
National College of Ireland

Capstone Project

Thesis Proposal

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# Can Blockchain Technology Resolve Tax Avoidance Issues Associated with Multinational Companies in Ireland?

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# Abstract

The low corporate tax rate in Ireland has attracted a multitude of large multinational corporations since the 1980's. Government policies have been catered towards these corporations due to the influx of funding and investment that they contribute to the Irish economy. Yet in recent years, these large corporations have begun to exploit these policies and the taxation system by using targeted tax avoidance mechanisms. Due to this, corporations have been able to pay little to no tax which has led to the degradation of societal resources. These effects are unsustainable for the Irish economy in the long run. Therefore, this study aims to determine if newer technology such as blockchain, which has been proven to mitigate similar instances in other countries, could resolve the aforementioned issues in Ireland. Building on existing research, this study asks: can blockchain technology resolve tax avoidance issues associated with multinational corporations in Ireland?

Based on a review of current literature, many believe that it can. Hence a practical proof of concept was experimented with using a blockchain simulation. The simulation was supported by expert opinion from senior members in government and multinational companies that were acquired through interviews. The results indicate that the use of blockchain technologies would resolve tax avoidance issues associated with multinational companies by providing more transparency and oversight. The implementation would be cost effective, more secure, and is supported by a strong technical Irish infrastructure. On this basis, it is recommended that future blockchain platforms be implemented into governing structures. These findings are considered within the context of debate about how blockchains can be used in systems of E-governance and reformation. Future research is needed to gather a larger consensus and showcase the potentials of a blockchain with the use of complementary technologies.

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# List of Abbreviations

| | |
|---|---|
| **AIB** | Allied Irish Banks |
| **ASI** | Apple Subsidiaries Ireland |
| **BEPS** | Base Erosion and Profit Switching |
| **BOI** | Bank of Ireland |
| **CMMS** | Computerised Maintenance and Management Software |
| **CN** | China |
| **CT** | Corporation Tax |
| **DE** | Germany |
| **EU** | European Union |
| **GDP** | Gross Domestic Product |
| **IBM** | International Business Machines |
| **ICIJ** | International Consortium of Investigative Journalists |
| **IDA** | Industrial Development Authority |
| **IE** | Ireland |
| **IOT** | Internet of Things |
| **IP** | Intellectual Property |
| **IT** | Information Technology |
| **KBC** | Kredietbank ABB Insurance CERA Bank |
| **MNC (s)** | Multinational Corporation/Company (s) |
| **OECD** | Organisation for Economic Co-operation and Development |
| **P2P** | Peer-to-Peer |
| **SFI** | Science Foundation Ireland |
| **SSI** | Semi-Structured Interview |
| **SI** | Structured Interview |
| **UK** | United Kingdom |
| **US** | United States |
| **VAT** | Value Added Tax |

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# Chapter 1

## Introduction

Ireland is described by many as a tax haven (Levin and Mccain, 2013; Jaafar and Thornton, 2015 p.435-457; Phillips *et al.*, 2016). The corporation tax (CT) currently stands at 12.5%, attracting a number of multinational corporations (MNC's) (Revenue Commissioners, 2019). Metadata by the Industrial Development Authority (IDA) (2019) indicate that over 1,486 MNC's currently reside in Ireland. The Revenue commission (2019) states these MNC's recorded profits of up to €50 Billion in 2018, but weren't taxed due to Intellectual Property (IP) capital allowances (McCarthy, 2019). This tax avoidance technique alongside many others, if taxed at 12.5%, would have amounted to a €6.25 Billion surplus to Irelands economy (Ibid). Globally, these losses amount to €217 Billion (OECD, 2015). Due to the nature of fiscal policies, corporations have implemented aggressive tax planning strategies by making use of subsidies, grants, and policies that alleviate tax responsibilities (Eden, 2009). Thus, this thesis aims to describe the tax environment, the variables that contribute to its manipulation, and how new technology may enforce better oversight and accountability. The development of blockchain technologies and its uses as a decentralised-digital ledger has become increasingly adopted worldwide (Yli-Huumo *et al.*, 2016). Their implementations has proven to serve multitude of financial needs (Hou, 2017; Treleaven, Brown and Yang, 2017). Therefore, this study seeks to propose a blockchain framework that allows greater precision in lodging financial data and oversight by regulatory authorities. This study will validate or disprove this proposal by using expert opinion gathered from semi-structured/structured interviews (SSI/SI) from high ranking members in society. A simulated blockchain model will then be used as a proof of concept and contrasted against the interview results. Outlined below are the aims of this proposal and the literature review:

### Aims:

1. Describe the causes of current fiscal policies and the inception of MNC's in Ireland.
2. Define tax avoidance, the strategies that constitute it, and explore the effect it has on Irish society.
3. Propose how a blockchain system could potentially resolve corporate tax issues through better enforcement, oversight, transparency, and implementation.

# Chapter 2

## Literature Review

This literature review seeks to define what tax avoidance is and whether it can be alleviated. To understand tax avoidance, a brief history of Irish policy and economic structures will be outlined. Once an understanding is gained, the parameters tax avoidance as it relates to this thesis will be defined and supported by examples of tax avoidance strategies. The sustainability of these strategies and effect on society will be explored to define whether there is a need for reform. Finally, the role that blockchains could have in alleviating tax manipulation strategies will be analysed. This analysis will outline if better oversight can be achieved, thus reducing the positive and potential instances of tax avoidance.

### 2.1 Ireland's Economic and Policy Structure: A Tax Avoidance Flame

To understand the landscape and variables that allow MNC tax avoidance strategies, an outline of events has been analysed and extracted from literary sources. Honohan (2009), presents a two phased critical argument describing the amalgamation of MNC's and tax avoidance catering. The first phase emerged after the 1980's. Ireland had been experiencing economic stagnation due to the economic deficit (Honohan, 2009). New policies were introduced to tackle this problem (Dellepiane and Hardiman, 2015), whereby government spending was restricted, and centralised social partnership agreements were arranged with corporations to bring about wage moderation. In return, MNC's were granted income tax concessions (Ibid). Ireland began to export more goods and services, which secured the economic structure and developed the nation to the point of having one of the highest living standards in Europe (O'Leary, 1997). The newfound competitiveness and export-led revenue structure resulted in meticulous development of public infrastructure and a rise in employment by 12% (Honohan, 2009). The Irish economy was recovering and entered new growth, which was seen as a massive success by analysts around the world.(Murphy, 2000). Phase one is what many refer to as the 'Celtic Tiger' (Coulter and Coleman, 2003).

Phase two is described as having begun in the early 2000's and continuing till the 2007 Great Recession (Honohan, 2009). Growth sources in Ireland remained strong, however drastic systematic changes in revenue generation and fiscal structure occurred at the early 2000's

(Ibid). The unsustainable property and construction boom continued in Ireland, as it had done so in the United States (US) and United Kingdom (UK) for the past decade (Coleman IV, LaCour-Little and Vandell, 2008). Banks took and gave out more loans, pricing in the property market metastasized (Friedman and Posner, 2011), and exports became less relied upon (Honohan, 2009). Furthermore, tax concessions continued since the government could afford to subsidise them on the basis of construction industry growth and corporate profits (Ibid). This weakened Irelands' international competitiveness and shifted focus from revenues such as income tax, Value Added Tax (VAT) and excises that were considered to be more secure, to CT, stamp duties and capital gains that proved to be more sensitive, particularly in periods of economic distress (Honohan, 2009). MNC's noted these policies and began relocating operating factions to Ireland to escape higher CT rates in elsewhere, make use of the private services sector, and the emerging educated workforce (Ibid; Hart and Gudgin, 1994). Once the recession ensued in 2007, the Irish administration were already reliant on MNC's for potential investment, competitiveness, and profit that would fuel future economic growth (Honohan, 2009).

Contemporary and modern analytical sources tend to support the same sentiment that Honohan, (2009) outlines, with unfaltering viewpoints that attribute the national tax policy and environment to the events described above (Cochran, 2001; Stewart, 2015; Fagan, 2018). Whilst there is consensus on how these strategies became prominent, the effects and sustainability of such practices are still widely in debate in academic and professional settings (Hoshi and Kashyap, 2004a; Kapfer, 2006; Killian, 2006; Crivelli, De Mooij and Keen, 2015; Bird and Davis-Nozemack, 2018; Tedeschi, 2018). In order to better understand this, a definition has been formed in the following section which will be used to describe tax avoidance practices throughout this study.

### 2.2 Defining Tax Avoidance and How MNC's Plan Tax Strategies

The neo-corporatist relationship between the Irish state, labour, and MNC interest groups are referenced as the source of reliance on sensitive revenue sources as described the previously (Honohan, 2009; Stewart, 2015; Fagan, 2018). The following literary work aims to describe how MNC's have tailored taxation strategies to capitalise on the current environment and policies. Therefore, outlining the root definition of what tax avoidance is in relation to this study.

Johannesen, (2010) discusses the tripartism that allows MNC's to utilise tax avoidance strategies made possible by the taxation landscape, to enhance their profit generation. These strategies are executed through shell assets deployed by MNC's within an economy (Ibid). A review of 31 US IP-intensive MNC's found that firms have manufactured tax strategies that resulted in tax rates lower than the nominal US tax rate and far lower than those published in company accounts (Stewart, 2018). Stewart, (2013) also concluded that these results as seen in table 1, similarly correlate to MNC's in Ireland too, highlighting the difference between the legislated CT rate and the effective tax rate.

**Table 1:** Effective Tax Rate for Selected MNC Subsidiaries Operating in Ireland ($ millions) (Stewart, 2013).

| | Turnover | Pre-tax Profit **P** | Accounting Depreciation/ Amortization **D** | Tax **T** | Effective Tax Rate (1) **P/T** | Effective Tax Rate (2) **T/(P+D)** |
|---|---|---|---|---|---|---|
| Boston Scientific (2001-03)[a] | 1243 | 769 | 1.66 | 4.15 | 0.54 | 0.538 |
| Forest Laboratories (2005-07) | 4755 | 1618.1 | 44.11 | 100.9 | 6.2 | 6.1 |
| Symantic (2004-05)[b] | 275.1 | 275.1 | 0.10 | 0 | 0 | 0 |

a) "The principal activity of this subsidiary is the holding of shares in other companies and related intellectual property for which it receives royalties".

b) "The principal activity is described as "investment and intellectual property holding" (Stewart, 2013).

The results suggest that MNC's are able to pay little to no CT, as they have low or no taxable profits. This is done through a process known as Base Erosion and Profit Switching (BEPS) which forms the definition of tax avoidance throughout this thesis. According to the Organisation for Economic Co-operation and Development (OECD) (2013), BEPS is defined

as "*exploiting gaps and mismatches in tax rules*" (Ibid). This is done through a number of instruments as explained in the following sections.

Each country has predetermined tax rules and laws based on their local economic territory, known as the jurisdiction to tax (Norr, 1962). A MNC will be taxed on the goods and services it sells, based on the laws in place within that jurisdiction. If a MNC is based in multiple locations, it can lead to transfer pricing/profit switching practices. Transfer pricing refers to the internal pricing/transaction structures between entities owned by a MNC (Norr, 1962; Marian, 2013). This means that the MNC has the ability to set the price of a transaction between the entities it owns, dictating the cost of goods sold and earnings of its subsiding companies (Ibid). If, for example, a MNC owns two entities, entity X which is located in a highly taxed territory and entity Y located in a lower taxed territory. The MNC will sell cheaply goods from entity X to entity Y to raise profit margins, avoid tariffs, and pay lower taxes on earnings. Entity X is therefore taxed at a lower rate too as their earnings and revenue appear to be lower within their territory.

The allocation of revenue and expenditure is tailored to the MNC's discretion (Balakrishnan, Blouin and Guay, 2019). Meanwhile, the given territory where the transactions should have been taxed, are unpaid or paid to a lesser degree. Further instruments can then be used to further capitalise on the situation. Capital allowances is one such example, where the expenses of tools or services used to create a products is refunded through tax credits/discounts, or remittances (McCarthy, 2019). In cases where the MNC distributes digital products, the process of identifying these transactions becomes harder for authorities to regulate (Bunn, 2018). Particularly with globalised software products, the distinction between where the product is distributed, the sale location, and where the end user receives the product can be hard to classify (Ibid).

Using Apple as an example; Apple Sales International (ASI), one seven subsidiaries located in Ireland, is 'factory-less' (Stewart, 2018). ASI orders products from contracted firms in China who distribute the products to their final markets shown in figure 1. ASI pay for the goods while en-route and never physically handle the goods in Ireland (Ibid). The goods are resold "*to… appropriate distribution entities*" during shipping, otherwise known as licensed resellers for Apple products, meaning ASI aren't required to pay any excise or VAT fees either (Stewart, 2018). ASI switches the profits to another Irish subsidiary using BEPS by selling the title of ownership for the goods transactions (Ibid). These subsidiaries have no declared tax

residency anywhere in the world, despite being located in Ireland, and therefore, pay no CT on unrepatriated earnings (Stewart, 2018). ASI then claims that the subsidiaries' central management and control are not determined by ASI or Apple Inc, meaning that Apple are not directly taxed in the US either (Ibid), leading to double non-taxation or as recognised by the media as the "Double Irish" (Brothers, 2014). Despite having no employees at ASI, Apple accrued $22 Billion in revenue in 2011 whilst only paying $10 million in taxes (Stewart, 2018).

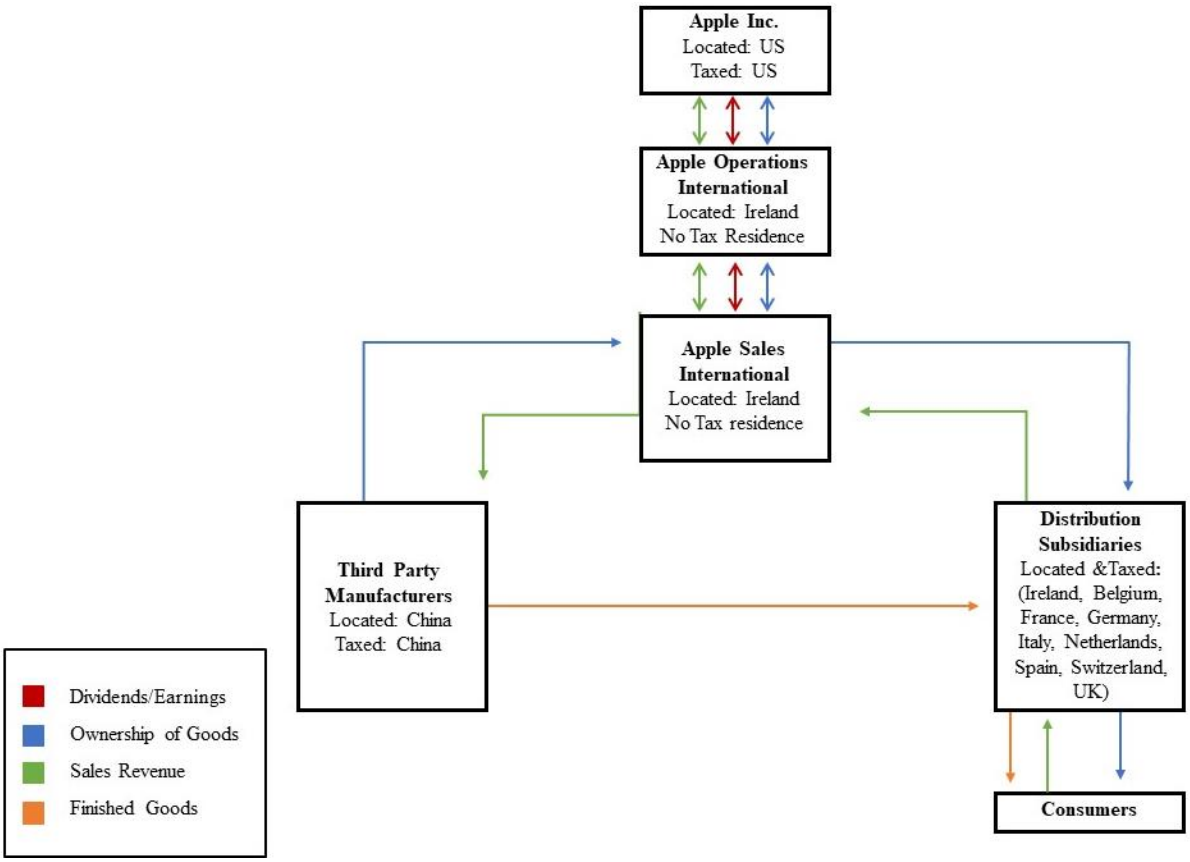


**Figure 1:** Apple's Transfer Pricing Structure (Levin and Mccain, 2013).

The use of transfer pricing is not illegal or abusive, the misuse is (Higinbotham *et al.*, 1986). Transfer pricing is necessary for certain transactions within a business and so, this study instead aims to focus on the BEPS instances of tax avoidance. Current BEPS regulations are strictly enforced but are tailored towards traditional forms of business (Ibid). In the new age of globalisation and digitalisation, the current legislation is lacking and requires a multilateral agreement instead of individual policies (Genschel, Kemmerling and Seils, 2011). Doing so, may promote fairness, and discourage the formation and use of tax havens (Lohse and Riedel,

2012). Updated regulations would alleviate the situation to a certain degree but the largest discrepancy in BEPS strategies is the lack of transparency and oversight (Eden, 2009; Balakrishnan, Blouin and Guay, 2019).

Key authorities around the world such as the International Consortium of Investigative Journalists (ICIJ) (2019), have shown overwhelming evidence through the Offshore Leaks, Bahama, Panama, and Paradise papers, of MNC's utilising BEPS strategies. The database collated by the ICIJ shows that over 785,000 MNC's currently operate in this capacity. The European Union (EU) and OECD have attempted to introduce stricter criteria/guidelines in the form of the EU's Black and Grey list to better classify BEPS instances, but in doing so, has delisted most of the world's tax havens in 2019 (Langerock, 2019). The legitimisation of tax policies allows MNC's to enhance avoidance strategies, attributing the lack of enforcement and oversight to regulating authorities (Ibid). Yet some authorities attribute the lack of enforcement to the large amount of personnel needed to analyse the data which can, in some cases, range to over a billion transactions per day (Cao, Chychyla and Stewart, 2015). With such lackadaisical enforcement on both aspects, the BEPS is predicted to continue (Tørsløv, Wier and Zucman, 2020). The continuation of tax avoidance can act as positive and negative variables to a society which will be discussed in the next section.

### 2.3 The Impact on Society and the Sustainability of Aggressive Tax Plans and Tax Avoidance

Fiscally, the government argue that MNC's provide increased foreign direct investments (FDI) and healthy tax competition, trumping the effects of tax manipulation (Kapfer, 2006). Killian (2006) argues that negative implications that occur as a result of tax avoidance will likely continue as it is based on individuals in the employment of the firm that must uphold responsibilities to various shareholders and directors based on a set of public and personal motivations. This includes raising profit margins while reducing expenses which is often done by passing costs onto to smaller contracted firms that they deal with (Ibid). Its contended that if the tax rates were to increase then MNC's could choose to relocate and cease investment (Ibid). This results in higher costs for contracted firms due to increased costs of business when acquiring a product or service. Tax non-compliance also tends to generate more non-compliance as more firms try to compete (Bird and Davis-Nozemack, 2018). As more

firms transfer intellectual property assets to Ireland, the Gross Domestic Product (GDP) inflates and distorts the reality of how Ireland benefits from these assets (Tedeschi, 2018).

In terms of societal impacts, MNC's are able to utilise the benefits of an educated workforce, foundational research funded, transportation, and utility systems that are created, subsidised, and maintained by tax revenue. This revenue could instead be focused towards the state's ability to provide essential services or securing the economy (Crivelli, De Mooij and Keen, 2015). MNC's erode and overuse the Irelands resources, yet no moral or ethical responsibility is reciprocated to society (Ibid). Logically, this could result in a multitude of corporations utilising these resources continuously to ensure gains, whilst the state continues to cater taxation policies towards them (Bird and Davis-Nozemack, 2018). Once a more lucrative location becomes available, these corporations may start to relocate. Although they have ensured success for themselves, the state and its people have incurred the resulting costs. In contrast, the Irish government could have concentrated resources toward society instead (Kapfer, 2006). Since MNCs have been relied upon to include Ireland in the global economy; if they were to pull out, Ireland could be in a weaker position, making it harder to negotiate competitively (Honohan, 2009). This is currently showcased by the zombie banks and corporations phenomenon seen in Japan (Guilford, 2014). Export led growth subsided as MNCs relocated to China, forcing banks to prop up unprofitable indigenous companies (Ibid). This led companies to feed on credit, causing market failure due to a lack of demand and rising debt (Hoshi and Kashyap, 2004b). Based on these sources, it's evident that MNC BEPS utilisation result in more negative outputs than positive ones and that major reform is needed in the long run.

### 2.4 Can Blockchain Technology Alleviate Tax Avoidance?

The Blockchain is an incorruptible digital ledger of information. It can not only be programmed to record financial transactions, but virtually everything of importance (Crosby *et al.*, 2016). Presently, the Irish tax system relies on truth (Stewart, 2018; Balakrishnan, Blouin and Guay, 2019). The principal firm relays past financial data to the government, which issues an invoice for tax returns (Alkhodre *et al.*, 2019). Instead, a Blockchain ledger would allow a MNC to log relevant data in real-time (Lin and Liao, 2017). This data would be stored permanently, with any changes being logged and transparent (Ibid). A blockchain system was first proposed by Stuart Haber and W.Scott Stornetta in (1991), but not invented until the

launch of bitcoin in 2009 by an entity with the pseudonym; Satoshi Nakamoto. The identity of the inventor(s) is unknown to date. Whether it was invented by an individual or a group of people, is also unknown (Swan, 2015).

The process of forming a blockchain is as follows; A party will request a transaction submission to start a block, the transaction is then broadcasted to a peer-to-peer (P2P) digital network, also known as nodes, where algorithms validate the transaction and the users (Drescher, 2017). The verified transaction is permanent and immutable. It is then combined with transactions from other users to create a chain of blocks for the ledger (Hearn and Brown, 2019). Once this done, the transactions are complete and a blockchain has been formed (Ibid). This is what's known as the blockchain system.

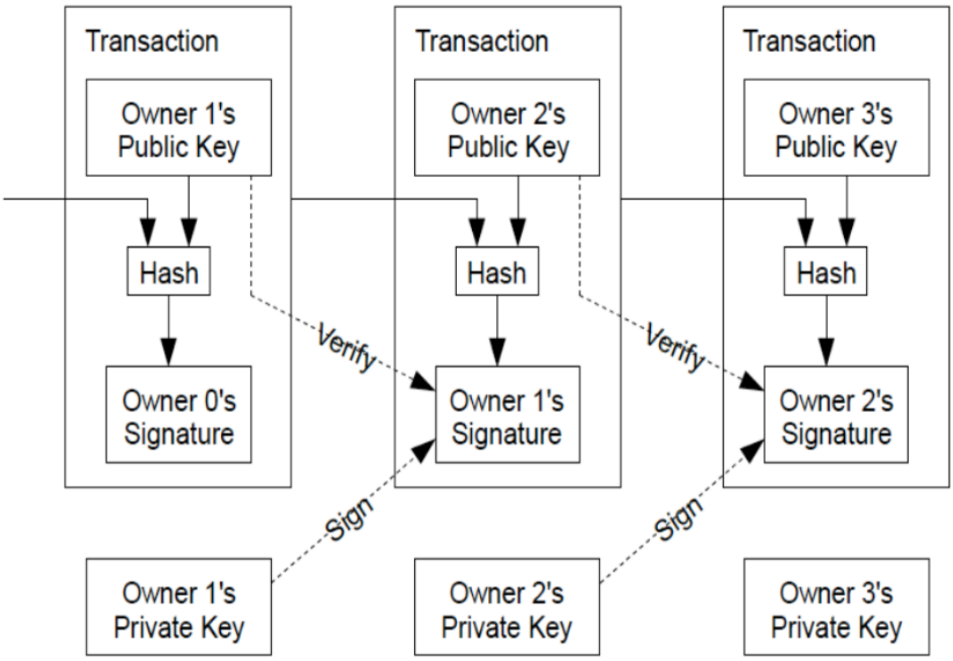


**Figure 2:** Blockchain Structure (Lemieux, 2017).

When starting a blockchain, a genesis block must be formed as shown in figure 2 (Lemieux, 2017; Pierro, 2017). The genesis/first block acts as an anchor for the blockchain system (Singh and Singh, 2016). It has no previous hash and ensures the hash of the next correlating block (Ibid). The hash in a block is its digital signature. Using algorithms, it converts the blocks text/data/transactions/commands into an encrypted output of fixed length (Pierro, 2017). A

submitted block will always use the same hash, but when any details are changed, the hash changes too (Drescher, 2017; Pierro, 2017; Zheng *et al.*, 2017). This is why a blockchain system is considered to be secure and transparent (Khan and Salah, 2018). To aid the readers understanding, an example has been outlined to demonstrate this; If MNC-X buys a pen from MNC-Y on weekly intervals and were using a blockchain system to log these transactions, a particular hash would be assigned provided it remained the same every time. MNC-X might then have to report its earnings but want to display lower purchase costs and so, they delete these transactions or sell the pen to a subsidiary. The hash would then change as the data within the block has changed. MNC-X may present their earnings and are audited. The auditor would be able to see that the original transaction's hash changed in comparison to what it previously was.

Hou, (2017) discusses china as one of the world's first ever applicators of blockchain technology in E-governing infrastructures. Some use cases of China's blockchain system includes information sharing, greater transparency/accessibility to government information/services, strengthened security, and further public service capabilities. Implementation nationwide has occurred in various forms which reinforces China's notion of blockchain as an effective framework for modernisation (Ibid). The significance of this large-scale modernisation effort is important to note and is one of the first successes of its kind in history (Giebe and Schweinzer, 2014). Feng *et al.,* (2020) builds on this by proposing a paperless electronic invoice system which tracks and automatically processes transaction responses involved in the administration of taxes. These ideas have come to fruition recently, with mega-cities such as Shenzhen and Beijing adopting pilot applications in collaboration with Tencent, to validate blockchains credibility (Hou, 2017). This framework known as *Fapiao,* is tailored towards VAT and CT transactions (He and Xiao, 2019). So far, the results have been positive, leading to lower operating costs for both the business and state. Its benefits include lowering public service costs, increasing convenience, and bettering oversight to ensure a healthy and fair tax environment (Ibid). In relation to Ireland's tax avoidance cases, transparency is the key issue. MNC's argue information isn't disclosed to stay competitive and not manipulate share listings (Balakrishnan, Blouin and Guay, 2019; Langerock, 2019). Nodes could therefore be operated and maintained by government officials or appointees agreed upon by the state and MNC's. Appointees would have the ability to maintain security over this information similarly to what Hou, (2017) outlines. The Fapiao has been introduced in response to the growing emergence of large Chinese E-commerce and digital firms, which operate on

much larger scales and thus require far more oversight (Conrad, Sunny and KPMG China, 2019). The immense volume of transactions per day can be hard to monitor, requiring large amounts of personnel, time, and money for oversight (Ibid; Cao, Chychyla and Stewart, 2015).

A common misconception with blockchain is the accessibility of information (Lin and Liao, 2017). At present, information stored on blockchains is available for public access however, this feature built in and can be instructed to maintain firm privacy and compliance (Ibid). This system would cut down on administration costs while providing significant improvements in oversight (Alkhodre *et al.*, 2019). As shown in the sources above, current implementations have proven tangible frameworks (Giebe and Schweinzer, 2014; He and Xiao, 2019). Despite the fact that China has been the first to implement such a system, the results have garnered more attention and development on blockchains worldwide (Yli-Huumo *et al.*, 2016; Zheng *et al.*, 2017). In addition, this has widened the appeal of the technology on a global level, with proposals being made on other taxation sources such as VAT (Wijaya *et al.*, 2017). As research progresses, the inevitable transition to disruptors in technology become ever growing and thus, through economies of scale, easier to implement (Yli-Huumo *et al.*, 2016; Biswas and Muthukkumarasamy, 2017).

The implementation of such a framework cannot be discussed without acknowledging the resources and costs involved with its adoption. Economies of scale, whilst a tried concept, doesn't currently exist with blockchains that are used on wide-scale professional platforms (Catalini and Gans, 2016). Other costs involve hiring/training development and maintenance teams (Ibid). Servers or nodes need to be established which require comprehensive physical and cyber security systems/personnel (Halpin and Piekarska, 2017). These nodes will need to be housed in secure locations which can be expensive to acquire (Davidson, De Filippi and Potts, 2016). Educational infrastructures need to be established to build up the skill set of future prospective staff as outsourcing will be expensive (Jun, 2018). Courses have been introduced by universities in Ireland, but are only in their infancy and will need to be refined to establish a comprehensive educated workforce in this field (Clohessy *et al.*, 2018). For smaller companies, these costs may be hard to manage and, in some cases, impossible to implement. On a general basis, companies using current revenue infrastructures have already employed and trained staff with expertise on the matter. Significant resources have been assigned to facilitate this and opposition may be raised if further changes are required, particularly if a MNC has future proofed current company digital interfaces. In terms of the government, massive amounts of investment will be needed from taxpayers (Alkhodre *et al.*, 2019).

At the time of writing, the state is facing an unprecedented historic event due to COVID-19 (Ozili and Arun, 2020), which has increased the budget deficit and degraded the economy to an extent far worse than the great recession in 2007 (Beirne *et al.*, 2020). This could result in political opposition as forefront issues become prioritised. Even if one were to ignore the current status of Ireland's economy, precedence set by governmental actions seem to suggest that the government is not wholly interested in the enforcement of CT rates with certain MNC's (Barrera and Bustamante, 2018). As presented in the EUs' State Aid investigation of Apple in 2014 (Wang, 2018), Apple were given preferentially endorsed commission assessments of tax returns. These returns amounted to an effective rate of 1% "*despite having no factual or economic justification*" (European Commission, 2014). The EU ruled that €14 Billion had to be recovered for the debts owed, which was subsequently rejected, and set for appeal by the Irish government and Apple (Renta, 2018). The ruling was rejected to preserve the integrity of a low-tax environment for MNC's and ensure tax certainty for prospective for future MNC's (Ibid). Besides these objections, no other justified arguments have been made by the state except for a potential loss of interest in MNC's operating or setting up in Ireland and the loss of jobs that result from this (Renta, 2018).

This becomes a moral question for those in government: Does the Irish state want to keep expanding its reputation as the tech-capital of Europe or would they prefer to enhance enforcement and policies to ensure the betterment of the public through more state capital? Based on the response above, one can see the former as being the answer to this question (Stuart, 2017). Based on the current situation with COVID-19, the state has already issued large amounts of funding to MNC's to maintain operations through the pandemic (Holton, Phelan and Stuart, 2020). This has put a strain on public resources to a certain degree (Ozili and Arun, 2020), where recouped tax payments could have been used to subsidise those costs or minimise the effects of the current recession. MNC's are however, a current key driver of macroenvironmental policies for the state and this trend looks to be continuing (Laffan, 2018). The state may look to blockchains to ensure better transparency, increase its reputation and public appeal. Overall, making sure that if there are valid cases where returns are not duly valid, comprehensive arguments/proof are more easily accessible which would dissuade the encroachment of the EU on sovereign state member policies. One can assume that the implementation of blockchain technology is in the state's best interest resulting in the state meeting the responsibilities it has to the public, ensure the integrity of the Irish tax system, and allow the continued development of technological dominance in Europe.

## 2.5 Conclusion

This paper argues that the introduction of a blockchain would allow greater transparency and oversight ability, which will result in a reduction of tax avoidance cases by MNC's in Ireland. Ireland has adopted a culture for facilitating MNC's in order to stay competitive globally (Killian, 2006). The basis of tax avoidance is rooted in policy structure (Honohan, 2009; OECD, 2013, 2015) and the complicated transactions structures that lack transparency (Balakrishnan, Blouin and Guay, 2019), but a blockchain system may be the first step towards holding MNC's accountable and regulating their actions as seen in China (Giebe and Schweinzer, 2014; Hou, 2017; Conrad, Sunny and KPMG China, 2019; He and Xiao, 2019). Tax avoidance may have negative impacts on society and may lead to a domino effect where firms influence other firms to incorporate BEPS strategies (Kapfer, 2006). This would be unsustainable for the economy in the long run (Bird and Davis-Nozemack, 2018) and leads to economic decline and extraverted reliance (Crivelli, De Mooij and Keen, 2015). Furthermore, the potential revenue acquired from enforced tax returns would result in greater public infrastructure development, ultimately bettering the nations resources (Ibid).

The viability of blockchain platforms as a state administration and taxation tool has been proven to work and shows success in lowering cases of tax avoidance (Hou, 2017; Conrad, Sunny and KPMG China, 2019; He and Xiao, 2019). Whilst the cost of implementation may be high and opposition may be faced, ultimately, it would be in the interest of the Irish government and the public to support and implement a framework to increase transparency/enforcement (Laffan, 2018; Renta, 2018). This would increase the public's perception, ensure more harmonised collaboration with MNC's, and reduce the involvement of the EU Commission in sovereign state matters. Based on these points, this study proposes the following research question in the next section.

# Chapter 3

## Research Question

*Can Blockchain Technology Resolve Tax Avoidance Issues Associated with Multinational Companies in Ireland*?

As aforementioned, this study seeks to establish preliminary exploratory research on how blockchain can resolve tax avoidance issues in Ireland. China have proven that blockchain technologies are effective for administering taxation requirements (Giebe and Schweinzer, 2014; Hou, 2017; Conrad, Sunny and KPMG China, 2019; He and Xiao, 2019). The researcher does acknowledge that the context that China operates in, is widely different to Irelands landscape and infrastructure. Therefore, a thorough review and proof of concept will be established in the following sections to show how blockchain technology can be used in an Irish context and determine whether it's an effective tool in combatting cases of tax avoidance. The methods that will be used to establish these enquiries will be discussed in the next section.

# Chapter 4

## Methodology

The methodology aims to outline how any structurally supporting data will be acquired in order to validate or disprove the views presented in the literature review and therefore, answer the research question; *Can Blockchain Technology Resolve Tax Avoidance Issues Associated With Multinational Companies in Ireland?* The research stance and any prerequisite assumptions that dictate the methodological approach will be explained, clarifying why certain actions contrast other studies analysed in chapter 2. The intricacies of the research methods used to gather, analyse, and present upcoming data will also be discussed in detail, as well as the limitations that might occur throughout the process.

### 4.1 Research Philosophy

Tax avoidance in Ireland is immensely complicated due to the number of possible variables involved, and that continue to evolve (Clausing, 2007; Devereux, Lockwood and Redoano, 2008; Balakrishnan, Blouin and Guay, 2019). One needs to be aware of the consistently fluid national and international contexts in which these MNC's operate in. Blockchain technologies are similar in this aspect and continue to evolve at rapidly. The technology is in its infancy and is continuously being developed (Catalini and Gans, 2016; Yli-Huumo *et al.*, 2016). As critiqued in chapter 2, the use of blockchain in taxation instances is not widely implemented and lacks an abundance of sufficient empirical data (Giebe and Schweinzer, 2014; Catalini and Gans, 2016; Biswas and Muthukkumarasamy, 2017; Hou, 2017). Therefore, this thesis requires the use of interpretive methods to complete its objective. The study is guided by the works presented by Hou, (2017), He, and Xiao, (2019) in the literature review but this section aims to build on the more technically focused methods proposed by Pierro, 2017, Alkhodre *et al.*, (2019), Hearn and Brown, (2019), and Drescher, (2017).

In terms of blockchain technologies, the use of 'Fapiao' does not bear any relevance to the Irish tax landscape. The technology is implemented through an online/phone application known as *WeChat* (2015), which does not operate in Ireland (Riccardi, 2018). Hence, the use of alternative platforms will be used to infer whether similar results can be obtained through

different means. Additionally, the Irish revenue commission already has online capabilities that it uses to process tax requirements (Connolly, Bannister and Kearney, 2010). These capabilities may make it easier to transition to a blockchain framework. Experts' opinions must be gathered from authorising bodies to see if; transitional capabilities exist, assert how a transition could be established, and assess if it will mitigate BEPS instances. To gather these experts' opinions, SSI's were used, as a first phase, to allow topics to be explored in detail whilst remaining relevant to the study (McIntosh and Morse, 2015). SI's were also used as a separate tier in sensitive instances to divert implication while obtaining data (Bardoloi *et al.*, 2017). Considering that this research is exploratory in nature blockchain simulations were used, as a second phase, to demonstrate a fixed BEPS environment. This must occur as the rigidity of privacy and operating laws do not allow for firms or the state to partake in such studies without extensive authorisation processes (McLaughlin, 2018; Clarke *et al.*, 2019). Due to the complex nature of the subject matter and the wide breadth of specialised knowledge required, a multi-tiered approached was used in context to the specialisation of the individual participant. These two phases of methods drive the overall methodological approach, which is to determine whether cases of BEPS can be resolved by the blockchain technologies proposed in chapter 2 whilst maintaining privacy and exhibiting a practical theoretical framework.

## 4.2 Research Design

This research uses a multi-tiered and multi-phased approach. Each interview participant covers a field of expertise that they are knowledgeable in. These varied responses provide a tiered list of professional opinions' and expertise on the topics outlined in the literature review. The responses were collated and compared to a simulation of a working blockchain model to see whether their evaluations coincide with the physical implementation of a blockchain. As mentioned in the literature review, the current relationship between MNC's and the state is unsustainable and requires reform (Kapfer, 2006; Crivelli, De Mooij and Keen, 2015; Bird and Davis-Nozemack, 2018; Tedeschi, 2018). These two phases aim to provide a working proof of concept supported by expert opinion, that can be developed into a fully-fledged blockchain model that can used to reform in the future. The interviewees consisted of high-ranking individuals in organisations that are involved in the processes described in chapter 2. This includes members of government and MNC's. The simulation was built to emulate a fixed example of a MNC that utilised BEPS strategies. By using experimental simulation data, the researcher hoped to establish reproducibility and scalability for future research/development.

The simulation ran two blockchain instances influenced by Apples BEPS strategies in Chapter 2 (European Commission, 2014; Stewart, 2018). The first blockchain consisted of possible transactions in the course of business between a MNC, its subsidiaries, and contracted manufacturing firms. These transactions outputted a set of particular hash values. The second blockchain exists in the same context and utilises a transfer pricing attempt. The hash values were retrieved were then compared to the initial values.

### 4.3 Interview Design

Desirable interview participants were chosen based on their rank within an organisation. Senior officials were prioritised due to their high level of overview in their organisation. Senior members generally tend to have a better understanding of the context that they operate in (Starbuck and Mezias, 1996; Hayes, Rose-Quirie and Allinson, 2000), whereas general staff tend to be more knowledgeable on specific functions (Ibid). To maintain a fair balance of critical responses, a variety of organisations were propositioned across a number of sectors. This included banking, investment groups, MNC's in Ireland and China, technology companies specialising in blockchain, the department of finance, and the department of revenue. Candidates were sent an email using *Gmail,* (2020) describing the research project and how it applies to their area of expertise (Appendix I). Once the candidate conveyed an interest, consent emails were sent for the candidate to complete and return to the researcher (Appendix IV). If requested, the interview questions were also sent so the candidate could prepare or to submit to higher authorities for approval to participate (Appendix II; Appendix III). This would become a common occurrence throughout the acquisition process. Upon completion of the consent form (Appendix IV), a date was arranged for an informal conversation to discuss the parameters of the interview. Once the candidate felt comfortable, formal interviews were arranged for a later date. Two pilot interviews were first held with colleagues to refine the researchers interview techniques and prepare for later interviews.

The interviews needed to be open ended, yet focused. This would allow the participants to elaborate on ideas, while remaining relevant to the subject matter. SSI's were deemed to be the most fitting method under these requirements (McIntosh and Morse, 2015). Depending on the individual's, interviews ranged from informal conversations to formal interviews. Informal interviews/conversations were effective in providing a comforting and engaging environment that prompted the discussion of ideas. This meant that respondents were encouraged to outline

their positions without being forced into specific subject lines or being limited in what they could say. This approach was particularly useful for candidates discussing the technological aspects of the project. The formalised approach was used for individuals that required the utmost compliance for what they could discuss. Some candidates worked with certain private individuals, departments, or organisations which limited some information that could be used on record. The formal approach allowed the expression of opinion and discourse without implicating the individual or anyone else (Bardoloi *et al.*, 2017). This approach was useful for members of government or candidates that were employed at MNC's.

Interviews were originally intended to be in-person. This had to be changed due to the widespread social distancing/lockdown measures, incorporated by the Irish government in response to the COVID-19 pandemic (Department of the Taoiseach, 2020). Instead, the use of online, email, and phone interviews were adopted alternatively. Interviews occurred in 15 to 45-minute timeframes with interviewee's answering five-to-10 questions each. Questions were pre-selected based on their sector. Questions also varied based on the rank of the individual within an organisation. In some instances, questions were deemed to be too sensitive to discuss, as cases and rulings were still pending. These questions were then omitted or revaluated.

### 4.4 Qualitative interviews

Two qualitative interviews were held during this process. One interview was conducted in an informal, semi-structured manner and one required the use of a structured interview. Each candidate held expertise on a specific sector as shown in table 2 below.

**Table 2:** Participant Profile (Appendix II; Appendix III).

| | |
|---|---|
| **Interviewee 1** | Department of Finance |
| **Interviewee 2** | Fluke Corporations |

Interviewee one's line of questioning was centred on blockchain and the use cases of such technologies in society/governance. This candidate currently specialises in legislation and implementation of blockchain technologies in society. They are recognised as one of the leading blockchain experts in Ireland and collaborate with a variety of institutions and

governments around the world. The interview was held on *Zoom* (2020) which allowed the use of in-app local recording that was automatically saved into the encrypted file. The interview lasted 40 minutes and a number of topics were discussed with the ranging from the participants current perceptions of technologies used to administer tax, their thoughts on new blockchain platforms, the estimated cost of implementation, and the potential benefits in doing so (Appendix II).

Interview two revolved around the MNC's perspective on blockchain technologies. The participant holds a senior position in the company which specialises in Computerised Maintenance and Management Software's (CMMS). Whilst the participant did not have a large repertoire of technical blockchain knowledge, they did describe how their organisation was preparing for an implementation and the reasons as to why. The interview lasted for 15 minutes and followed a rigid line of questioning as requested by the candidate. The candidate described the current digital platforms used by the MNC, their perspective on blockchain implementation, and the costs that may be involved. Certain topics contained sensitive information and therefore had to be redacted during the meeting, but the interview allowed a large amount of discourse and understanding. The breakdown of the two participants answers will be given in the following chapter (Appendix III).

### 4.5 Blockchain Simulation Models

The following section details the creation process of two blockchains (Appendix V). All experiments were simulated in the open-source application *Python* (2001) using the *PyCharm interface* (2010). Each line of code produced and demonstrated in the figures below will be explained thoroughly to ensure the understanding of all readers. Each blockchain system demonstrates the fundamental architecture of a blockchain and aims to prove how such systems can provide greater precision in lodging financial data. Hence, allowing greater oversight by regulatory authorities which could potentially resolve corporate tax issues in Ireland (Hou, 2017; Laffan, 2018; Renta, 2018; Conrad, Sunny and KPMG China, 2019; He and Xiao, 2019). To ensure that the reader understands the upcoming terminology within the code, the researcher would like to outline the following classifications; MNC-US refers to a MNC that is located in America, MNC- DE refers to a MNC/Subsidiary in Germany, MNC-CN refers to a MNC/subsidiary in China, MNC-IE refers to a MNC/subsidiary in Ireland, and Customer-1 refers to a specific individual.

Block-1.py

```
1   #BEPS Blockchain Simulation
2   #Python Script 1
3   #File Name: Block.py
4
5   import hashlib
6
7   class Block:
8       def __init__(self, previous_hash, transaction):
9           self.transactions = transaction
10          self.previous_hash = previous_hash
11          string_to_hash = "".join(transaction) + previous_hash
12          self.block_hash = hashlib.sha256(string_to_hash.encode()).hexdigest()
```

**Figure 3:** Creation of Block Architecture in Script 1 (Appendix V).

Figure 3 shows the initial steps in script 1, file *Block-1.py*, for creating the first block. This figure shows the code to write the blocks within *blockchain's 1* and *2*. The overall contents within this script details all functions that were necessary to store all hashing functionalities. The meaning behind each line of code is as follows; line 5: imports PyCharm's module called *hashlib*. Hashlib is the core of the researcher's simulation, it allows one to use hash functions in PyCharm, which is a critical aspect of blockchain. The hashlib is a library made for Python users to access hash algorithms (Pierro, 2017), line 7: creates a class called *Block* which stores all hashing functions, line 8: initialises the block's two critical components, the transactions, and the previous blocks hash, line 9: sets up variables called *self.transactions* to ensure each block contains transitions, line 10: sets up variables called *self.previous_hash* to ensure each block contains the hash of the previous block, line 11: creates a string of all the transactions appended to each other, with the previous blocks hash appended last, and Finally, line 12: constructs the hash of this current block, using PyCharm's hash function, *sha256*, which is the same function used in Bitcoin transactions (Pierro, 2017). Sha256 uses an algorithm to compresses the hash to 245bits or more simply, 64-character outputs (Ibid). It is also responsible for verifying the transaction which makes it a critical security component (Alkhodre *et al.*, 2019). An important note to make is that the last component of line 12 produces a hash in a hexadecimal format (Pierro, 2017), which is vital to print the outputted hash in a text representation as will be shown in the next chapter.

Main-1.py

```
#BEPS Blockchain Simulation
#Python Script 1
#File Name: Main.py

from Block import Block

blockchain = []

# Number 1: A genesis block is used to create the blockchain. It starts with a transaction submission.
genesis_block = Block("start", ["MNC-US orders 1 phone from MNC-CN to send to MNC-DE"])

# Number 2: The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries.
second_block = Block(genesis_block.block_hash,["MNC-CN send 1 phone to MNC-DE"])

# Number 3: The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities.
third_block = Block(second_block.block_hash,["MNC-US pay $5 to MNC-CN for 1 phone en-route to MNC-DE"
                                             "MNC-CN transfers title of phone ownership to MNC-US",
                                             "MNC-US sells 1 phone for $500 to MNC-DE",
                                             "MNC-US transfers title of phone ownership to MNC-DE"])

# Number 4: The distribution entities sell the goods to the final market and takes receipt of the payment.
fourth_block = Block(third_block.block_hash,["MNC-DE take delivery of 1 phone,"
                                             "MNC-DE sells 1 phone to CUSTOMER-1",
                                             "CUSTOMER-1 pays $1000 to MNC-DE"])

print("Block hash: Genesis Block (A genesis block is used to create the blockchain. It starts with a transaction submission)")
print(genesis_block.block_hash)

print("Block hash: Second Block (The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries)")
print(second_block.block_hash)

print("Block hash: Third Block (The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities)")
print(third_block.block_hash)

print("Block hash: Fourth Block (The distribution entities sell the goods to the final market and takes receipt of the payment)")
print(fourth_block.block_hash)

```

**Figure 4:** Blockchain Framework, Recording MNC's Transactions Pre-BEPS Strategies Implementation (Appendix V).

Figure 4 shows every command in script 1, file *Main-1.py*, for creating all blocks and associated transactions for blockchain 1. This figure shows the code that was written to adjoin the blocks in blockchain 1 and 2. Each line of code is explained as follows; line 5: imports the block as a separate entity, as described and shown above in figure 3, line 7: creates an empty array which will be filled with all blocks created for both blockchains, line 10: creates the genesis block, which is the first block in the blockchains. Another important key to note is that since this is the first block of the blockchain there is no previous block, therefore no previous hash. Within the genesis block the researcher created a digital message stating: *start* (Ibid). This message is now considered as the previous hash for the next block. The digital message can be any arbitrary message/digital information, it is simply used to anchor the blockchain because there is no previous hash. The next important aspect of the blockchain is the transactions. One transaction in line 10 states: “MNC-US orders 1 phone from MNC-CN to send to MNC-DE”. However, it’s necessary to note that if this were a real implementation, these transactions would not necessarily be in text as it can be lodged in any data form. Since this is a fundamental model, the researcher intended to leave the transactions in text to demonstrate the legitimacy and integrity the blockchain holds.

Line 13: creates a second block which contains the genesis' blocks hash and a transaction stating "MNC-CN send 1 phone to MNC-DE". This line shows the MNCs contracted manufacturer sends the requested goods to its distribution entities/subsidiaries (Ibid). Line 15: creates a third block which contains the second blocks hash and a total of four transactions; Transaction 1: "MNC-US pay $5 to MNC-CN for 1 phone en-route to MNC-DE", transaction 2: "MNC-CN transfers title of phone ownership to MNC-US", transaction 3: "MNC-US sells 1 phone for $500 to MNC-DE", transaction 4: "MNC-US transfers title of phone ownership to MNC-DE". Overall, this block is intended demonstrate the MNC paying the contracted manufacturer for goods, then selling the goods to its distribution entities (Appendix V). Lastly, line 22 creates block four. Block four contains the hash of block three and 3 transactions. Transaction 1: "MNC-DE take delivery of 1 phone", transaction 2: " MNC-DE sells 1 phone to CUSTOMER-1", transaction 3: CUSTOMER-1 pays $1000 to MNC-DE". Block four portrays how the distribution entities sell the goods to the final market whilst obtaining receipt of the payment (Ibid). Lines 26-36 clearly annotates each line of code necessary for the output of each blocks unique hash identity. These outputted hashes will be analysed and compared to blockchain 2 to determine if such systems can provide greater precision and oversight in lodging financial data (Appendix V).

Block-2.py

```
1   #BEPS Blockchain Simulation
2   #Python Script 2
3   #File Name: Block.py
4
5   import hashlib
6
7   class Block:
8       def __init__(self, previous_hash, transaction):
9           self.transactions = transaction
10          self.previous_hash = previous_hash
11          string_to_hash = "".join(transaction) + previous_hash
12          self.block_hash = hashlib.sha256(string_to_hash.encode()).hexdigest()
```

**Figure 5:** Creation of Block Architecture in Script 2 (Appendix V).

Figure 5 shows the initial steps in script 2, file *Block-2.py*, for creating blockchain 2 (Ibid). This figure shows the code that was written to store the blocks within blockchain 2, in summary the entirety of this figure matches the code used in figure 3 since both scripts create blockchains, 1 and 2, respectively. With the exception of blockchain 2 containing a different set of transactions as discussed below (Appendix V).

Main-2.py

```
#BEPS Blockchain Simulation
#Python Script 2
#File Name: Main.py

from Block import Block

blockchain = []

# Number 1: A genesis block is used to create the blockchain. It starts with a transaction submission.
genesis_block = Block("start", ["MNC-US orders 1 phone from MNC-CN to send to MNC-DE"])

# Number 2: The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries.
second_block = Block(genesis_block.block_hash,["MNC-CN send 1 phone to MNC-DE"])

# Number 3: The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities.
third_block = Block(second_block.block_hash,["MNC-US pay $5 to MNC-CN for 1 phone en-route to MNC-DE"
                                             "MNC-CN transfers title of phone ownership to MNC-US",
                                             "MNC-US sells 1 phone for $500 to MNC-DE"])

# Number 4: The distribution entities sell the goods to the final market and takes receipt of the payment.
# Payment is then transferred/shifted to country that has the title of ownership.
fourth_block = Block(third_block.block_hash,["MNC-DE take delivery of 1 phone,"
                                             "MNC-DE sells 1 phone to CUSTOMER-1",
                                             "CUSTOMER-1 pays $1000 to MNC-DE",
                                             "MNC-US sells the title of phone ownership to MNC-IE"
                                             "MNC-DE transfer profits to MNC-IE"])

print("Block hash: Genesis Block (A genesis block is used to create the blockchain. It starts with a transaction submission)")
print(genesis_block.block_hash)

print("Block hash: Second Block (The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries)")
print(second_block.block_hash)

print("Block hash: Third Block (The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities)")
print(third_block.block_hash)

print("Block hash: Fourth Block (The distribution entities sell the goods to the final market and takes receipt of the payment)")
print(fourth_block.block_hash)
```

**Figure 6:** Blockchain Framework, Recording MNC's Transactions Post-BEPS Strategies Implementation (Appendix V).

Figure 6 follows the same structure as figure 4 or blockchain 1. The only difference being the addition and removal of certain transactions (Ibid). These changes occurred in the third and fourth block in blockchain 2. The changes are as follows; in the third block, “MNC-US transfers title of phone ownership to MNC-DE" was removed, in the fourth block, line 25, “MNC-US sells the title of phone ownership to MNC-IE”, and line 26, “MNC-DE transfer profits to MNC-IE” was added. These two transactions represent a transfer pricing attempt by the MNC (Appendix V).

### 4.6 Data collection

The software’s used to contact participants and conduct the interviews were Gmail and Zoom. This software choice was made as recordings are saved directly to the encrypted device and folder, rather than online mediums that could compromise the data. Recorded files were kept on an encrypted laptop in a secure file only accessible to the researcher by password. The laptop was held in a secure locker at the researchers’ home, accessible only to the researcher.

## 4.7 Limitations

This dissertation uses an exploratory approach due to the limited instances physical implementations of blockchain in E-governance. The instance where it has been implemented is in China, which abides by different laws and governing structures. The country is also the first of its kind to implement blockchain technology in this context (Hou, 2017). The implementation is still in the early stages of the program thereby, limiting the amount accessible, quantifiable, data that exists (Ibid). Furthermore, the existing data is being analysed by the Chinese officials and Tencent. Further analysis by external parties are planned, but as of yet have not been arranged (Hou, 2017). Aside from this, no other practical implementations have occurred in the same context, limiting the influences that the researcher could relate to in this study. This is why uses of blockchain in other taxation applications were used as methodological influences.

The researchers academic background lies in business and not coding/programming. A significant portion of time had to be set aside to become familiar with the basics of the python language. Once this was achieved, the researcher then had to formulate a blockchain structure that would be relevant to the intended use of this thesis. As the intricacies of 'fapiao' remain private for security and competition reasons (Hou, 2017), other methodological approaches had to be referred to so that the model achieved a similar function (Pierro, 2017). The researcher had intended to use the *Hyperledger platform* (2020) originally but was restricted in doing so due to the limited knowledge and skill threshold.

The researcher initially received a large amount of interest, relative to the number of participants that were propositioned. From the 40 emails that were sent out, the researcher initially received 23 interested prospects. Out of the 23 prospects, 12 respondents accepted the interview proposal. The remaining 11 respondents required more information or approval from authorisation at their organisation. The request for more information was fulfilled by sending question lists or discussing the parameters with an individual. Once this was completed, two participants received approval to partake in the interviews whilst the remaining either rejected or were not allowed to partake in the study. However, several participants did engage in informal conversations and helped point the researcher to several new sources of information.

The interview process occurred during the COVID-19 pandemic when most of the country and businesses were in lockdown (Department of the Taoiseach, 2020). This hindered

the researcher's ability to meet participants for face-to-face engagements and limited the participation of two individuals that required in-person engagements. Phone, email, and online interviews were conducted as an alternative data-gathering method to compensate for this. This led to a higher abandonment rate as certain candidates required very specific settings for interviews, no longer possible through online platforms. Some setting examples include the use of specific recording equipment, specific interview location, and the inclusion of a Human Resource (HR) Member/third-party overseer to ensure that no one was implicated. Not every participant had the necessary internet capabilities to participate in the interviews and most participants were working from home, so some did not feel comfortable in conducting an interview over digital platforms. The other remaining interviews were rescheduled upon the candidate's requests, which meant that interviews intended for March till May, were instead completed during June and early/mid-July. Five participants had to cancel in this time to tend to personal engagements.

Most participants held senior positions, which meant that they had time constraints as they were managing reopening plans for their organisation in preparation for the easing of lockdown measures. The time constraints also impacted the depth of research conducted as interviews that were scheduled before the lockdown needed to be reorganized or cancelled. Therefore, limiting the scope of research to a smaller number of participants. Due to the sensitive subject matter, many participants had to decline from stating an opinion as it could impact their professional working relationships negatively and confirm bias in positions of authority. Some participants weren't able to participate due to the subject matter. The association with a study of this nature would be deemed inappropriate due to their role and so, they rejected the proposal. Similarly, some information could not be disclosed legally, which forced the researcher to approach certain candidate interviews with extreme care and in some cases, disregard certain lines of questioning. During these months, there was a change in Taoiseach which brought changes in government personnel (Martin, 2020). Earlier instances where permission was received, were suddenly revoked. This combination of factors meant that a further five participants had to withdraw their participation and out of the 14 individuals originally available, only two participants remained after the course of these events (Appendix II; Appendix III).

# Chapter 5

## Analysis and Findings

The purpose of this research was to answer the research question; *Can Blockchain Technology Resolve Tax Avoidance Issues Associated with Multinational Companies in Ireland?* Based on the findings listed below, the researcher aims to answer and conclude this study's objective. To establish whether the proposal was possible, the researcher needed to first establish if such a proposal was necessary. As detailed in chapter 2, MNC tax avoidance is currently an issue for the Irish state and its people (Honohan, 2009). The instances of BEPS falsely inflates the Irish economy, uses the country's vital resources, and does not leave any lasting benefit (Kapfer, 2006; Killian, 2006; Tedeschi, 2018). There is a need for reform and to challenge these instances for the betterment of society (Ibid). The current taxation infrastructure relies on trust which may explain the lack of oversight/enforcement but is also a very complex and sophisticated system (Stewart, 2018; Balakrishnan, Blouin and Guay, 2019). Hence, the researcher needed to verify whether the current infrastructure could fulfil the objectives for better enforcement/oversight. If it could then the proposals outlined in this study would be disproved as conjecture and would not add value to society. To do this, interviews were held with prominent members of society to gather their expert opinions on the matter, the results of which are listed below.

### 5.1 Ireland's Current Taxation infrastructure

Interviewee one was asked to comment on the current taxation infrastructure used in Ireland. The candidate noted that the Irish revenue system was considered to be one of the most advanced digital systems in the world. The main benefits are the ease of how transactions are filed. The current system also has a reputation of being trusted, reliable and cohesive. Yet, it is not perfect, and requires businesses and the state to silo large amounts of data. As explained in chapter 2, this is why enforcement can be hard to manage (Cao, Chychyla and Stewart, 2015). The interviewee explains that society and businesses are constantly changing and rapidly advancing. The researcher likens this to the reason as to why China developed the 'Fapiao' system as explained in the literature review (Conrad, Sunny and KPMG China, 2019). The introduction of large globalised firms requires consistent change and adaptation. Therefore, the

interviewee believes that the current system is not complete and does need to change. Ireland has become one of the largest growing economies in the world and whilst it has proven its adaptability, the introduction of these large companies alongside the development of the country's financial institutions and services sector, point to a more globalised Irish economy. A globalised economy requires far more oversight, which the current system does not provide fully. The use of blockchain technologies is not only needed in taxation instances but across a range of different sectors and services (Appendix II).

### 5.2 Blockchain Capabilities

When asked to comment on the oversight/enforcement ability of current structures in comparison to blockchain platforms, interviewee one advised that society in general, needs to become more responsible with its digital proficiency. The blockchain would aid in this and change the way enforcement/oversight is conducted. It would negate the need for large amounts of personnel to inspect and audit large transactions where BEPS strategies can be harder to identify (Ibid). The researcher notes that when dealing with large corporations that conduct billions of transactions per day, it can be tedious as explained in chapter 2. The candidate expanded on this by saying that blockchains are transparent and immutable. Once a transaction is submitted, it is permanent and traceable. The technology is also one of the most secure systems that exist. Due to the consensus mechanism, a blockchain is virtually unable to hacked, so changes cannot be made without notice. The hashing power needed to make changes where all nodes show the same hash are nearly impossible and requires an exponential source of power. Traditional technologies are far easier to exploit and hack which makes blockchain a much more secure platform (Appendix II).

The interviewee builds on this by explaining that the most overlooked aspect of a blockchain system is its automated micro-level programming functionality. A blockchain is able to not only record data but also process its own transactions and functionalities. If for example, one was to implement a blockchain to administer tax requirements, the blockchain could be programmed to recognise 'suspicious' transactions and isolate/disable that transaction. Furthermore, these capabilities can be applied to any imaginable use. The researcher highlights another example of this use case to expand on this line of thought; a MNC can automatically have a blockchain submit their transaction portfolio at the end of the tax year, the blockchain could then identify the list of transactions, automatically audit them, recognise

the use of BEPS, and deduct the CT that should have originally been applied. An official wouldn't need to provide oversight as the system would conduct these actions automatically based on preprogramed parameters. The interviewee recognises this as an important function of a blockchain and continues by explaining that a blockchain, when used with complimentary technologies such as artificial intelligence, machine learning, Internet of Things (IOT), smart contracts and cryptography, has an unmatched capability. The internal capabilities and ability to collaborate is what makes blockchain more secure, transparent, enforceable in comparison to traditional systems (Appendix II).

Interviewee two held the same regard. As stated in Chapter 4, the candidate is part of a MNC that specialises in CMMS. In the following example, the individual outlines why they believe blockchain to be the next logical evolutionary step for their business. The MNC deliver products used to maintain and manage factory equipment. These can include vibration sensors, gas leak detectors, and software that analyses and informs of an issue. The current systems use a Bluetooth device which is programmed to submit these detections to an app. The manager then has to action a resolution. If the manager is not present or is unable to action a resolution, significant delays in their manufacturing processes or breakdowns of certain machines can occur. A blockchain would be automatically able to detect or predict an issue, recognise what the issue is, associate a resolution, and book the parts or technicians required. This takes the human element out and results in much better oversight. A distinct comment stood out to the researcher, which was that the organisation intended to move away from reactive/preventative solutions to predictive solutions. A blockchain is what can make this possible by monitoring and scheduling actions by itself (Appendix III).

These evaluations indicate that the current infrastructure cannot fulfil the objectives of enforcement/oversight and that there is a need for the implementation of blockchain. The Irish revenue system requires large amounts of resources in terms of time and personnel which hinder its enforcement ability. Whereas the blockchain is secure, transparent, efficient, automatable, and immutability. These findings also confirm that the use of blockchain technologies could resolve the issue of tax avoidance issues associated with MNC's in Ireland and thus, answers the research question (Appendix II; Appendix III). Yet, the researcher must verify the practicalities of implementing such a system. As mentioned in chapter 2, the current Irish blockchain educational and industry infrastructures are still inefficient and there are a variety of costs involved in its implementation (Catalini and Gans, 2016). If this is factored in, the proposal will be highly opposed, expensive, and may therefore be rejected. If the

implementation did somehow occur, then the current status of blockchain proficiency could result in its failure. The following results aim to clarify the realities of the blockchain infrastructure and implementation in Ireland.

### 5.3 Implementation and Infrastructure

Interviewee one was asked to comment on the current status of blockchain proficiency and implementation costs. The candidate responded by explaining that it depended on the needs of the individual/organisation. In terms of condensed technical knowledge, Ireland currently has one of the largest blockchain hubs in the world. International Business Machines (IBM), Citi Bank, Deloitte, Accenture, Cardinal, Mediledger, Corda, Consensys, and Hyperledger are only some of the few examples given that currently develop blockchain labs and platforms in Ireland. The country also has access to the worlds largest blockchain platforms such as Ethereum and Bitcoin. These companies offer industrial and consumer grade products that cover a wide range of societal needs, not limited to the ones described in this research. Innovation hubs have been set up by Ulster Bank, Allied Irish Banks (AIB), Kredietbank ABB Insurance CERA Bank (KBC), and Bank of Ireland (BOI) which are currently working on converting financial services to blockchain systems too (Appendix II).

The government is spearheading educational resources. Research centres such as Adapt and Science foundation Ireland (SFI) have begun to receive increasing support from the Department of public expenditure and Reform. Multiple universities now offer blockchain courses that range from undergraduate to postgraduate levels. Policymakers have also begun to introduce more legislation to manage and support these innovations. In terms of public knowledge, the increasing digitalisation of society has led to a decrease in technophobia to adapt with the trends of society. In reality, blockchains are a mix of three old technologies; encryption/cryptography, distributed ledgers, and P2P networks which when combined, deliver new capabilities. Hence, society is already aware of the technology subconsciously as it is already embedded into technologies used on a daily basis. Furthermore, the end user doesn't need to have comprehensive knowledge of blockchain to use it. This will be handled by the providers, the users themselves will not necessarily care for how its administered as long as it meets their needs. Based on these points, the interviewee believes that the infrastructure in Ireland is actually quite developed which disproves the notion that the country is still in its infancy as noted in the literature review. Due to this, they believe blockchains it will be easier

to implement as its already used in a variety of applications, and the costs associated would be relatively low as a result (Appendix II).

Candidate one explains that blockchain is free to develop and use because its open-sourced. With the added benefit of a strong foundational basis, anyone can go online and build applications. This is evident from the researcher's ability to create a working blockchain despite having no previous formal background. Candidate one continues by explaining that economies of scale, a point contested in chapter 2, will occur as the technology evolves. Costs will remain minimal as it is already integrated into Irish society. The main contesting costs would be in the security of the system, but the interviewee interjects by advising that current digital systems require much more security and are more expensive to build and maintain. A blockchain lowers the costs as it isn't as vulnerable to hacking as traditional systems are. Any instances where blockchain replaces the current infrastructure would result in lower costs than technologies used today. This leads back to the point made about enforcement and micro-programming, where companies that traditionally needed active maintenance, notification and personnel systems could simply replace this with a blockchain that encompasses all these functionalities (Appendix II).

Interviewee two advised that most companies already have or are transitioning to a blockchain system. The individual's organisation already has development, Information technology (IT) teams, and new-product development teams that are being repurposed to develop blockchains. As stated in Chapter 2, legislators have had trouble identifying BEPS in digital/technology MNC's (Conrad, Sunny and KPMG China, 2019), but many of these MNC's are now implementing these capabilities, making this transition seamless or in some cases, already complete. Interviewee two did however highlight that the legislation in place will make it harder for MNC's due to GDPR. If a MNC choses to locate their nodes in US for example, this may degrade the integrity of an EU citizens data. This is a topic that is already currently being worked on and is not too dissimilar to how MNC's accounts for regional requirements when selling their products. This one variable is the only delay the interviewee attributes to its implementation (Appendix III).

Discourse provided through expert opinions, show that the implementations of blockchains result in minimal initial costs and may reduce existing costs in many instances (Appendix II; Appendix III). The researcher has also established that the current blockchain infrastructure is not lacking as previously argued, and is quite advanced, which will lead

economies of scale shortly. In the following section, the researcher has provided a practical example of a blockchain to highlight the points that have currently been discussed.

### 5.4 Hashing

As explained, the researcher formulated a working blockchain to highlight if tax avoidance issues could be resolved. As established above, blockchains can resolve these issues, therefore the researcher has provided a practical example with the following results to support these opinions.

Blockchain Simulation 1: Hash Result

```
"C:\Users\User\PycharmProjects\Blockchain Thesis Example\venv\Scripts\python.exe" "C:/Users/User/PycharmProjects/Blockchain Thesis Example/Main.py"
Block hash: Genesis Block (A genesis block is used to create the blockchain. It starts with a transaction submission)
e15645891fe142f2cb1df7ccec695c3e8b4ebdf4817282996612b602782efa69
Block hash: Second Block (The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries)
9a6f1c8828daba46ff5f72c3d7eedce199f8c2cf3c87135ce61c71df46f67c8c
Block hash: Third Block (The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities)
317c6e0b07b35b7575978cbceb87eb6868cdfb12ac3c15ab826dcd403abf94dc
Block hash: Fourth Block (The distribution entities sell the goods to the final market and takes receipt of the payment)
0b8479c44d34b655059a195a7cf9db2c43dbf8d01576154961d2597a81a406c6

Process finished with exit code 0
```

**Figure 7:** Hash Values of MNC's Transactions, Pre-BEPS Strategies Implementation (Appendix V).

As shown in above, MNC-US has engaged in dealings by ordering a product from a contracted firm/subsidiary in China. MNC-CN then ships the product to MNC-DE and is paid for the product. MNC-DE receives the title of ownership and sells that product to a customer, the profits of which are kept by MNC-DE. Figure 7 shows the outputted hash from these transactions. The next section shows the changes in hash values when BEPS strategies are utilised.

Blockchain Simulation 2: Hash Result

```
1 "C:\Users\User\PycharmProjects\Blockchain Thesis Example\venv\Scripts\python.
  exe" "C:/Users/User/PycharmProjects/Blockchain Thesis Example/Main.py"
2 Block hash: Genesis Block (A genesis block is used to create the blockchain. It
   starts with a transaction submission)
3 e15645891fe142f2cb1df7ccec695c3e8b4ebdf4817282996612b602782efa69
4 Block hash: Second Block (The MNCs contracted manufacturer sends the goods to
  it's distribution entities/subsidiaries)
5 9a6f1c8828daba46ff5f72c3d7eedce199f8c2cf3c87135ce61c71df46f67c8c
6 Block hash: Third Block (The MNC pays the contracted manufacturer for goods.
  The MNC then sells the goods to its distribution entities)
7 407f71b52c0d90730e0b82c1bea166ea6af05cb419e5926e507d6b4405114796
8 Block hash: Fourth Block (The distribution entities sell the goods to the final
   market and takes receipt of the payment)
9 e5edb60fa7546cd848c0bcd280316d60c42ccbaf3a7ff92941f501b661b760c0
10
11 Process finished with exit code 0
```

**Figure 8:** Hash Values of MNC's Transactions, Post-BEPS Strategies Implementation (Appendix V).

Figure 8 shows MNC-US keeping the title of ownership, despite MNC-DE handling the product's sale and distribution in Germany. The changed transaction where title of ownership is not transferred, is displayed in the third block, line 7, which is different from blockchain 1 in figure 7. The fourth blocks hash in line 9, is also changed as MNC-US sells the title of ownership to MNC-IE and MNC-DE profit shift the revenue to MNC-IE. The change in hash values indicate a suspicious transaction. Since the transactions are transparent, this means that the auditor would simply compare each hash and know specifically where BEPS has been attempted. If a MNC later decides to profit shift, the transactions and hashes would show that the sale of the product and its profits were accounted for in a different locations Alternatively, the Irish revenue could automatically programme the two blockchains to compare hashes, identify these transactions, audit them, and issue an invoice to that MNC. This further supports the arguments of this research, as it physically shows a reproducible, scalable model of a blockchain that can be used to resolve tax avoidance issues associated with MNC's in Ireland and therefore answers the research question; Yes, a blockchain system can resolve tax avoidance issues associated with Multinational companies in Ireland by providing better transparency, oversight, enforcement, security, and immutability that would be cost effect and easy to implement (Appendix II; Appendix III; Appendix V).

# Chapter 6

## Conclusion

In conclusion, the objective of this thesis was to validate or disprove the following research question; *Can Blockchain Technology Resolve Tax Avoidance Issues Associated with Multinational Companies in Ireland?*

Ireland is labelled by many as a tax haven (Levin and Mccain, 2013; Jaafar and Thornton, 2015; Phillips *et al.*, 2016), due to the CT rate which stands at 12.5% (Revenue Commissioners, 2019). Fiscal policies introduced during the Celtic tiger and 2007 Recession aimed to alleviate the economic deficit (Honohan, 2009) but resulted in further reliance on sensitive revenues such as CT, stamp duties, and capital gains (Ibid). MNC's capitalised on this through BEPS strategies (Johannesen, 2010), resulting in double non-taxation (Brothers, 2014). BEPS are harder to enforce due to the volume of daily transactions (Cao, Chychyla and Stewart, 2015), leading to unsustainable negative societal effects and requires reform (Ibid; Crivelli, De Mooij and Keen, 2015). Reform could be provided by a blockchain, a digital ledger that uses encryption, distributed ledgers, and P2P networks to log and facilitate transactions in a permanent, tamperproof, secure, and immutable way (Crosby *et al.*, 2016; Lin and Liao, 2017). Recently, China's Fapiao has demonstrated this by improving oversight on large digital and e-commerce MNC's. (Giebe and Schweinzer, 2014; Hou, 2017; Conrad, Sunny and KPMG China, 2019). This implementation garnered more attention for the blockchain community worldwide (Yli-Huumo *et al.*, 2016; Zheng *et al.*, 2017; Langerock, 2019). Initially, the researcher argued that the implementation of blockchain was expensive, opposed, and lacked foundational support (Catalini and Gans, 2016). SSI/SI's with high ranking professionals and simulations, established that blockchains could be used to resolve tax avoidance issues associated with MNC's in Ireland (Appendix II; Appendix III; Appendix V). Blockchains offer better transparency, oversight, enforcement, security, immutability, and has a strong foundational bases that would be cost effective and easy to implement.

Overall, the researcher concluded that this study has been successful and presents a fully-fledged, scalable, and reproducible proof of concept. The researcher hopes that this study adds value as a foundational platform for future reform in government, who has expressed an interest in the proposal and asked to collaborate on a working concept. In terms of the studies position in the field of research, the researcher aims to expand the current research on

blockchains in taxation infrastructures. The researcher recommends future studies to look at implementations of these systems in other countries and complimentary technologies. As the world becomes more digital, the use of collaborative technologies may improve harmonisation and provide better reformation potential to that state. The researcher also notes that a large part of this study was affected by COVID-19 and would recommend that future researchers obtain a larger consensus in society to add to the discourse obtained in this study and the overall field of blockchain and government reform.

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# Appendices

## I. Interview Email Draft

Dear Mr/Ms. X,

My name is Tariq Khan, I am an undergraduate student at the National College of Ireland. I am currently researching for my dissertation, with a focus on Blockchain Technology; specifically investigating tax avoidances strategies implemented by Multinational corporations in Ireland.

I am familiar with your work/efforts on (X) which was why I was particularly interested on speaking with you about this topic. Your vast experience, views and thoughts on this subject would genuinely be invaluable in providing a broader context to this dissertation. Therefore, I am asking if you could take some time to allow me to interview you or to even have an informal chat just to collect some ideas from (a leader in our government/a senior member in X organisation), particularly as it relates to the subject matter immensely.

All interviews will be conducted ensuring that anonymity can be protected. As I know you must be quite busy, especially during these unprecedented times, these interviews can be conducted via a medium and time that would suit. On agreement to engage within this process, I will forward a consent form for you to complete prior to the commencement of the interview.

Many thanks in advance for your time on this matter.

I look forward to your response.

Kindest Regards,
Tariq Khan
National College of Ireland

## II. Interviewee One Question List

**Interviewee One Questions:**

1. We discussed the achievements and widespread success of the current terminals used by the revenue commission and its customers; how effective do you think it is in fulfilling necessary taxation functions?

2. In terms of the technologies implemented to run such a system, in your opinion are they up to date and perfect?

3. What is currently lacking in the way transactions are carried out?

4. You have discussed the ability of Ireland in becoming the Blockchain hub of the world, with reference to Shenzhen's Fapiao invoicing system, do you think renovating our current taxation system is possible? And that the integration of blockchain in our society is necessary?

5. What resources would be needed to implement blockchain technologies?

6. What costs would be incurred to implement these systems?

7. Do you think that Ireland has the proficient educational and technical infrastructure to implement these technologies?

8. Do you think that Blockchain systems could provide better oversight and enforcement in comparison to traditional digital technologies?

## III. Interviewee Two Question List

**Interviewee Two Questions:**

1. Can you explain your role in the organisation?
2. Are you familiar with blockchain technologies? And to what capacity?
3. In terms of the current digital infrastructures that you use at work, how effective are they at allowing you to do your job?
4. Would you ever consider replacing these systems with a blockchain platform?
5. If so, Why? Or why not? And to what degree?
6. Do you think that the administration of transactions would be benefitted from by implementing a blockchain system?
7. What resources and costs would be involved from such an implementation?
8. In terms of the interface systems that you currently have for your customers, how easy or hard would it be to convert that to a blockchain system?

# IV. Interviewee Consent Form

Interview No: _____X_____

## Interview Consent Form

A study into '*Can Blockchain Technology Resolve Tax Avoidance Issues Associated with Multinationals in Ireland?*'.

The study explores a proposed theoretical blockchain framework that may provide greater oversight in relation to multinational companies operating in Ireland that utilise BEPS strategies in relation to tax avoidance. This dissertation aims to explore whether a tax avoidance issue does in fact exist, what implications such strategies would have on society, and in terms of sustainability. This research asks: whether tax avoidance strategies are a by-product of policy or a lack of enforcement and would an e-governing model lend itself to Irelands governing structure in terms of practicality and necessity. The interviews conducted in this study will aid the research in providing experiential evidence and create a better understanding of how participants view the integration and use of blockchain technology in regard to future governance and the taxation incidences that occur in Ireland.

**Consent to take part in research:**

I …… voluntarily agree to participate in this research study.

I have had the above purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.

I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.

I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.

I understand that participation involves providing personal thoughts and opinions regarding blockchain technology and tax avoidance strategies implemented by multinational companies.

I understand that I will not benefit directly from participating in this research.

I agree to my interview being audio-recorded.

I understand that all information I provide for this study will be treated confidentially.

I understand that in any report on the results of this research, my identity will remain anonymous. This will be done by referring to me as a numbered participant and disguising any details of my interview which may reveal my identity or the identity of any parties or people I speak about.

I understand that anonymised disguised extracts from my interview may be quoted in the undergraduate dissertation carried out by the researcher Tariq Khan.

I understand that if I inform the researcher that myself or someone else is at risk of harm they may have to report this to the relevant authorities - they will discuss this with me first but may be required to report with or without my permission.

I understand that signed consent forms will be kept on file in a secure storage space, and original audio recordings will be retained on a secure, password protected (encrypted) digital storage device owned and accessed solely by the researcher Tariq Khan for five years from the completion of the dissertation in accordance with National College of Ireland ethics policy.

I understand that under the freedom of information legalisation I am entitled to access the information I have provided at any time while it is in storage as specified above.

I understand that I am free to contact any of the people involved in the research to seek further clarification and information.

Primary researcher for undergraduate dissertation: **Tariq Khan.**

School of Business,

National College of Ireland

Email: **x16320671@student.ncirl.ie**

Signature of research participant

---------- ----------

Signature of participant Date

Signature of researcher

I believe the participant is giving informed consent to participate in this study

Tariq Khan XX/XX/XXXX

Signature of researcher Date

# V. Blockchain Simulation Raw Code

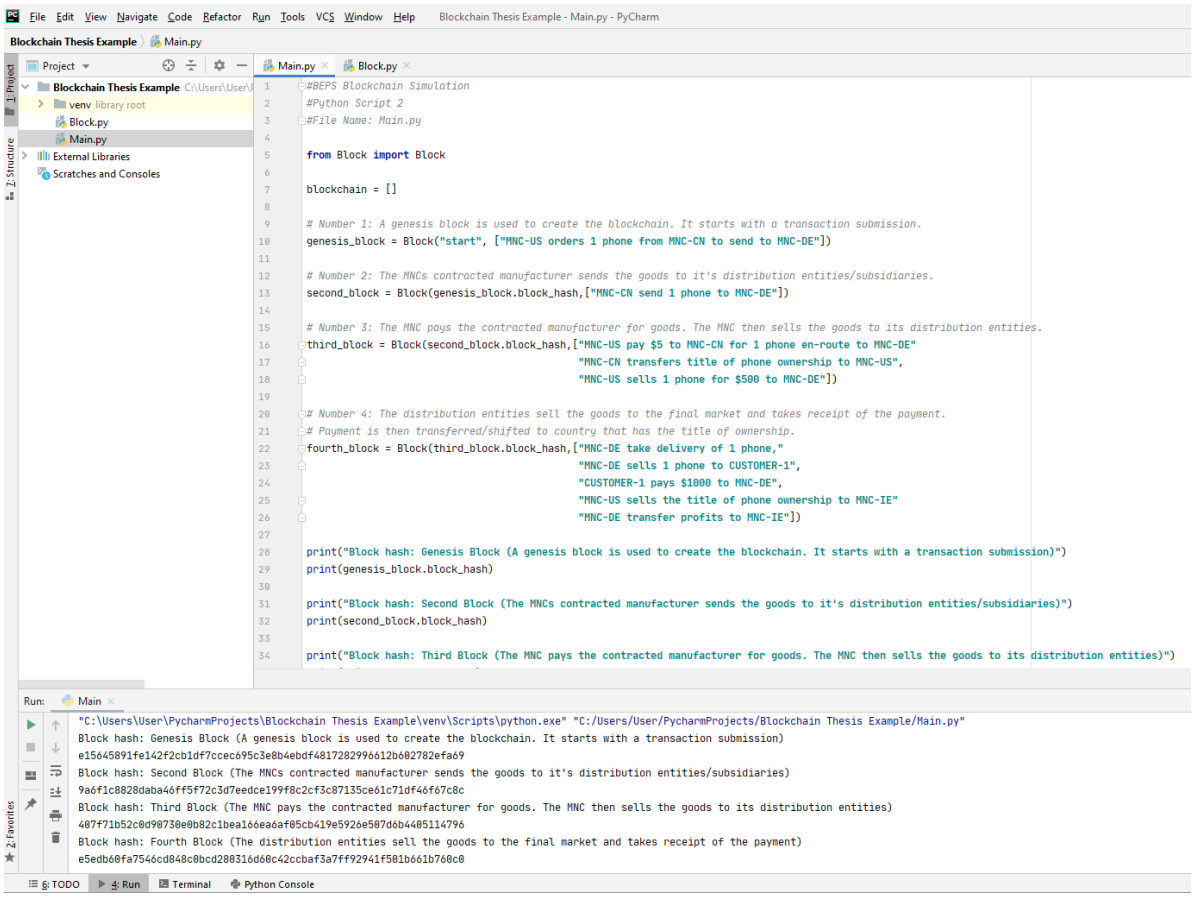


**Figure 9:** PyCharm (Python) Working Interface.

```python
#BEPS Blockchain Simulation
#Python Script 2
#File Name: Block.py

import hashlib

class Block:
    def __init__(self, previous_hash, transaction):
        self.transactions = transaction
        self.previous_hash = previous_hash
        string_to_hash = "".join(transaction) + previous_hash
        self.block_hash = hashlib.sha256(string_to_hash.encode()).hexdigest()

```

**Figure 10:** Python Raw Code - Creation of Block Architecture in Script 2.

```python
#BEPS Blockchain Simulation
#Python Script 1
#File Name: Main.py

from Block import Block

blockchain = []

# Number 1: A genesis block is used to create the blockchain. It starts with a transaction submission.
genesis_block = Block("start", ["MNC-US orders 1 phone from MNC-CN to send to MNC-DE"])

# Number 2: The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries.
second_block = Block(genesis_block.block_hash,["MNC-CN send 1 phone to MNC-DE"])

# Number 3: The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities.
third_block = Block(second_block.block_hash,["MNC-US pay $5 to MNC-CN for 1 phone en-route to MNC-DE"
                                             "MNC-CN transfers title of phone ownership to MNC-US",
                                             "MNC-US sells 1 phone for $500 to MNC-DE",
                                             "MNC-US transfers title of phone ownership to MNC-DE"])

# Number 4: The distribution entities sell the goods to the final market and takes receipt of the payment.
fourth_block = Block(third_block.block_hash,["MNC-DE take delivery of 1 phone,"
                                             "MNC-DE sells 1 phone to CUSTOMER-1",
                                             "CUSTOMER-1 pays $1000 to MNC-DE"])
```

**Figure 11:** Python Raw Code - Blockchain Framework, Recording MNC's Transactions Pre-BEPS Strategies Implementation.

```python
print("Block hash: Genesis Block (A genesis block is used to create the blockchain. It starts with a transaction submission)")
print(genesis_block.block_hash)

print("Block hash: Second Block (The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries)")
print(second_block.block_hash)

print("Block hash: Third Block (The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities)")
print(third_block.block_hash)

print("Block hash: Fourth Block (The distribution entities sell the goods to the final market and takes receipt of the payment)")
print(fourth_block.block_hash)
```

**Figure 12:** Python Raw Code - Code Used to Extrapolate Hash Values from Blocks on the Blockchain Array from Script 1.

```
"C:\Users\User\PycharmProjects\Blockchain Thesis Example\venv\Scripts\python.exe" "C:/Users/User/PycharmProjects/Blockchain Thesis Example/Main.py"
Block hash: Genesis Block (A genesis block is used to create the blockchain. It starts with a transaction submission)
e15645891fe142f2cb1df7ccec695c3e8b4ebdf4817282996612b602782efa69
Block hash: Second Block (The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries)
9a6f1c8828daba46ff5f72c3d7eedce199f8c2cf3c87135ce61c71df46f67c8c
Block hash: Third Block (The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities)
317c6e0b07b35b7575978cbceb87eb6868cdfb12ac3c15ab826dcd403abf94dc
Block hash: Fourth Block (The distribution entities sell the goods to the final market and takes receipt of the payment)
0b8479c44d34b655059a195a7cf9db2c43dbf8d0157615496 1d2597a81a406c6

Process finished with exit code 0
```

**Figure 13:** Python Raw Code - Hash Values of MNC's Transactions, Pre-BEPS Strategies Implementation.

```python
#BEPS Blockchain Simulation
#Python Script 2
#File Name: Main.py

from Block import Block

blockchain = []

# Number 1: A genesis block is used to create the blockchain. It starts with a transaction submission.
genesis_block = Block("start", ["MNC-US orders 1 phone from MNC-CN to send to MNC-DE"])

# Number 2: The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries.
second_block = Block(genesis_block.block_hash,["MNC-CN send 1 phone to MNC-DE"])

# Number 3: The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities.
third_block = Block(second_block.block_hash,["MNC-US pay $5 to MNC-CN for 1 phone en-route to MNC-DE"
                                             "MNC-CN transfers title of phone ownership to MNC-US",
                                             "MNC-US sells 1 phone for $500 to MNC-DE"])

# Number 4: The distribution entities sell the goods to the final market and takes receipt of the payment.
# Payment is then transferred/shifted to country that has the title of ownership.
fourth_block = Block(third_block.block_hash,["MNC-DE take delivery of 1 phone,"
                                             "MNC-DE sells 1 phone to CUSTOMER-1",
                                             "CUSTOMER-1 pays $1000 to MNC-DE",
                                             "MNC-US sells the title of phone ownership to MNC-IE"
                                             "MNC-DE transfer profits to MNC-IE"])
```

**Figure 14**: Python Raw Code - Blockchain Framework, Recording MNC's Transactions Post-BEPS Strategies Implementation.

```python

print("Block hash: Genesis Block (A genesis block is used to create the blockchain. It starts with a transaction submission)")
print(genesis_block.block_hash)

print("Block hash: Second Block (The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries)")
print(second_block.block_hash)

print("Block hash: Third Block (The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities)")
print(third_block.block_hash)

print("Block hash: Fourth Block (The distribution entities sell the goods to the final market and takes receipt of the payment)")
print(fourth_block.block_hash)

```

**Figure 15:** Python Raw Code - Code Used to Extrapolate Hash Values from Blocks on the Blockchain Array from Script 2.

```
"C:\Users\User\PycharmProjects\Blockchain Thesis Example\venv\Scripts\python.exe" "C:/Users/User/PycharmProjects/Blockchain Thesis Example/Main.py"
Block hash: Genesis Block (A genesis block is used to create the blockchain. It starts with a transaction submission)
e15645891fe142f2cb1df7ccec695c3e8b4ebdf4817282996612b602782efa69
Block hash: Second Block (The MNCs contracted manufacturer sends the goods to it's distribution entities/subsidiaries)
9a6f1c8828daba46ff5f72c3d7eedce199f8c2cf3c87135ce61c71df46f67c8c
Block hash: Third Block (The MNC pays the contracted manufacturer for goods. The MNC then sells the goods to its distribution entities)
407f71b52c0d98730e0b82c1bea166ea6af05cb419e5926e507d6b4405114796
Block hash: Fourth Block (The distribution entities sell the goods to the final market and takes receipt of the payment)
e5edb60fa7546cd848c8bcd280316d60c42ccbaf3a7ff92941f501b661b760c0

Process finished with exit code 0
```

**Figure 16:** Python Raw Code - Hash Values of MNC's Transactions, Post-BEPS Strategies Implementation.