLICY CONSIDERATIONS

Despite the comprehensive institutional approach towards reducing informality, the statistics remain worryingly high. The success, or lack of it, of reforms might depend on many significant factors, but this thesis identifies one main reason behind the slow success rate of the reforms.

The existing theory identifies three main agents for the implementation and success of reforms, the state administration, employers (including own-account workers) and employees. Briefly put, the state administration is expected to provide a smooth system for the other two agents, while the other two agents are expected to comply with the state administration, under the ambit of law and regulations.

Perry et al (2007) concluded that, most of the own-account workers are voluntarily informal, i.e. they decide to exit the formal sector of the economy. Whereas, majority of the informal workers are excluded from their desired formal jobs, i.e. they are involuntarily informal, but they want to be part of the formal sector. However, the employers do not provide their workers the opportunity to become the part of the formal sector.

The employers would always have an incentive, private benefit, to not comply with the state administration. They do so, by concealing their revenue information. The social benefit when, the employers reveal their true information would be always be higher, as compared to employers concealing their information. However, when an individual has a trade-off between social benefit and a private benefit, an individual, person or organization, would always choose the private benefit.

All the reforms have always tried to target the employers by providing them with the incentives to reveal their information, for tax purposes. However, unless the incentives provided do not offset the private costs that the businesses would have to incur, when revealing their information, the businesses would always voluntarily conceal their information.

The state administration, on the other hand cannot provide private benefits greater than the private costs, because it would mean ever increasing fiscal deficit. This conundrum would always have a negative effect on any reforms that they implement to curb informality.

The reforms, until now, have overlooked the second party in a transaction, the consumer. The consumers don’t have an incentive to conceal their spending information. So, if the state administration incentivizes the consumers to reveal their spending information, as the consumers’ spending information is equal to the businesses’ revenue information, the state
administration would then have the required information to implement its regulations and laws regarding the businesses.

While there are many variations to incentives that a government can provide to the consumers, for revealing their spending information. For simplicity, this thesis only analyses the incentives as gross reimbursements to consumers. The reimbursements would be a percentage of the gross amount of spending that the consumer reveals.

The mechanism for revealing consumer spending information would be to use electronic/digital payments, e.g. credit, debit cards and mobile applications for payments etc, instead of cash, for their purchases. The electronic payments are easier and cheaper for the state administration to audit as compared to cash-based transactions. Hence, the government would provide a reimbursement on the gross amount spent through electronic payments, i.e. transfer from their consumer accounts to other business accounts.

Such a reform effectively offers discounts on consumers’ purchases. It must be emphasized that the reimbursements and discounts must only be offered for transactions from a consumer account to a business account, only. The business to business transactions should not be subjected to reimbursements at all.

Once the consumers have revealed their spending information, the revenue details for the business in question, e.g. a retailer, would be revealed. Hence, it incentivizes the retailer to reveal the information of his costs incurred, i.e. purchases from their suppliers. This would create a vertical chain all the way to the producer, the same as VAT was intended for. The difference between VAT and this policy is, that when the chain is broken under the VAT regime the government taxes are negatively affected, whereas according to this policy, the discontinuation of chain effect will only mean higher taxes for the businesses the revenue information of which is revealed.

The policy proposed in the thesis, could be viewed as an extension of the “Finnish Household Reduction Act”. Whereas, the “Finnish Household Reduction Act” only offers reimbursements to tax payers for hired domestic work, the thesis expands the policy to every individual, irrespective of their employment status and types of expenses.

Secondly, referring to the statistics, the 61.2 percent of global employment that is informal comprises of 51.9 percent in the informal sector, 6.7 percent in the formal sector and 2.5 percent in households. If the state administration gets the revenue information from businesses, most employees working in the informal sector would be formalized, as the
businesses would have the incentive to reveal their cost information with regards to their employees, if their revenue information is revealed.

A deeper look into the statistics provided by World Bank’s Findex database reveals that throughout the world, only 0.28 percent of adults reported to have received payments, from self-employment, into an account during the preceding year, while not sending or receiving any other digital payment. Global Findex survey (2017), for the first-time asked respondents about receiving payments from self-employment, includes part-time work, in the previous year. These respondents neither received wages or agricultural payments digitally.

Around 8 percent of adults in the high income and developing countries, reported to receiving the payments from self-employment. However, only two-thirds of recipients reported to receiving such payments into their accounts, for the high-income countries. For the developing countries, only 25 percent received the payments into their accounts. Successful implementation of the policy would mean exponential increase in the payments being made into the accounts, hence making it easy for the state to audit and tax the income.

The increase in digital payments, would also help decrease the informality caused due to “Exclusion” or involuntary informality, due to difficulties in reporting. As, reporting for businesses now would be much easier as most of their revenues and expenses would be digitized.

Next, the existing literature on elasticity of consumer payment choices to a price discount is reviewed, to determine if the consumers would be willing to change their payment mediums, to enjoy the discounts.
3.1. Consumer’s Price Elasticity of Demand for Payment Choices

The economic model proposed, aims to change consumer payment methods by, effectively, offering a price discount to the consumers on the retail prices. For the model to be successful, the price discounts must be an effective measure to deviate the consumers from paying cash, or its preferred payment method, towards plastic money.

Many credit/debit card companies offer different incentives to encourage the use of cards. Some of the rewards offered, on Debit and credit card payments, are airline miles, cash back discounts and gift vouchers etc. Carten, Littman, Schuh and Stavin (2006) state that Tony Hayes, an industry expert, gave an average value of rewards to be 1% of the purchase value, for credit cards and 0.25% of the purchase value for Debit cards.

If these loyalty program rewards are an effective tool to alter the consumer payment choice, then the proposed model can successfully shift the consumers towards plastic money payments, as well.

There is a growing list of literature available, on the price elasticity of consumer payment choice. Ching and Hayashi (2010) estimate the effects of rewards on consumer choice of payment methods. The data used for the study contains detailed information about consumer payment choice and consumers’ attitudes toward each payment method. After controlling for consumer heterogeneity, Ching and Hayashi (2010) find statistically significant effects of rewards. Their method suggests that for the sub-population holding both credit and debit cards, removing card payment rewards would increase their share of cash transactions, by no more than 4 percentage points.

Agarwal, Chakravorti, and Lunn (2010) use a credit card transaction dataset from a large and diverse U.S. financial institution. They study the impact of 1 percent cash-back reward on individuals. They find that cardholders who do not use their card prior to the cash-back reward increase their spending, and debt, more than cardholders with debt prior to the cash-back program. The cash-back reward provides enough incentives to 11 percent of inactive cardholders to use their cards.

Using the transaction-level data, obtained from a survey of how consumers pay for goods and services, commissioned by the Reserve Bank of Australia in 2007 as part of its 2007/08 review of payments system reforms, Simon, Smith, and West (2010) calculate the effect of loyalty programs and access to interest free period on consumer payment
choice. They find that the deviation towards credit card from debit card or cash depends on the level of price incentives, or discounts. The interest-free periods induce substitution between the plastic money, however loyalty program rewards cause a movement away from cash usage. They calculate that loyalty programs increase the probability of credit card use by 23 percentage points and reduce the probability of cash use by 14 percentage points.

Arango, Huynh and Sabetti (2011) find that credit card usage increases as the credit card rewards increase, among other factors. The literature supports the idea that, financial incentives can generate significant shifts in consumer payment methods.

However, if the retailers decide to impose an additional fee for card payment, to compensate themselves for extra taxes due to an increase in the disclosed information, then the model proposed would be less effective or even redundant, conditional on additional fees deterring the consumers from using plastic money.

As it turns out, the retailers often have differentiated prices for transactions involving plastic money and hard cash. The reason being the merchant processing fees, the card issuing institution charges from the vendor. The vendor charges an additional surcharge for card transactions by shifting the, part or complete, burden of transaction to the customer. As the card issuing institution’s rules are sometimes difficult to follow, the merchants usually offer discounts on paying cash. A very strong example is the gas stations offering price discounts on cash in the US.

Effecting consumer payment method by offering differentiated prices is known as “merchant steering”. If merchant steering turns out to be a powerful tool, the merchants would use it to deter the consumers from using plastic money, to avoid additional taxes.

Stavins and Wu (2017) investigate the effects of discounts on consumer payment choice using the data from 2015 Diary Consumer of Consumer Payment Choice. They conclude that for a consumer preferring non-cash payment method there is an 11.7 percent probability of changing to cash, if cash discount existed. They further state that the choice of payment method is dependent upon individual preferences, but merchant may be able to steer the consumers, under special circumstances.

Bolt, Wilko, Jonker, and Renselaar (2010) found that in the Netherlands debit card surcharges caused some consumers to use cash rather than a debit card hence decreasing debit card payments as a share of total payments by 8 percent.
A consumer survey conducted by Reserve Bank of Australia (2011), found that around half of consumers who have a credit card would seek to avoid paying a surcharge by either using a different payment method that does not attract a surcharge (e.g., cash and debit cards) or going to another store.

The above literature indicates that “merchant steering” can influence consumer payment methods as well. This would result in two parallel retail prices in an economy, one for hard money and another one for plastic money, rendering our model less effective, or even redundant.

It must be noted that since the primary problem we are trying to tackle is the informal economy, so legislating against, and subsequently regulating against merchant steering would not be an effective measure. A further investigation into the model recommended would clear the picture in a better way.
4 THEORETICAL MODEL

This section builds a theoretical model detailing the policy presented in the previous section. The buyer’s and seller’s decisions, in accordance with the policy, are analysed in detail. However, before examining the buyer’s and seller’s decisions in detail, the seller’s response to the policy should be extrapolated.

The response to the policy by sellers can be of 3 types:

1) Offer electronic payment facilities to their customers, without any premium i.e. charge same price for cash and electronic transactions. This would mean full compliance with tax laws and authorities.

2) Only accept Cash transactions. This would mean they would evade taxes.

3) Accept Cash and electronic payments but charge a premium for electronic payments or provide discounts on cash payments. They partially comply with taxes authorities.

The buyer response to each of the strategies above would be analysed later in the section. However, a rational consumer is always looking to maximise utility from every purchase. The recommended policy offers the customer a chance to increase its utility by opting for electronic payments. The model integrates the proposed policy into the consumer utility theory and discusses different implications, of the policy, for the consumer. After that, the model explains the implications of the policy to the sellers. Then the interaction of the buyer and the seller is analysed by using game theory.

4.1 Notations

This section uses mathematical equations to analyse the model. Below is the list of variables, and their meanings, that the equations contain.

V: monetary worth of a purchase to the consumer

P: market price of the purchase

X: percentage of electronically paid amount reimbursed by the government

C: search costs incurred by a consumer for finding a seller, $C \sim U(0, \overline{c})$

Y: premium charged by the reluctant retailers, to pay electronically
Q: Ratio of firms offering electronic payments without charge, $0 < Q < 1$. It is also the probability of a consumer finding electronic payment facilities, when randomly searching for a seller.

T: Tax rate

### 4.1.1. Search Costs

The search costs faced by a consumer can be categorized into two types, external and internal. According to Investopedia, External costs are the monetary costs of obtaining the information as well as the opportunity cost of the time required for searching. External costs can not be controlled by the consumer. However, the decision to incur the costs is dependent upon the consumer. Internal costs include the mental effort spent in undertaking the search, this includes sorting new information and applying it according to the existing knowledge. Internal costs are determined by the consumer's ability to undertake the search. The ability to undertake search depends on intelligence, prior knowledge, education and training.

In this model, the search costs faced by a single buyer is a random variable, because the search costs faced by any consumer would depend on different factors, such as consumer’s location, mode of transportation, opportunity costs and intelligence and education etc. All these factors vary from person to person, so random variable is the most suited nature of search costs in the model.

### 4.2. Assumptions

Before continuing with the model, some assumptions undertaken in the model are presented below:

1) Sellers are price takers, hence they sell homogeneous products. The sellers can charge a premium for using e-payments but cannot change the price of the products.

2) The only taxable income is the one received in the seller’s bank account, all the income received in the bank account is taxed. Cash transactions are not auditable, hence not taxed, at all. In other words, the cash transactions are not detectible by the government.

3) The only cost to sellers is the tax they pay. All other costs are zero.

4) A consumer buys at most one unit of good or service, per visit.
5) The consumers only differentiate the sellers with the mode of payment they offer.

6) The consumers do not know about the type of seller it is visiting, until it reaches the point of sale (POS) to complete the purchase.

7) The individual consumer’s cost is not visible to the seller, and the buyer conceals it. The seller only knows the range of costs a consumer can face.

8) The seller only gets to offer payment facility method only once. The consumer can either Accept or opt to search.

9) Utility from using card or cash, for consumer, only differs due to the reimbursements offered by the government. Other factors, such as use of safe mode of payment, do not affect the utility of using either cash or card.

10) There are no negative search costs, or no “shoppers” in the set of consumers.

11) The values attributed to the notations are public knowledge, other than the consumer’s search costs (C).

### 4.3. The Buyer’s Decisions

This subsection examines the buyer’s decision according to proposed policy. The consumer’s utility, from a certain seller, depends on the type of payment method it uses.

The consumer’s utility from paying cash is

\[ U(\text{Cash}) = V - P. \]

The consumer’s utility from paying with card is

\[ U(\text{Card}) = V - P(1-X), \]

where

\[ V - P(1-X) > V - P, \text{ for } X>0. \]

Hence, the rational consumer always tries to make electronic payments, as it maximizes the utility. However, when the consumer is not sure about the type of seller it will visit, the consumer’s utility is based on expected utility theory (EUT).

This consumer’s expected utility in this model is

\[ E[U] = \text{Probability of finding cash facility}\times\text{Utility from paying with cash} + \text{Probability of finding card facility}\times\text{Utility from paying with card}, \]
which can be written as

\[ E[U] = (1 - Q)(V - P) + Q(V - P(1 - X)), \]

which can be simplified to

\[ E[U] = V - P + XQP. \]

Note, that the \( E[U] \) increases as the ratio of firms accepting e-payments increases.

Expected utility from searching after visiting a seller is

\[ EU(S): (1 - Q)(V - P) + Q(V - P(1 - X)) - C, \]

which can be simplified to

\[ V - P + XQP - C. \]

### 4.4. The Seller’s Decisions

This section analyses the seller’s decision according to the proposed policy. The seller’s profit from a single customer, depends on the type of transaction method used.

The seller's profit from a cash transaction is

\[ \Pi (\text{Cash}) = P. \]

The seller's profit from a card transaction is

\[ \Pi (\text{Card}) = P(1 - T), \]

where

\[ P > P(1 - T), \text{ for } T > 0. \]

A rational seller, under assumption(2) always wants to choose cash transactions, as it maximizes the seller's profits. As stated in assumptions(3), there are no input costs faced by the seller. Hence the profits, in case of cash transactions are equal to the price of the product, whereas in case of card transaction, the profits are price received minus the tax paid.
4.5. The Game

A game is defined by three elements, players, player’s payoffs and strategies to be used by the players. There are two players in this model, a buyer and a seller. A buyer’s payoff is the utility, that it receives from the different mode of payments or expected utility from searching for a different seller. The seller’s payoffs are the profits it earns from different mode of payments, or zero if the buyer decides to search for a different seller.

The buyers’ set of strategies consists of two actions, they can either “Accept” the mode of payment available to them or reject the mode of payment available and opt to “Search” for a new seller. The sellers’ strategy set consists of two actions as well. The seller can offer “Cash” payments or “Card” payments. This corresponds to the first two responses of a seller, mentioned at the start of the section. The third response of the seller is discussed later.

As the buyer and the seller interaction begins by the consumer visiting a seller and trying to purchase a single product. If the consumer pays by cash the seller earns $\Pi(\text{Cash})$ whereas the buyer’s utility is $U(\text{Cash})$. The same goes for a card transaction. If the buyer and seller do not agree on a payment mode, the buyer leaves and searches for a new seller, incurring costs “c”.

Prior to implementing the policy, where there is no reimbursement offered for using e-payments, the strategic form of game with the stated assumptions is:

<table>
<thead>
<tr>
<th>Seller</th>
<th>Buyer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card</td>
<td>Accept</td>
</tr>
<tr>
<td></td>
<td>$P(1-T)$</td>
</tr>
<tr>
<td></td>
<td>$V - P$</td>
</tr>
<tr>
<td>Cash</td>
<td>$P$</td>
</tr>
<tr>
<td></td>
<td>$V - P$</td>
</tr>
</tbody>
</table>

*The entries in each cell are a payoff to seller (upper expression) and to buyer (lower expression)*

The two rows resemble to the two different strategies, Card or Cash transactions, available to a seller. The two columns correspond to the set of strategies available to the
buyer, Accept and Search. The entries in the tables show the payoffs, the profits for the seller (the upper expression in each cell of the table) and utility of the buyer (the lower expression in each cell). If seller offers card payment facilities and the buyer accepts (the upper left cell), then the seller makes a profit associated with card payments, i.e. $P(1-T)$ and the buyer’s payoff is $V-P$. If the seller offers cash only payment facilities (bottom left cell), then the seller’s profit is $P$, as no tax is collected, whereas the buyer’s utility is the same as with card payments, $V-P$. For the cells in the upper right and lower right, the buyer has decided to reject the payment mode and opts to search for a new seller. The payoff for the seller is zero, since it doesn’t make a sale, and the buyer’s payoff is the utility it receives from buying minus the search costs.

Given the payoff structure, “Accept” is a dominant strategy for a buyer. A strategy is a dominant strategy for a player if it is optimal, no matter what strategy is used by the other players. As, is the case with the buyer in the above payoff structure, no matter what strategy is employed by the seller, the buyer’s best response is to “Accept”. A player’s best response is the strategy, or set of strategies, that maximizes the player’s payoff, given the strategies of the other players. Given that “Accept” is the dominant strategy for a buyer, the seller’s best response to “Accept” is to employ cash only strategy, as $\Pi(\text{Cash}) > \Pi(\text{Card})$, if the tax rate is positive.

The strategy profile $\{\text{Cash, Accept}\}$ is a unique Nash Equilibrium of this game. The players are in a Nash Equilibrium if the strategy of each player is the best response to the strategies of the other firms. Equivalently, in a Nash equilibrium, none of the players have any incentive to unilaterally deviate from its strategy.

The buyer is enjoying highest utility with Accept, while the seller is earning the highest profits with Cash, hence both don’t have an incentive to deviate. However, this equilibrium is not optimal for the government, as it collects no taxes.
If, the government offers reimbursements to the buyer for using cards as a mode of transaction, 0 < X, then the game in a strategic form is:

**Table 2** The game matrix, after policy implementation

<table>
<thead>
<tr>
<th></th>
<th>Buyer</th>
<th>Seller</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Card</strong></td>
<td>Accept</td>
<td>Search</td>
</tr>
<tr>
<td><strong>Buyer</strong></td>
<td>$P(t-T)$</td>
<td>0</td>
</tr>
<tr>
<td><strong>Seller</strong></td>
<td>$V - P(t-X)$</td>
<td>$V - P + XQP - C$</td>
</tr>
<tr>
<td><strong>Cash</strong></td>
<td>$P$</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$V - P$</td>
<td>$V - P + XQP - C$</td>
</tr>
</tbody>
</table>

*The entries in each cell are a payoff to seller(upper expression) and to buyer(lower expression)*

As before, the rows represent the set of strategies for a seller and the columns represent the set of strategies for the buyer. The payoff expressions for seller are unchanged, however, the payoff expressions for the buyer have changed.

The seller’s best response to buyer accepting is Cash, as P > P(1-T). The same as before the introduction of reimbursements. However, the buyer’s best responses are now dependent upon different variables.

For a rational expected utility maximiser, the option yielding the highest utility is always the best response to any strategy of the opposing player. The probability that a rational consumer will search, given the strategy of the seller, is a step function,

$$\Pr(\text{Search}) = \begin{cases} 
1 & \text{if } EU(S) > U(B) \\
0 & \text{if } EU(S) < U(B) 
\end{cases}.$$

In the equation above, EU(S) is the consumer’s expected utility from searching, whereas U(B) is the utility that a consumer attains if it buys from the seller, it is physically present.

The buyer’s best response to seller offering card transactions is Accept, if

$$V - P(1-X) > V - P + XQP - C,$$

which can be simplified to

$$XP > XQP - C, \text{ if } Q<1 \text{ or } C>0.$$
The buyer accepts card payments, with \( \text{Prob}(\text{Search}) = 1 \), if the ratio of formal firms is below 1, i.e. informality exists, or the search costs are positive. Given the parameters of \( Q \) i.e. \( 0 < Q < 1 \), the consumer’s best response to card payments is to accept.

The buyer’s best response to seller offering cash transactions is Accept, if

\[
V - P > V - P + XQP - C,
\]

which can be simplified to

\[
C > C^* = XQP. \tag{1}
\]

Since \( C \sim U(0, c) \), then \( C^* \) gives a threshold for search costs. Buyers with search costs below \( C^* \) would search for a different seller, if the current seller chooses cash transactions, as lower search cost means higher EU[S]. In other words, for buyers with search costs below \( C^* \), the best response to Cash is Search. For buyers with search costs above \( C^* \) the best response to Cash is Accept.

From equation (1) it can be deduced that

\[
U(\text{Cash}) > \text{EU}[S | C > XQP], \tag{2}
\]

\[
U(\text{Cash}) \leq \text{EU}[S | C \leq XQP], \tag{3}
\]

where \( \text{EU}[S | C > XQP] \) is the expected utility from searching, given that the cost of searching is greater than \( XQP \). As \( C \sim U(0, c) \), the probability that the cost of the consumer is below \( C^* \) is the cumulative distribution function (CDF) of a uniform distribution between 0 and \( c \).

The CDF for search costs of consumers is

\[
\Pr(C \leq C^*) = \begin{cases} 
0 & C^* < 0 \\
\frac{C^*}{c} & 0 \leq C^* \leq c \\
1 & c \leq C^*.
\end{cases}
\]

Also, the probability that the random consumer’s search cost is greater than \( C^* \) is

\[
\Pr(C > C^*) = 1 - \Pr(C \leq C^*)
\]

As defined by (1) that \( C > C^* = XQP \) should hold, for the consumer to accept cash payment facilities. So, if \( C^* = XQP = 0 \), then \( \Pr(C > C^*) = 1 \). This means that the consumer would
always have $U(Cash) > EU[S]$. Now, Accept is the buyer’s dominant strategy, which makes the unique Nash Equilibrium at {Cash, Accept}.

This is the same equilibrium that was reached, when $X=0$ and it is consistent with the value of $XQP=0$. For the product of $X$, $Q$ and $P$ to be zero, at least one of them must be zero. This makes intuitive sense as well. If there are no reimbursements offered, no firms offering electronic payment facilities or products are given for free then the buyer can never have higher utility from searching than buying from the current seller.

For $c ≤ C^*=XQP$, then $Pr(C > C^*)= 0$. The maximum cost of searching any consumer can incur is $c$, but if $XQP ≥ c$ then none of the consumer’s cost will be greater than threshold required for $U(Cash) > EU[S]$. Now, the buyer’s best response to seller’s Cash strategy is Search.

Expressing the game with an illustrating example for the notations would help analyse the game in a better way. Consider, $V=1.2$, $P=1$, $T = 0.3$, $X=0.25$, $Q=0.5$ and $c=0.1$. The game theory matrix now looks like,

<table>
<thead>
<tr>
<th></th>
<th>Card</th>
<th>Seller</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cash</strong></td>
<td>$P(1-T) = 0.7$</td>
<td>$V - P(1-X) = 0.45$</td>
</tr>
<tr>
<td></td>
<td>$V - P = 0.2$</td>
<td></td>
</tr>
<tr>
<td><strong>Accept</strong></td>
<td>0</td>
<td>$V - P + XQP - C = \sim U[0.225,0.325]$</td>
</tr>
<tr>
<td><strong>Search</strong></td>
<td>0</td>
<td>$V - P + XQP - C = \sim U[0.225,0.325]$</td>
</tr>
</tbody>
</table>

*The entries in each sell are a payoff to seller(upper expression) and to buyer(lower expression)*

In the above game matrix, $EU[S]$ is expressed as a random variable uniformly distributed between 0.225 and 0.325, because the search cost is a uniformly distributed random variable. For further analysis, it is assumed that the buyer’s $EU[S]$ is minimum, i.e. 0.225.

The buyer’s best response to the seller’s Card strategy is Accept, however if the buyer opts for Accept, the seller’s best response is Cash. So, the strategy set {Card, Accept} is not the Nash Equilibrium, as the seller has an incentive to move given the strategy of the buyer.
For the seller’s strategy Cash, the buyer’s best response is Search, as payoff from Search, 0.225, in this instance is higher than that of Accept, 0.2. So, the strategy set {Cash, Accept} is also not the Nash Equilibrium.

The Unique Nash Equilibrium in pure strategy in this instance is the strategy set {Cash, Search}, as now neither the buyer nor the seller has an incentive to deviate, given the strategy of the other.

However, this is not the optimal strategy nor the outcome that the implementation of the policy hopes for. The optimal outcome of the policy seems to be the strategy set {Card, Accept}. The buyer and seller both seem to be better off than the Nash Equilibrium.

One key issue to consider at this stage is that the above game, is a representation of a simultaneous game. In a simultaneous game both players choose a strategy without the knowledge of the strategy chosen by the other player. However, the best representation of the seller-buyer game, for this model, is a sequential game, because in a sequential game, one player chooses its strategy before the other. In other words, there is a first mover and a second mover.

For the buyer-seller with respect to payment method, it doesn’t matter who moves first. It has already been established if the buyer is given the first move, a rational buyer will always opt to use card. It depends on the seller’s response to the buyer’s payment method from where the game begins. So, in this sequential game the seller is the first mover and the buyer as the responder, or the second mover.

The best representation of the sequential game is the extensive form. The extensive-form representation of the game theory describes the game as a game tree.
The extensive-form game, with the same parameter combinations as above is:

**Figure 1  The extensive-form game**

Each branch represents the strategy of the player it extends from. The strategy is labelled on the branches as well. For example, the branch extending from the seller labelled as card, depicts the seller’s strategy Card. After the seller has made the decision of card, the buyer can decide its strategy, Accept or Search. If the buyer chooses Accept, then the payoff is 0.7 for seller and 0.45 for the buyer.

For a sequential game, the Nash equilibrium is analysed in a refined form. In a sequential game a subgame perfect equilibrium or subgame perfect Nash equilibrium represents a chosen strategy set for each subgame, such that the chosen strategy set is a Nash equilibrium of the subgame. A Subgame is any smaller subset of the larger game.

Backward induction is the most common method used to determine the subgame perfect equilibrium. For a backward induction at first, the last actions of the game are considered. This determines the strategies that the final mover should take in each possible circumstance to maximize its payoffs.

There are three subgames in the model, with two proper subgames, and the last mover is the buyer. The buyer will take the following action for each subgame:

1) For subgame starting after Card, the buyer will choose Accept with the payoff of 0.45, as it exceeds the payoff from search.

2) For the subgame starting after Cash, the buyer will choose Search, with the payoff of 0.225.
The seller now knows that if it opts for strategy Cash, the buyer will opt for Search, hence the seller’s payoff from Cash is 0. The pay-off from Card is 0.7 as the buyer will always choose Accept. The extensive-form representation now looks like,

**Figure 2  The extensive-form game, with eliminated actions**

The payoffs are represented at the end of each branch. The first payoff is for the seller whereas, the second one represents the buyer.

The red branches would not be chosen by the buyer, hence the payoff at the end of them are struck-out. The seller’s pay off now is maximized by choosing Card. Hence, the Subgame perfect equilibrium is the strategy set \{Card, Accept\} with the payoffs \{0.7,0.45\}.

This is the precise outcome that the government would hope for. The seller’s offering card payment facilities without hard audits or extreme supervision, while the consumers accept the payment methods. The government’s surplus from just this trade is

\[
\text{Gov’t Surplus}=T-X, \\
= 0.3 - 0.25, \\
=0.05.
\]

Now, considering the case when \(0 < C^*=XQP < \bar{c}\). Recall that, if the consumer’s cost(C) of searching is greater than XPQ, then the customer accepts cash transaction. However, if the cost(C) is less than XPQ, then the consumer searches for the next seller. So, there are two types of consumer’s that the seller can face,

Consumer’s with \(C \leq XQP\),
Consumer’s with \( C > XQP \).

The seller cannot observe the type of consumer. This means that the seller has imperfect information. The seller can however assign probabilities to type of consumer. The probabilities are,

\[
\Pr(C \leq XQP) = \frac{XQP}{\bar{c}},
\]

\[
\Pr(C > XQP) = 1 - \frac{XQP}{\bar{c}}.
\]

The games with incomplete information, are called Bayesian Games. The notion of associating types with players was introduced by the Nobel Prize winner John Harsanyi. In a Harsanyi’s model, in addition to players, payoffs and strategies, the players consider their beliefs about the types of other players. The probabilities on other player’s type is associated by the beliefs, that a player holds, about the type of other players.

In this model, the seller’s beliefs about the type of buyer would depend on the value of \( \bar{c} \). As the values of \( X, Q \) and \( P \), are public information, but the range of costs that a consumer faces would depend on the seller’s beliefs about the search costs that could occur in the seller’s premises’ vicinity. For example, if the seller operates in a busy market place or on the internet, then the seller’s beliefs about the value of \( \bar{c} \), would be very low.

Similarly, when \( \bar{c} < XPQ \) was considered, in the previous game, it was the seller’s belief that the maximum cost of searching that a buyer can incur is below threshold of cost required for searching. The lower the seller’s belief of \( \bar{c} \), the higher the probability it assigns to consumer incurring search costs if offered cash only payment facilities.
The extensive-form representation of the Bayesian Game is:

Figure 3 The extensive-form Bayesian game, the Harsanyi’s model

The payoffs are represented at the end of each branch. The first payoff is for the seller whereas, the second one represents the buyer.

The extensive-form representation starts with the “buyer type” and the branches extending from that node, represent the probability of consumer types. The rest of the branches show the same sequential game where the seller makes the first move and the buyer responds.

It has already been established that strategy combination \{Card, Search\} is strictly dominated by \{Card, Accept\}. So \{Card, Search\} can be crossed off from the analysis for both types of buyers.

Recall equations (2) and (3). The strategy sets \{1 - \frac{X_Q P}{c}, Cash, Search\} and \{\frac{X_Q P}{c}, Cash, Accept\} can be eliminated from the analysis, as well.
The extensive-form representation now is:

**Figure 4** The extensive-form Bayesian game, the Harsanyi’s model with eliminated actions

The payoffs are represented at the end of each branch. The first payoff is for the seller whereas, the second one represents the buyer.

In figure 4, the strategies, that will not be chosen by the buyer are coloured red, and the payoffs have been struck-out.

For a Bayesian game, the Nash equilibrium is called Bayesian Nash Equilibrium. Bayesian Nash Equilibrium is a straightforward extension of the Nash equilibrium, where a player chooses a strategy that maximizes expected payoff given the actions of all types of other players and the player’s beliefs about others’ types. In a sequential game, the equilibrium is called Perfect Bayesian Equilibrium.

For the seller in the model, the ex-post expected profit from strategy Cash is,

\[
\Pr(C \leq XQP)*0 + \Pr(C > XQP)*P.
\]

Inserting the expressions for the CDF, the equation becomes

\[
\left(\frac{XQP}{c}\right)*0 + \left(1 - \frac{XQP}{c}\right)*P,
\]
which can be simplified to

\[(1 - \frac{XQP}{c}) \cdot P.\]

The seller’s ex-post profit from strategy Card is

\[\Pr(C \leq XQP) \cdot P(1-T) + \Pr(C > XQP) \cdot P(1-T).\]

Inserting the expressions for CDF, the equation becomes

\[(\frac{XQP}{c}) \cdot P(1-T) + (1 - \frac{XQP}{c}) \cdot P(1-T),\]

which can be simplified to

\[P(1-T).\]

The seller’s ex-post profit from strategy Cash > Card, if

\[(1 - \frac{XQP}{c}) \cdot P > P(1-T),\]

which can be simplified to

\[T > \frac{XQP}{c}.\]

So, if the Tax rate is higher than the \(\Pr(C \leq XQP)\), then the seller always chooses the strategy Cash. There are two Perfect Bayesian Equilibrium in this case,

\[\{\text{Cash, Accept}\} \text{ when } C > \frac{XQP}{c},\]

\[\{\text{Cash, Search}\} \text{ when } C < \frac{XQP}{c}.\]

If the Tax rate is lower than the \(\Pr(C \leq XQP)\), then the seller always chooses the strategy Card. There is only one Perfect Bayesian Equilibrium in this case,

\[\{\text{Card, Accept}\}\]

This shows that the government will have to choose the values of Tax rate(T) and the reimbursement rate(X), in such a way that the equality \(T \leq \frac{XQP}{c}\) holds most of the time. Q and \(\bar{c}\) can be calculated through surveys. It is highly possible that Q and \(\bar{c}\) will vary from
area to area and region to region. Hence to maximize the effect of the policy, a higher reimbursement rate for the regions with higher search costs and informality should be implemented.

It must be pointed out that for the government to earn a surplus from to policy $T > X$ should hold. Meaning that $QP > \bar{c}$, should hold.

Considering the same values for the parameters as defined before, i.e., $V=1.2$, $P=1$, $T=0.3$, $X=0.25$ and $\bar{c}=0.1$. However, consider that ratio of formal firms has fallen that $Q=0.15$

The seller’s ex-post expected profit from strategy Cash is

$$\left(1 - \frac{XQP}{\bar{c}}\right)P.$$  

Inserting the values of variables, the equation becomes

$$\left(1 - \frac{0.25\times0.15\times1}{0.1}\right)\times1 = 0.625$$

The seller’s ex-post expected profit from strategy Card is

$$P(1-T).$$

Inserting the values of variables, the equation becomes

$$1(1-0.3) = 0.7.$$ 

This also means that

$$T < \frac{XQP}{\bar{c}},$$

as

$$0.3 < 0.375$$

Hence, a rational seller, given his beliefs about the search costs, $\bar{c}=0.1$, of the consumer will always offer Card payment facilities.
4.5.1. **Premium on Card Payments**

This subsection considers the case of a seller charging a premium on card payments. This would mean that the producer would charge a different price for accepting card payments, to compensate for the taxes it would have to pay for offering card payments.

Before considering the case of premium payments with card, the range of prices that the seller can charge is determined. Consider that the seller charges price, $\bar{P}$. The minimum value of $\bar{P}$ is $P$, as selling for price lower than $P$ would mean unnecessarily decreasing revenue and profits.

However, for $\bar{P}$ to be credible, the maximum value of $\bar{P}$ should not cause the buyer’s utility from using card to fall below the utility from cash, else the buyer would be better off opting for cash and the games described before would come into play.

So, for $\bar{P}$ to be credible, $U(\text{Card with } \bar{P}) > U(\text{Cash})$. By inserting the values in the equation, the equality now becomes

$$V - \bar{P} + XP > V - P,$$

which can be simplified to

$$\bar{P} < \frac{P}{1 - X}.$$ 

The maximum and minimum values for $\bar{P}$ are

$$P < \bar{P} < \frac{P}{1 - X}.$$ 

The buyer’s response to being offered Card with premium prices, is to analyse if it’s $EU[S] > U(\text{Card with } \bar{P})$. By analysing this inequality, the buyer can find the search costs ranges. By inserting the values into the inequality, the equation now becomes

$$V - P - XQP - C > V - P + X\bar{P},$$

which can be simplified to

$$C < \bar{P} - P + X(QP - \bar{P}) = c^{**}.$$
The probability of searching is, when offered Card with $\bar{p}$, is

$$\frac{c^{**}}{c}$$

The seller’s ex-post profit from strategy Card with $\bar{p}$, is $\Pi(\text{Card with } \bar{p}) \times \text{Probability of Accepting}$. By inserting the variables, it becomes

$$\bar{p}(1 - T)(1 - \frac{c^{**}}{c}).$$

The seller’s ex-post profit from strategy Card with $\bar{p} > \text{Card}$, if

$$\bar{p}(1 - T)(1 - \frac{c^{**}}{c}) > P(1 - T),$$

which can be simplified to

$$(1 - \frac{c^{**}}{c}) > \frac{P}{\bar{p}} \quad (4)$$

So, if the probability of accepting is greater than the ratio $P : \bar{p}$, the seller will have a higher profit for offering Card with $\bar{p}$ then Card.

Now analysing the maximum possible parameter for $\bar{p}$. Substituting $\bar{p} = \frac{p}{1 - X}$ in the equation (4), the equation becomes

$$(1 - \frac{c^{**}}{c}) > \frac{P}{\bar{p}} (1 - X).$$

Substituting parameters of $c^{**} = \bar{p} - P + X(QP - \bar{p})$ in the equation

$$(1 - \frac{\frac{p}{1 - X} - P + X(QP - \frac{p}{1 - X})}{\bar{p}}) > 1 - X,$$

which can be simplified to

$$Q\frac{p}{c} < 1$$

So, for $\Pi(\text{Card with } \bar{p}) > \Pi(\text{Card})$, when the seller charges the maximum possible premium, $\frac{Qp}{c} < 1$ should always hold.
Considering the values for the parameters as, i.e., \(V=1.2, P=1, T = 0.3, X=0.25, Q=0.15\) and \(\bar{c}=0.1\). The range of \(P\) is, \(P < \bar{P} < \frac{p}{1-X}\). Inserting the values of parameters, the range is

\[1 < \bar{P} < 1.333\]

And for \(\Pi(\text{Card with } \bar{P}) > \Pi(\text{Card})\). The equation with values assigned to parameters becomes

\[
(1 - \bar{P} + \frac{0.15+1-\bar{P}}{0.1}) > \bar{P},
\]

which can be simplified to

\[\bar{P} < 1.315\]

So, for the range, \(1.315 < \bar{P} < 1.333\), \(\Pi(\text{Card with } \bar{P}) < \Pi(\text{Card})\).

For \(\bar{P} < 1.315\), there are two Perfect Bayesian Equilibrium in this case,

\[
\{\text{Card with } \bar{P}, \text{ Accept}\} \text{ when } C > \frac{c^{**}}{\bar{c}},
\]

\[
\{\text{Card with } \bar{P}, \text{ Search}\} \text{ when } C < \frac{c^{**}}{\bar{c}}.
\]

The equilibrium \{Card with \(\bar{P}\), Accept\} is the equilibrium that the government would hope for, as this means that the seller would be paying taxes. The buyer will have a different perspective on this.

For sellers deciding with the strategy set \{Card with \(\bar{P}\), Cash\}, the ex-post profit from strategy Card with \(\bar{P} > \text{Cash}\), if \(\Pi(\text{Card with } \bar{P}) \times \text{Probability of Accepting Card with } \bar{P} > \Pi(\text{Cash}) \times \text{Probability of Accepting Cash}\). The inequality with variables inserted in it becomes,

\[
\bar{P}(1 - T)(1 - \frac{c^{**}}{\bar{c}}) > P(1 - \frac{c^{*}}{\bar{c}}),
\]

which can be simplified to

\[
\left(\frac{\bar{c} - c^{**}}{\bar{c} - c^{*}}\right) > \frac{p}{\bar{P}(1 - T)}
\]
Substituting in the maximum possible value of $\bar{P} = \frac{P}{1 - X}$, where $c^{**} = XQP$, the equation now becomes

$$\left( \frac{\bar{c} - XQP}{\bar{c} - X} \right) > \frac{P(1 - X)}{P(1 - T)}$$

which can be simplified to

$$T < X$$

So, for the seller's expected payoff from strategy \{Card with $\bar{P}$\} to be higher than strategy \{Cash\}, while charging the maximum possible premium on card payments, the tax rate must be lower than the reimbursement rate. This is not possible, as the government’s surplus from the policy would be negative and will be irrational on the government’s part.

### 4.5.2. Repeated Interactions

The games discussed, so far, only involve single interactions, where the seller and buyer only consider the contemporary period while trading. However, in the real world, the seller and buyer scarcely trade for a single period. The buyers and sellers often develop a long-term trading relation. So, an analysis of the policy must include a repeated game model.

This subsection analyses the games where future payoffs play a role for the buyers and seller. The buyer will use price referencing model, to calculate its future payoffs, from visiting the same seller.

It has been established, that the consumer gets higher utility from visiting a seller that offers card payments and lower utility from visiting the seller that offers cash only or charges a premium on card. The probability of finding a seller with card payment facilities is $Q$ and probability of finding cash only, or card payments with premium, facilities is $1 - Q$.

The customer purchasing from $Q$ sellers, would know for certainty about higher utility, denoted $H$, in the future if it decided to return to the same retailer. Whereas a customer buying from $(1 - Q)$ retailer would know for certain about lower utility, denoted $L$, in the future as well.
Future expected utility, if the buyer decided to search again for the next purchase, or in the next period is

$$\text{EU[S]} = QH + (1 - Q)L.$$  

The buyer’s utility is greater than buying from the cash only retailer if,

$$QH + (1 - Q)L > L,$$

which can be simplified to,

$$Q(H + L) > 0$$

Hence, if $$0 < Q$$ then the $$\text{EU[S]} > L$$. Similarly, if $$Q < 1$$ then $$\text{EU[S]} < H$$.

If the expected utility from search is greater than buying from the same seller, the probability of search is 1. And if the expected utility from search is lower than buying from the same seller, the probability of search is 0.

Hence, a rational customer will visit the same seller in the proceeding periods, if it is offered card payments. Whereas, the ones who visits cash only, or card payments with premium, sellers, would always search again in the next period, but not return to the same seller again. These results will have a significant effect on the future payoffs of the seller as well.

For a seller, that offers a payment facility other than card without premium, the future payoffs are zero. The total worth of payoff this type of seller can receive is $$P$$, or $$\bar{P}(1 - T)$$. [From now on this sub-section only considers cash only payment facilities].

The seller offering card only facilities, the payoffs from the buyer are as follows,

$$P(1 - T) + \partial P(1 - T) + \partial^2 P (1 - T),$$

which can be written as

$$\sum_{n=0}^{S} \partial^n P (1 - T),$$

where, "$$\partial$$" is the discount factor that the seller applies to future payoffs. Typically, $$\partial < 1$$ always holds. “$$S$$” is the number of future purchases the seller believes the consumer will make. The maximum possible sales a seller can make to a buyer is($$S = \infty$$).
The net present value of maximum payoff, from a single buyer, that a seller can receive is \( \sum_{n=0}^{\infty} \theta^n P (1 - T) \), which is equal to,

\[
\frac{P(1 - T)}{1 - \theta}.
\]

The Bayesian Nash equilibrium, in a single period, for which a seller can offer cash only facilities, the ex-post expected profit from cash should be greater than the ex-post expected profit from card. The inequality, expressed in terms of the variables is,

\[
(1 - \frac{XQ_P}{c}) P > P(1-T).
\]

For repeated interactions, the future payoffs when offering cash only facilities, is zero. Hence, the net present value of ex-post expected profit from cash with repeated interactions is the same as ex-post profit from cash in a single interaction. However, the net present value of expected profit from card, with repeated interactions, is \( \frac{P(1 - T)}{1 - \theta} \) for \( 0 < \theta < 1 \).

The inequality to maintain Bayesian Nash equilibrium, in repeated interactions, for which a seller can offer cash only facilities is,

\[
(1 - \frac{XQ_P}{c}) P > \frac{P(1 - T)}{1 - \theta}.
\]

So, for repeated interactions the probability of a buyer accepting cash, \( (1 - \frac{XQ_P}{c}) \), needs to be higher than the single period game because, \( (1 - \frac{XQ_P}{c}) > (1 - T) \) had to hold for the seller to choose strategy Cash as a best response in a single period game. However, for repeated interactions, \( (1 - \frac{XQ_P}{c}) > \frac{(1 - T)}{1 - \theta} \) must hold, and since \( 0 < \theta < 1 \), then \( \frac{(1 - T)}{1 - \theta} \) is always greater than \( (1 - T) \).

It must be noted that for very high number of repetitions i.e. “S” is very high or discount factor, the seller might never find the strategy Cash to be a perfect Bayesian equilibrium. Consider an example with \( T = 0.3 \) and \( \theta = 0.95 \) with \( P = 1 \). The present value of future payoffs, with infinite S, will be,

\[
\frac{0.7}{0.05} = 14
\]
The seller using the strategy Cash, will never be able to earn 14, even if the probability of accepting Cash is 1, since the maximum payoff would be 1. Hence, when considering repeated interactions, the values for X and Q, required to achieve the perfect Nash equilibrium at strategy combination \{\text{Card, Accept}\} are less strict as compared to a single period game.

This leads to interesting results. The sellers operating in the regions where buyers do not interact repeatedly, such as a region with a lot of tourists, might find it feasible to employ the strategy Cash. However, for the sellers operating in the regions with high recurrence of same buyers, such as supermarkets and retailers, will find opting for Card as the optimal strategy.

The analysis in this section conclusively show that the tax evading sellers’ profits will dependent upon the relationship between search costs, reimbursement rates and taxes. The government can make tax evasion non-profitable, if it chooses the values of Tax rate\(T\) and the reimbursement rate\(X\), in such a way that the equality \(T \leq \frac{XQP}{c}\) holds.

The policy will thus help eradicate the businesses’ “Exit”, voluntary informality, from the tax net as exiting would mean lower profits. The businesses who are “Excluded”, due to complexities of reporting would also benefit from the policy, as reporting due to digitization of records would be considerably simple and easy. So, the policy target both the Exit and Exclusion.

### 4.6. Empirical Hypothesis

The theoretical model in this section establishes that under certain combinations of reimbursed amount, search costs and formality in the economy, the consumer is not willing to purchase from the informal sellers, thus negatively affecting the sellers’ profits. The model also shows that under certain permutations of tax rates, reimbursed amount, formality in the economy and search costs, it is more profitable for the businesses to be tax compliant than evade taxes.

Under the permutations that make tax compliance more profitable, an increase in reimbursement rate, ceteris paribus, decreases the profitability of informal firms further. This means that the reimbursement rate and profitability of informal firms should be negatively correlated. The empirical hypothesis derived from the theoretical model thus
becomes: the profits of the tax evading firms can be negatively affected if the government introduces, or increases, reimbursements against electronic payments.

However, formulating an empirical strategy that encapsulates the effects of reimbursements on the profits of businesses, is almost impossible for many reasons. The lack of data available for individual firms’ profits in an economy, especially due to informality, is one the main deterrents of successful formulation of the empirical strategy. The lack of reimbursements offered on electronic payments in the real world is another huge deterrent.

Nevertheless, the electronic payments in some parts of the world have been increasing due to cultural shifts in population and improvements in technology. Given that, the primary aim of introducing reimbursements is to increase electronic payments, the reimbursement can be dropped as a variable and the electronic payment statistics can be used as one of the variables in the empirical strategy.

The decrease in profits of informal firms would mean more firms moving out of the informal sector. Also, the aim of negatively affecting the profits of informal economy is to decrease informality in the long run. So, the indicators related to informality can be substituted instead of the firms’ profitability as the dependent variable in the empirical hypothesis.

The empirical hypothesis now becomes: the increase in electronic payments has negative affect on the level of informality in an economy. The next section uses real-world data to find a correlation between informality and electronic payments.
5 ECONOMETRIC MODEL AND ANALYSIS

The model presented, in previous section, aims to show how electronic payments can decrease informality and tax evasion. It must be emphasised, that the tests conducted in this section aim to provide an empirical verification of the theoretical model.

There are previous studies conducted to study the impact of different factors on informality or tax evasion. One of the main indicators of informality and tax evasion is tax gap. Tax gap is defined as the difference between taxes payable by taxpayers for a specified period and the actual tax that have been contributed to the state budget.

This section employs linear regression analysis, ordinary least square, to verify the effects of electronic payments on the tax gap. In addition to electronic payments, other variables to explain the variations in tax gap are used as well. These variables would be related to the tax administration.

5.1 Literature Review

A study by Raczkowski and Mróz (2018) measured the tax gap in the 28 EU member states and 7 other countries for the years 2011 till 2015. The study uses MIMIC(Multiple Indicators Multiple Causes) model to calculate level of informal economy. Then, using the product of shadow economy and total tax rate(TTR), they calculate the tax gap in all 35 countries.

Alm(2012) discusses, three administrative approaches that a tax administration can take to reduce tax evasion. They are referred to as, “the administrative paradigms”. The first approach is "the traditional enforcement paradigm". It involves the tax administration treating taxpayers as someone who would always look to avoid taxes and commit tax fraud. So, the administration would have to use repressive measures to control tax evasion, such as audits and severe penalties. The second approach is called "the service paradigm", it suggests that the tax administration should act friendly towards the taxpayers, and act as a service provider. The last one is "the trust paradigm" which suggest trust creation by enhancing ethics and morality.

Alm(2012) also suggests improving information among national state agencies and international institutions, simplification of tax system, simplification of the tax payment procedures and improving the tax authorities’ website.
The European Commission’s report on VAT gap (2018) performs econometric analysis, by regressing VAT gap on different explanatory variables, from 28 EU states for the years 2000 till 2015. The report uses fixed-effects model. The explanatory variables are divided into two groups, "private agents” and "tax administration”. The "private agents” group relates to agents specifically related with sellers and buyers in a transaction. This includes general population characteristics as well. The "tax administration” group includes characteristics and performance variables of the tax administration in a specific country.

### 5.2. Basic Framework, Variables involved

This subsection identifies the variables, that are employed to estimate the impact on tax gap. There will be two groups of explanatory variables, the “payment statistics” and “tax administration” variables. The countries chosen for testing are all the European Union member states. The main reason for choosing European Union, is the availability of the payment statistics. The payment statistics are not easily available for other countries.

The variable chosen for tax gap is the “tax gap as the percentage of GDP”. The values of tax gap are borrowed from Raczkowski and Mróz (2018). The reason for using tax gap as the percentage of GDP is to make the tag gap statistic comparable between countries.

The payment statistics data are taken from the European Central Bank statistics available on the ECB website. The statistics include information of usage of different payment services and instruments complied for the European Union and individual countries.

The indicator of interest for the analysis is “total payments involving non-MFIs”. It is the sum of the six mutually exclusive sub-categories: “credit transfers”, “direct debits”, “card payments with cards issued by resident PSPs (except cards with an e-money function only)”, “e-money payments”, “cheques” and “other payment services”.

An MFI is a Monetary Financial Institution which includes all institutional units included in the sub-sectors central bank, deposit-taking corporations except the central bank and money market funds. The ECB payments statistics excludes all Payment Service Providers (PSPs) from the non-MFI sector.
For country specific data, the location of payment terminals is used. The two types of “total payment involving Non-MFIs” statistics variables used are:

- **Total Number of payment transactions**, includes the total number of payments made through PSPs at the terminals within a country. For comparison to be valid among countries, the total number of payments per capita is used. According to the hypothesis, this variable should be negatively correlated with tax gap.

- **Total Value of payment transactions**, includes the value of payments made through PSPs at the terminals within a country. For comparison to be valid among countries, the value of payments per capita is used. According to the hypothesis, this variable should be negatively correlated with the tax gap.

Tax administration variables would try to capture the administrative paradigms discussed above. The variables used, are the same tax administration variables used by the European Commission’s report on VAT gap (2018). The variables are:

- **Tax Administration budget**, the total administration budget of tax administration of a state. To be able to compare between countries, Tax administration budget as a percentage of GDP is used. This variable should be negatively correlated with the tax gap.

- **Public deficit**, the excess of government expenditure over its revenues. (Esteller-Moré, 2005) state that the incentive to decrease tax gap is higher when public deficit exists, hence it should be positively correlated, as the values of public deficit in the data are negative. Public deficit as a percentage of GDP, is used to compare between countries.

- **IT ratio in tax administration budget**, the emphasis on Information and technology should help close the gap in tax gap, hence negative correlation.

The first variables demonstrate the emphasis on tax administration within the state, whereas the third variable explains the nature of expenditure in within the tax administration.

It must be noted that, indicators related to criminal investigations and prosecutions by the tax administration would have further detailed the “tax administration” variable, but the lack of data reporting from many countries in the EU, restricts this study from using these variables.
5.3. Descriptive Statistics and Sources

The table 4 shows the descriptive statistics of the variables shown in the econometrics model and estimation. For each variable, the data source, number of observations, mean and standard deviation are presented. There are 140 observations for tax gap as percentage of GDP, from years 2011 to 2015, 28 for each year. The observations for “payment statistics” are 138, because two observations from years 2011 and 2012 are missing for Croatia. The standard deviation values don’t include the numbers from Luxembourg, as its numbers are very high.

Table 4  Descriptive Statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Data Source</th>
<th>Observations</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countries</td>
<td>European Union</td>
<td>28</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tax Gap as % of GDP</td>
<td>Konrad Raczkowski &amp; Bogdan Mróz (2018)</td>
<td>140</td>
<td>7.72</td>
<td>3.3</td>
</tr>
<tr>
<td>Number of Payments per capita</td>
<td>European Central Bank</td>
<td>138</td>
<td>273.3</td>
<td>116.5*</td>
</tr>
<tr>
<td>Value of Payments per Capita</td>
<td>European Central Bank</td>
<td>138</td>
<td>409.5</td>
<td>318.5*</td>
</tr>
<tr>
<td>Tax Admin Budget as % of GDP</td>
<td>OECD</td>
<td>56</td>
<td>1.94</td>
<td>0.8</td>
</tr>
<tr>
<td>Public deficit as % of GDP</td>
<td>Eurostat</td>
<td>56</td>
<td>-2.47</td>
<td>2.07</td>
</tr>
<tr>
<td>IT ratio in tax admin budget</td>
<td>OECD</td>
<td>32</td>
<td>9.33</td>
<td>2.16</td>
</tr>
</tbody>
</table>

*Doesn’t include data, from Luxembourg.

For, “tax administration” variables, the data consists of years 2014 and 2015, but due to gaps in reporting for IT ratio in tax admin budget, only 32 observations are available for this variable. The public deficit variable is negative, because it represents the government revenues minus government expenditures, so the mean of -2.47 means the on average countries faced a deficit in the EU.
5.4. Empirical Model and Estimation

This subsection uses two types of approaches to estimate the effects of explanatory variables on the Tax gap as percentage of GDP. At first, the regression analysis for cross-sectional data, for years 2013 to 2015 for “payment statistics” variables are conducted. When controlling for “tax administration” variables, the regression analysis will only be held for 2 years, 2014 and 2015, due to lack of data. This yearly analysis does not test for any dependence in time, rather the yearly results would be represented separately, to ascertain the effects of explanatory variables in each year.

After the cross-sectional analysis, a panel data analysis is conducted, for years 2011 to 2015. The “tax administration” variables are dropped, due to lack of data availability and only test for payment statistics.

5.4.1. Cross-sectional Data Analysis

In this subsection, cross-sectional data is used to analyse the effects of independent variables, on the tax gap as percentage of GDP, for different years, separately.

The basic model is

\[ TG = \text{Constant} + \beta_1 NPPC + \beta_2 VPPC + \text{Error term}, \]

where

TG = Tax Gap as percentage of GDP
NPPC = Number of Payments per capita
VPPC = Value of Payments per capita

As it can be seen, that ”Tax Gap as percentage of GDP” is controlled by two variables, “Number of Payments per capita” and ”Value of Payments per capita”. The econometric strategy employed is to proceed parsimoniously, i.e. test one variable after another individually, and in the end test both variables simultaneously.

The table 4.1, under Appendix 4 “regression results”, shows the results of cross-sectional data results for payment statistics. The R output for regressions executed are given from R1 to R9 in R Output in Appendices. When tested individually, the NPPC has the regression coefficients of \(-0.0035\), \(-0.0027\) and \(-0.0022\) for the years 2013 till 2015,
respectively. The coefficients are statistically significant at 99% confidence level for the year 2013 and 2014. For the year 2015, the confidence level is 95%. The Constants are all positive and higher than 8. The standard errors, mentioned in parenthesis, are quite smaller for each year. Hence, the null hypothesis can be rejected.

The VPPC test results return the coefficient $-0.0033$, $-0.0035$ and $-0.0034$, for the years 2013 till 2015. The p-values for all the years is less than 0.01, hence the statistical significance is at 99% confidence level. The standard errors of approximately 0.001, for all the years, means that the null hypothesis can be rejected. The Constants are positive and greater than 9 for all the years.

The results state that NPPC and VPPC are negatively correlated with TG for all the years. This verifies the hypothesis that the increase in the usage of electronic payments, either in volume or value, will decrease tax gap and informality. The positive constant terms also verify the hypothesis, that without electronic payments, the TG is higher. The R-Squared for NPPC is 0.2 and 0.3 for VPPC, on average. This shows that there are other factors that effect the TG, however 20% and 30% variations being caused by NPPC and VPPC, respectively, are high enough for the model. However, as the R-squared for individual testing is always higher for VPPC, for every year, this means that a variation in TG is better explained by VPPC than NPPC.

The small values of co-efficient should not be worrisome. For example, the average value of VPPC, 318.5, decreases the tax gap as a percentage of GDP by $1.08(0.0034*318.5)$ in the year 2015. If the NPPC is at its average value of 116.5, the TG decreases by 0.35, in the year 2013. Even though, each variable is statistically significant, the results show that the government should emphasize more on VPPC rather than NPPC. VPPC, on average, decreases the TG more than NPPC, the R-squared for the VPPC is also 10% higher.

However, when testing for both variables simultaneously, NPPC is positively correlated for all the years. However, the NPPC coefficients are statistically insignificant at 90% confidence level. The VPPC is still negatively correlated and only significant for years 2014 and 2015, at 10% and 5% level, respectively. The coefficients for VPPC in the year 2014 and 2015 are around $-0.004$. The R-squared is around 0.3 for all the years.

One of the problems, with the testing both variables simultaneously is collinearity. The variables, NPPC and VPPC, can be highly correlated, as increase in NPPC would ultimately mean an increase in VPPC.
Next, “tax administration variables” are added to the model. The table 4.2 in Appendix 4 “regression results” shows the results from the years 2014 and 2015 individually, with all the explanatory variables tested simultaneously. Controlling for ”tax administration variables”, in addition to the “payment statistics”, increases the R-squared to more than 0.5, for both years, hence the variations in TG are explained better under this model.

Most of the variables, correlate in the direction they are expected to according to the hypothesis, except Public deficit and NPPC in 2015. The coefficients for VPPC are $-0.002$ and $-0.0039$, for the years 2014 and 2015, which means, the effect of VPPC is lower, in this model as compared to the previous regression analysis. However, with high standard errors for VPPC, the null hypothesis can not be rejected.

The tax administration budget as a percentage of GDP also has negative coefficients, – 0.49 and –0.38, meaning an increase in tax administration budget decreases the TG, however the coefficients are statistically insignificant at 90% confidence level. The IT ration in the tax administration budget has the coefficients of $-0.21$ and $-0.18$. This is consistent with the hypothesis, that a higher emphasis on IT, decreases tax evasion. The p-values of less than 0.1 and 0.05 make the variable statistically significant in both the years. In fact, for both years, IT ratio in tax administrations budget is the only statistically significant variable, for all the others, the null hypothesis can not be rejected.

### 5.4.2. Panel Data Analysis

This subsection uses Panel analysis, by setting the data up as a panel data. As before the endogenous variable is TG, and regressors are NPPC and VPPC. The “tax administration variables” are dropped due to lack of data. Again, the test is conducted parsimoniously, i.e. individually regress the variables and then in the end simultaneously regress both the explanatory variables.

Initially, an Augmented Dickey-Fuller test for unit root/stationarity is conducted. The output of the test is given under R10 in R Output in Appendices. The results show that the null hypothesis of the presence of unit root is rejected and all three series are stationary. Hence, none of the variables needs to be transformed.

Before testing for Fixed effects, “Breusch-Pagan LM test” for time-fixed effects is conducted. R11 in R Output in the Appendices gives the results of the test. The null-hypothesis of ”insignificant time effects” cannot be rejected, hence the further analysis
do not account for fixed time effects. The table 4.3 under Appendix 4 “regression results” summarizes the results from the Fixed effects and Random effects model.

Testing for fixed effect of explanatory variables on TG, individually and simultaneously, gives the negative coefficients for both variables. This means that both variables have the same effects on the TG as the hypothesis. However, none of the results is significant. So, a pooled ordinary least square or random effects model is conducted, to explain the model in a better way. The R output for fixed-effect regressions executed are given from R12 to R14 in R Output in Appendices.

However, before continuing further, a “Breusch-Pagan LM test” for random effects is conducted. This test decides the compatibility between a pooled OLS or a random effects regression model, to the data. R15 in R output of Appendices gives the results for the test. The null-hypothesis in the LM test is that there are no panel effects. If there are no panel effects, then pooled OLS would be employed else a random effects regression would be used. The output of R15 suggests that the null hypothesis is rejected and that there are significant panel effects. So now, a random effects regression would be conducted. The R16 till R18 shows the R Output.

The results of the random effects regression are already in the table 4.3 in Appendix 4. Both the variables are negatively correlated, individually and simultaneously. Also, the constant is positive for all the tests.

The NPPC, when tested individually has the coefficient of $-0.00077$, which is not significant at 10% level but is very close at 12% confidence level. The R-Squared is very low at 0.015, meaning NPPC explains less than 2 percent of the variation in TG. However, the coefficient is consistent with the empirical hypothesis, of decrease in TG as the NPPC increases.

The coefficient of VPPC, $-0.0012$, is significant at 5% confidence level, hence the null hypothesis can be rejected. The R-squared is at 0.03, hence very low variations in TG are explained by VPPC. However, the random effects panel data regression verifies the empirical hypothesis, with statistical significance, of a negative correlation between electronic payments and tax evasion.

When regressing both variables simultaneously, only VPPC is significant at 12% level, with the coefficient of $-0.00095$. Even though NPPC is $-0.00045$, but it is not significant
at 90% confidence level, hence the null hypothesis can not be rejected. As stated before, the effects of collinearity maybe one of the reasons for the statistical insignificance.

The results of random effects regression analysis of the panel data, are consistent with the yearly cross-sectional data. The payment statistics hold statistical significance, when tested individually, but when tested simultaneously, the p-value for NPPC are greater than 0.1. The results are also consistent in finding a higher effect of VPPC as compared to NPPC. So, the panel data results also point to the same conclusion as cross-sectional data results, i.e. the government should emphasise more on the increase in VPPC rather than NPPC, while verifying the hypothesis of increase in electronic payments, decrease tax evasion.

It must be noted that the underlying assumption with a random effect model, is that the covariance between individual specific events, in this case countries, and independent variables is zero. It is almost impossible that this assumption would hold. Hence, the random effects estimator is not consistent. Also, the testing for serial correlation tests applies to macro panels, with long time series. Since the data used consists of few years, there is no need to conduct a serial correlation test.

5.5. General Findings

The regressions performed, verify the hypothesis derived from the theoretical model of a negative relationship electronic payments and tax evasion. These results hold for yearly cross-sectional data as well as panel data, with both fixed and random effects. The results may not always be significant, especially when both payment statistics are regressed simultaneously but when tested individually, the coefficients hold significance. The results also point towards a government policy of emphasising the importance of value of payments over the number of payments, for each individual.

The previous studies have used different types of explanatory variables when testing for the effects on tax gap. Most of the explanatory variables relate to the tax administration, country specific demographics and success of criminal indictments against tax evasion. This study contributes to the existing literature by controlling for “payment statistics” as one of the explanatory variables for tax gap.

It must be emphasised again that the purpose of this empirical exercise was to verify the hypothesis derived from theoretical model. The limitations of the model, can not allow
to extract any causality. However, a correlation has verified the theoretical model and hypothesis.
6 POLICY FACILITATION

This section mentions different measures the government and other agents can take to facilitate the smooth implementation of the policy.

6.1 Reducing Search Costs

As shown before, the consumers will be willing to incur search costs, if the government’s reimbursements are high enough. However, the search costs will always have to be less than the reimbursement rates.

6.1.1 Initiatives by businesses

Reduced search costs will mean smaller threshold for reimbursements, hence it will be beneficial for the implementation of the policy. However, it will also be beneficial for the businesses already complying with tax authorities, as reduced search costs mean higher demand and revenues. Therefore, a rational business will try to decrease consumers’ search costs, as well.

One of the most commonly known tactics for businesses is to display a sign outside their premises, which states their policy with respect to acceptance of electronic payments. Some of the examples are shown in the figure below:

Figure 5 Retailers signalling
The picture on the top left corner is the latest trend with businesses trying to incorporate latest payment methods. The image in top right corner depicts the current scenario in most of the businesses that trying to conceal their earnings from the tax authorities. However, with the implementation of the policy, such displays would be unprofitable since a rational consumer would avoid visiting.

The image in bottom left corner states, “accepts all credit and debit cards, free of charge”. This is what tax complying businesses will try to display, if they intend to minimize consumers’ search costs. The bottom right image is where the policy ultimately wants to lead businesses.

For own-account workers, who accept payments outside their business premises, such as plumbers, domestic help, cleaners etc. can start using mobile/portable card readers. Restaurants and food chains are already using mobile/portable card readers to facilitate electronic payments on home deliveries.

6.1.2. Government Initiative

The governments can reduce search costs by creating central databases where businesses, offering electronic payment facilities, can register themselves. The database can be available through mobile applications for the general public, so that the consumers can readily check the availability of electronic payments.

The database should be subject to periodic updates with help of the consumer feedback, about the availability of electronic payments without premium. One example of such a database is Google maps, which offers reviews and ratings by users for businesses appearing on its database. For own-account workers, who accept payments outside their business premises, the government can subsidize mobile/portable card readers.

6.2. Increase in businesses accepting electronic payments increases searches

Recall that expected utility from searching increases as the number of business accepting electronic payments increases. So, if the number of businesses adhering to the policy increases, the business trying to evade taxes would have less probability of selling to the consumers. Hence, a rational business will start offering electronic payments, once the policy is implemented.
The government can also announce limited number of subsidies on the extra costs incurred by businesses for offering electronic payment facilities. For example, government can announce a subsidy on card readers for the first 100,000 businesses who shift towards electronic payments. A subsidy on internet connection for the businesses initially moving towards electronic payments can be another example.

These subsidies will nudge the businesses towards shifting to electronic payments faster, hence providing more successful results to consumer searches.

6.3. The time elapsed between purchase and reimbursement

The time elapsed between the purchase and reimbursement can also, effect the consumer’s willingness to search for a retailer willing to accept electronic payment. Simply put, the rational consumer will discount the gross reimbursement with the prevailing interest rate, r. The most simplified equation to search for the willing retailer will then become,

\[ C < \frac{XQP}{1+r} < \frac{XQP}{(1+r)^2} \ldots < \frac{XQP}{(1+r)^n} \]

If \( r > 0 \),

Hence, a lengthy period, for reimbursements, provides for a lower threshold for the government to nudge the consumer towards incurring the search costs.

The government can, initially, try to offer reimbursements on a monthly basis. This will cause higher administrative costs, however it will help develop a wide acceptance of policy among the public. Once a government feels the culture of electronic payments has been strengthened, it can gradually increase the time lapse up to a year.
7 FEASIBILITY OF THE POLICY

Implementing the policy, would be highly dependent upon many existing factors in the economy. Some of the factors are discussed in this section, to find out the best environment for the policy implementation.

7.1. Literacy Rates

The focus of the policy is to shift the usage of hard cash to plastic money. The existing literacy rate in the economy, would play an important role in the effectiveness of the policy. However, usage of plastic money is more of a complex issue than just the literacy rates, as usage of plastic money requires understanding of internet, technology and cyber security.

Hence, the best indicator for the ease of general public to shift towards plastic payments would not be simple literacy rate, rather the existing usage of a technology, in the economy, that gives a better understanding of internet and cyber security. Thus, the most suited indicator is the mobile phone users as a percentage of total population, as the mobile phone usage includes an understanding of digital technology which requires reading values and characters of a digital screen, the same understanding required for using plastic money.

According to Statista, mobile phone users around the world would cross five billion users in 2019. The percentage of world population owning a mobile phone would be around 67 percent in 2019.
The World Bank Open Data provides an indicator, “mobile cellular subscriptions per 100 people”. Below is the world map, that depicts the indicator values from the year 2017.

**Figure 6  Mobile cellular subscriptions per 100 people**

The maps above show that many developed and developing countries have a high number of cellular subscriptions. The countries with very low cellular phone subscriptions and mobile phone ownership will have a disadvantage in shifting the population away from hard cash.

Examples of countries with very low cellular subscriptions are South Sudan (12 percent), Cuba (40 percent), Malawi (42 percent). However, countries such a China (105 percent) and India (87 percent), can have greater success in implementing these policies, as the public is generally aware about the basic technology required to use plastic money.

### 7.2. Bank Account Owners

The percentage of existing bank account ownerships, in an economy, would provide a good indicator for successful implementation of the policy as most of the plastic money is connected to the payers’ bank accounts.

The high percentage of bank account owners in an economy would indicate a high level of trust in the existing banking system, hence more consumers will be willing to use banking system as a medium of payment, provided they have an incentive to do so.
Also, a high percentage of bank account ownership will mean that the general public will not need a major cultural shift, if the policy is implemented. This will decrease the time elapsed between implementing the policy and gaining its benefits.

The Global Findex database is the world’s most comprehensive data set on how adults save, borrow, make payments, and manage risk. The World Bank launched the database with funding from the Bill & Melinda Gates Foundation, the database has been published every three years since 2011. The 2017 Global Findex database shows that 1.2 billion adults have obtained an account since 2011, including 515 million since 2014. Between 2014 and 2017, the share of adults who have an account with a financial institution or through a mobile money service rose globally from 62 percent to 69 percent. In developing economies, the share rose from 54 percent to 63 percent.

The figure 7 shows the global map with Account ownership, percentage of adults with an account, in 2017.

**Figure 7  Adults with a bank account(%), 2017**

The Global Findex Database 2017 analyses in detail about the reasons for adults without bank accounts. However, the figure above shows that regions other than Central Africa, who have very low bank account ownership, will have an easier time in implementing the policy.

According to Findex Database 2017, the use of digital payments is increasing throughout the world. The percentage of adults around the world making or receiving, at least one, digital payments increased by 11 percentage points between 2014 and 2017, to 52
percent. In developing economies, the share of adults using digital payments rose by 12 percentage points, to 44 percent.

These percentages include all respondents who reported using mobile money, a debit or credit card, or a mobile phone to make a payment from an account or reported using the internet to pay bills or to buy something online, in the past 12 months. They also include those who reported paying bills, sending or receiving remittances, receiving payments for agricultural products, or receiving wages, government transfers, or a public sector pension directly from or into a financial institution account or through a mobile money account in the past 12 months.

Furthermore, The Findex Database 2017 shows that, for high-income economies 89 percent of account owners reported to own a debit card, while 75 percent of account owners reported to use the card for direct purchase, during the preceding year. The percentage of account owners owning a debit card and making a purchase from the card, for developing economies, is 63 percent and 50 percent, respectively. The debit card holders, as a percentage of adults is 83 percent for high-income economies and 40 percent for developing economies.

The report further states that, throughout the world, only 20 percent of the account owners, reported to not using their bank account for any purposes, hence they are inactive accounts. For South Asia, the share of inactive accounts is very high.

It must be noted that, the Findex Database 2017 points out at least one purchase in its statistics, whereas this thesis aims at increasing the frequency of purchases and overall users, simultaneously. After the government introduces reimbursements, the frequency of digital payments as well as the share of adults using digital payments can increase exponentially, while people will start using their inactive accounts as well.

### 7.3. Unbanked Population

Findex Database(2017) states that globally, about 1.1 billion—or about two-thirds of all unbanked adults, have a mobile phone. The people in this segment of the society can have a potential access to mobile money payment, and hence can take advantage of the government reimbursements.

The government can also offer stored-value cards for customers without any access to plastic money, otherwise. Stored-value cards have a specific money value programmed
into them. Banks provide these cards as a service for customers who cannot open checking or other deposit accounts (Investopedia).

The stored-value card offered by the government under the policy should compensate the consumer with rate of reimbursement already included in the stored-value of the card. This will help the population with no access to other methods of plastic payments, make electronic payments.

7.4. Representative Economies

The public trust in the state institutions would play a huge role in the implementation process of the policy. If the public trust is low, they might not be willing to incur search costs, for future gains.

The type of political regime, in an economy, can be used an indicator for the level of public trust on the state institutions. Since, democracies are pluralistic, inclusive and a better functioning government, the policy will have a better chance of finding roots in a democratic economy as compared to authoritarian regimes, who might not see an enthusiastic reaction from the general public to the policy.

The Economist Group’s, the Economist Intelligent Unit (EIU) compiles data from around the globe to publish the Democracy index. The five variables that make up the index are, electoral process and pluralism, civil liberties, the functioning of government, political participation and political culture. Each country is then characterized according to the scores of the index. The picture below shows the democracy index around the globe, for the year 2017.

Figure 8 Democracy Index 2017
The countries with the score closer to 10, or green colour, will have an easier time in implementing the policy.

7.5. Initial Rate of Informality

The initial rate of informality would be one of the main deciding factors in the success rate of the policy. Implementing the policy in an economy with low levels of informality, would end up costing more than it benefits the government, because the state is essentially subsidizing consumption from the formal sector. So, a high level of formality means that high level of consumption is subsidized, which was already included in the formal sector. The additional taxes collected with the policy could end up being less than the amount of reimbursements state must give out.

An equation would help simplify the matter. The current amount of taxes in the state should be a product of tax rate and formality, \( Q \times T \), whereas implementing the policy, would provide the government surplus, in case of eradicating complete informality, to be equal to, \( T - X \).

For the policy to be successful, the tax collection prior to the policy, should be less than the government surplus after the success of the policy. So,

\[
Q \times T < T - X,
\]

which can be rewritten as,

\[
\frac{X}{T} < (1 - Q)
\]

The ratio of reimbursement rate to tax rate should be less than the level of informality in the economy, \( (1 - Q) \), for the policy to provide a surplus to the state. So, if the prevailing rate of informality is low, the government’s threshold to provide reimbursement rate falls.

7.6. Consumer Privacy

The policy essentially asks the consumers to reveal their spending habits and patterns. The consumers would have to decide between privacy and rewards. If the general trend in the economy is for the consumers to value their personal information over the rewards, then the recommended policy might not be feasible for the economy. On the other hand,
if the consumers are more receptive towards rewards, then the policy could be feasible for the society.

One way around, the society valuing privacy over rewards, is for the government to offer stored-value cards. The stored-value cards can provide anonymity while making digital payments.

7.7. Regions Feasible for the Policy

The table in Appendix, depicts the combined results, of variables discussed in this section, from the different regions around the world. The four variables are, “share of informal employment”, “mobile cellular subscriptions per 100 people”, “Bank account ownership in Adults” and “Democracy Indicator”.

The table shows that the regions of Africa and Southern Asia, have the highest level of informality in employment, hence these regions need the policy more than others. However, the other indicators for Africa such as “Bank account ownership in Adults” and “democracy indicator” do no deem the region feasible for the implementation of the policy, or the possibility of successful implementation of the policy might be difficult.

“Northern America” and “North, South and Western Europe” require the policy the least, as they have very low levels of informality, even if the other indicators make it feasible for the policy to be implemented there.

The most suited regions for the policy are, “South East Asia and the Pacific” and the “Southern Asia”. The high ratio of informality makes both the regions require the policy the more than others, while the high levels of informality can also allow the governments to use high reimbursements to taxes ratio. The high levels of cellular phone subscriptions, make the general public more open towards digital payments. The regions also have an average levels of democracy index, not authoritarian regimes, while the bank account ownerships among the adults are high as well.
8 SUMMARY AND CONCLUSION

The informal economy affects almost every economy around the world. The reasons, and consequently impact, of informality may vary between economies. The policies to control informality are, usually, misdirected and end up overburdening the existing formal sector of the economy, hence creating an informality trap.

The government can increase the electronic payments among the consumers to decrease informality, so that the businesses can not conceal their information. If the government subsidizes electronic payments, then the consumers will be willing to search for an electronic payment facility, if the sellers do not offer one.

Using game theory, the thesis establishes that the consumers are willing to search for electronic payment facility, if the cost of searching is less than the product of reimbursed amount and the firms providing electronic payments. The game theory analysis further establishes, that for sellers, it is profitable to offer electronic payment facilities, if the tax rate is below the consumer’s probability of searching for another seller.

One of the main implications of this thesis is that, it conceptualizes the theory that, once the government introduces reimbursements against electronic payments, the profitability of the informal sector decreases. Thus, making it irrational for profit-maximizing businesses to operate in the informal economy.

The thesis also implicates that introducing reimbursements against the electronic payments can force the voluntary informal agents, those who choose to Exit, to formalize themselves, as now their profits would decrease. For the involuntary informal agents, those who were Excluded, the electronic payments provide an ease of reporting and compliance with the state law and regulations. Hence, the policy encompasses almost all types of the informalities, and tackles them, while avoiding the informality trap.

Analysing the real-world data, a correlation between informality (tax gap) and electronic payments (Value and Number of payments per capita) in the European Union is detected, while analysing data from individual years or as a panel data. An increase in value of payments per capita of € 1000, decreases the tax gap in the EU, by 3.4 percentage points in the year 2015. For the Panel data between 2011 to 2015, an increase of € 1000 in value of payments per capita decreases the tax gap by 1.2 percentage points. Similarly,
an increase of 300 payments per capita, also decreases the tax gap in the EU, by 0.66 percentage points, for the year 2015.

A future research can be undertaken, with greater focus on the regions feasible for the policy implementation, i.e. Southern Asia, South East Asia and the Pacific. The research will take the region-specific parameters into consideration and compute ideal reimbursement rates for each country in the regions.

Another direction of future research could be to conceptualize the impact of the policy on the fiscal and monetary system of an economy. A detailed analysis of the structural shocks that the policy could cause would be an interesting topic for future research as well.

However, it must be stated that the policy should always be implemented in combination with other policies, especially ILO recommendations 204, to decrease the level of informality within an economy.
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Appendix 1  R OUTPUT

R1. Regression results for Number of payments per capita, cross-sectional data, year 2013.

Call:
lm(formula = TG ~ Number_payments_pc, data = X2013_compiled)

Residuals:
  Min     1Q Median     3Q    Max
-4.987  -2.159  -0.091  1.876   6.037

Coefficients:  Estimate Std. Error t value Pr(>|t|)
(Intercept)    8.832117  0.660154  13.379 3.63e-13 ***
Number_payments_pc -0.003463  0.001234  -2.806  0.00938 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.019 on 26 degrees of freedom
Multiple R-squared: 0.2324, Adjusted R-squared: 0.2029
F-statistic: 7.872 on 1 and 26 DF,  p-value: 0.009383

R2. Regression results for Number of payments per capita, cross-sectional data, year 2014.

Call:
lm(formula = TG ~ Number_payments_pc, data = X2014_compiled)

Residuals:
  Min     1Q Median     3Q    Max
-4.936  -2.232  -0.262  1.963   5.856

Coefficients:  Estimate Std. Error t value Pr(>|t|)
(Intercept)    8.523371  0.656251  12.988 7.12e-13 ***
Number_payments_pc -0.002732  0.001060  -2.578  0.016 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.061 on 26 degrees of freedom
Multiple R-squared: 0.2035, Adjusted R-squared: 0.1729
F-statistic: 6.644 on 1 and 26 DF,  p-value: 0.01597
R3. Regression results for Number of payments per capita, cross-sectional data, year 2015.

Call:
\[ \text{lm(formula = TG} \sim \text{Number\_payments\_pc, data = X2015\_compiled)} \]

Residuals:
<table>
<thead>
<tr>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4.8545</td>
<td>-2.2924</td>
<td>-0.1143</td>
<td>2.1692</td>
<td>5.4025</td>
</tr>
</tbody>
</table>

Coefficients:

| Estimate  | Std. Error | t value | Pr(>|t|) |
|-----------|------------|---------|---------|
| (Intercept) | 8.2601021 | 0.6268441 | 13.177  | 5.13e-13 *** |
| Number\_payments\_pc | -0.0022113 | 0.0008765 | -2.523  | 0.0181 * |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 1

Residual standard error: 2.952 on 26 degrees of freedom
Multiple R-squared: 0.1967, Adjusted R-squared: 0.1658
F-statistic: 6.365 on 1 and 26 DF, p-value: 0.01809

R4. Regression results for value of payments per capita, cross-sectional data, year 2013.

Call:
\[ \text{lm(formula = TG} \sim \text{Value\_payment\_pc, data = X2013\_compiled)} \]

Residuals:
<table>
<thead>
<tr>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5.5348</td>
<td>-1.3035</td>
<td>-0.4774</td>
<td>1.7905</td>
<td>5.4963</td>
</tr>
</tbody>
</table>

Coefficients:

| Estimate  | Std. Error | t value | Pr(>|t|) |
|-----------|------------|---------|---------|
| (Intercept) | 9.2453725 | 0.6731449 | 13.735  | 1.99e-13 *** |
| Value\_payment\_pc | -0.0033024 | 0.0009774 | -3.379  | 0.0023 ** |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.873 on 26 degrees of freedom
Multiple R-squared: 0.3051, Adjusted R-squared: 0.2784
F-statistic: 11.42 on 1 and 26 DF, p-value: 0.002304
R5. Regression results for value of payments per capita, cross-sectional data, year 2014.

Call:
\texttt{lm(formula = TG ~ Value\_payment\_pc, data = X2014\_compiled)}

Residuals:
\begin{tabular}{cccccc}
Min & 1Q & Median & 3Q & Max \\
-5.213 & -1.662 & -0.546 & 2.495 & 5.150 \\
\end{tabular}

Coefficients:
\begin{tabular}{ccccc}
& Estimate & Std. Error & t value & Pr(>|t|) \\
(Intercept) & 9.165534 & 0.685796 & 13.365 & 3.71e-13 *** \\
Value\_payment\_pc & -0.003516 & 0.001034 & -3.401 & 0.00218 ** \\
\end{tabular}

---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.853 on 26 degrees of freedom
Multiple R-squared: 0.3079, Adjusted R-squared: 0.2813
F-statistic: 11.57 on 1 and 26 DF, p-value: 0.00218

R6. Regression results for value of payments per capita, cross-sectional data, year 2015.

Call:
\texttt{lm(formula = TG ~ Value\_payment\_pc, data = X2015\_compiled)}

Residuals:
\begin{tabular}{cccccc}
Min & 1Q & Median & 3Q & Max \\
-5.4244 & -1.6875 & -0.3526 & 2.2311 & 4.8758 \\
\end{tabular}

Coefficients:
\begin{tabular}{ccccc}
& Estimate & Std. Error & t value & Pr(>|t|) \\
(Intercept) & 9.00762194 & 0.6663748 & 13.620 & 2.41e-13 *** \\
Value\_payment\_pc & -0.0034091 & 0.0009525 & -3.579 & 0.00139 ** \\
\end{tabular}

---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.695 on 26 degrees of freedom
Multiple R-squared: 0.3301, Adjusted R-squared: 0.3043
F-statistic: 12.81 on 1 and 26 DF, p-value: 0.001387

Call:
`lm(formula = TG ~ Number_payments_pc + Value_payment_pc, data = X2013_compiled)`

Residuals:
```
  Min     1Q Median     3Q    Max
-5.5624 -1.3095 -0.4931  1.7927  5.5000
```

Coefficients:
```
                           Estimate Std. Error   t value  Pr(>|t|)
(Intercept)               9.2542100  0.6912846  13.387 6.65e-13 ***
Number_payments_pc        0.0002777  0.0025992   0.107    0.916
Value_payment_pc          -0.0035075  0.0021632  -1.621    0.117
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 2.929 on 25 degrees of freedom
Multiple R-squared: 0.3054, Adjusted R-squared: 0.2499
F-statistic: 5.497 on 2 and 25 DF, p-value: 0.0105


Call:
`lm(formula = TG ~ Number_payments_pc + Value_payment_pc, data = X2014_compiled)`

Residuals:
```
  Min     1Q Median     3Q    Max
-5.4410 -1.5746 -0.4587  2.6083  5.1303
```

Coefficients:
```
                           Estimate Std. Error   t value  Pr(>|t|)
(Intercept)               9.2266698  0.7161019  12.885 6.14e-13 ***
Number_payments_pc        0.0007629  0.0020286   0.376    0.7100
Value_payment_pc          -0.0042092  0.0021226  -1.983    0.0585 .
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 2.901 on 25 degrees of freedom
Multiple R-squared: 0.3118, Adjusted R-squared: 0.2567
F-statistic: 5.663 on 2 and 25 DF, p-value: 0.009367

Call:
```r
lm(formula = TG ~ Number_payments_pc + Value_payment_pc, data = x2015_compiled)
```

Residuals:
```
                        Min       1Q  Median       3Q      Max
-5.6085 -1.5630 -0.0976  2.2930  4.8389
```

Coefficients:
```
                        Estimate Std. Error  t value  Pr(>|t|)
(Intercept)            9.1422156  0.7000379  13.060   1.15e-12 ***
Number_payments_pc    0.0005504  0.0014643   0.376     0.7102
Value_payment_pc     -0.0039536  0.0017427  -2.269     0.0322 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Residual standard error: 2.741 on 25 degrees of freedom
Multiple R-squared: 0.3338, Adjusted R-squared: 0.2805
F-statistic: 6.264 on 2 and 25 DF, p-value: 0.006235

R10. Augmented Dickey-Fuller Tests for Tax gap as percentage of GDP

Augmented Dickey-Fuller Test
data:  Panel.set$TG
Dickey-Fuller = -5.1614, Lag order = 2, p-value = 0.01
alternative hypothesis: stationary

Augmented Dickey-Fuller Tests for number of payments per capita.

Augmented Dickey-Fuller Test
data:  omitPanel.set$NPPC
Dickey-Fuller = -4.6098, Lag order = 2, p-value = 0.01
alternative hypothesis: stationary

Augmented Dickey-Fuller Tests for value of payments per capita.

Augmented Dickey-Fuller Test
data:  omitPanel.set$VPPC
Dickey-Fuller = -4.3981, Lag order = 2, p-value = 0.01
alternative hypothesis: stationary
R11. Breusch-Pagan test for fixed-time effects for number of payments per capita on Tax gap as percentage of GDP

Lagrange Multiplier Test - time effects (Breusch-Pagan)

for unbalanced panels

data: TG ~ NPPC
chisq = 2.0475, df = 1, p-value = 0.1525
alternative hypothesis: significant effects

Breusch-Pagan test for fixed-time effects for value of payments per capita on Tax gap as percentage of GDP

Lagrange Multiplier Test - time effects (Breusch-Pagan)

for unbalanced panels

data: TG ~ VPPC
chisq = 1.8072, df = 1, p-value = 0.1788
alternative hypothesis: significant effects

Breusch-Pagan test for fixed-time effects for payment statistics on Tax gap as percentage of GDP

Lagrange Multiplier Test - time effects (Breusch-Pagan)

for unbalanced panels

data: TG ~ VPPC + NPPC
chisq = 1.7713, df = 1, p-value = 0.1832
alternative hypothesis: significant effects

R12. Fixed effects regression for number of payments per capita.

Oneway (individual) effect Within Model

Call:
plm(formula = TG ~ NPPC, data = Panel_Data, model = "within",
    index = c("Country", "Year"))

Unbalanced Panel: n = 28, T = 3-5, N = 138

Residuals:

Min. 1st Qu. Median 3rd Qu. Max.
-2.4026170 -0.2313679 0.0053397 0.2491412 4.2427030

Coefficients:

                Estimate Std. Error t-value Pr(>|t|)
NPPC -0.00033998 0.00051546 -0.6596 0.5109

Total Sum of Squares:  60.115
Residual Sum of Squares:  59.876
R-Squared:  0.0039751
Adj. R-Squared: -0.25188
F-statistic: 0.435017 on 1 and 109 DF, p-value: 0.51093
**R13. Fixed effects regression for value of payments per capita.**

Oneway (individual) effect Within Model

Call:
```
plm(formula = TG ~ VPPC, data = Panel_Data, model = "within",
    index = c("Country", "Year"))
```

Unbalanced Panel: n = 28, T = 3-5, N = 138

Residuals:
```
          Min.       1st Qu.        Median   3rd Qu.       Max.  
-2.4185736 -0.2100536 -0.0034601  0.2469120  4.2480751
```

Coefficients:
```
            Estimate  Std. Error     t-value Pr(>|t|)  
VPPC  -0.00042112  0.00058851  -0.7156      0.4758
```

Total Sum of Squares:  60.115
Residual Sum of Squares: 59.834
R-Squared: 0.0046757
Adj. R-Squared: -0.251
F-statistic: 0.512046 on 1 and 109 DF, p-value: 0.47578

**R14. Fixed effects regression for “payments statistics”.**

Oneway (individual) effect Within Model

Call:
```
plm(formula = TG ~ VPPC + NPPC, data = Panel_Data, model = "within",
    index = c("Country", "Year"))
```

Unbalanced Panel: n = 28, T = 3-5, N = 138

Residuals:
```
          Min.       1st Qu.        Median   3rd Qu.       Max.  
-2.4084344 -0.2163698  0.0036761  0.2575384  4.2441454
```

Coefficients:
```
            Estimate  Std. Error     t-value Pr(>|t|)  
VPPC  -0.00033172  0.00062236  -0.533      0.5951
NPPC  -0.00024848  0.00054491  -0.456      0.6493
```

Total Sum of Squares:  60.115
Residual Sum of Squares: 59.719
R-Squared: 0.0065883
Adj. R-Squared: -0.251
F-statistic: 0.512046 on 2 and 109 DF, p-value: 0.47578
R15. Breusch-Pagan Lagrange Multiplier for random effects for number of payments per capita

```r
> plmtest(poolNPPC,type = c("bp"))
```

Lagrange Multiplier Test - (Breusch-Pagan) for unbalanced panel

```r
data:  TG ~ NPPC
chisq = 235.6, df = 1, p-value < 2.2e-16
alternative hypothesis: significant effects
```

Breusch-Pagan Lagrange Multiplier for random effects for value of payments per capita

```r
plmtest(poolVPPC,type = c("bp"))
```

Lagrange Multiplier Test - (Breusch-Pagan) for unbalanced panel

```r
data:  TG ~ VPPC
chisq = 225.72, df = 1, p-value < 2.2e-16
alternative hypothesis: significant effects
```

R16. Random effects regression for number of payments per capita.

Oneway (individual) effect Random Effect Model

(Swamy-Arora's transformation)

```r
Call:
plm(formula = TG ~ NPPC, data = Panel_Data, model = "random", index = c("Country","Year"))
```

Unbalanced Panel: n = 28, T = 3-5, N = 138

Effects:

<table>
<thead>
<tr>
<th></th>
<th>var</th>
<th>std.dev</th>
<th>share</th>
</tr>
</thead>
<tbody>
<tr>
<td>idiosyncratic</td>
<td>0.5493</td>
<td>0.7412</td>
<td>0.053</td>
</tr>
<tr>
<td>individual</td>
<td>9.7341</td>
<td>3.1200</td>
<td>0.947</td>
</tr>
</tbody>
</table>

theta:

<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>1st Qu.</th>
<th>Median</th>
<th>Mean</th>
<th>3rd Qu.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>theta</td>
<td>0.8641</td>
<td>0.8944</td>
<td>0.8944</td>
<td>0.8944</td>
<td>0.8944</td>
<td></td>
</tr>
</tbody>
</table>

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>1st Qu.</th>
<th>Median</th>
<th>Mean</th>
<th>3rd Qu.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residuals</td>
<td>-2.0138</td>
<td>-0.4019</td>
<td>-0.1319</td>
<td>0.0022</td>
<td>0.3001</td>
<td>5.0193</td>
</tr>
</tbody>
</table>

Coefficients:

|         | Estimate | Std. Error | z-value | Pr(>|z|) |
|---------|----------|------------|---------|---------|
| (Intercept) | 8.10172321 | 0.61532372 | 13.1666 | <2e-16 *** |
| NPPC    | -0.00076643 | 0.00048381 | -1.5842 | 0.1132 |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares: 77.87
Residual Sum of Squares: 76.773
R-Squared: 0.014611
Adj. R-Squared: 0.0073659
Chisq: 1.94356 on 1 DF, p-value: 0.16328
### R17. Random effects regression for value of payments per capita.

Oneway (individual) effect Random Effect Model  
(Swamy–Arora's transformation)

```
Call: plm(formula = TG ~ VPPC, data = Panel_Data, model = "random", 
index = c("Country", "Year"))

Unbalanced Panel: n = 28, T = 3–5, N = 138

Effects: 

<table>
<thead>
<tr>
<th>var</th>
<th>std.dev</th>
<th>share</th>
</tr>
</thead>
<tbody>
<tr>
<td>idiosyncratic</td>
<td>0.5489</td>
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<tr>
<td>individual</td>
<td>8.3990</td>
<td>2.8981</td>
</tr>
</tbody>
</table>

theta:

<table>
<thead>
<tr>
<th>Min.</th>
<th>1st Qu.</th>
<th>Median</th>
<th>Mean</th>
<th>3rd Qu.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8540</td>
<td>0.8864</td>
<td>0.8864</td>
<td>0.8857</td>
<td>0.8864</td>
<td>0.8864</td>
</tr>
</tbody>
</table>

Residuals:

<table>
<thead>
<tr>
<th>Min.</th>
<th>1st Qu.</th>
<th>Median</th>
<th>Mean</th>
<th>3rd Qu.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.0435</td>
<td>-0.4086</td>
<td>-0.0841</td>
<td>0.0026</td>
<td>0.2819</td>
<td>5.0575</td>
</tr>
</tbody>
</table>

Coefficients: 

| Estimate | Std. Error | z-value | Pr(>|z|) |
|----------|------------|---------|----------|
| (Intercept) | 8.36743070 | 0.60366995 | 13.8609 | <2e-16 *** |
| VPPC      | -0.00117050 | 0.00052997 | -2.2086 | 0.0272 * |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares: 80.642
Residual Sum of Squares: 78.205
R-Squared: 0.03065
Adj. R-Squared: 0.023523
Chisq: 4.23691 on 1 DF, p-value: 0.039554

### R18. Random effects regression for payments statistics.

Oneway (individual) effect Random Effect Model  
(Swamy–Arora's transformation)

```
Call: plm(formula = TG ~ NPPC + VPPC, data = Panel_Data, model = "random", 
index = c("Country", "Year"))

Unbalanced Panel: n = 28, T = 3–5, N = 138

Effects: 

<table>
<thead>
<tr>
<th>var</th>
<th>std.dev</th>
<th>share</th>
</tr>
</thead>
<tbody>
<tr>
<td>idiosyncratic</td>
<td>0.5530</td>
<td>0.7436</td>
</tr>
<tr>
<td>individual</td>
<td>8.6993</td>
<td>2.9494</td>
</tr>
</tbody>
</table>

theta:

<table>
<thead>
<tr>
<th>Min.</th>
<th>1st Qu.</th>
<th>Median</th>
<th>Mean</th>
<th>3rd Qu.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8540</td>
<td>0.8864</td>
<td>0.8864</td>
<td>0.8857</td>
<td>0.8864</td>
<td>0.8864</td>
</tr>
</tbody>
</table>

Residuals:

<table>
<thead>
<tr>
<th>Min.</th>
<th>1st Qu.</th>
<th>Median</th>
<th>Mean</th>
<th>3rd Qu.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.0435</td>
<td>-0.4086</td>
<td>-0.0841</td>
<td>0.0026</td>
<td>0.2819</td>
<td>5.0575</td>
</tr>
</tbody>
</table>

Coefficients: 

| Estimate | Std. Error | z-value | Pr(>|z|) |
|----------|------------|---------|----------|
| (Intercept) | 8.39978004 | 0.61168298 | 13.7322 | <2e-16 *** |
| NPPC      | -0.00045110 | 0.00053153 | -0.8487 | 0.3961 |
| VPPC      | -0.00094792 | 0.00058379 | -1.6237 | 0.1044 |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares: 80.085
Residual Sum of Squares: 77.319
R-Squared: 0.034924
Adj. R-Squared: 0.020326
Chisq: 4.83072 on 2 DF, p-value: 0.089335
## Appendix 2  DATA TABLES

### 2.1 Tax Gap, as percentage of Gross Domestic Product

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>4.13</td>
<td>3.98</td>
<td>3.94</td>
<td>3.90</td>
<td>4.26</td>
</tr>
<tr>
<td>Belgium</td>
<td>9.75</td>
<td>10.02</td>
<td>9.64</td>
<td>9.48</td>
<td>9.36</td>
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<tr>
<td>Bulgaria</td>
<td>8.78</td>
<td>9.03</td>
<td>8.61</td>
<td>8.42</td>
<td>8.26</td>
</tr>
<tr>
<td>Croatia</td>
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<td>6.50</td>
<td>5.68</td>
<td>5.33</td>
<td>5.22</td>
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<tr>
<td>Czech Republic</td>
<td>7.89</td>
<td>8.03</td>
<td>7.68</td>
<td>7.52</td>
<td>7.32</td>
</tr>
<tr>
<td>Denmark</td>
<td>3.64</td>
<td>3.78</td>
<td>3.52</td>
<td>3.38</td>
<td>3.12</td>
</tr>
<tr>
<td>Estonia</td>
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<td>19.56</td>
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<td>13.59</td>
<td>12.90</td>
</tr>
<tr>
<td>Finland</td>
<td>5.34</td>
<td>5.68</td>
<td>5.29</td>
<td>5.20</td>
<td>4.96</td>
</tr>
<tr>
<td>France</td>
<td>7.23</td>
<td>7.51</td>
<td>7.19</td>
<td>6.59</td>
<td>8.19</td>
</tr>
<tr>
<td>Germany</td>
<td>6.25</td>
<td>6.38</td>
<td>6.53</td>
<td>6.34</td>
<td>5.95</td>
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<tr>
<td>Greece</td>
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<td>11.78</td>
<td>11.18</td>
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<td>Hungary</td>
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<td>11.60</td>
<td>11.09</td>
<td>10.61</td>
<td>10.51</td>
</tr>
<tr>
<td>Ireland</td>
<td>3.25</td>
<td>3.30</td>
<td>3.27</td>
<td>3.16</td>
<td>2.93</td>
</tr>
<tr>
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<td>14.76</td>
<td>14.21</td>
<td>13.80</td>
<td>13.47</td>
</tr>
<tr>
<td>Latvia</td>
<td>9.93</td>
<td>9.75</td>
<td>9.13</td>
<td>8.93</td>
<td>8.26</td>
</tr>
<tr>
<td>Lithuania</td>
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### 2.4 Feasibility of the Policy.

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Appendix 3  FIGURES

3.1 Components of informal employment % of total employment(2)

Share of informal employment (%)
3.2 Percentage of economic units in the informal, formal and household sector (2016)
3.3 Government Deficit, % of GDP(2000-2017)
### 4.1 Cross-Sectional Data results for “payment statistics”

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Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
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<td>Tax Admin Budget as % of GDP</td>
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</tr>
<tr>
<td></td>
<td>(1.475197)</td>
</tr>
<tr>
<td>Public deficit as % of GDP</td>
<td>0.403983</td>
</tr>
<tr>
<td></td>
<td>(0.331033)</td>
</tr>
<tr>
<td>IT ratio in tax admin budget</td>
<td>-0.215506*</td>
</tr>
<tr>
<td></td>
<td>(0.101009)</td>
</tr>
<tr>
<td>Constant</td>
<td>12.695899***</td>
</tr>
<tr>
<td></td>
<td>(3.560741)</td>
</tr>
<tr>
<td>R-Squared</td>
<td>0.5469</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
### 4.3 Panel Data results

<table>
<thead>
<tr>
<th>Effect</th>
<th>Variable</th>
<th>Tax Gap as % of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Effects</td>
<td>Number of Payments per capita</td>
<td>-0.00034 (0.0005)</td>
</tr>
<tr>
<td></td>
<td>Value of Payments per capita</td>
<td>-0.00042 (0.0006)</td>
</tr>
<tr>
<td></td>
<td>R-Squared</td>
<td>0.0039751 0.0046757</td>
</tr>
<tr>
<td>Random Effects</td>
<td>Number of Payments per capita</td>
<td>-0.00077 (0.00048)</td>
</tr>
<tr>
<td></td>
<td>Value of Payments per capita</td>
<td>-0.0012 (0.0005)</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>8.1*** (0.61)</td>
</tr>
<tr>
<td></td>
<td>R-Squared</td>
<td>0.015 0.03065</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses.  *** p<0.01, ** p<0.05, * p<0.1, ’.’ p < 0.12