CLIC

Circular models Leveraging Investments in Cultural heritage adaptive reuse

D4.3
Analysis of Three Levels of Innovative Financial Models

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Abstract

The recent financial crisis has certainly impacted negatively on local authorities' ability to raise funds for capital investment and in particular for cultural heritage. A fundamental need thus exists for many municipalities and regional authorities in Europe to broaden their financial channels and explore new flexible financial options.

In European cities and regions, three main levels coexist and simultaneously invest in cultural heritage. We have identified the three levels as: 1) **Micro**, such as cultural institutions, foundations, museums, NGOs, cultural trusts, etc.; 2) **Meso**, such as the dedicated departments and agencies in cities and regions and 3) **Macro**, such as central governments and EU institutions.
For each level we have identified a specific instrument which is best suited to be adapted for their business models and their capacity to implement the investments. The three instruments will increase the possibility of attracting financial sources for cultural heritage, but each of them is innovative and transformational in relation to the ways we invest and manage cultural heritage through a circular economy vision:

1) For the Micro Level we propose the **Adoption Token**, which aims to incentivise further investment, but above all greater participation and stake in cultural heritage by the general public. This is a bottom-up approach which, given its transparency in operation, allows the general public to be direct investors and thus adopters of cultural heritage assets.

2) For the Meso level we consider **impact investment**. This instrument is proposed through the wide variety of possibilities in which impact investment is operationalised in coordination with other financial instruments. Given its feature of flexibility and adaptability, impact investment is perfectly suited for cities and regions, where its implementation can easily be synergistic with other already established financial instruments. However, also in this case, impact investing is transformational because by prioritising a study of the impacts (social and environmental) of the investments, it ultimately requires a more comprehensive approach and understanding of how cultural heritage is intertwined with and plays a fundamental role in the economic growth of a city or region.

3) For the **Macro** level we propose a more innovative transformational instrument. We aim to reach a twofold objective: increasing the financial resources for cultural heritage and tackling the problem of negative externalities produced by the tourism industry. In this case we can point to the highly successful experience of the EU Emissions Trading System (EU ETS). We propose a similar system, but one which targets tourism and its negative externalities. The instrument is leading-edge and can be implemented at regional, national and EU level. The impact of this instrument, which is strongly anchored in the circular economy concept, will certainly determine a fundamental impact on how cultural heritage assets are enjoyed and protected and ultimately financed.

Against this background it is necessary to stress how these three instruments advance the concept of circularity in finance which usually focusses on the environmental aspects; instead, as proposed in CLIC, circularity is seen in these three instruments as a way to re-examine the role of cultural heritage assets as a fulcrum of economic and social development because they can encompass different aspects together, like a bridge from our past towards our more sustainable and equitable future.

Partners involved in the document

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1 Coordinator	CONSIGLIO NAZIONALE DELLE RICERCHE	IRISS CNR	
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I Description of the Project

The overarching goal of CLIC trans-disciplinary research project is to identify evaluation tools to test, implement, validate and share innovative "circular" financing, business and governance models for systemic adaptive reuse of cultural heritage and landscape, demonstrating the economic, social, environmental convenience, in terms of long lasting economic, cultural and environmental wealth.

The characteristics of cultural heritage and landscape pose significant challenges for its governance. Cultural heritage is a “common good”, which enjoyment cannot be denied to citizens, although many buildings and landscape structures are privately owned. Furthermore, the large economic resources needed for recovery and maintenance of heritage goods are rarely available to the private owner, often charged of the additional cost of non-use due to limited degree of transformation allowed. The existing governance arrangements currently involve limited stakeholders concerning for the historic, aesthetic or religious sociocultural values, severely restricting the use of the heritage properties, and charge the central government of conservation costs. The approach of regulatory and planning tools throughout European countries has been to preserve cultural heritage by preventing transformation of buildings or areas having historic-cultural significance.

“The current monument-based, full protection, and government-financed approach that restricts the use of protected properties and relies almost entirely on public funds is incapable of tackling the vast urban heritage of most communities and of sustaining conservation efforts in the long term” (Rojas, 2016). To turn cultural heritage and landscape into a resource, instead of a cost for the community, the structures of authority, institutions and financial arrangements should be adjusted to ensure larger stakeholders’ involvement in decision-making, attract private investments and facilitate cooperation between community actors, public institutions, property owners, informal users and producers (Rojas, 2016). The risk is that without financing channels the decay of European heritage and landscape will increase, until its irreversible loss.
Flexible, transparent and inclusive tools to manage change are required to leverage the potential of cultural heritage for Europe, fostering adaptive reuse of cultural heritage / landscape. Tools for management of change should consider costs and benefits at the local level and for all stakeholders, including future generations, and should take into account the cultural, social, environmental and economic costs of disrepair through neglect, compared to the benefits obtained through diverse scenarios of transformation / integrated conservation.

Costs and values of cultural heritage adaptive reuse have to be compared in a multidimensional space: the relationship between costs and “complex values” influences the willingness to invest in the functional recovery of cultural heritage and landscape. Therefore, it is necessary to clarify what is intended for the value of cultural heritage. The higher the perceived value for potential actors,

the higher the willingness to take the risk of investment. This “complex value” of cultural heritage depends on the intrinsic characteristics, but also from extrinsic (context) characters.
Investment costs are related to the materials, technologies and techniques to be used to preserve the cultural value of the heritage / landscape, and to maintenance / management / operating costs. The willingness to invest, the same value done, increases with the reduction of costs. Then, the social cost of abandonment – and eventual irreversible loss of heritage – must be included in the investment choice.

The investment gap in cultural heritage and landscape regeneration can be addressed through careful evaluation of costs, complex values and impacts of adaptive reuse, providing critical evidence of the wealth of jobs, social, cultural, environmental and economic returns on the investment in cultural heritage.

II CLIC Specific objectives

The scopes of CLIC project will be achieved through a set of specific, measurable, achievable, realistic and time-constrained (SMART) specific objectives:
Objective 1 – To synthesize existing knowledge on best practices of cultural heritage adaptive reuse making it accessible to researchers, policy makers, entrepreneurs and civil society organizations, also with direct dialogue with their promoters;
Objective 2 – To provide a holistic ex-post evaluation of the economic, social, cultural and environmental impacts of cultural heritage adaptive reuse, stressing on the importance of appropriate conservation and maintenance approaches able to highlight the integrity and authenticity of heritage;
Objective 3 – To provide EU-wide participated policy guidelines to overcome existing cultural, social, economic, institutional, legal, regulatory and administrative barriers and bottlenecks for cultural heritage systemic adaptive reuse;
Objective 4 – To develop and test innovative governance models and a set of evidence-based, participative, usable, scalable and replicable decision support evaluation tools to improve policy and management options/choices on cultural heritage systemic adaptive reuse, in the perspective of the circular economy;
Objective 5 – To analyse hybrid financing and business models that promote circularity through shared value creation, and assess their feasibility, bankability and robustness for cultural heritage adaptive reuse;
Objective 6 – To validate the CLIC circular financing, business and governance practical tools in 4 European cities / territories representative of different geographic, historic, cultural and political contexts;
Objective 7 – To contribute to operationalise the management change of the cultural landscape also in implementing the UNESCO Recommendation on Historic Urban Landscape;

Objective 8 – To re-connect fragmented landscapes, through functions, infrastructures, visual relations at macro and micro scale;
Objective 9 – To design and implement a stakeholders-oriented Knowledge and Information Hub to make tools and information accessible, useful and usable and test them with policy-makers, entrepreneurs, investment funds and civil society organizations;
Objective 10 To contribute to the creation of new jobs and skills in the circular economy through cultural heritage adaptive reuse, boosting startups and sustainable hybrid businesses and empowering local communities and stakeholders through public-private-social cooperation models.
Objective 11 To contribute to the monitoring and implementation of SDGs (especially Target 11.4) and the New Urban Agenda, creating operational synergies with global initiatives of UN-Habitat, UNESCO/ICOMOS and the World Urban Campaign.
All partners have wide experience in developing and testing CLIC proposed tools, ensuring the effective and time-constrained achievement of all the above-mentioned specific goals. The integration of sectorial knowledge, tools and methods will be achieved through a trans-disciplinary approach promoting partners and stakeholders' cooperation, co-creation of knowledge and co-delivery of outcomes.

The expected impacts of the project are the following:

- Validation of integrated approaches and strategies for cultural heritage adaptive re-use, comprising innovative finance with high leverage capacity, business models and institutional and governance arrangements that foster multi-stakeholder involvement, citizens' and communities' engagement and empowerment;

- New investments and market opportunities in adaptive re-use of cultural heritage, also stimulating the creation of start-ups;

- An enabling context for the development and wide deployment of new technologies, techniques and expertise enhancing industrial competitiveness and contributing to economic growth, new skills and jobs;

- Innovative adaptive re-use models that are culturally, socially and economically inclusive;

- Contribution to implementing the Sustainable Development Goals (SDGs) (Goals 1, 15, 11 particularly) and the United Nations New Urban Agenda.

III Introduction

The public sector, and especially city and regional local authorities, have difficulty developing efficient ways of financing cultural heritage. The role of innovative financial mechanisms can therefore be seen as a robust way to minimise volatility during economic crises, increase accountability and transparency, and as a source of alternative funding under different methods of implementation. The importance of the instruments we are proposing is based on the necessity for public and private sectors to work together more closely by applying socially and environmentally sustainable ways for cities/regions (society) to reach higher levels of economic growth.

In recent decades the call for accountability of the societal and environmental impacts of financial decision makers has given rise to an increasingly rich and diversified branch of finance, i.e. impact investing, circular economy and digital finance. These emerging fields are particularly well-suited to respond to the needs of cultural heritage adaptive reuse projects, both because cultural heritage represents an asset class targeted by new types of investors and because, broadly speaking, they address all the key dimensions identified by the CLIC framework in this area. Indeed, as highlighted by (Gravagnuolo et al., 2018): “Decisions for adaptive reuse implement the use of circular business models (balancing cultural and economic values), the use of circular governance model (public, private and social stakeholders in cooperation and/or partnerships, top-down and bottom-up approaches), and the use of circular financing models (crowdfunding, investment at local level through local banks, ethical banks, Foundations, and involvement of the third sector, NGOs, Foundations, Social Enterprises, Associations)”.

The two critical points from our analysis needing to be addressed are first, the contextual element: what city/region and what type of cultural heritage investments are we considering? Second, crucially, we need to know the economic relationship between the life cycle of the cultural heritage assets and the investment market.

The three proposed models (Adoption Token, Impact Investment and Tourism Permits) address the relevant context and economic relationships, and are appropriately designed for the three levels which occur simultaneously in cities and regions that own, operate, maintain, invest, and manage cultural capital:

- **Micro**, such as cultural institutions, museums, specific cultural heritage assets, foundations, NGOs and trusts, etc.
- **Meso**, such as cities and regional local authorities.
- **Macro**, such as central governments and the EU.

Although each instrument operates at a specific level in the urban and regional context, they can be implemented in combination, in accordance with a particular cultural heritage asset, thereby creating an additional circular financial approach.

Given this background, policymakers will need to know the extent to which the community is willing to pay for its cultural heritage so they can correctly allocate the risks, for example, with the private sector operators of the heritage assets. The public sector therefore has to consider a variety of options before making a decision, and in practice must make a judgment on the trade-offs between the various and sometimes conflicting objectives. It is particularly important to develop research that determines impartial and objective instruments for evaluating the most efficient and sustainable ways to finance cultural heritage investments.

The three proposed instruments encourage decentralised financing and implementation of cultural heritage projects that better respond to city and region needs. Bringing more flexible tools and alternative forms of investment to the forefront thus allows the most endangered cultural assets to be protected and preserved. 'This attention to detail at the community scale lies at the heart of successful integrated land-use planning' (Kennedy et al., 2005).

The three instruments define, above all, equitable and transparent finance. The main potential benefit of the proposed instruments for cultural heritage investment is their flexibility in adapting the structure of incentives and risk-sharing to the features of the project and to the specific economic and institutional environment. However, it is precisely the flexibility of the proposed instruments that prevents us from implementing a standardised model that can be easily replicated across cities and countries in the EU. In this regard, Medda (2009) argues that cultural capital, and in particular cultural capital accessibility, should be evaluated as a merit good. The concept of accessibility as a merit good is based on the idea that, for example, an investment in community cultural activity and an investment in a cultural heritage asset, although both increase the wellbeing of various facets and activities of our lives, each type has a different accessibility emphasis. Cultural heritage operators, particularly if they are private or under public-private partnership agreements, therefore need to align their objectives with those of city and regional authorities, but this alignment is best defined case-by-case and city-by-city.

IV Document structure

In the next sections we set out the characteristics of the main three instruments by examining in detail the successful financial models targeting cultural heritage adaptive reuse projects; these often involve combining different financial tools to suit the needs of the various business models underlying the most complex regeneration projects. Case studies will exemplify the main concepts and models identified.

Chapter 1 MICRO: Adoption Tokens

1.1 Introduction

This paper proposes the use of adoption tokens, issued by cultural heritage organizations, that connect conservation of sites of cultural significance with those who feel strongly about them. Individuals and groups would “adopt” the related cultural heritage site via the token, making donations that raise a new source of finance for its renovation and maintenance. These tokens could exist on a centralized European wide platform, or as an application on an established blockchain platform. These tokens are envisaged as transferring no binding rights, but rather embody a relationship.

Three dimensions are considered. First is the digitization of existing forms of philanthropy. Secondly is the potential to make such tokens transferable in a way that enables a small but contemporaneous donation to the issuing cultural heritage organization. Such a mechanism could have a positive effect on the half a trillion Euros held by Philanthropic Foundations. These are social funds not directly utilized by social projects. They are presently invested in financial assets for income purposes. Adoption tokens could create a step change in the impact of such cultural heritage organizations, by alleviating concerns that they require large investment portfolios to finance their future work, and therefore free these funds for capital investment in cultural heritage. Finally, this paper proposes the gifting of adoption tokens to under privileged groups. If implemented within a randomized controlled study, embodying a relationship in a token can be tested for its effects on the intensity of that relationship. The hypothesis would be that adoption tokens boost engagement and connection.

1.2 Literature review

1.2.1 Blockchain as a mechanism

A feature of blockchain is that it is immutable. Or in other words, that the data is append only (Narayanan et al., 2016). In order to generate consensus regarding this data, the Bitcoin blockchain combines append only with Proof of Work (PoW - where agents compete to update a consensus state) and a rule that the longest chain of proofs is the true chain. This Nakamoto consensus, produces a ledger that contains valuable information without use of a single point of control e.g. government department or bank. The corollary of immutability and decentralization is censorship resistance, arguably the raison d’etre of blockchain based payment protocols and Bitcoin like payment assets (Nakamoto, 2009).

Yli-Huuomo et al. (2016) is a computer science orientated literature review of blockchain. Bohme et al. (2015) is an introduction to the Bitcoin ecosystem and its economics. Zheng et al. (2018) provides a concise survey of the blockchain. The literature review that follows is primarily focused on the social science around blockchain.

An early caveat to this is that any discussion of a technology's impact on society must observe that society has endogenously created that technology. Narayanan and Clark (2017) connects a panoply of historical research with the invention of Bitcoin, and then to recent attempts to adapt the underlying technology. This adaptation is considered necessary as PoW is costly by design (Lo and Medda, 2018). Broadly, multiple chains or forks can co-exist, and the true chain is determined by resources expended. A problem with resource consumption focused adaptations are they often fail to distinguish between architectural decentralization and political decentralization.[4] There is an enormous difference between no single point of failure, and no single point of control.

In contrast to Nakamoto consensus, combining append only with no single point of failure is a narrower form of distributed consensus. This could be implemented as Proof of Stake (PoS), where the proportion of tokens held determines an agent's probability of being elected leader and able to append the next block of data (Li et al., 2017). A discussion of this alternative consensus mechanism is useful as it highlights why users choose to bear the cost of Proof of Work. Proof of Stake does not in itself create consensus. Under PoS only one block is added at a time and that block defines the true chain i.e. is determined to canonical. Therefore, the conundrum is rather how to validate the true block. Byzantine Fault Tolerant (BFT) mechanisms are one solution to this (Vukoli´c, 2016). The technology of BFT is a decades old messaging based consensus protocol that resolves disagreements in the presence of malicious agents, yet is rarely used commercially (Chondros et al., 2012). Non-Nakamoto blockchains can have no single point of control, but the permissioning, or pre-awareness of node identities, often required by BFT currently limits this. A set of upgrades referred to as Ethereum 2.0, proposes using random leadership election of a subset of permissioned validation nodes in order to deliver no single point of control within a PoS / BFT framework.[5] The value of a blockchain without decentralization is debatable, given their similarity to more scalable, no single point of failure, cloud computing systems such as Amazon AWS.[6]. At this time Proof of Work and longest chain continues to be the leading way to implement ledgers with no single point of control.

1.2.2 Blockchain as a technology

Davidson et al. (2018) draws the links between much of the hype around blockchain and two perspectives of technological innovation. The seminal paper of Bresnahan and Trajtenberg (1995) used the examples of the steam engine and semiconductors to illustrate General Purpose Technologies (GPT) that contributed to sustained periods of technical progress and economic

4 https://medium.com/@VitalikButerin/the-meaning-of-decentralization-a0c92b76a274

5 https://blog.sfox.com/ethereum-2-0-what-the-next-three-years-of-ethereum-will-look-like-b366a46f9704

6 https://aws.amazon.com/

growth. In a Schumpeterian sense blockchain as a GPT is disrupting existing economic rents related to existing patterns of production and exchange (Schumpeter, 1934). Such a framework views blockchain as a reduction in production cost via the elimination of intermediaries.

Conversely, Catalini and Gans (2016) is focused on reductions in transaction costs, which links with the work of Coase (1937) and Williamson (1975, 1985). Coase makes the case that firms are preferred to markets in the presence of transaction costs. Williamson's work develops this by acknowledging that with full rationality, complete information and costless transactions, all agents can make complete contracts with no need for trust. Therefore, in the converse, real world scenario of bounded rationality and incomplete information, an ability to exploit trust arises that is referred to as opportunism. One example of the latter is in the presence of asset specificity i.e. assets are specialized to the task and difficult to repurpose. In these circumstances, sunk costs by one party can be exploited ex-post by the other party. Hierarchical organization and relational contracting become ways to control for opportunism, and with a blockchain that lowers transaction cost, this new technology might support markets over firms. The example is given of using smart contracts to define and resolve ex ante a large number of low probability contingencies. However, Davidson et al. (2018) uses this background to argue that both perspectives might be distracting us from blockchain as a new form of institutional technology. Economic institutions of capitalism have consisted of firms, markets, commons, clubs, relational contracts and governments that furnish society with money, law, property rights, contracts and finance. Instead of supporting markets over firms, Davidson et al. (2018) posits that perhaps blockchain is adding a new entry to the list of possible economic institutions. Although a fascinating paper in its own right, Davidson et al. (2018)'s argument is somewhat too black and white in its categorization of alternate theories, for instance their citation of blockchain lowering transaction cost Catalini and Gans (2016) is the leading paper arguing that blockchain is a General Purpose Technology, making no distinction between production and transaction costs. In addition, it ignores the dependence of blockchains on others to enforce a digital record on real world outcomes (Abadi and Brunnermeier, 2018). As will be explored further down, blockchains may not have the breadth of applicability consistent with an institutional technology, except in digital spaces where digital enforcement is sufficient.

Taking a philosophical approach Reijers and Coeckelbergh (2018), introduces the concept of blockchain as a narrative technology. The existing financial system has the power to determine whether a transaction is good or bad. Bitcoin does not do this and therefore changes our view of finance. At the same time their paper questions whether institutional power will be decentralized or merely abstracted. At its heart Bitcoin is a cost centred way to enable censorship resistance. Kewell et al. (2017) uses affordance theory to explore how distributed ledger technologies might become a force for good and contribute to the sustainability and development agenda.

1.2.3 Benefits and costs of decentralization

From a simplified viewpoint, it is possible to consider blockchain at three levels. The first is as a mechanism to enable decentralization. Secondly are the tokens that can be created by such a system. The third level are blockchain synonymous technologies such as smart contracts. This section focuses on the first of these levels. Ma et al. (2018) maps the Bitcoin protocol to a game between miners and highlights the role of competition and free entry in determining system costs. These costs are likely to be wasteful, at the same time as driving miners' equilibrium profits to zero. Their work notes that regulation, for example dynamically deciding the number of miners, as one way to reduce system costs. It also sets a different tone to much research on resource consumption in calling for further analysis of what benefits are being derived from decentralization. Abadi and Brunnermeier (2018) discusses how blockchain splits a centralized ledger into separate proposer of rules (e.g. developers) and record writers (e.g. miners). Both blockchains and centralized ledgers control a valuable set of user data. This user data, which can be a balance of currency or as intangible as an individual's social media account, is a stake in the network, that enables a centralized ledger keeper to charge an economic rent. Users' stakes embed value in an incumbent ledger relative to any new competitor. However, blockchain forks enable users to take their ledger data with them, increasing competition as user stake no longer locks them into a given platform. Furthermore, free entry of record keepers plays a critical role as it makes record keeper profits zero at equilibrium, ameliorating their opportunity to bribe and collude in such a state. Abadi and Brunnermeier (2018) also explains how blockchain forks that roll back history are powerful defense mechanisms against attacks, and how real-world enforcement requirements may favour a centralized ledger.

One aspect of this decentralization is explored by Huberman et al. (2019), who compare a stylized Bitcoin payment system (BPS) with a monopolistic payments firm. The latter charges higher willingness to pay users and processes transactions without delay, the corollary of which is to exclude low value users. The BPS serves everyone with a delay, generating strictly positive economic surpluses for all users with charges based on platform congestion. The tradeoff is a costly set of infrastructures that ensure competitive pricing (as small miners enter freely), versus private monopolist dead weight losses due to price discrimination.

Considerable research is now focused on reducing the cost component associated with no single point of control under proof of work (Eyal et al., 2015; Bentov et al., 2017; Li et al., 2017; Rocket, 2018). Budish (2018) explores this cost via a series of equations. Under a condition of repurposable mining technology, at equilibrium such a blockchain system would have (1) zero-profit miners and (2) incentive compatibility such that the computational costs of majority attack exceed the benefit to the attacker. These two points imply a third condition: that the recurring "flow" payments to miners are large relative to the one off "stock" benefits of attacking this blockchain i.e. the system is fundamentally expensive. Under the assumption of non-repurposable mining technology, which is the case with specialized Bitcoin ASIC miners, then an attacker also risks the

value of its sunk investments in equipment. This mitigates the original system cost conditions, at the same time as raising a fresh critique. The higher the value of Bitcoin in aggregate, the higher the potential vulnerability to a sabotage attack that wishes to profit from a collapse in value. Budish (2018) suggests this may ultimately lead to a ceiling on Bitcoin's value.

Abadi and Brunnermeier (2018) points out that other oft cited benefits of blockchain, such as transparency and fast settlement, are incidental to blockchain technology as they are implementable under other technologies. But given the successful deployment of these features under Bitcoin, blockchain could still be the most practicable way to deploy transparency in other ledgers. Federal Reserve governor Brainard (2016) notes that distributed ledgers could be revolutionary, specifically with respect to transparency and settlement within financial markets, and also through smart contract automation of tasks currently provided by intermediaries such as the payment of dividends.

1.2.4 The novelty of provably scarce digital assets for payments

The above sections of the literature review illustrate that the technological rails formulated by blockchain are novel, not simply relative to technology in production (typically a centralized mainframe or centrally managed cloud computing network), but also relative to products speculated on by academia e.g. BFT systems such as PBFT and Paxos. They create decentralized systems with no central point of control.

From this it follows that the blockchain tokens that run on these rails will share some of this novelty, but to what extent and in what way? Catalini and Gans (2016) summarizes the economics of blockchain [as a mechanism] to a reduction in verification cost. Any person with an excel spreadsheet can attempt to track the ownership of an asset, but can the record be relied upon, can the intermediary be trusted and can they enforce this record? As markets scale, this verification becomes increasingly difficult and more valuable. When entrusted to an intermediary, a party is created that is well placed to censor records and charge an economic rent. Conversely, where verification is prohibitively high, markets unravel and trades do not occur. Lower verification costs due to blockchain reduce the market power of intermediaries and redefine how the latter add value.

However, for new use cases, Catalini and Gans (2016) argues that blockchain's largest benefit could arise from reductions in networking costs. They divide this into two separate aspects, or phases. The first phase is at start up, where issuing a token in an ICO finances the project, and offering the token to partners and employees is a form of early employee equity. These uses of a token help bootstrap the launch of a new venture. The second phase is the operation and scaling of the project. Tokens can be used to reward miners to process transactions (Bitcoin, Ethereum), infrastructure providers to offer storage (Filecoin, Storj), or individuals to generate content

(Steemit). Blockchain "allows open source projects and startups to directly compete with entrenched incumbents through the design of platforms where rents from direct and indirect network effects are shared more widely among participants" Catalini and Gans (2016, page 21). Their paper defines a set of conditions where blockchain can add value, one of which is the primary interest of this research: how the reduction in verification and networking costs allows for the definition of new types of digital assets, liabilities and responsibilities.

Before moving on to these prospective use cases, it is useful to contextualize the discussion of token novelty with the wider debate around digital money. Schreft (1997) notes that US dollars in physical cash and US dollars deposited at a bank are not perfect substitutes. In the modern era where these deposits exist primarily electronically, the author observes that the key point is not that one form is physical while the other is electronic, but that the bank deposit in this instance is privately issued. This could be addressed by the full backing of each deposit by US treasury bills and bonds, but this is rarely the case. Instead each bank engages in, for profit, risk and maturity transformation characteristic of fractional reserve banking, potentially securitizing liabilities in a way such that these risks do not even appear on its balance sheet (Merton, 1995). Therefore, each holder of a bank deposit is exposed to mismanagement and default risk, that can be thought of as a tail risk of differences in exchange (Schreft, 1997).

Blockchain tokens designed to work as a currency are clearly different from legal tender in a way that does not fit easily on a substitution scale from perfect to imperfect. They are worse than bank deposits in not sharing a name, approximate value and unit of account with a form of state money such as the US dollar. At this time, they cannot be used directly to discharge debt-contracts, the definition of money put forward by Keynes (1930). However, they have an advantage over bank deposits in that although they are privately issued, they are not privately backed. Previous digital assets required trusted counterparties and custodians to maintain a ledger, who are a counterparty risk and often monopolistic price makers. Importantly, the latter are able to censor behaviour (Aste et al., 2017). Blockchain based tokens are provably scare digital assets that are absent traditional forms of counterparty risk. This type of risk even extends to state issuers. Mazumdar (2017) examines empirically the benefit to real GDP of allowing a rise in trend inflation (decline in purchasing power of money) by one percentage point, an incentive that does not apply in the same way for blockchain token systems with transparent issuance schedules.

Awkwardly, that does not change the fact that early blockchain based payment assets have no intrinsic value. This statement is often used as a critique, ignoring that "State monopoly currencies, such as the U.S. dollar, the euro, and the Swiss franc, have no intrinsic value either", (Berentsen and Schar, 2018, Page 9). This paper, from researchers at the St Louis Federal Reserve, highlights characteristics that Bitcoin shares with physical cash, e.g. anonymity and decentralization. In contrast, digital cash facilitated by the banking network, which resolved physical cash's requirement that the buyer and seller be physically proximate, is centralized and easily traced to an identity. Kahn et al. (2004) makes the case in favour of anonymous money. A

model is devised where public information regarding the identity of a buyer increases the chance of theft. The theft is socially wasteful and inhibits trading. The paper argues that money has social value in situations where parties cannot trust each other not to take subsequent opportunistic actions. Cryptocurrencies are characterized as a costly and low capacity version of bank digital cash. The reality is that digital bank money is a convenient but circumscribed version of physical cash, and cryptocurrencies plausibly a closer approximation of the money in your wallet. Raskin et al. (2019) develops a model of digital currencies in an emerging market and shows that diversification and restraint on monetary policy benefits can lead to higher consumer welfare in an incentive compatible way for governments. A useful component of their analysis is that they provide a definition of centralization: if a party is not prevented to participate or there does not exist someone who can act in such a way, then the digital currency is decentralized.

Despite the benefits described above, Bitcoin has many flaws, including low throughput, multiple prices (Pieters and Vivanco, 2017), and regular exposure to centralized trading venue risks (Brandvold et al., 2015; Gandal et al., 2018). Although Athey et al. (2016) searches for fundamental drivers of the price of Bitcoin (steady state, non-investor, transaction levels and beliefs regarding the survival of Bitcoin), it is easy to argue that tokens designed for payments have become synonymous with speculation. Cocco et al. (2017) models cryptocurrency markets with an agent-based model and finds that momentum traders using limits can generate the non-stationarity, fat tails and volatility clustering seen in the price history of Bitcoin. Even privacy benefits should not be assumed to be valuable. Athey et al. (2017) uses data from a behavioural economics experiment that gave Bitcoin to a group of students to find evidence of the privacy paradox: revealed preference for privacy typically ran much lower than stated preferences. However, these should not distract from the breakthrough of a differentiated class of assets, the prices of which could even be an adoption signal for a technological prototype (Lo, 2017). At the same time though, their work concedes the power of investors in deriving the price of Bitcoin. Using an autoregressive distributed lag model (ADRL), Ciaian et al. (2017) finds a variety of relationships between Bitcoin and various altcoins (1st and 2nd generation blockchain tokens). Additionally, at the 95% statistical significance level, their paper finds 15 long run relationships between 19 digital assets or indices, and 6 macro variables. This is out of a possible 114 relationships, adding empirical evidence to the building argument that cryptoasset prices are relatively unconnected to macroeconomics and other asset classes (See also Briere et al. (2015) and Bouri et al. (2017)).

1.2.5 Smart contracts

An important step between cryptocurrencies and the alternate use case of raising funds by third parties, is the invention of smart contracts. This enabled digital tokens to break free of having to constitute their own blockchain. Smart contracts can be described as responsive computer objects that can manipulate state, are first mentioned in Szabo (1994), and are poorly implemented on the

Bitcoin blockchain. Buterin (2013) illustrates this by explaining how currency token systems are databases with one operation: subtract X from A and give X to B; on the proviso that (i) A has > X units prior to transaction and that (ii) A approves of the transaction. Buterin's Etherium platform created two step changes in smart contract performance, first by enabling programmatic flexibility (a Turing complete computer language), and then implementing the ERC-20 tokenization standards. Smart contracts on the Ethereum platform metamorphosed blockchain tokens from payment assets related to a specific blockchain protocol, into anything the human mind could conceive, from as mundane as a US dollar proxy,[7] to as light-hearted as cryptographic cats.[8]

The name smart contract is a category error as they are neither smart nor contracts. They are more accurately described as shared computer code. These objects can predefine certain contract like actions, such as contingent payments, but they cannot address unexpected events. Including smart contracts on a blockchain imbues these programming objects with the reliable record of fact and action of the underlying blockchain, however Monlina-Jimenez et al. (2019) notes that it is unproven that smart contracts necessarily belong on the blockchain. The authors speculate that in the future it may be optimal for computation to occur off blockchain, with solely verification of the behavior of the computation recorded on the blockchain. A separate risk is that smart contracts may be coded to accrue benefits to their owners dishonestly. Harz and Boman (2018) puts forward a trust model for detecting misbehaving smart contracts in permissionless blockchains, based on deposits, reputation and incentives for review agents.

The study of smart contracts is an emerging area and their risks continue to be only loosely delineated. Perez and Livshits (2019) surveys smart contract vulnerabilities and finds that only 504 out of 21,270 contracts have been exploited. A critical reason is that most funds are kept in a small number of smart contracts that are kept to higher standards. DAO re-entry and Parity multisig locked Ether are two notable exceptions. McCorry et al. (2019) presents 3 smart contracts that can be used to exchange mining bribes for activities favourable to the miner. These incentivize actions such as mining uncle blocks away from the main chain, mining a fork rather than the longest current chain facilitating a double spend attack, or pay for the mining of empty blocks on another blockchain. A discussion of the benefits of smart contracts continues in subsection 2.7.

1.2.6 Decentralization as a method to subvert rules

In order to fully understand the topic of blockchain tokenization, it is necessary to touch on the history of technologically enabled decentralization. Napster and BitTorrent, shared computer resources without centralized intermediation or support (Androutsellis-Theotokis and Spinellis,

7 https://media.consensys.net/the-state-of-stablecoins-2018-79ccb9988e63

8 https://medium.com/loom-network/how-to-code-your-own-cryptokitties-style-game-on-ethereum-7c8ac86a4eb3

2004), and facilitated the peer-to-peer movement of media files. The sharing of music, video and software via these platforms broke long standing rules regarding content copyright, but the owners of this content had little ability to prevent such sharing, other than by increasing the attractiveness of legal digital downloading and reducing prices (Vernik et al., 2011). BitTorrent in particular, prevented traditional copyright models migrating from offline to online. Decentralization was used to break a rule, ultimately so much so that the rule became untenable.

Despite being technically completely different, blockchain applied a superficially similar decentralization to the task of moving money without a bank. Bitcoin, which facilitates this movement of value, circumvents the traditional banking system (or more accurately the payment system they jointly administer), with its Know Your Customer (KYC) and Anti-Money Laundering (AML) requirements. In these two areas, technological decentralization is again being used as a methodology to circumvent rules and regulations. Foley et al. (2019) uses a variety of network analyses, such as transactions with known dark web market wallets, to estimate that during their sample period, one quarter of Bitcoin users were involved with illegal activities, equating to USD 76 billion in transactions. “Cryptocurrencies are transforming...black markets by enabling black e-commerce”, Foley et al. (2019, Page 1798).

It is worth highlighting though that Napster and BitTorrent led to the rise of private companies such as YouTube and Netflix, whereas Bitcoin remains largely outside the scope of government regulators, except via service providers such as exchanges and wallets (Vandezande, 2017). Banking rules, such as KYC and AML, will likely put up a much stronger fight than copyright - conversely hinting that perhaps Bitcoin will prove more durable than the first movers in the peer to peer media space. This will soon be tested by the proposed launch of a purported cryptocurrency Libra by the social media firm Facebook (Libra, 2019). The latter is testing the possibility that it is not AML and KYC rules that are driving the use case for digital currencies, but simply the banking industry and its multiple layers of margin.

Moving away from cryptocurrencies, initial coin offerings (ICOs), where tokens are sold to potential future platform users and third-party investors, can be thought of as blockchain’s second killer app. They are less a desire to avoid the banking system than a need to access financing without being subject to onerous securities regulation. “Crypto-tokens have turned out to be a successful way for startups to raise early financing” Conley (2017). The next two subsections explore the characteristics of this iteration of blockchain tokens.

1.2.7 Non-cryptocurrency tokens

Bitcoin is a payment asset. Ether is a payment asset on the Ethereum platform, as well as a utility token used to access its smart contract functionality. ICO tokens seeking funding make a venture specific case regarding its purpose. With such token sales, what are entrepreneurs giving up and

investors receiving in exchange? Unfortunately, the dictionary is little help, Merriam Webster having simply added “a unit of cryptocurrency” to its definition of token.[9] Additionally, we decline to use commercially centric conceptualizations of a token such as a “unit of value that an organization uses to self-govern its business model”.[10] Instead we put forward a minimal definition: digital tokens are scarce entities that come with rights and / or responsibilities. Such a formulation arguably ends up including electronic bank balances as tokens. However pure blockchain tokens are provably scarce digital entities (by third parties using public information), whereas bank deposits are merely credibly scarce. Additionally, the ability to include a responsibility is far removed from what is expressed by token presently. Blockchain tokens constitute bundles of issuer defined claims. These rights and responsibilities exist at two levels: those that are made in associated documentation, and those that are written in the software code. Cohney et al. (2019) surveys the 50 largest token issues of 2017, and compares marketing promises with smart contract code. They find that most promise a token supply cap, and two thirds deliver this in code. However, they also find that a quarter (12/45) enabled code modification - for example by referencing another smart contract that can be easily replaced. Their survey highlights the opportunity to use technology to address agency costs, at the same time as revealing major issues in implementation.

A caveat to tokenization is that it does not require blockchain, while conversely a blockchain does not require a token. For clarity, the terms cryptocurrencies and ICOs do not even sit within the same taxonomy but are respectively an asset native to a payment protocol (Dwyer, 2015) and a category of fund raising. Bitcoin is the leading cryptocurrency and is mined into existence as processors are rewarded for carrying out tasks. In contrast, ICOs involve a crowdfunding to third parties. It is possible for cryptocurrencies to be an ICO, by engaging in what is termed a premine, and then selling these tokens. However, the subtlety is that for most ICOs, a change in underlying claim is paralleled by a change in how the tokens are made available. The creation of Bitcoin did not fund anything. Whereas ICO tokens can be sold for capital or distributed to potential users.

1.2.8 Initial coin offerings

ICOs have a clear use case as a new way to raise capital. Beyond this, Li and Mann (2018) points out the coordination problems in building a platform, where a lack of users can torpedo a socially valuable concept and shows how it is possible to move this coordination problem to the sale of tokens at the time of ICO. If tokens are purchased, forward induction makes user adoption the logical choice. Their solution to the ICO coordination problem, extending the time period of the ICO, is unsatisfying, however it hints at how financial speculation might improve the probability of a socially positive equilibrium. Kampakis (2018) presents three case studies on token issuers

[9] https://www.merriam-webster.com/dictionary/token
[10] http://thebusinessblockchain.com/

focused on the modelling of their micro-economies and ways to incentivize the holding of their specific tokens.

Beyond the ecosystem mechanics, individual token structures are non-standardized, which gives rise to the unique economics of each token. This is based not on their legal claims, but on their promises and abilities, and the consequent relationships that extend from the underlying business. In contrast, a share in IBM and a share in Coca Cola are the same legal and financial claim upon different businesses. As it stands there is no effective class of attributes that groups all ICO tokens. They can take the form of a profit share, a utility token, or simply a non-legally binding promise to develop (similar to crowdfunding). This variation begs the question of whether or not such attributes impact price and is only starting to be explored e.g. Catalini and Gans (2018).

Howell et al. (2018) provides a thorough discussion of the similarities and differences between ICOs and equity initial public offerings (IPOs). Evidently ICOs that possess the characteristics of a security offering likely breach legislation around financial regulation. In SEC (2017), the Securities and Exchange Commission determined that DAO tokens were securities under the Securities Act of 1933. It used the Howey test to determine whether or not an offering is a security, with the dimensions: (1) investment of money, (2) a common venture, (3) expectation of profits and (4) the efforts of others. A year later, SEC (2018) found against two token issues, Paragon Coin and Carrier-EQ (AirFox). These were American registered corporations that raised funds from American citizens and made marketing claims implying future profits. Both firms agreed to refund investors and register their tokens as securities. Additionally, AirFox agreed to pay a fine of $250k, which equates to 1.67% of original funds raised, below the yield at the time on 10yr treasuries.[11] Lo and Medda (2019) use token function dummies to provide empirical evidence that blockchain token structure does impact token price. This suggests that projects with a value are being successfully connected to tokens that have a market price and is supportive of the SEC's claim that they are investment contracts in a common venture. Going forward ICOs are likely to either avoid US exposure or register as securities. Empirical papers in the field includes Benedetti and Kostovetsky (2018)'s survey of the price performance of a sample of 4,003 ICOs; Amsden and Schweizer (2018) that looks at 1,009 tokens and attempts to define determinants of crowdfunding success (e.g. quantity of raised funds), a topic that Howell et al. (2018), Ante et al. (2018) and Adhami et al. (2018) also address. The choice of dependent and independent variables can be important in dealing with potential endogeneity of the supposedly independent variables. Variables such as team size and social media metrics will change if a fund-raising gains momentum before closing.

Cong et al. (2018) uses network effects to formulate a dynamic model of a tokenized economy, providing a wider lens to the why go crypto question. Fenu et al. (2018) examines 1388 initial coin offerings, adumbrates the importance of the Ethereum platform in the space, and discusses the

11 https://www.bloomberg.com/quote/USGG10YR:IND

mechanics of ERC-20. These standards consist of a set of rules for the issuance of a token on the Ethereum platform, including six mandatory functions such as how tokens are moved between addresses. These rules mean anyone with Internet access can issue a token.

1.2.9 Equity, debt and crowd funding within a capital structure

Given the use of blockchain tokens to raise finance, it is logical to connect them to the fecund literature on capital structure. Jensen and Meckling (1976) lays the foundations of the links between asymmetric information, the separation of control caused by the issuance of equity, and the Principal-Agent problem this leads to. Myers (2000) defines a pecking order for funding a business, from preferable to least preferable: internal cash flow, external debt, and external equity. Myers usefully highlights the primitive rights encapsulated by debt and equity. Lenders have a call option on a firms' assets, contingent on failure to pay interest and principal on debt. Equity investors can withdraw assets from insiders at any time. The clear contrast with ICO tokens is that blockchain tokens have no primitive rights. Ritter and Welch (2002) and Robb and Robinson (2014) study the empirical data on initial public offerings and on newly founded firms respectively, to better understand firm actions and decision making.

Financial instruments from cash to equity shares to financial bonds, are well established fungible items with frequent pricing. They are valuable enough so as to warrant representation in paper and more recently in digital form at a custodian. In theory it is possible to represent each of them with a blockchain token, and immediately save on custody costs. Eliminating intermediaries enables the elimination of custodians (Micheler and Heyde, 2016). It is logical that these prized markets have been targeted for blockchain implementation, but to the extent that high aggregate price is correlated to high transaction levels, these markets may not be the most suitable for low transaction capacity blockchains. Conversely there are potential use cases of blockchain where transaction velocity will not become a binding constraint. Such use cases may require a higher level of coordination (Iansiti and Lakhani, 2017), but if implemented could reduce costs, particularly where oligopolistic rents are being extracted, and increase trust in the truth recorded.

A bridge between existing financial securities and blockchain tokens is crowdfunding. Belleflamme et al. (2014) examines two models of crowdfunding: pre-ordering and profit share. They discuss pre-ordering as a form of price discrimination, with examples where the pre-order price is higher than the later full availability price. This contrasts with ICOs where typically early funders receive purchase discounts or bonus tokens. Belleflamme et al. (2014) notes that profit share is increasingly preferred as the amount of capital required increases. In some ways ICOs are a tradeable crowdfunding asset (and even we adhere to the phrase that ICOs crowdfund), however token models offer greater flexibility around technical features, business models and economics. Clearly one of these flexibilities is that blockchain tokens are liquid and easily traded, a key driver

and benefit of blockchain tokenization. These tokens leverage the features and network of the underlying blockchain platform, e.g. using it as a custody or notarization data layer.

1.2.10 Proposed token applications

Zhao et al. (2016) provides an early introduction to a number of research opportunities in blockchain. Gatteschi et al. (2018) discusses the potential implementation of blockchain in the insurance industry. It is focused on possible applications rather than appropriateness. Ferraro et al. (2018) pairs a useful overview of the directed acyclic graph in IOTA's Tangle consensus algorithm, with a proposal to use a token to enforce rule compliance in a traffic management setting. Sun et al. (2016) connects blockchain to the trending concepts of smart cities and the sharing economy. Nowinski and Kozma (2017) tries to link blockchain to the literature on business models. Maull et al. (2017) takes the blockchain and business model discussion further towards implications, with a series of workshops and interviews with individuals at incumbent firms and startups. Mohan (2019) proposes using a blockchain mechanism to address academic misconduct, based on token rewards and agent reputation. Hughes et al. (2019) approaches the subject from the perspective of firms, analysing applications within a series of industry verticals. Burer et al. (2019) provides a wide-ranging survey of incumbent and start up efforts to introduce blockchain and tokens across the energy sector.

Many of the applications discussed can be characterized as solutions looking for problems. This can be seen when trying to use blockchain to replace an intermediary without considering deeply whether it is empirically superior to the use of an intermediary. When examining the literature on proposed token applications, two preliminary fields stand out.

Supply chains are an economy wide industry, with multiple agents that must work with partners up and down the logistic network. Ganne (2019) notes how the shipping industry has seen relatively little innovation since Malcolm McLean invented the intermodal sea container in the 1950s. They provide an example of shipping a container of roses and avocados from Mombasa to Rotterdam, and state that such a shipment might produce a 25-centimeter-high pile of paperwork. The administrative cost of this may end up exceeding the associated transportation cost. The process itself may involve 100 individuals and 200 information exchanges. Furthermore, each agent has some incentive to hide any mistakes.

Using blockchain in supply chains, complemented by other technologies such as radio frequency identification (RFID) tags and GPS location tracking, is a clear opportunity that Maersk and IBM are currently attempting to address. Montecchi et al. (2019) discusses how blockchain can provide four capabilities (traceability, certifiability, trackability and verifiability) that enable the four assurances of (1) origin, (2) authenticity, (3) custody, and (4) integrity. Azzi et al. (2019) includes

two case studies of commercial blockchain based supply chain systems, that integrate such systems with RFID and GPS tags. George et al. (2019) observes that Walmart have introduced blockchain systems with respect to the tracing of pork and mangoes in their supply chain, and the propose their own variant to track food quality. They use an example of use by dates on pork, and lay out a blockchain system that records and indexes the age of food in the supply chain, or location, relative to its final use by date. This is an interesting application of the transparency possible in any database system, but that is inherent in an appropriately configured blockchain system, and raises the possibility of new vectors of competition between restaurants and retailers. Pearson et al. (2019) focuses on using distributed ledgers to enhance food traceability. Current standards revolve around the concept of "one up, one down", where agents in the supply chain are expected to record the the sources of their purchases and sales. Blockchain could bring all these parties and their disparate data into a single record of fact, improving traceability at the same time as addressing the complexity of multi-step, vertical and horizontal branching of supply chains e.g. where products are blended, dissected or mixed. If such a system recorded weights or volumes, it might even enable preemptive identification and discouragement of adulteration. However, distributed ledger technology "helps secure the evidence chain, it does not replace any of the industry and regulatory standard procedures required...to control fraud" Pearson et al. (2019, page 147). A major limit of blockchain continues to be the line between the digital and the physical, a problem that is often reflected in discussions regarding the gap between expectations and reality. Although the title of Melnyk et al. (2019) includes the phrase "Blockchain is vastly overrated", it barely discusses the technology, instead expounding on the importance of multi layered cyber security. This is trivially correct. Their paper mentions the NotPetya trojan computer virus attack on Ukraine, yet fails to reference the fact that the virus' code was based on tools developed by the National Security Agency, USA.[12] This is a somewhat potent example of how centralized systems are not necessarily managed by agents focused on the interests of users, and that a framework of trustlessness (assuming some agents to be malign) may be both architecturally preferable and provide improvements over existing supply chain models.

Hofmann et al. (2019) focuses on opportunity of blockchain in supply chain finance. Large amounts of capital are tied up in cargos of goods moving great distances. Supply chain finance process are often manual e.g. compliance checks comparing different paper-based trade finance documents. Blockchain can visualise the physical flow of goods, digitize administration, and therefore identify where cash and liquidity are being held up in the supply chain. Marrying this with fast settlement would not be a unique improvement but would enable greater efficiency and lower risk in the financing of trade flows.

Healthcare data also presents a problem that could be improved. Each individual has a healthcare record written by many parties. The two most common state of affairs is either that this record is

12 https://thenextweb.com/security/2017/06/27/nsa-knew-about-the-vulnerability-exploited-by-notpetya-for-over5-years/

not accessible by a specific doctor at the point of treatment, and / or that the data is held outside the individual's control. Kuo et al. (2019) compares a blockchain system with a distributed traditional database management system (DDBMS), within the healthcare industry. They highlight five key advantages. The first is decentralized database management whereby cooperation can occur without any party ceding control to an intermediary. Secondly, blockchain comes with an immutable audit trail, as such systems only support create and read functions, largely extirpating the ability to update and delete. Third, the ownership of a digital asset, such as an individual's data, can only be changed by the asset owner, rather than solely by the system administrator. This also means such assets are traceable and suitable for reuse, for example for insurance purposes. Forth, it would be costly for DDBMS to match blockchain's level of data redundancy and therefore its anti-fragility. Fifth, security and privacy is enhanced by the use of cryptographic algorithms by default. Kuo et al. (2019) notes that Health Information Exchange (HIE) related to patient records is the most discussed use case, followed by insurance claims and secondary use of data in research e.g. genomic studies. Problems to be addressed includes confidentiality, scalability, and the threat of 51% attacks. Given these factors, a permissioned blockchain may be the type most suited to being applied in a healthcare setting. Both healthcare and supply chain are areas where valuable data is held in multiple locations without any system of reconciliation. Both areas have a business case for a central authority, yet past industry structure has prevented one from coalescing. Both areas are ripe for improvement. Unlike in finance where incumbents create resistance to disintermediation, the primary barrier in healthcare and supply chains to adopting blockchain is the required level of cooperation.

In the unconstrained speculative application space, Laabs and Dukanovic (2018) links blockchain with the possible fourth industrial revolution of self-organizing production lines / supply chains that coordinate across devices and firms with ease. They provide two case studies, briefly explaining the opportunity for blockchain in self-organizing production lines and commercial machine to machine (M2M) services.

Relative to this, the use case adumbrated by this paper is much more straightforward. It proposes the issuance of an "adoption token" on a blockchain platform to raise funds for a philanthropic cause. This beds the practicality of the idea in the ICO space which raised significant funds in 2017, but at the same time attemps to avoid the regulatory investment contract issues that brought this period to a close (SEC, 2018). The academic significance though is somewhat deeper. Such an effort would be tokenizing a relationship. To our knowledge this would be the first such project to digitize a connection between a person and a cause and open up a large space for innovation and further research.

1.2.11 Barriers to wider adoption

Meiklejohn (2018) uses a list of ten issues with distributed ledgers in order to shine a light on current and future avenues for research and development. Saito and Iwamura (2019) attempts to

address the high volatility of cryptocurrencies, and a proposes a number of ongoing supply adjustment mechanisms, namely difficulty adjustment mechanisms and negative interest rates on unspent (UTXO) balances. However, these discussions are focused on the areas where blockchain that has already succeeded, notably Bitcoin and ICOs.

Moving beyond this, the slow adoption of blockchain outside of payments but within the financial sector is for our purposes more relevant. Wadsworth (2018) uses an 8-part criteria to compare distributed ledgers to existing payment systems. This criterion included (1) national boundaries, (2) speed, (3) cost, (4) transparency, (5) liquidity, (6) scalability, and (8) finality. Existing systems have low domestic fees, high cross border fees, at the same time as being fast, scalable and private. The paper identifies single point of failure as the key risk and ignores the topic of single point of control. In comparison, the Bitcoin blockchain has high domestic fees, relatively low cross border fees, high energy use, public transaction data, and poor scalability. A point that emerges from their analysis is that merging clearing and settlement into a single validation stage increases liquidity requirements as payments cannot be batched and offset on a daily basis. Wadsworth (2018) then summarizes two tests of distributed ledger technology: Project Jasper by the Central Bank of Canada and Project Ubin by the Monetary Authority of Singapore. The first phase of both projects used permissioned PoW blockchains. This phase was viewed particularly negatively as degradations in energy use, scalability and privacy were not offset by reduced single point of failure risk, which had been reintroduced by efforts to implement permissioning and better privacy. The second phase utilized hierarchy via a central node that validated transactions and replaced PoW. Although this eliminated many of the problems with blockchain based systems, the resulting system had more similarities to existing payment rails than blockchain.

Kuhn and Yaga (2019) takes a different tack and observe that many financial applications require the ability to delete erroneous data and transactions. They put forward the use of a verified time protocol as an alternative consensus algorithm, and the use of a data block matrix. The latter uses hashes at the column and row level, such that deletion of one table entry leaves other entries verifiable by the remaining column and row hashes.

Outside of the financial sector, it is necessary to contextualise the lack of implementation of blockchain by asking does a use case even need to be on a distributed ledger. Wust and Gervais (2018) formulates a process for judging whether or not a blockchain may be appropriate for a specific application. This framework suggests the following necessary conditions for the applicability of a blockchain: (1) a need to store state, (2) multiple writers and (3) a reason that mitigates the benefits of using a trusted third party. The criteria of whether or not all agents are known and / or trusted determines a preference for permissioned or unpermissioned distributed ledgers. A key problem is the interface between the real world and the digital world mapped out by a blockchain.

If a trusted third party is required to enforce the blockchain, then a trusted third party is likely the dominant option, for example a patent office that enforces intellectual property protection. Until this issue is resolved, the applicability of a blockchain will be relatively more appropriate for digital goods and services. Furthermore, it becomes clear that many speculated use cases never made any sense. Many aspects of government are simply ledgers, from citizenship to home ownership. However, if the government or its agency is removed from process, who enforces these ledgers and who has the right to write to them? Conversely, the financial aspects of government such as tax obligations can make more sense. Tax liabilities arise from multiple vectors, and blockchain, as a payment protocol, can enforce changes of state and the movement of funds.

Tucker and Catalini (2018) links with this in observing that blockchain does not solve the “last mile” verification of the existence or location of something physical. They use the example of the location of a baby, or that a viewer of an advertisement is human rather than a programmatic bot, where it should be clear that a blockchain can provide a digital record but not physical proof. This is in contrast to the previously intractable problem of privacy and the property rights over personal data - a digital asset that can now be owned, once it is framed on an appropriate blockchain based system.

1.2.12 In search of the next dimension of tokenization

Bitcoin, Ethereum and blockchain have dramatically diminished the barriers to issuing tradeable digital tokens. Two examples where research could shed more light include (1) the dramatically lower cost to create new, financially liquid tokens that can be used to bootstrap and scale a venture; and (2) the new relationships made possible by a blockchain token. In many domains, copying technology is litigated through the courts. Yet nearly all ICO issuers begin by building on another token’s software implementation. Successful hard forks do not merely replicate the application software, but the actual state (Abadi and Brunnermeier, 2018). Furthermore, public open source code libraries are only one of the ways that blockchains have made tokens easier to issue. They have also led to the development of a suite of infrastructure, numerous service providers and a deep pool of crowdfunders.

Taking this further, in an important paper connecting the technology to the economics of blockchain, Cong and He (2019) provides a formal proof of how a blockchain based consensus, that includes smart contract based prices contingent on delivery, can support new entrants. In their framework, new entrants signal quality by trustlessly guaranteeing buyer’s compensation if the product fails, explicitly enlarging the contract space. Together, this implies that a digital token representing anything which is excludable in usage can now be traded, and that it has become relatively easy to temporarily escrow sufficient funds to support the commitments an individual or firm attaches to such a token.

This paper observes that the features and functions of blockchain are sufficient to enable relationships and responsibilities to be embodied in a token. It proposes the issuance of an

"adoption token" on a blockchain platform to raise funds for a philanthropic cause. This beds the practicality of the idea in the ICO space which raised significant funds in 2017, but at the same time attempts to avoid the regulatory investment contract issues that brought this period to a close (SEC, 2018). The academic significance though is somewhat deeper. Such an effort would be tokenizing a relationship. To our knowledge this would be the first such project to digitize a connection between a person and a cause and open up a large space for innovation and further research. Such a token can raise finance for investment in cultural heritage at the same time as strengthening the connection between the two.

1.3 Section for blockchain in cultural heritage

1.3.1 Context

Public goods are non-excludable and incur zero marginal costs in their usage by the incremental consumer. Streetlights and defence are two examples of public goods. Barton (2000) highlights heritage as a mixed public good where exclusion may be feasible but is undesirable because of low marginal cost and / or social welfare maximization. This invariably pushes alternatives to private market funding to the fore. The two primary options are public spending by the government (raised via taxation or government borrowing), and donations from individuals. The broader background to this fund raising is that the sites recognized as cultural heritage are increasing, the costs for functional reuse are growing, while public resources are becoming scarcer. Over time there is a reduction in the proportion of cultural heritage that can be supported by government expenditure, and an increased dependence on donations and the organizations that raise donations from the public. Munoz-Darde (2013) critiques the choice the public sphere subjects itself to, between funding museums and hospitals. The paper concludes that although this debate is inescapable, at no point does the debate necessitate the tearing down of museums in favour of other social goods.

In terms of defining heritage, CHCFE (2015) provides a dynamic conceptualization of heritage that involves using the past, for both present and future potential purposes. Heritage, which can be both tangible and intangible, belongs to all those who wish to identify with it. This idealization enables a framework that brings together the economic, social, cultural and environmental benefits of cultural heritage. In this way heritage becomes a resource belonging to people and their descendants, with associated benefits and grounds for investment. De Jesus et al. (2016) surveys the literature on the transition to a circular economy. The latter concept postulates moving away from a linear economy (extraction, production, distribution, consumption and disposal), towards a permanently regenerative economy, exemplified by recycling of materials. Andreoni (2006) delivers an overview of an economic model of private giving to public goods, touching on "warm glow" feelings and tax treatment. Philanthropic donations are often one off, yet the needs of cultural heritage and other good causes are typically recurring. Work package 4 of the CLIC

project, funded by the European Union's Horizon 2020 programme, seeks to entwine heritage, circularity and finance, into an innovative model for boosting cultural heritage.

1.3.2 Problem definition

Philanthropic foundations are an important class of cultural heritage organization. These groups are a key agent in the preservation of our cultural heritage, yet instead of utilizing their resources fully, often accumulate financial assets and spend the income this generates on their charitable objectives. In 2016, Donors and Foundations Networks in Europe (DAFNE) reported public benefit foundation spending of €60 billion compared to €511 in assets (**Error! Reference source not found.** - (McGill, 2016). The implied 12% rate of spending is exaggerated by the inflow of new donations, and sampling. This choice reflects both the uncertainty in their own funding, and the highly repetitive costs involved in fund raising. We characterize these foundation holdings as social funds seeking circularity via investment returns. Donations are being invested to create an income stream. **Given the appropriate financial tools, is it possible to persuade these foundations to spend €120 billion instead of the €60 billion? Can we expand investments by cultural heritage organizations by making their financing more circular?**

	Sampled countries	Total
Number of public benefit foundations	24	147,000
Expenditures	18	€59.5 bn
Assets	17	€511.3 bn

Table 1.1 European public benefit foundations, DAFNE 2016

1.3.3 Objectives

- Develop financial tools that increase circularity in the cultural heritage sector.
- Increase capital investment in cultural heritage.
- Reduce the quantity of social funds held in financial assets.
- Test pricing models based on fundamental measures.
- Strengthen the relationship between donors and cultural heritage.

This report aims to build on prior research that demonstrates how cultural heritage can impact the lives of people (CHCFE, 2015), specifically via the vector of financing these public or mixed-public goods. In contrast to other areas of finance, such as impact investing (Maduro et al., 2018), the raising of money for philanthropy has seen comparatively less innovation, being largely an evolution in cultural values (Schervish and Bremner, 1995). In laying the ground work for meeting the above objectives, this paper outlines a financial tool, contextualizes it, and sets out a plan of future research.

1.4 Business model: hypothesis, opportunities and limits

The DAFNE data on foundation assets requires clarification. Due to the diversity of legal systems across the European Union, there is no single definition of a foundation. The data relates solely to public benefit groups, and excludes trusts and foundations established for the benefit of relatives and children. Some foundations, such as Fondation de France, are involved in projects as diverse as social vulnerability to enterprise innovation to cultural heritage. The emphasis of this report is on cultural heritage organizations (a broader category than a philanthropic foundation), and that engage in activities with a cultural or heritage dimension (a subgroup of the charitable sector).

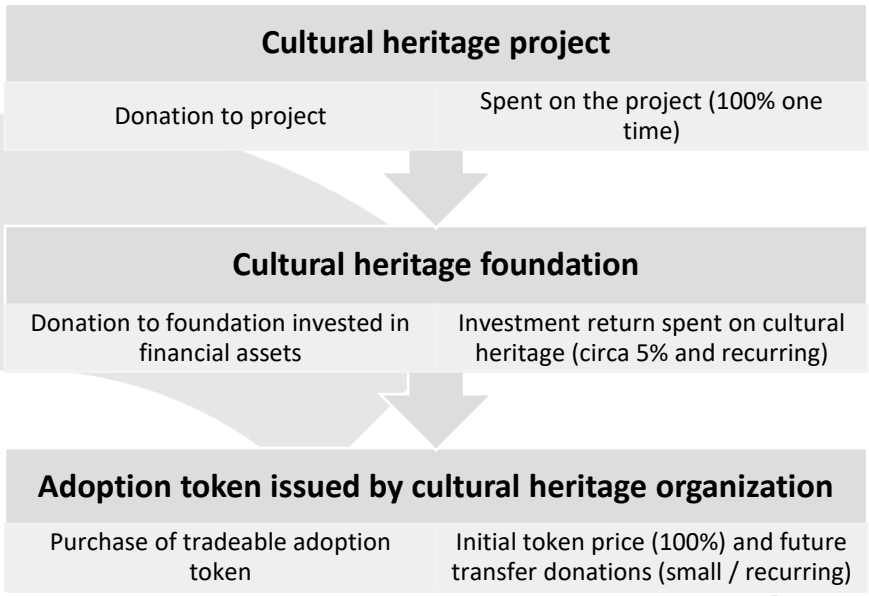


Figure 1.1 Three stylized models of philanthropy

The financial tool proposed could be used for many different groups involved in cultural heritage, but for illustration purposes will be applied to a charitable organization that owns tangible cultural heritage, such as a historic building, a museum, or a work of art. Such an organization has multiple funding options. It may monetize its cultural heritage via tickets or events. It could seek to fund itself entirely through public funding from the government. Or it could pay all expenses with donations received in the same year. Clearly, cultural heritage organizations utilize all of these funding methodologies. These methods are non-mutually exclusive and intrinsically linear. Figure 1.1 shows three stylized models of giving. The first is donation towards a project, which has an end date and therefore sees the donation spent fully on the project.

The second model is a donation towards a foundation, which seeks to fund a stream of projects indefinitely. This stylized example argues that because the foundation faces uncertainty in fundraising, it invests in financial assets and spends the income they generate on cultural heritage. A large proportion of cultural heritage organizations, that are by design over represented in the most prominent philanthropic foundations (See table 1.2), are injecting circularity into their funding strategies by this method. These assets subsequently generate a recurring income that may prospectively match the recurring nature of their expenses. For clarity, this funding strategy may be non-discretionary, based on a requirement made by the donor at the time of bequest or

donation. This report's objective is to offer a funding tool that is of potential use to all cultural heritage organizations, but that has particular relevance to a cultural heritage organization that is currently utilizing a discretionary portfolio invested in financial assets. This paper hypothesizes that these unrestricted investment assets exist due to risk aversion by the cultural heritage organization. This implies that if a financing tool could create a future recurring income stream, then some of these investment assets could be redeployed into social projects. The third example from figure 1.1 will be explored from section 0 onwards.

There are limits to the idea of redeploying investment holdings. One of these, which has been touched upon, is that many of these assets are encumbered by restrictions on nature or on use. Another is that within a portfolio funding approach it may not be possible to persuade foundations to reduce the size of their investment portfolios. Nevertheless, these limitations do not detract from the strong case for alternative funding strategies, innovative pricing models and greater investment in cultural heritage.

1.5 Cultural heritage tokenization

Blockchain tokenization has changed what is possible with organizational capital structures (Lo and Medda, 2019). New fundraising techniques such as crowd funding remained within existing conceptualizations of a deferred purchase or equity funding (Belleflamme et al., 2014). Blockchain tokenization introduced multiple new ideas - including the utility token. This token, which can be exchanged for a service, is less important than what it heralds: the concept of reliably embodying commitments in a tradeable structure not dependent on either a centralized entity or legal recourse. Within blockchain, this has been referred to as enabling social scaling via trustlessness. An alternative way to consider this is that instead of using familiar structures such as governments, companies and judiciaries to deliver an objective, it is now possible to use open source, publicly available code to reliably deliver the same objective, whether it is for money transfer, fund raising, or coordination.

This paper details a new fund-raising tool for cultural heritage, that is in practice a highly customized claim on the cultural heritage yet transfers no legal rights or financial obligations. This tool is a blockchain adoption token. The steps of the framework are as follows:

- Adoption tokens are sold to raise money for a specific example of cultural heritage.
- These tokens can be freely transferred between individuals at a price.
- Each time they are transferred, the underlying cultural heritage receives a small donation.
- The need for investments in financial assets to generate income declines.
- Foundations can fund more socially beneficial projects.
- Token price may be linked to an underlying measure such as visitor numbers.

Beyond the metaphysical “warm glow” appeal to the donor of adoption via a token, the token facilitates the innovative ability to transfer the donation. Additionally, it is possible to incorporate non-standard features into the adoption token, namely the recurring donation associated with each transfer. The impact and significance of these two innovations, plus potentially the use of fundamentally different pricing mechanisms, such as a link with the number of visitors, are within the scope of the future research objectives for the project. If it is possible to implement such a pricing mechanism, then the token becomes more than a fund-raising tool. It becomes a new type of asset valued not on supply and demand for the security but on supply and demand for the cultural heritage.

1.6 Application of tokenization to cultural heritage

In order to illustrate the idea, a hypothetical example is provided. The Palace of Versailles is an important part of humanity’s cultural heritage. Multiple organizations are involved in the conservation and restoration of the Palace. La Société des Amis de Versailles was founded in 1913 to restore and enhance the palace, its surrounding parc and its collections of art and furniture. It is financed primarily through memberships, donations and corporate sponsorships. The Versailles and Giverny Foundation is committed to the ongoing restoration of the marbles of the Parc. The Palace itself offers the privilege of adopting statues and involvement in restoration specific projects. Since 2015 the Palace offers a €5 patronage token cast in metal. Given the number of organizations involved, significant financial assets are held in perpetuity to support the high costs of cultural heritage conservation Versailles demands.

Figure 1.2 Image: Versailles Patronage token, chateauversailles.fr

The alternative within a blockchain token model would be that one of the cultural heritage organizations responsible for Versailles issues 1 million adoption tokens that are sold to the general public. Each token would come with no financial rights but would signify that the holder had ‘adopted’ the Palace and its grounds. It is clear that this is similar to a traditional philanthropic fund-

raising model. However, in this traditional model, the donations may not be transferred at a later date, and do not repeat.

To date, most blockchains are payment protocols, a set of rules and conventions for the transfer of value. A blockchain based adoption token is inherently transferable for value – and therefore receiving funds for unadopting could be as straightforward as giving funds by adopting. Another way of thinking about this is to say that an adoption token could be described as a form of tradeable crowdfunding.

Using tradeable tokens, existing adopters can exit, and new adopters enter. A core idea proposed is that a small portion of the price (for example the buy-sell spread at time of transfer) can revolve back to the cultural heritage project. The token has moved from solely financing the refurbishment to providing ongoing funding. This connects with the cultural heritage organizations described in Section 0, in that the income stream from transfers of the blockchain token reduces the riskiness associated with not holding financial assets and forgoing the related payments of dividends and interest. In this way, a blockchain token offers the possibility of boosting capital spending on cultural heritage as funds held in financial assets are shifted into social projects. Additionally the adoption token proposed in this example is aligned with calls for funding to be directed to strategic goals and organizations, rather than just projects (Carazzone, 2018). Furthermore, with the alternative pricing models under consideration, it may be possible to make the transfer price dependent on fundamental measures, such as visits to the Palace of Versailles.

The use of blockchain technology would imbue adoption tokens with characteristics, such as provable scarcity, that prior forms of adoption could not achieve cheaply. Adoption tokens can be referred to as assets, but for this proposal's purposes, is more accurately thought of as a digital signifier of a connection between adopter and a social organization, an area or social good.

1.7 Application of tokenization to a cultural heritage organization

For the purposes of this discussion, this report now examines a specific type of foundation, exemplified by Fondo Ambiente Italiano (FAI) and the National Trust, UK. The Fondo Ambiente Italiano (2017) annual report states that they protect, restore or open to the public, 59 sites of cultural heritage. The National Trust is responsible for over 500 historic sites (National Trust, 2018). Although both organizations charge admission fees, they are essentially funded via membership income and donations. In February 2018, The National Trust had charitable assets of £1.38 billion, of which £310 million were neither restricted by endowment, or ring fenced by purpose. During the 2017-18 financial year, Investment income and net gains equated to 15% of expenditure. The National Trust also receives donations from commercial subsidiaries it controls in renewable energy and hotels. In contrast, the FAI has de Minimis financial assets, the majority of which are restricted. It is possible that these low investment fund holdings, relative to their

annual expenditures, are related to their many property related recurring income streams e.g. tickets, rents and events, plus a combination of brand strength and fund-raising skill. 19% of FAI's expenditures are on fund raising and communication. In table 1.2 at the end of this paper, information is provided on the twenty largest UK foundations by level of grants, which illustrates the diversity of philanthropic foundations, from those that spend a small fraction of their investment assets, to those that choose not to build up large investment foundations (similar to FAI), and those that are somewhere in between (e.g. the National Trust).
For all charities, but particularly for the FAI with no investment assets, a key reason to issue the cultural heritage tokens introduced in this paper is the creation of an additional form of fundraising. They constitute a hybrid between a funding drive on behalf of a specific historical site, and member subscriptions. Repeating and predictable member subscriptions are a preferable way to raise donations, however memberships are limited to per capita, whereas it is possible to adopt multiple cultural heritage sites concurrently. In contrast for other foundations, such as the National Trust, the income generated by an adoption token reduces their dependency on their current £310 million portfolio of unrestricted investment assets. This paper argues that these assets are being used as an income stream, and as a reserve due to risk aversion, part of which could be addressed by the token framework described. Any incremental spending out of these investment assets would lead to more spending on social projects, on the assumption that they are not constrained by the supply of socially positive net present value opportunities.

In contrast to the tangible benefit of financing, adoption tokens also introduce the digitalization of something intangible – the relationship between an object of cultural heritage and an individual who cares about it at an emotional level. The impact of this digitization is a potential topic of future research.

1.8 Blockchain tokenization

The token framework proposed is theoretically technology neutral. It can be implemented as a European wide charitable adoption platform, or as an application on an established smart contract blockchain platform such as Ethereum or EOS. Narayanan et al. (2016) provides a comprehensive review of blockchain and smart contract technology. As originally formulated in Nakamoto (2009), blockchain can be thought of as a set of rules and conventions for the movement of value between network addresses.

At a non-technical level, blockchain combines two features, append only and no single point of control, in order to deliver the functionality of a reliable record of fact. The three together enables provably scarce

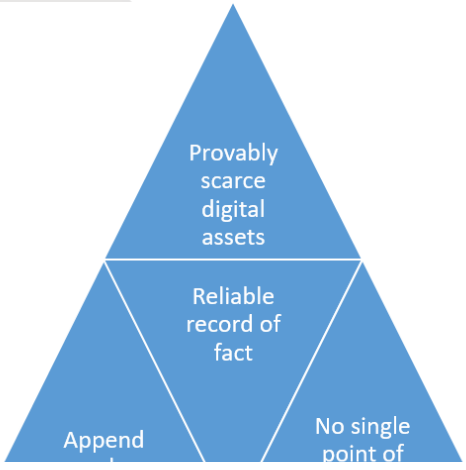


Figure 1.3 Blockchain features

digital assets, such as Bitcoin. It is important to observe here that digital bank cash is not the same as physical cash. Trivially, the latter is backed by the ECB, whereas digital bank cash is backed by the private bank providing a consumer's current account. Both require a centralized entity. As discussed in Lo and Medda (2018), blockchain does not build superior systems, but rather trades system capacity for decentralization. Visa is capable of a peak rate of 56,000 transactions per second, whereas Bitcoin is specified for approximately seven transactions per second (Croman et al., 2016). At a high level, a blockchain based token requires no central authority, whereas implementing adoption tokens on a non-blockchain platform requires the development of a central authority to manage trust between issuers and users. A centralized system would be faster and more scalable. Another issue that should not to be underestimated is that a centralized system, accepting conventional payment methods, would make exchange from Euros into a token significantly easier. Blockchain would provide a number of alternative benefits:

- Less upfront investment. Blockchain tokens on the Ethereum platform can be issued in 30 minutes.[13]
- Transparency on flow of funds.
- Reliable and public record of fact. A feature of many equity stock markets is that, due to short sales, more shares are owned than actually issued by companies i.e. they are not a reliable record of fact.
- Smart contracts could transparently control the pricing and specification of tokens.
- Multi signature blockchain features could be used by the issuer to prevent adoption by less suitable token holders (though difficult in practice).

An ambiguously understood fact regarding Blockchain tokens used for payments, also known as cryptocurrencies such as Bitcoin, are that they have no intrinsic value (Berentsen and Schär, 2018). It is possible to go further with adoption tokens, stating in the programming code itself that the tokens have no financial claim on the underlying cultural heritage. This fact does not preclude requiring that major plans, such as changes in ownership, must involve consultation with token holders, and potentially a non-binding vote in favor or against. This creates the advantage that a token that transfers no financial value may be able to create protections for the cultural heritage at its heart, and by implication generate a degree of intrinsic value arising from these consultative capabilities.

13 https://news.bitcoin.com/launching-an-ico-token-on-ethereum-in-less-than-thirty-minutes/

1.9 Tokenization of cultural asset: why

In a traditional cultural heritage model, a philanthropic foundation may attempt to raise sufficient funds for both the refurbishment, and the creation of an investment portfolio to support the ongoing costs of conservation post refurbishment. For a project with a €25 million up front cost (such as the Colosseum in Rome) and a hypothetical annual recurring conservation cost of €2.5 million, the assumption of a 5% investment yield implies €50 million is required for the purpose of future expenses. This immediately trebles the targeted fund raising to €75 million in total. This can be viewed from two different perspectives in that (1) a token could divide by three the cost of a cultural heritage fund raising for a foundation, or (2) that it enables three equivalent large-scale projects, instead of one.

Figure 1.4 Image: Guillermo Alonso

Two further examples are addressed briefly. The token model in Section 0 would be suitable to enable the acquisition of a work of art via private sale. However, as the needs for a recurring income stream are smaller, the benefits over traditional fundraising are lower. In contrast to the purchase of a work of art, it is possible that an adoption token may be suited to a highly local scheme, such as saving a historic library, where the upfront refurbishment cost is small relative to the longer-term ongoing expenses. Such a project can generate the high stated preferences necessary during initial fund raising but suffer from lower revealed preferences reflected in recurring visits and ongoing willingness to donate. All of the project examples highlight the core requirement of this framework, which is that the underlying cultural heritage is sufficiently charismatic to generate highly motivated supporters.

In addition to the potential for increased cultural heritage protections discussed in Section 2.3 (due to consultation requirements or non-binding voting features), another plausible benefit of an adoption type token would be to encourage increased levels of participation and engagement in the cultural heritage. With respect to a local library, if pricing is linked to visitor numbers, such a token may incentivize token holders to increase the frequency of their visits. This is one possible

hypothesis for this specific form of digitizing the relationship between the cultural heritage and its adopter.

In terms of regulation, the United States has punished issuers of blockchain based assets for investment contracts marketed with the promise of investment returns (SEC, 2018). The Financial Conduct Authority in the UK has taken a contrastingly softer line. Although activities related to financial services, such as advising, are regulated, issuance is unregulated as long as the token is not similar to an existing financial product such as an equity, a bond, or a derivative (FCA, 2019). Although Europe has no obligation to follow UK and Swiss guidance (FINMA, 2018), there is some evidence that tradeable adoption tokens, with rights no greater than non-binding votes, may be outside the scope of financial regulation in Europe, but potentially within the scope of financial regulation in the United States.

The largest barrier to adoption tokens is arguably one of its most attractive features: the ability for price to vary. Roubini (2018) highlights many of the problems of the cryptocurrency space including the inflating and bursting of a speculative bubble in 2018. Some mitigation is provided by the donation component of any transfer. Research will also be carried out to link the price of the token to a cultural heritage measure, such as visitor numbers. Another possibility is that following a short period of time, the opposite to a speculative bubble occurs with trading in the token declining to zero. Research avenues to mitigate or modulate the ability of adoption tokens to rapidly change price are included in the plan of future work below.

1.10 Plan of future work

This paper identifies a number of important academic research directions:

- Pricing: further work is required to develop a pricing framework. A potential preference is to link this to visitor numbers, but is it possible to set a price that is not designed to balance supply and demand for tokens?
- Mechanisms for supply and demand.
- Mechanisms for generating recurring donations.
- Risks from speculation.
- Risks from interest in adoption declining over time.
- Token design with respect to:
    - The needs of the foundation
    - The needs of the adopter
    - The needs of the cultural heritage
- Token life cycle.

It is important to consult a foundation responsible for highly marketable cultural heritage assets with the ideas detailed. This will generate early feedback and gauge foundation appetite for adoption tokens. The fact that tokens bear some similarities with existing fund-raising tools is an

opportunity and a weakness. Are such tokens an attractive fund-raising tool? Do cultural heritage organizations believe adoption tokens will cannibalize their other fundraising channels? Might adoption tokens strengthen the charities' relationship their volunteers and subscribing members?

An initial proposal for implementation of an adoption token has been made to CLIC partner Pakhuis de Zwijger, Amsterdam.

Table 1.2 20 largest foundations in UK by most recently reported annual grants, GBP mil

	Accounting year	**Grants** (£m)	**Net assets** (£m)	**Grant** rate
Wellcome Trust	Sep-17	844.7	21,877.00	3.9%
Children's Investment Fund Foundation	Dec-16	170.1	3,825.40	4.4%
Comic Relief	Jul-16	99.5	93.5	106.4%
Leverhulme Trust	Dec-17	75.1	3,255.70	2.3%
Garfield Weston Foundation	Apr-17	62.3	9,905.70	0.6%
BBC Children in Need Appeal	Jun-17	61.3	45.1	135.9%
Arcadia	Dec-17	54.6	12.4	440.3%
Esmée Fairbairn Foundation	Dec-17	40.5	996.9	4.1%
Gatsby Charitable Foundation	Apr-17	36.3	396.8	9.1%
Monument Trust	Apr-17	35.3	35.2	100.3%
Wolfson Foundation	Mar-17	30	774.5	3.9%
Grace Trust	Jun-16	30	15	200.0%
Henry Smith Charity	Dec-16	28.1	952.8	2.9%
Gilmoor Benevolent Fund Ltd	Mar-17	26	91	28.6%
Ahmadiyya Muslim Jamaat International	Dec-16	23.6	14.1	167.4%
United Talmudical Associates Ltd	Mar-17	22.9	1.5	1526.7%
Lloyd's Register Foundation	Jun-17	22.8	306.7	7.4%
Barnabas Aid International	Apr-17	22.5	0	N/A
The Sackler Trust	Dec-16	21.1	37.8	55.8%
The Basil Larsen 1999 Charitable Trust	Apr-17	21.1	30.3	69.6%

Chapter 2 MESO: Private Capital for the Common Good: Impact Investing and Cultural Heritage

Given cultural and natural heritage assets capability to generate a wide array of economic, social, beside obviously cultural and environmental values, they often represent excellent candidates to access funds for their preservation and regeneration in the form of impact investing; however, according to the GIIN 2019 Annual Impact Investor Survey – the most comprehensive and authoritative report on the state and trends of the industry since 2011 – in 2018 only about 2% of the 239 bn in impact investing assets managed by respondents globally were allocated to Arts & Culture, the only area among the 13 considered where investment levels decreased compared to 2014. To understand the reasons of this apparently underwhelming performance, in the following sections we will briefly outline what impact investment is and how it evolved in the last decades, before focussing on the implications and possible ways forward in the domain of adaptive reuse of cultural heritage and historic urban landscapes – the main focus of EU the CLIC project.

2.1 Impact investment: definition and developments

Impact investing, sometimes termed social finance, has been emerging in the 2000' mainly in the United Kingdom and United States and includes all those "investments made with the intention to generate positive, measurable social and environmental impact alongside a financial return" (A. Mudaliar, R. Bass, 2019).[14]

According to its growing community of practice, impact investing is characterised by three main features: **intentionality, measurability and additionality**. Intentionality refers to the fact that, while any investment can potentially generate positive social and environmental outcomes, impact investing explicitly and proactively seeks to achieve determined social and environmental objectives along with financial returns. Measurability means that any social and environmental impact generated by the investment needs to be assessed objectively and consistently, ensuring accountability and transparency. Finally, additionality indicates that impact investing provides capital for the achievement of results that would not be attained otherwise, with particular reference to those sectors and objectives that are traditionally underinvested due to their lower profitability, and usually require governmental intervention through public spending.

While specialised financial intermediaries serving disadvantaged communities either at lower-than-market return rates or by providing credit to "unbackable" organisations always existed, particularly within the world of cooperative and religious organisations, impact investing as

[14] Other definitions include OECD's (2015), according to which "social impact investment is the use of public, philanthropic and private capital to support businesses that are designed to achieve positive, measurable social and/or environmental outcomes together with financial returns", and the G8 Social Impact Investment Task Force (now Global Steering Group for Impact Investment - GSG), which defines social impact investments as "[…] those that intentionally target specific social objectives along with a financial return and measure the achievement of both".

previously defined is a relatively new phenomenon, which gained much traction in the aftermath of the 2008 financial crisis.

In Europe, Tony Blair's government established the first working group on impact investing in 2000, hence kickstarting a complex national agenda which has developed in the following decades across different governments and political parties. Largely policy driven initiatives in the UK included the establishment in 2001 of UnLtd, a business service support organisation tasked with providing social enterprises with small grants and capacity building to become investment ready, while on the supply side Bridges Ventures and the Charity bank were created in 2002 to provide specialised equity and debt funding, followed in 2007 by Social Finance, which played a major role in launching the first social impact bond in 2010. In 2012 Big Society Capital was created pooling resources from dormant accounts, a £600m wholesaler targeting impact funds and social finance intermediaries across the country, while in 2013 the Unit Cost Database and What Works centres were made available to support both commissioners and practitioners in identifying and attribute costs to social issues, thus laying the foundations of a private market for social impact. In 2014, the Social Value Act came into force introducing a social clause in public procurement procedures, while in the same year a 30% social investment tax relief for impact investors was introduced. It was again thanks to the initiative of the UK government, this time under the leadership of David Cameron, that the G8 Taskforce for social impact investing was launched in 2013, igniting a global conversation around the emerging financial field.

The United States and Canada, where roughly 60% of the 1,100 impact investing organisations identified by GIIN in 2019 are based, also have a long tradition in impact investing, largely emerging from community development finance and the pioneering work of private foundations such as the Rockefeller Foundation – the term impact investing was actually coined in 2007 at the Rockefeller Bellaggio Center – the Bill & Melinda Gates Foundation, the Ford Foundation, the McArthur Foundation, the Case Foundation and the Omidyar Network. In 2011, the Obama administration launched the $1 billion Small Business Investment Company (SBIC) Impact Fund with the objective of providing capital to private equity funds making impact investments across the country[15]. Most recently, the U.S. federal government designated the first set of Opportunity Zones to spur investment in economically distressed areas, making available tax benefits and the opportunity for investors to form Qualified Opportunity Funds by self-certifying, using a tax form to make investments into Opportunity Zones[16].

At the EU level, the European Commission, with the support of the European Investment Bank (EIB) group, has also championed the sector, and today the European Investment Fund (EIF) has

[15] The initiative came to an end in June 2018 as "in six years under the Impact Policy, few qualified funds applied to be licensed as Impact SBICs, and SBA licensed only nine Impact SBICs. SBA believes that many of these SBICs would have applied to the SBIC program Start Printed Page regardless of the existence of the Impact Policy. SBA determined that the cost of the Impact Policy was not commensurate with the benefits" (Federal Register, 06/11/2018).

[16] The first 18 opportunity zones were announced by the US Department of the Treasury in April 2018: https://home.treasury.gov/news/press-releases/sm0341

over 370 million euros committed to social impact programmes, which is expected to raise to 4 billion in the next programming period under the so-called "social window" of InvestEU, the successor of the European Fund for Strategic Infrastructure launched by the Juncker Commission in 2014. Importantly, the new programme will mainstream all the existing financial instruments under four windows (further to the social window, a SME window, an infrastructure window and an RDI window) with cultural and heritage projects and companies able to access funding under all windows, and the current Cultural and Creative Industries (CCI) financial instrument being included under the SMEs window.

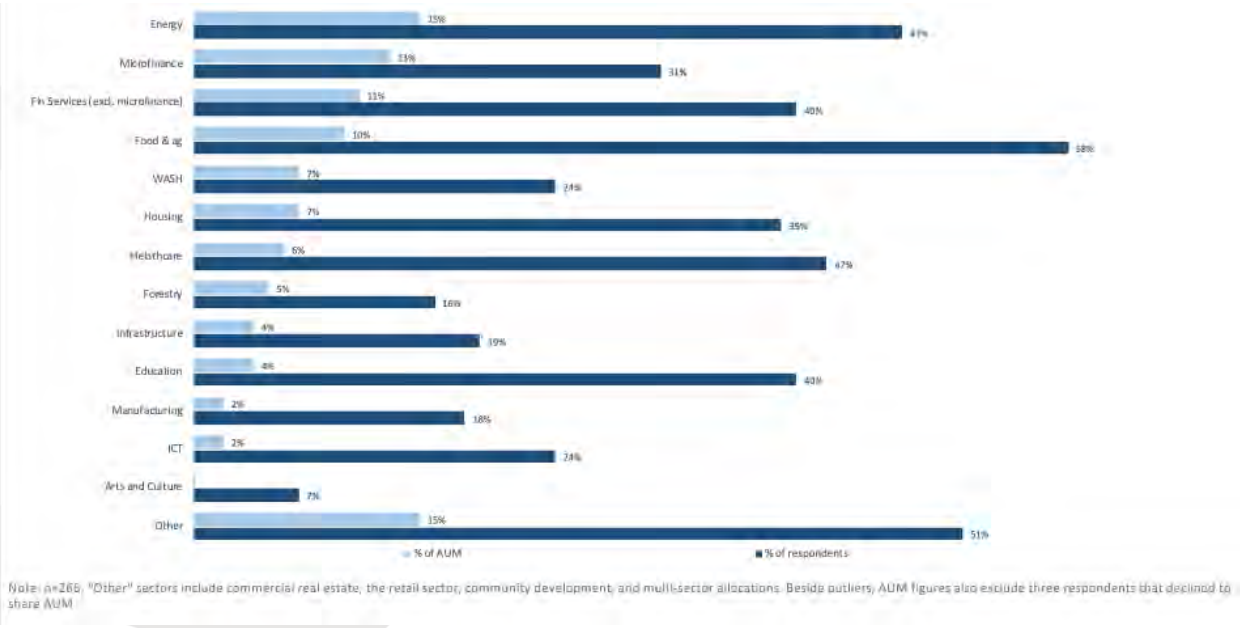
Regulatory initiatives such as the EU directive on public tendering and the European Social Entrepreneurship Fund (EuSEF) label for funds investing in social enterprises also helped shaping the impact investing market across EU member states, and so did the Social Business Initiative launched by then Single Market Commissioner Michel Barnier to raise the visibility of the sector by regrouping all EU related initiatives under a single hat.

2.1.1 Impact investing market size and characteristics

Concerning the impact investment market size and main characteristics, according to the latest GIIN study (A. Mudaliar, 2019)[17], in 2018 the impact investing market amounted to **USD 502 bn**, managed by **1,340** organisations, out of which over 60% are asset managers, around 20% are foundations and the rest are banks (4%), Development Finance Institutions – DFIs (2%), family offices (2%), and institutional asset owners such as pension funds and insurance companies (1%). Asset managers are responsible for 51% of impact investing Assets Under Management (AUM), followed by DFI (27%), banks (12%), Pension Funds (6%) and Foundations (6%).
While most impact investors are relatively small (the median investor AUM is USD 29 million), several investors manage very large impact investing portfolios (the average is USD 452 million). As mentioned, most investors (i.e. the 58%) are based either in the States or Canada, followed by Europe, which is home to the 21% of identified investors.
If we look at the sample of **266 impact investors surveyed in detail** by (A. Mudaliar, R. Bass, 2019), whose AUM amount to **239 billion**, we will realize how diverse the impact investment world is across geographies, sectors, instruments and return expectations.

[17] While there is not total agreement on the definition of impact investing, and therefore on its market size, the GIIN definition and database is considered the standard by practitioners at the global level and will therefore be our main reference. At the European level, EUROSIF has been monitoring the sector within its work on Sustainable and Responsible Finance, through a survey which in 2018 concerned 263 asset managers and asset owners with combined assets under management (AUM) of EUR 20 trillion, representing market coverage of 79%. Estimates from EUROSIF on the EU impact investing market are consistent with GIIN's, placing it at €108 billion in assets in 2018, from only €20 billion in 2013, with a 6-year CAGR of 52%.

Figure 2.1 Sector allocation by AUM and number of respondents

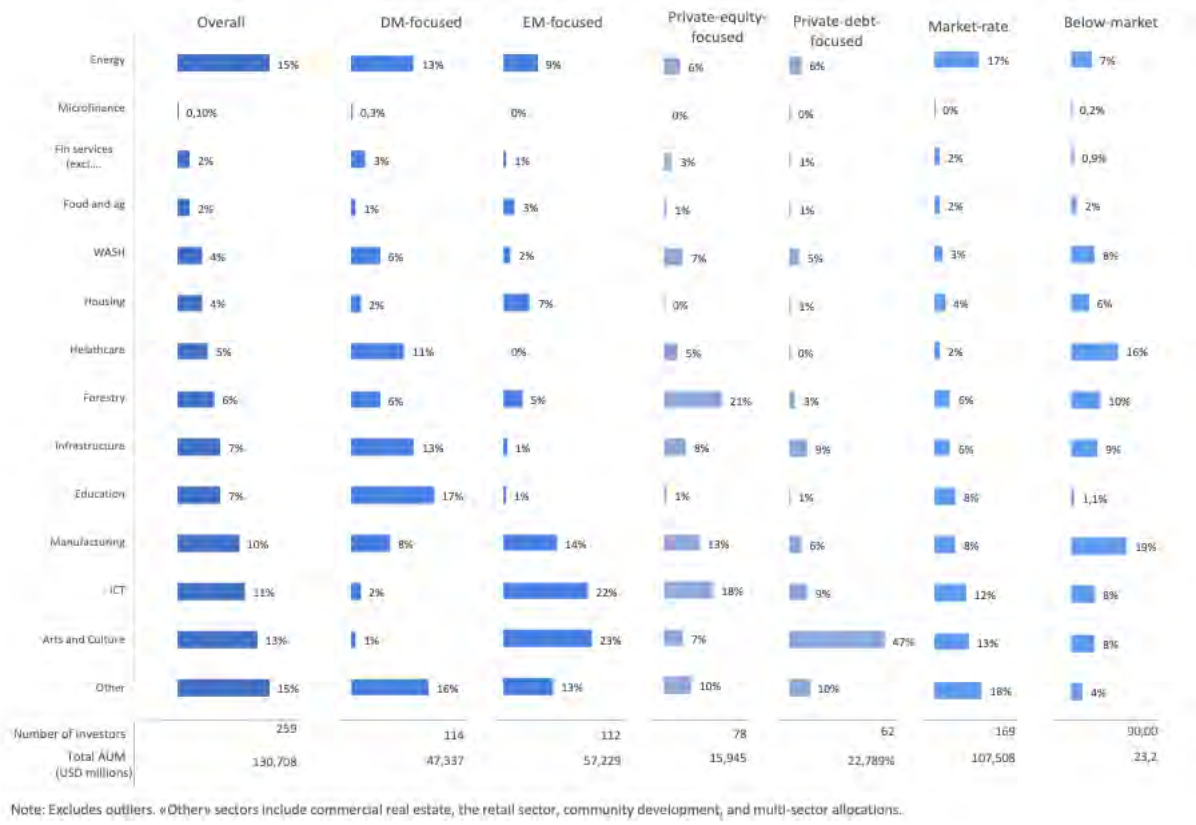


Source: own elaboration based on A. Mudaliar, R. Bass, 2019

In terms of geographies, around half of the impact investing AUM are allocated to Emerging Markets (EM) and the other half to Developed Markets (DM) and more precisely 28% in the US and Canada and 10% in Europe. Concerning sectors, energy and financial services are by far the most invested areas, with Arts and Culture being the less invested.

If we break down sectoral investment according to geographical scope, asset class and returns expectations, we will find that DM-focused investors allocated a greater share of their capital to housing (13%) and forestry (11%) than did EM-focused Investors, which are more focused into financial services and agriculture. Private-equity-focused investors also had greater allocations to healthcare (21%) than private-debt-focused investors (3%), and Market-Rate Investors allocated a greater proportion of their capital to energy (18%) than Below-Market Investors (4%):

Table 2.1 Asset allocations by sector, among respondent subgroups



Note: Excludes outliers. «Other» sectors include commercial real estate, the retail sector, community development, and multi-sector allocations.

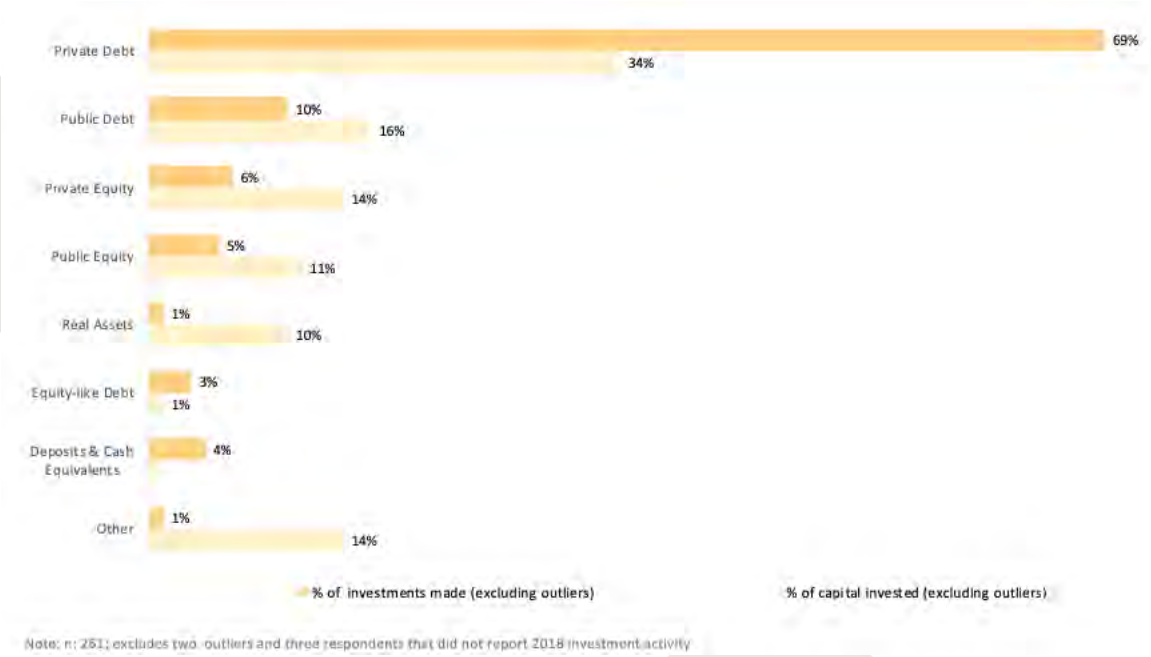
Source: own elaboration based on A. Mudaliar, R. Bass, 2019

If we take a closer look at impact investing in Arts and Culture, we will see that only developed markets are represented, that there is no equity investment, and that debt investors are mostly public. Moreover, investments in Arts and Culture tend to aim for below market returns more often, albeit marginally, than they do aim for market returns – an opposite trend with respect with sectors such as Energy, Water, Sanitation &Hygiene, and Microfinance. Arts & Culture has also been the only sector which saw a decrease in investment in the last 4 years, from 129 million invested in 2014 to 36 million in 2018 (compound annual growth rate or CAGR= -27%), whereas infrastructure, WASH (Water, Sanitation and Hygiene) and ICT were the fastest growing sectors (CAGR= 61%, 43% and 43% respectively). Importantly, heritage projects – and particularly investment in abandoned or underused heritage assets and in creative place-making projects, are likely to be represented within the "Other" category, which includes commercial real estate, retail, community development and multi-sector allocations.

In terms of instruments, private and public debt make the bulk of the impact investment market both in terms of number (private debt represents the 69% of all transactions, public debt the 10%)

and size of investments (34% and 16% respectively), with equity representing the 11% of transactions but the 25% of capital invested, and real assets representing only 1% of investments made but accounting for 10% of capital invested. These proportions are largely reflected by data on average investment sizes, equal to $20,1 million for real assets, $6,4 million for public equity, $5,5 million for private equity, $4,4 million for public debt and $1,3 million for private debt (with an overall average deal size equal to 2,6 million).

Figure 2.2 Volume of capital invested and number of investments (USD million) made in 2018, by asset class



Source: own elaboration based on A. Mudaliar, R. Bass, 2019

Concerning expectations in terms of financial returns – and opposite to what often perceived by the public at large –, **66% of surveyed organisations targeted market-rate returns**, with a further 19% primarily seeking below-market returns that are closer to market rate, and the remaining 15% targeting returns closer to capital preservation. Over 70% of foundations and not-for-profit fund managers pursue below-market returns, and so do most private debt-focused investors (59%), whereas a majority of private equity-focused investors target market-rate returns (79%).

As far as performances are related, the **overwhelming majority (over 90%) of impact investors saw both their impact and financial expectations either matched or surpassed, with private market investors operating at market rates achieving average gross realised returns equal to 16,9% in the equity segment (both for developed and emerging markets) and equal to**

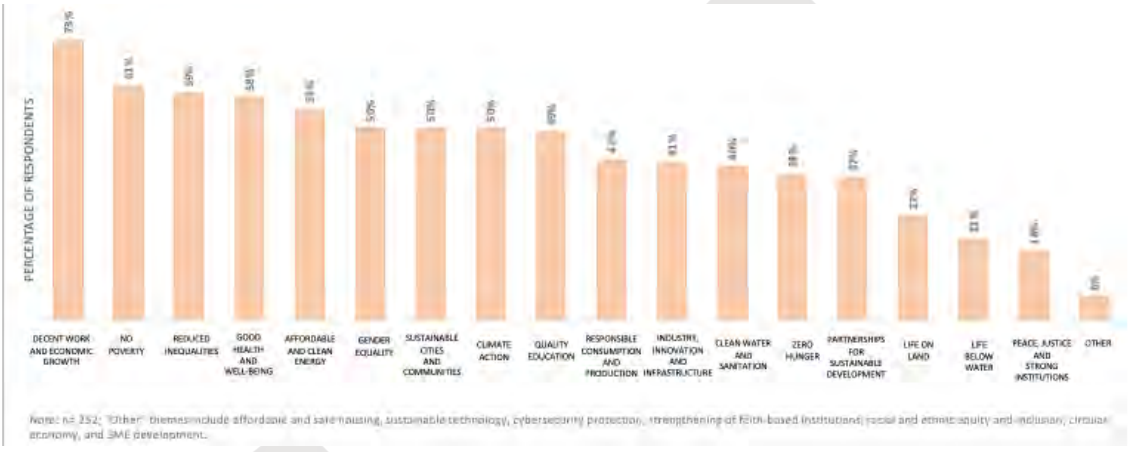
7% and 8% in the debt segment for developed and emerging markets respectively. As for below-market operators, results were equal to 6,9% (developed markets) and 10,6% (emerging markets) in the equity segment, and to 4,4% and 7% respectively in the debt segment.

Finally, if we look at impact objectives and impact assessment approaches, we find that all surveyed organisations but two have impact monitoring systems in place[18], and that over 60% of them monitor their impact against Sustainable Development Goals (SDGs), a trend which has been growing steadily in the last few years, seeing the convergence between governments and large multilateral institutions, including the European Commission and OECD.

According to (A. Mudaliar, R. Bass, 2019), "nearly 75% of investors target 'decent work and economic growth,' and more than half target each of 'no poverty,' 'reduced inequalities,' 'good health and well-being,' and 'affordable and clean energy.' The median investor reported targeting seven themes across their portfolio".

Of course, SDG targeted priorities vary considerably based on impact investors' geographical focus: 'no poverty', 'gender equality' and 'decent work and economic growth' are more common among EM investors, with 'sustainable cities and communities', 'climate action' and 'peace, justice, and strong institutions' being more widespread among DM investors. Similarly, market-rate investors tend to focus on specific goals such as 'affordable and clean energy', 'climate action', 'clean water and sanitation' and 'industry, innovation, and infrastructure' compared to their below-market counterparts. Finally, we can observe high level of co-occurrence between 'decent work and economic growth', 'no poverty' and 'reduced inequalities' as well as between 'good health and well-being', 'quality education', and 'gender equality'.

Figure 2.3 Targeted SDG-aligned themes



[18] "Around two-thirds of impact investors use qualitative information, with a slightly lesser proportion using proprietary metrics and nearly half using metrics aligned to IRIS" (A. Mudaliar, R. Bass, 2019).

Source: own elaboration based on A. Mudaliar, R. Bass, 2019

Although the first comprehensive quantification of the global market was published by GIIN only in 2019 (A. Mudaliar and H. Dithrich, 2019), and therefore no sound historical comparison is possible yet, there are signs showing that, while still in its infancy, the impact investing market is growing rapidly. In fact, if we look at the subset of 80 impact investors which participated in the GIIN Survey both in 2019 and in 2015, their impact investing assets went from $37 billion in 2014 to nearly $69 billion in 2018, a CAGR of nearly 17%. Volume of capital invested raised by 16% per annum (from $7.5 billion in 2014 to $13.6 billion in 2018), and the number of impact investments by 11% (from 4,396 to 6,617). The average deal size grew by 20%, from just over $1.7 million in 2014 to nearly $2.1 m in 2018. Over this four-year period, the geographies that experienced strongest growth were Middle East and North Africa (CAGR of 43%) and South Asia (24%), while the fastest growing sectors were infrastructure (61%), WASH (43%), and ICT (43%).

2.2 Impact investing and the Creative Economy

As highlighted by (Bonny Moellenbrock, 2018), despite the fact that Arts and Culture account for only 0,1% of impact investing assets monitored by the GIIN survey, it might well be that "impact investing in the creative economy has been hiding in plain sight", with over 107 funds (out of which 53% are impact funds, 11% are sustainable and responsible funds and 36% are conventional funds) - representing an estimated $60 billion AUM – which provided public and private debt, equity and real estate investment in the creative economy in 2018 across the globe.

In the sample considered by Moellenbrock however, **only 19% of the funds have explicit creative economy strategies in place or are exclusively dedicated to the 5 primary creative economy categories identified**, i.e. Creative Places, Ethical Fashion, Social Impact Media, Sustainable Food, and Other Creative Businesses, and only 4 funds (NESTA Arts Impact Fund, EDGE Creative Enterprise Fund, the Designer Fund and New Jersey Community Capital Creative Placemaking Fund) explicitly mention the arts or the creative economy in their names. **This signals a lack of recognition of the Creative Economy Sector as a specific asset class which is very likely hampering the development of an impact investing market targeting the sector despite its economic viability and investors' growing appetite**.

In line with CLIC priorities, in the following sections we will be mainly focussing on impact investment in relation to Creative Places – including via investment into creative industries which contribute to the adaptive reuse of regenerated heritage assets -; however, it is important to signal how impact organisations operating in the "Sustainable Food" domain – which is not considered part of the cultural and creative industry sector in its EU definition[19] -, might have an important role

[19] For an EU definition of the Cultural and Creative sector see https://ec.europa.eu/culture/policy/cultural-creative-industries_en

in preserving and re-functionalising both immaterial cultural assets and natural heritage assets, both in developed and developing markets, which would deserve further study.

Our assumption is that a combination of impact funding instruments targeting both cultural infrastructures (so mainly real estate investment) and creative industries which could contribute to the revitalisation of endangered/underused cultural and natural heritage assets could greatly contribute to advance the agenda of European cities towards sustainable and inclusive growth.

2.2.1 Investment into the adaptive reuse of natural and cultural assets and historic urban landscapes: theoretical and policy background

In a recent article, (Grodach, 2017) examines three decades of culture-led urban policies, identifying three main narratives behind their ascent in the 1980' and multifaced evolution up to today, which respond to three socio-economic trends, i.e. changing demographic structures and social trends; the rapid deindustrialisation of urban centres, and the raise of fiscal austerity and privatisations under neoliberal governments. The three narratives, which are largely interrelated, see the arts and creative industry as a consumption booster for citizens and visitors alike; as an emerging productive sector which might offset the negative consequences of deindustrialisation (or, if we think to ongoing debates, to digitalisation and jobless-growth phenomena - and as a "gentrification force" counteracting deurbanization and abandonment. In all cases, heritage sites and creative and cultural activities are interpreted as development assets on which local and national authorities should have invested to revive struggling urban centres.

Concerning initiatives aimed at boosting consumption and tourism, these were largely about culture-led developments of abandoned/underused assets or, in the most ambitious cases, about culture-led urban regeneration of entire neighbourhoods and their transformation into cultural districts, supported by land write-downs, tax credits, amenity bonuses and, in several American, European and Australian states, art percent programmes aimed at lending aesthetic values to the redevelopment projects. The huge success and worldwide echo which accompanied the opening of Frank Gehry's Guggenheim Museum in Bilbao accelerated this trend: "by the 1990', over 90 US cities had designated arts districts to encourage the rehabilitation of vacant industrial spaces, and many attempted to achieve their own "Bilbao effect" with a high concept cultural building to brand the city" (Grodach, 2017). In Europe, operations such as the establishment of the Centre Pompidou in Paris, the Tate Modern in London or Gateshead's Baltic Centre for Contemporary Art exemplify this approach, which is still very much alive in different regions of the world, as demonstrated by the recent opening of the Louvre Abu Dhabi, the museum of the Second World Word in Gdansk or the Zeitz MOCAA in Cape Town. As for cultural districts, they typically involve a mix of the first and second narrative, where arts and culture and creative industries (from fashion to design, from new media to advertising), were seen as paradigmatic of the knowledge economy which, with its attention to technology advancement and servitisation processes - should have replaced manufacturing as the main source of growth in developed markets according to the neoliberal paradigm. Europe, and particularly the UK, were championing this approach – with the

early contribution of the UNESCO - and prominent examples of place-based programmes include Sheffield's cultural industry quarter, Manchester's northern quarter, Liverpool £100 million plan to transform the city centre into a mecca for creative industries and, most recently, London Knowledge Quarter. The hugely successfully European Capital of Culture initiative, launched in 1985, also contributed to raise awareness about the positive socio-economic potential of arts and culture, as well as on their contribution to build relationships across communities at both local and global level. As highlighted by (Crossick and Kaszynska, 2016) "a new narrative emerged in which culture would drive both economic and urban regeneration. The concept of the post-industrial city required not only that it finds new economic motors, but that it also addresses declines in social cohesion, inner-city property values and urban infrastructure. Culture came to be seen as a key driver, as a sub-set of both the knowledge economy and its need for continuing innovation on the one hand, and the consumer, experience economy on the other". Of course, as these two approaches expanded, a third narrative emerged, where the presence of artists and creatives (what Richard Florida would have defined the "Creative Class" in 2002), became synonymous with gentrification, which in turn led to a revision of culture-led approaches to urban development, with increased attention paid on the one hand to the traditional role of the arts in terms of artistic merit, public value, access and national identity role (including in terms of "soft-power" towards foreign countries) and, on the other hand, to the social role of artists and the importance of community engagement in culture-led regeneration projects. This translated into new policies and funding programmes aimed at securing affordable place for artists and creatives while supporting bottom-up initiatives and collaboration between artists and local communities. As highlighted by (Grodach, 2017), this new paradigm, often defined "creative place making", particularly in the States, and sometimes overlapping with light-manufacturing and DIY(Do It Yourself)/Makers approaches, is not entirely new, bringing together elements of both cultural planning and cultural industries approaches, but, with programmes such as NEA's Our Town – which since 2010 sponsored over 389 projects – and ArtPlace – which funded over 227 projects – had the merit to orientate public discourse from "attracting the creative class" and capitalising on art's economic value, to the positive impact of arts and artists on community development, including, but not limited to, at the economic level. Indeed, as noted by (Sacco and Blessi, 2009) in their study of the culture-driven regeneration of the Bicocca district in Milan, in order to ensure that local communities benefit from arts-led regeneration projects, it is important to strike the right balance between investment in buildings and facilities ("hardware") and investment in activities and services ("software"). While, as highlighted by (Crossick and Kaszynska, 2016), most cultural regeneration projects have been focussing on hardware, the very successful ones always showed a good mix of top-down and bottom-up approaches, hardware and software investment. So, for instance, according to (Plaza et al, 2009), while it is true that the Guggenheim has strongly and positively impacted on the capacity of Bilbao to attract tourists, allowing for the creation and scaling of local businesses and the regeneration of other areas of the city, the museum was also found to have strongly contributed to the development of the local arts scene, while ensuring broad public support of the arts. Similarly, according to (Miles and Paddison, 2005), in the redevelopment of the Gateshead

waterfront artistic activities were key to counteract gentrification and link the development to people's strong sense of place, engaging with both original and new communities to rearticulate a sense of local identity. In this sense, the flagship buildings were intended and received as the culmination of a long commitment of the city council to grassroots cultural activity. On the contrary, projects where community engagement and "software" activities were not embedded in the development work have in most cases failed their objectives, as in the case of the Cité de l'Océan in Biarritz (Lipparini, 2018).

At the European level, the New European Agenda for Culture (European Commission, 2018), launched in May 2018, builds on all the above-mentioned trends, ensuring support at the EU level along 3 main dimensions, i.e. culture for social cohesion and well-being, including cultural participation, mobility of artists and protection of heritage; culture to support jobs and growth in the cultural and creative sectors, including cultural skills and research and innovation; and cultural diplomacy to foster sustainable development and peace at the global level. The Work Plan for Culture 2019-22 translated these policy lines into 5 priority areas (Sustainability in cultural heritage; Cohesion and well-being; An ecosystem supporting artists, cultural and creative professionals and European content; Gender equality and International cultural relations) to be supported between 2018 and 2022 with a set of 17 concrete actions (Councicl of the European Union, 2018). The European Framework for Action on Cultural Heritage, announced in the New European Agenda for Culture and launched by the Commission in December 2018, is particularly interesting from our perspective, setting over 60 actions under 5 Pillars, i.e. Cultural heritage for an inclusive Europe: participation and access for all; Cultural heritage for a sustainable Europe: smart solutions for a cohesive and sustainable future; Cultural heritage for a resilient Europe: safeguarding endangered heritage; Cultural heritage for an innovative Europe: mobilising knowledge and research; and Cultural heritage for stronger global partnerships: reinforcing international cooperation. Adaptive reuse of underused/abandoned heritage assets is a priority under the second pillar, with interesting pilot projects cutting across pillars such as the Cultural and Creative Spaces and Cities policy project[20] launched at the end of 2018 are already underway.

Importantly, the multiplication of public programmes in support of culture-led regenerations developed from the early 1980s up to today, also had the merit of focussing researchers across the world on assessing both social and economic impact of such investments. So for instance, a comprehensive study carried out for the European Parliament found convincing evidence of short-term positive impact of the initiatives in the 48 ECoC cities examined for the period 1985-2011, mainly in terms of "vibrancy and capacity in the cultural sector, an image of renaissance for cities with a low profile, a local sense of pride, a wider diversity of arts audiences during the ECoC year, and increased tourism with associated economic benefits" (Garcia, Melville and Cox, 2010). While the claim that for every £ spent in Liverpool for the ECoC year, a return of £7 was achieved might be somewhat simplistic, there seems to be sufficient evidence of the fact that investing in artistic practices and avenues can generate substantial economic benefits: as highlighted by (Crossick

[20] http://www.creativespacesandcities.com/

and Kaszynska, 2016) "an outpouring of studies has demonstrated the economic impact of cultural organisations and heritage (Reeves, 2002; Dümke & Gnedovsky, 2013), and, for example, the economic contribution of museums to local and national economies (TBR, 2015). Interest has grown in the sector's ability to attract business and investment (Garcia, 2010), and to generate spill over effects and innovation across the economy as a whole (Work Foundation, 2007; Potts, 2007). As a UNESCO report observed, in many analyses the cultural sector or creative industries were seen as one of the few areas where dynamic economic development might be expected, spurring creativity and innovation across the economy as a whole (UNESCO, 2012)". Both the traditional cultural sector and creative industries are revenue-generating sectors and a growing source of jobs, representing around 3,8% of EU total employment in 2016, and 2.7% of total value added in the EU[21]. Secondly, a growing body of evidence shows how the presence of a vibrant cultural sector, including both not for profit institutions and commercial enterprises have beneficial effects on workforce productivity. While these benefits are not straightforwardly measurable, there is sufficient academic evidence demonstrating the correlation between artistic and cultural education/participation and academic attainment, as well as the acquisition of transferable skills, which are in turn related to better employment outcomes. For example, the American National Educational Longitudinal Survey found that children who had significant involvement with the arts performed better in standardised tests and stayed in school for longer, which in turn translated into higher wages later on.

Concerning the impact of arts on wellbeing levels, (Daniel Fujiwara, 2014) completed a cost-benefit analysis to understand the impact of different types of heritage visits on wellbeing, using data from the Understanding Society survey and attaching monetary values to this impact using the wellbeing valuation approach. They found that the amount of money we would have to take away from someone who visits heritage sites to return them to the level of wellbeing they would have had if they visited the sites was equal to £1,646 per person per year for the average number of heritage visits per year (3.4 visits) in the Understanding Society dataset.

Most interesting from the point of view of urban regeneration projects, a positive correlation was found in the UK between cultural density (intended as the relative number of cultural institutions per 1,000 people in each local authority) and house prices, using linear regression analysis: "holding constant the proportion of the population who are educated to degree level, average income per capita, average age of occupant, access to transport, areas of green space and water and the vacancy rate, doubling cultural density compared to the UK average increases house prices by £26,816" (CEBR, 2013). To make a comparison, a study by the Department for Education (DfE) found that across England, the average house price of £232,900 would go up

[21] See Eurostat data for 2016: "cultural businesses accounted for EUR 193 billion, representing 2.7 % of total value added in the EU (Table 2). For the sake of comparison, this figure was higher than for wholesale and retail trade and repair of motor vehicles and motorcycles (NACE G45, EUR 173 billion) and almost equal to manufacture of food products (NACE C10, EUR 194 billion). The cultural sector's turnover (the total value of market sales of goods and services) was EUR 466 billion, which represented 1.7 % of the total turnover of the non-financial business economy".

£18,600 near one of the best primary schools (which would become £38,800 in London, where the average house price was equal to £484,700 in July 2016) and £15,800 near one of the best secondary schools.

Similar studies have been carried out to investigate how Heritage Designation influence house pricing, most recently in Amsterdam, where researchers from VU University looked at both individual landmarking and location within a heritage district to determine the impact of those variables on property value (Licciardi, Amirtahmasebi, 2012). Results showed that a premium equal to 26.9% was paid for individually landmarked properties, of 26.4% for location within a heritage district and of 0.28% for any property located within 50 million from an individually landmarked property or monument. Another interesting aspect emerging from network analysis-based research on cultural density, concerns the links with the creative and cultural industry. As remarked by (Crossick and Kaszynska, 2016) “in these networks, that characterise much but by no means all of the creative industries, freelancers and micro-businesses interconnect for specialisation, production and projects in an environment where other arts spaces enlarge the locations for risk and experiment. These networked clusters and districts are rooted in the ways in which knowledge is formed and shared in the creative industries and have been characterised as having high levels of human input, clusters of small companies operating on a project basis, dense transactional flows of information, goods and services, and complex divisions of labour tying people to places”.

All this data is instrumental to fully unlock the potential of impact investing, with its attention to intentionality, measurability and additionality supporting the adaptive reuse of natural and cultural assets. However, as highlighted by (Ratti, 2014) it must be noted that measurement of outcomes relating to cultural activities (including preservation and reuse of heritage assets) is still very rare, also because of a lack of specific impact frameworks and tools. Indeed, one of the reasons under the apparent lack of interest of impact investors surveyed by GIIN into the Arts and Culture area might well lay with the fact that the GIIN’s IRIS catalogue of impact indicators, used by around 50% of the impact investing community, does include not even one single indicator specific to cultural activities. As we will see in the next paragraph, the rise of impact investing funds targeting exclusively the creative economy is starting to change this situation.

2.2.2 Impact investing into the adaptive reuse of cultural and natural heritage assets: state of play

As mentioned, it is hard to estimate the amount of impact investment in the creative economy, given that both investment into creative-led regeneration projects and into creative and cultural enterprises is often not perceived nor classified as investment in a specific impact investing area, but is instead distributed among different sectors, including real estate, education, community development, social inclusion, digital and so on.

More in general, lack of data on how arts and culture are funded across the world, has been hampering the development of research in this field, as remarked in the Word City Culture Finance

Report (BOP Consulting, 2017), particularly when it comes to public funding. Indeed, despite the fact that cities like Paris, Moscow and London receive comfortably over $1 billion of public money per year in culture-dedicated funding ($3.3 billion, $2.4 billion and $1.6 billion respectively) and that cities like New York, Tokyo and London receive similar amounts by private sponsors (1,6 billion, 600 million and 500 million respectively)[22], "no one really knows quite how much is spent, nor by whom – let alone where this money goes and the impact of this spending. These are serious gaps for policymakers" (ivi). Also, when it comes to capital investment, i.e. investment in premises and infrastructure, data - particularly at the city level-is scarce and little known. So for instance, there is very low awareness among citizens about the fact that the City of New-York, which owns most cultural assets in the city, spent around 1bn in capital investment between 2016 and 2019, which explains why investment on the contents developed by each institution is relatively low (BOP Consulting, 2017). Even from the point of view of private institutions, capital investment is a very important activity: just to make a few examples, LVMH invested USD 143m in the non-profit Guanfu Museum in Shanghai, 367 out of 422 million USD spent to build the New York Whitney Museum of American Art came from private donors, and totally private were the 390 million euros invested to turn a former textiles factory in Lodz into a cultural district including an arts centre, shopping mall, and leisure complex with 112,500 sqm of rental space and around 300 shops. Most recently, AEA Consulting on the behalf of the Global Cultural Districts Network started to monitor capital investment (larger than $10 million) into cultural infrastructure through its Cultural Infrastructure Index, where 4 main project categories are monitored, i.e. Museum/Gallery, Performing Arts Center, Multifunction Arts Venue and Cultural Hub/District. In 2017, 107 projects were completed and 123 were announced, for a total investment of $9,92 billion and 7,62 billion respectively. The median budget for announced projects was US$36.8 million, slightly higher than that for completed projects ($36.1 million), with museums being by far the most dominant building type, by number (50 completed and 59 announced) and budget ($4,03 billion and $3.10 billion respectively), followed by performing art centres (27 projects completed for a total investment of $3.26 billion and 32 announced for a total $1.31 billion allocation), multifunction arts venues (25 projects completed for a total investment of $0.59 billion and 19 announced for a total $1.49 billion allocation) and cultural hubs/districts (5 projects completed for a total investment of $1,13 billion and 13 announced for a total $2.62 billion allocation). Interestingly, new buildings account for 66% of the projects, expansions for the 13% and renovations for the 22%, while as far as sponsor institutions are concerned, not-for-profit, public, and commercial entities account for the 52%, 40%, and 8% of allocated budgets respectively (AEA Consulting, 2018). While non exhaustive, the Index gives an idea of both the importance of capital investment for the creative economy and the reasons why impact investing projects in this area might not being either perceived or classified as such.

[22] By comparison, EU27 public expenditure in recreation, culture and religion was equal to 162 billion in 2017 (around 1% of the EU GDP), with the UK being the second worst performer in terms of GDP to expenditure ratio, with only 0.6% of GDP spent in recreation, culture and religion.

Despite these shortcomings in the availability and trackability of data, it has been possible to identify several specific programmes and funds, as well as specific investment cases and innovative funding programmes with a cultural-social purpose which can provide a basis to better understand the role of impact investing in leveraging circular investment in the adaptive reuse of natural and cultural heritage assets.

2.2.2.1 Sector specific impact investing funds and programmes

While the creative economy – and arts & culture in particular – have always been among investable areas for impact investors, only few specific funds and programmes have been set-up so far, mainly in the UK and the States, and providing exclusively debt funding.

The first attempt in this area was made in the UK by NESTA – the National Endevavour for Science, Technology and the Arts, which in 2015 launched its Arts Impact Fund (AIF), the first impact investment fund targeting social outcomes in the arts and cultural sector in the world. The £7 million social investment fund, backed by Nesta together with the Bank of America Merrill Lynch, Arts Council England and the Esmée Fairbairn Foundation, was created as a pilot with the help of the Cabinet Office – whose research showed an investment demand of £28 million from art-based organisations –, to demonstrate the strong social value creation and commercial potential of the sector. The bespoke finance offer made available by the Arts Impact Fund was designed to be used by organisations to become more financially resilient, in order to protect and develop their social and artistic impact. AIF provides unsecured loans of £150,000 - £600,000 at interest rates of 4%-8.5%. Since 2015, 22 finance facilities were offered. Importantly, **the cost of borrowed money depends on the achievement of pre-agreed impact objectives, with organisations meeting their impact targets being offered a capital discount as an incentive to fulfil their social mission and monitor outcomes achieved**.

The pilot was so successful that the fundraising for a second fund has already started; in the meantime, new research commissioned by NESTA and carried out by MTM through a survey involving over 1,000 cultural organisations based in the UK evidenced a growing demand for impact capital from the sector: while only 15% of cultural organisations in the UK have taken out repayable finance to date, with £29 million received in 2016, demand for the next 5 years is expected to grow to around £309 million. Importantly, investable organisations are often seeking for small amounts (less than £150,000 for 41% of them) and for long investment periods (5 to 7 years). Not surprisingly, repayable funding is rarely a replacement for grant funding, and is mostly used either to stabilise cashflow/bridge ensured fundraising or to further develop entrepreneurial activities via the acquisition of facilities and the scaling-up of ongoing activities. More in detail, 31% of surveyed organisations used the capital raised in 2016 to acquire new tangible assets, 29% to scale-up existing activities, 19% for refurbishment and 18% to develop new revenue streams (MTM, 2018).

Looking at the 22 investments completed by NESTA's Arts Fund, we find that capital investment in the acquisition, re-functionalisation and/or refurbishment of cultural venues occurred in 15

cases, out of which 6, described below, are good examples of adaptive reuse of cultural heritage assets and, in most cases, of the importance of combining different sources of both grant and repayable capital, including both commercial and impact capital.

Impact investing for the adaptive reuse of endangered heritage assets: 6 cases from the Nesta's Impact Arts Fund

V22: the AIF' £300,000 loan will allow V22, the collective funded by Tara Cranswick in 2006 to democratise art ownership, support young artists and provide affordable workspace to artists, creative start-ups and non-profits – to acquire a new, Grade II listed site – The Priory, Orpington - and refurbish it to create studios, community and exhibition spaces. In this way, the heritage site will be preserved and adapted for cultural and community use and benefit, while at the same time helping V22 to further diversify its portfolio and expand its reach. V22 has a very thorough impact assessment system in place, and outcomes monitored include new creative collaborations sparked among artists in its studios and, in respect of its art collection, the number of shares controlled by artists.

The Story Museum: in this case, the £400,000 AIF loan contributed to the overall 5,6 million investment to restore a set of three abandoned buildings in central Oxford acquired by the Story Museum in 2009, which include Rochester House in Pembroke Street, dating back to the 19th century, and two further buildings that formerly housed the Post Office Sorting Office and Telephone Exchange. Renovation works will bring the buildings into full use for the first time: existing spaces will be upgraded, and new flexible spaces – including temporary and semi-permanent exhibitions, multimedia, performance and learning spaces – will be developed, all with an eye to improve the fabric of the building and increase their accessibility. This will enable The Story Museum to build on its activity to date and welcome more diverse audiences and beneficiaries to engage with and benefit from its work on literacy and the importance of learning and sharing stories.

Make it Sustainable: AIF's £300,000 loan will allow this community charity to fulfil the mission for which it was set up: to safeguard The Old Print Works, a Grade II-listed industrial site in South Birmingham, and preserve its heritage. Indeed, the loan will allow the charity to purchase the freehold for The Old Print Works and make further improvements to the facilities and fabric of the building, therefore attracting more tenants. In particular, the majority of the investment will be used as a deposit to unlock mortgage finance, which would otherwise have been out of reach for the organisation as it has not been in a position to build up financial reserves. Make-It-Sustainable will provide affordable studios, co-working and event space for local artists and arts organisations, designer makers and community enterprises, while also running initiatives targeting residents at risk of exclusion such as youth and women with minority backgrounds.

Second Floor Studios and Arts: The London-based studio space provider will use the £280,000 AIF loan to purchase and develop a new site, the Deptford Foundry – a former metal foundry

formed in 1831. Although operating on a lean business model, SFSA generated substantial market demand and the 65+ studios that are to be created at the Foundry have long been oversubscribed, with agreements with the future tenants already in place. SFSA, which operates as a membership organisation providing commercial opportunities for its members to help them sell their art, will not only provide affordable work and living space to artists based in London, but achieve positive impact on the community providing creative skills through a dense programme of events and learning courses run by associated artists.

The Old Courts: AIF £590,000 loan will allow the arts centre in Wigan to transform a derelict former hotel into an arts hub for the area. Indeed, the 42-bedroom mock-Tudor site will allow The Old Courts to expand its provision of artist studio space and visiting artists accommodation, add a new performance venue and provide workspace and equipment to early-stage entrepreneurs in the digital creative industries; while also preserving for future generations a key piece of physical heritage.

Village Underground / EartH: AIF £600,000 loan will allow Village Underground - the landmark Victorian warehouse in Shoreditch providing affordable studio space for artists and creative industry tenants hosting an annual audience of 150,000 people across more than 500 music performances - to open a new 2,500+ capacity multi-arts centre by converting a disused art-deco cinema and theatre complex in neighbouring Dalston, while partnering with arts charity Community Music to deliver social programmes. Lease acquisition and refurbishment of the site cost in excess of £2m, with nearly a quarter of the funds coming from Village Underground's reserves, leaving approximately £1.7m to raise from other sources. With a commercial co-investor pulling out at the 11th hour in June 2017 leaving a £1m+ gap in the financing package, the fundraising was somewhat adventurous, with Big Issue Invest and Triodos Bank finally stepping in and making it possible to launch of EartH (Evolutionary Arts Hackney) in September 2018.

In October 2018, to meet the demand for smaller size loans, NESTA launched a £3.7m social investment fund with the support of Access – The Foundation for Social Investment through the Growth Fund programme, with finance being provided by its partners Big Lottery Fund and Big Society Capital. The Fund will provide unsecured loans of £25,000 - £150,000 at interest rates of 5.5%-8.5%, while also offering dedicated support around developing social impact monitoring & evaluation capabilities. As in the case of the IAF, **cost of capital is linked to impact performances, as an incentive for investees to pursue their social impact mission**.

Importantly, impact targets and data collection methods are agreed by NESTA and invested organisations, with support and capacity building provided by NESTA and partner organisations to ensure transparency and consistency of data across their portfolio and, most importantly, to

raise the cultural sector ability to measure and leverage on impact achieved to take efficient management decisions[23].

Another impact fund specifically targeting heritage organisations in the UK – the **Heritage Impact Fund** (HIF) – was launched in early 2019 by The Architectural Heritage Fund (AHF), a registered charity, working since 1976 to promote the conservation and sustainable re-use of historic buildings for the benefit of communities across the UK. Since 1970's AHF has awarded loans with a total value of £125m to over 900 projects across the country, disbursing more than 1,200 individual early project grants totalling over £10 million. Funded projects include Merkinch Welfare Hall in Inverness, a Cat C listed building whose ground floor was converted in a gym for the Inverness City Boxing Club, with a community hub upstairs. AHF assistance consisted in a £28,500 grant combined with a £160,000 loan.

The £7 million HIF was launched targeting applicants across the UK seeking to acquire, reuse or redevelop buildings which are of historic or architectural importance – these may be buildings which are listed, in a conservation area, or may be of special significance to a certain community. The fund offers a mix of advice, support, grants and loans, often combining the different tools. Typically, the fund offers loans from £25,000 up to £500,000. Terms are flexible, but the facility normally lasts 3 years. Projects need to have measurable impact objectives and financial incentives are in place for impactful projects.

In the US, impact investing has mainly emerged from community development finance. At both sides of the ocean, Impact Funds targeting specifically the creative sector are largely supporting the acquisition and adaptive reuse of real assets by cultural organisations. However, while in the UK cost of capital is linked to the achievement of pre-agreed social outcomes, this is not the case in the US, where, on the other hand, expected returns from investors (and therefore cost of capital) are well below the market. This means that attention to impact frameworks and outcomes monitoring tends to be higher in the UK, with the American funds mainly focussing on jobs created (particularly for people on low-income or with low skills) and accessibility of spaces to artists and citizens at risk of social and economic exclusion.

The **NYC Inclusive Creative Economy Fund (ICEF)** was launched in October 2018 as an impact investment fund focused on arts, design, culture and creativity in the context of community development, with the goal of financing affordable workspaces for artists. Very much in line with the trends of creative place-making and urban manufacturing described by (Grodach, 2017) "by establishing and preserving affordable spaces for business incubation, maker and artist studios, cultural activities, and light manufacturing, the Fund will foster quality middle-skill jobs for low- and moderate-income New Yorkers. By focusing on projects that provide ongoing access to affordable space, the Fund ensures that creative and cultural activities that would otherwise be vulnerable to

[23] The Fund is also making available frameworks, tools and case studies to the wider impact community, see for instance the Impact management canvas. For a quick review of impact assessment approaches in the cultural sector see (Ratti, 2014).

displacement have an assured position in the New York City of the 21st century"(LISC NYC, 2019).

In its first year of activity, the NYC ICEF raised over $4.8 million from a range of investors - including long-time community development investors and funders; foundations and endowed arts institutions and High Net Worth Individuals – who purchased Notes which pay 2.75% interest per annum and mature at May 31, 2026. Notes are general obligations of LISC NY, which since 1980 has borrowed and repaid—on time and in full—more than $1.7 billion. In 2019, funds raised have generated 3 loans worth $13 million which have all been invested in adaptive reuse of cultural heritage assets projects (described below), often in synergy with other incentives aimed at promoting creative place-making.

Impact investing for the adaptive reuse of endangered heritage assets: 3 cases from NYC Inclusive Creative Economy Fund

Greenpoint Manufacturing & Design Center (GMDC) Ozone Park Industrial Centre project: in 2017, GMDC acquired an 85,000-square-foot property in Ozone Park, Queens, a complex of three interconnected buildings including a 1906 plant built for hat and cap manufacturer Spear & Company which later hosted bicycle manufacturer Worksman Cycles. The redevelopment will modernize the complex to create spaces for up to 25 small- or mid-size businesses selected among GMDC's long waiting lists of artisans and custom manufacturers for New York's cultural institutions. NYC ICEF loan will contribute to the $41 million development which already benefits of $16 million in state and local economic development grants and loans as well as of federal and state Historic Tax Credits. More in particular, the loan will allow the project to leverage New Markets Tax Credit financing, requiring an $8.7 million leveraged loan while the tax credits mature.

Brooklyn Navy Yard's Building 127: the $42 million redevelopment of the 100,000sqf historic Building 127 within the 300 acres Brooklyn Navy Yard industrial park will result in three modern industrial floors, approximately 33,000 square feet each, with spaces to be leased to manufacturing, industrial technology, and product design tenants. The operation will allow BNYDC to satisfy previously unmet requests, which will lead to the creation of approximately 300 jobs, with a focus on the manufacturing and industrial jobs that are accessible to people without a college degree. The project is funded through a combination of New Markets Tax Credits, Historic Tax Credits, private debt, and City of New York capital funds. Note proceeds from the NYC ICEF comprise a portion of LISC's loans to the project, bridging the receipt of the project's Historic Tax Credits.

La MaMa 74 EAST 4TH ST Redevelopment: La MaMa is, since 1961, New York's premier Off-Off-Broadway venue. Starting in 2015, La MaMa developed a master plan to renovate and restore its three buildings to improve its ability to support artists, allow day-time activation and expand educational activities. The $18 million redevelopment project will rely entirely on donations and public funding: since this latter are only available on a reimbursement basis, LISC NYC's $3 million bridge loan will allow to begin construction works without using operating cash flow.

Similarly to NYC Inclusive Creative Economy Fund, the $12 million **New Jersey Creative Placemaking Fund (CPF)**, managed by New Jersey Community Capital, was approved in 2015 and to date have invested in 8 projects with loans ranging between $20,000 to $20 million "supporting catalytic development projects that integrate or complement arts and creative-industry based elements, integrate with broad-based neighbourhood development strategies, and generate significant community impacts" (The Kresge Foundation, 2019). CPF was designed as a revolving loan fund to provide flexible and affordable capital to finance the acquisition, construction, development, and/or sustenance of affordable long-term spaces for creative-economy organisations serving low-income communities of New Jersey.

While community development finance institutions investing in creative places through an impact lens are more developed in the US than in Europe, in London the Mayor of London's, the Arts Council England, Bloomberg Philanthropies and the Outset Contemporary Art Fund are working to launch the **Creative Land Trust**, a £50 million fund combining impact investment and philanthropic capital which will finance affordable creative workspaces which will be protected in perpetuity to address the availability of affordable creative workspace in London. Most recently, the Mayor of London launched the **Creative Enterprise Zones (CEZs)** in local planning as part of his London Plan. £11 million were awarded so far to 6 projects across CEZs in 7 boroughs, offering incentives to retain and attract artists and new creative businesses to an area by offering permanent affordable workspace, business and skills support, business rates relief and super-fast connection. Interestingly, the initiative is co-funded by the Mayor's Good Growth Fund, a £70 million fund (which in turn uses the European Social Fund) providing grants to organisations working towards sustainable urban regeneration. The fund, which require a thorough assessment of bot social and economic impact achieved by grantees, is designed to catalyse impact and commercial investment. Similarly, the City of Paris has initiated the Funds for Paris initiative, which offers up to 66% tax deductions for patronage to finance heritage restoration projects (BOP Consulting, 2017).

While impact investing targeting the adaptive reuse of heritage and natural assets is mainly the apanage of debt investors, equity impact funds can play a key role in supporting creative industries, often in a synergic way with capital investors contributing to create the space and conducive ecosystem where these industries thrive. Equity investment is particularly well suited for tech impact ventures, particularly in the new-media domain, however, it was possible to find only one equity impact fund specifically dedicated to this typology of creative enterprises, i.e. San Francisco based New Media Ventures.

New Media Ventures (NMV): NMV brings together a community of more than sixty technology leaders, business angels, venture capitalists, entrepreneurs, philanthropists, and policy-makers, providing both grant funding, seed funding and early stage venture capital to not for profit organisations and impact businesses investing together to drive progressive social change via the promotion of democratic participation tools and unbiased information. To date, over $13 million have been invested in 6 social ventures, including a $8 million investment in Hustle, a peer-to-

peer text messaging platform providing advocacy organisations with an affordable, efficient, and effective tool to reach their target supporters and customers.

2.2.2.2 Relevant impact equity and equity crowdfunding cases

While impact funds targeting the creative economy through debt funding or a mix of debt and grants are becoming increasingly widespread, there are basically no examples of equity impact investing funds dedicated exclusively to the creative economy, and, when it comes to the adaptive reuse of natural and heritage assets, it has been basically impossible to find examples of impact equity investments from either public or private providers.

There are a number of reasons to explain this fact. Firstly, equity investment implies for investors to acquire control and voting rights in the investee company, and this generates the possibility for new capital to cause a shift in the priorities of the investee itself. For example, at the end of the investment period, the new management might also be tempted to adopt a more commercial approach, at the disadvantage of the company's social mission. The close collaboration required between investors and investees can easily become a barrier. Investee companies (which can take-up a variety of legal forms across different countries, from cooperatives to Ltd, from B-companies to social enterprises) have often impact objective incorporated in their statutes, and in most cases also feature particular governance structures to prevent the risk of mission drifts, i.e. the possibility that the company's social mission is overrun during the investment period or at the exit because of the take-over by a board with a conflicting agenda. These clauses, which in fact restrict the company's freedom to operate, and which sometimes imply the obligation to re-invest a part of the investee company's surpluses in other socially-oriented instruments, or other strategies such as asset locks and 'golden shares' (Nicholls et al., 2017), might be unappealing for equity investors. Conversely, when investors are particularly interested in the achievement of certain social outcomes, is de facto very difficult to ensure these outcomes are pursued after their exit.

Secondly, organisations operating in the creative economy are often small and work-intensive, hardly fit to provide the double-digits returns expected by impact equity investors, and they need patient capital allowing them to grow organically within their communities more than injections of liquidity designed to quickly scale on the global market: indeed, if we look at EUROSTAT data, we find that most companies in the creative economy are either micro or small enterprises and, in line with SMEs in other sectors, are more often seeking debt finance than equity[24].

Thirdly, reporting on impact achieved on top of management and financial performances come at high costs for both investors and investees, particularly in the absence of an accepted standard. This means that, while committed to their social and environmental missions, neither investors nor

[24] Data on access to finance for the creative economy sector is scarce and largely outdated: see (European Commission, 2013)

impact organisations looking for capital will light-heartedly increase their costs in order to monitor non-financial performance, hence the importance of incentives such as tax breaks.

Finally, as already mentioned, fast-growing companies looking for equity are often technology based, and therefore funded through impact funds covering different areas where impact ventures are particularly active, including Digital, MedTech, EdTech and FinTech, with creative companies often classified under these domains. Indeed, impact investing in technological start-ups and companies is a growing area of interest, with initiatives such as WayraUnLtd, the first Telefonica's global tech start-up accelerator programme focused on impact start-ups launched in 2012, proving very successful.

WayraUnLtd

WayraUnLtd is the result of a partnership between Telefonica and UnLtd, the leading provider of support to social entrepreneurs in the UK and is 50% funded by the UK government. The accelerator builds the capacity and invest in high-tech start-ups, which are addressing social issues and want to improve people's lives, for instance, in the following areas: digital inclusion, education, e-learning, employment, environment, health and social innovation. Up to date, more than 160 British and Irish start-ups were supported, with approximately $150 million in third-party funding raised. Portfolio companies are worth around 430 million, and already improved the lives of over 300,000 beneficiaries in the UK. WayraUnLtd has a rich portfolio of programmes suited to diverse technological and geographical areas, including: Wayra UK Call (cross-industry call for innovative digital products, services and technologies), GCHQ Cyber Accelerator (security agency for cyber security start-ups), Velocity Health (partnership with a global healthcare company, looking to transform healthcare through innovative solutions), Wayra Fair By Design (an accelerator programme in partnership with the Fair By Design Fund to tackle the poverty premium), Open Future_Haringey (regional call for digital start-ups in North London) and Intelligent Mobility Accelerator (powered by the Transport Systems Catapult and Wayra UK, a regional call for digital start-ups in North London).

Another interesting area for technology enabled creative start-up is equity-crowdfunding, which is becoming increasingly popular including through the creation of specific crypto-currencies. This is for instance the case of Maecenas, a British start-up which secured over $15 million through an Initial Coin Offering (ICO) and released its platform to tokenise art-works in 2018.

Maecenas and crypto-currency enabled equity crowdfunding

The Maecenas platform consists of two parts: the auction platform, and the trading platform. It gives the possibility to convert any art-work – which has been previously verified and is stored securely - into tamper-proof digital certificates or “fractions” based on the Ethereum blockchain network. Owners of physical artworks can list their artwork on the Maecenas Auction Platform and sell up to 49% of the economic interests of the artwork to interested investors. Once an art piece is successfully listed, it will appear on the Maecenas Auction Platform. The seller will set the auction date, duration of the auction and the currency that the artwork shares are sold in. Once

the auction starts, it will be run via a Smart Contract. Investors can choose to place their bid in any accepted cryptocurrency (bitcoin, Ethereum or Maecenas' native cryptocurrency, ART). The Smart Contract will automatically convert their bids into the spot price of ART at the time of bidding so that all the bids can be compared in a common currency. The conversion rate will be displayed for the investor to confirm the bid. Upon confirmation, the total bid amount (in their selected currency) will be credited from their account and held in escrow. The auction will successfully close at the deadline set by the seller if the bids exceed the reserve price or once target funding is reached. The economic interests of the artwork will then be allocated via a Dutch Auction Process by the Smart Contract algorithm to all successful bidders. Once the auction closes, the economic interests of the artwork will be credited to the accounts of the successful bidders, while bid amounts will be returned to unsuccessful bidders. Owners of the artwork fractions can sell their certificates to other buyers at any time via the Maecenas secondary marketplace. Paintings' economic interests bought from the auction can then be bought and sold in the secondary market. Shareholders will participate in the economic life of the paintings, so, for instance, if they are leased out for display, they will receive a cut of the profit in the form of a dividend. A first auction – entirely built on smart contracts - was successfully carried-out this year to purchase fractions of 14 Small Electric Chairs with Bitcoin, Ethereum or the ART token. Both the sale and subsequent trading of the certificates are tracked on a blockchain.

Despite the lack of Equity Impact Funds and Equity crowdfunding platforms specifically dedicated to the creative economy, and in particular to the adaptive reuse of natural and heritage assets, it is possible to find investible social enterprises in this space, which could greatly benefit from equity investment. One case is that of Kalatà, described in the box below. Interestingly, the social enterprise successfully underwent the due-diligence process to receive impact equity from an impact fund, but lastly withdrew due to the high cost of capital and mission-drifts risk connected to the changes in governance.

Kalatà

Innovative business models and financial models are often developed by entrepreneurial third sector organisations themselves as in the case of Italian company Kalatà, specialised in adaptive reuse of cultural heritage assets.

Kalatà is a social enterprise which creates unique artistic experiences to increase the value and accessibility of underused heritage assets. They scout the Italian territory for underexploited assets and build customised projects aimed at increasing their audience. They fund all the interventions which are necessary to implement the new itinerary or experience, which is then offered as a premium service alongside the original offer. Kalatà receive part of the revenues generated via the new offer so as to recover the original investment and a margin, while the asset's owner is entrusted with both a new revenues' stream and an increase in the number of visitors thanks to the communication and marketing work carried out by Kalatà as part of the project. A successful example is the visit to the Vicoforte dome (CN): http://www.magnificat-italia.com/

2.2.2.3 High-street banks and impact investing in the creative sector

Since 2010, when J.P.Morgan and the Rockefeller Foundation launched the first systemic study on "Impact Investing, an emerging asset class", which would have later become GIIN Impact Investor Annual Survey, most high-street banks and institutional investors entered the sustainable and responsible investment arena. From Goldman Sachs to Bain Capital, from Barclays to HSBC, from Deutsche Bank to TPG, impact investing, ESG, and green finance products are becoming mainstream, with BlackRock's CEO Larry Fink's declaring in his 2018 annual letter to the CEOs that corporate purpose would have been the focus of the year, since "as wealth shifts and investing preferences change, environmental, social, and governance issues will be increasingly material to corporate valuations. This is one of the reasons why BlackRock devotes considerable resources to improving the data and analytics for measuring these factors, integrates them across our entire investment platform, and engages with the companies in which we invest on behalf of our clients to better understand your approach to them".

Despite encouraging signs, however, identifying proper impact investment products among high-street banks and commercial asset managers is not always straightforward, and particularly when it comes to specific products targeting cultural heritage. Exceptions to this rule tend to lay with ethical and social banks, often specialising in providing credit to not-for-profit organisations. This is for instance the case of Dutch bank Triodos, established in 1980, which provides both equity and debt capital exclusively to impact businesses in the energy, food, inclusive finance, education, health and culture sectors. Among impact indicators monitored by the bank is the number of cultural events/visits made possible through investing in cultural organisations, so for instance, in 2017, 17.6 million visitors (up from 13.7 million in 2016) enjoyed cultural events including cinemas, theatres and museums across Europe, as a result of Triodos lending and investments activity to 3,900 cultural institutions.

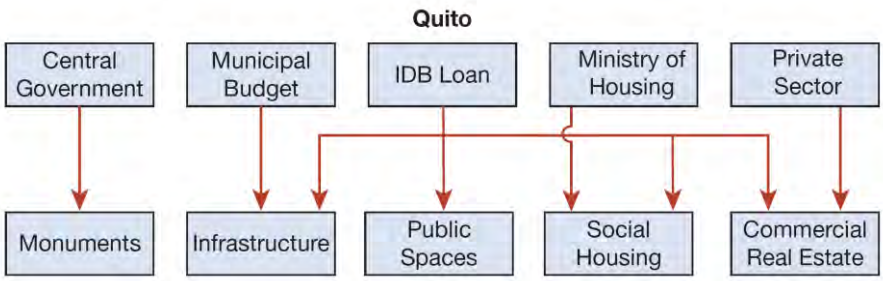
2.2.2.4 City Funds and PPPs with impact

City funds offer interesting models which could be applied to cultural heritage adaptive reuse projects – as in the cases of the New Jersey Creative Placemaking Fund and the NYC Inclusive Creative Economy Fund-, and which can be considered impact investing instruments in terms of both intentionality, measurability and additionality. A good example in this sense is the Liverpool City Region Impact Fund (LCRIF), a £2 million fund launched in January 2014 and financed in equal parts by the Social Investment Business Foundation and the European Regional Development Fund (ERDF). The fund mission is to promote local projects driving the resilience of their communities by providing high-potential social enterprises with a mix of advice, grants and 5 years flexible loans in between £50,000 and £250,000, at a 6% interest rate. The fund, which has a duration of ten years (2014-2013) invested £1.25 million in eight social enterprises so far,

supporting the refurbishment of heritage assets in 2 cases, and more investments are foreseen starting in 2020 when some of the returns will have flown back in.

Pooling of private and public investment resources to preserve and readapt historic city centres is not uncommon. An interesting example is provided by the conservation efforts in Quito, where, as described by Rojas in (Licciardi, Amirtahmasebi, 2012), the private sector was involved early on in financing the conversion of some historic building into commercial spaces, avoiding gentrification and attracting local businesses back to the city.

Figure 2.4 Sources of funding for Quito conservation programme



Source: Rojas, 2012 in (Licciardi, Amirtahmasebi, 2012).

Sources of funding for Quito conservation programme – Source: Rojas, 2012 in (Licciardi, Amirtahmasebi, 2012).

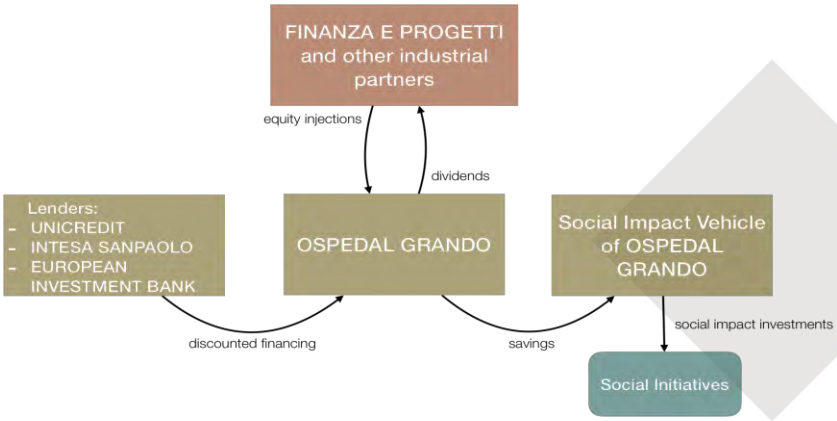
Looking at policy driven initiatives, Moscow is a leader in the use of public-private partnerships to restore and preserve cultural heritage: under concession agreements, private organisations are allowed to use historical buildings at a reduced price or even free of charge (usually for a 49 year term) in exchange for investing in their upkeep and restoration. For example, in 2013 the Podari Zhizn foundation created a recreation and health centre for children in Izmalkovo mansion in the Novo-Peredelkino district. In 2015, the city attracted about 500 million USD of investment for the restoration of historic buildings (BOP Consulting, 2017).

An important, though non-strictly-financial class of instruments which has seen a rapid development after the early 2000s is Public-Private Partnerships (PPP). These represent long term contracts between the public administration and a private contractor for the delivery of services and products, where payments are linked to performances. The contract typically establishes the transfer of project functions (financing, design, construction/refurbishment, maintenance and operation) from the public administration to the private partner, who therefore assumes a major part of the risk involved with the project and becomes responsible for the achievement of predetermined results. For the commissioning authority, PPPs represent a chance to overcome budget constraints while transferring most of the risk onto a private entity. Moreover, according to European accounting rules, the private partner must bear at least 50% of the capital

investment: if this condition holds, the public authority may account its investment off the balance sheet and thereby avoid the limits imposed by the European Growth and Stability Pact on public indebtment (Vecchi and Leone, 2006).

One interesting case in which PPPs were recently employed in Italy together with the principles of impact investing is the renewal of the Treviso Hospital[25]. The 250 million euros project consisting in the refurbishment of existing buildings as well as the construction of new ones, will generate positive social outcomes as a by-product of an impact investing strategy embedded in the main project financing. Through the strategy, which relies on the interaction of public and private entities, the private stakeholder (Lendlease, a multinational construction corporation, and its subsidiaries Finanza e Progetti and Opedal Grando) will be able to invest in social impact initiatives the savings generated by the below-market interest rates applied by the loans offered by the European Investment Bank and two commercial banks (Intesa Sanpaolo and Unicredit). The role played by the EIB – through its European Fund for Strategic Infrastructures – was crucial in order to generate a total amount of 1.8 million euros in savings, and to overcome the initial refusal by commercial banks to support a community bond to finance the project. As illustrated by the figure below, circular economy principles are particularly evident in this case, were savings generated by the lower cost of capital provided by the public bank – whose mission is to invest in public interest projects – are reinvested into community projects to generate further positive impact at both financial and social level.

Figure 2.5 Treviso Hospital impact investing strategy



Source: Sebastianelli (2019)

Looking at policy drive initiatives, Moscow is a leader in the use of public-private partnerships to restore and preserve cultural heritage: under concession agreements, private organisations are allowed to use historical buildings at a reduced price or even free of charge (usually for a 49 year

[25] See (Addarii and Al., 2018)

term) in exchange for investing in their upkeep and restoration. For example, in 2013 the Podari Zhizn foundation created a recreation and health centre for children in Izmalkovo mansion in the Novo-Peredelkino district. In 2015, the city attracted about $500 million of investment for the restoration of historic buildings (BOP Consulting, 2017).

2.3 Conclusions and way forward

Impact investing is an emerging but fast-growing field which holds tremendous potential in terms of supporting the CLIC circular approach to the adaptive reuse of natural and cultural heritage assets, and particularly if the availability and cost of capital are linked to the achievement of higher levels of circularity along the autopoietic, generative and symbiotic axes of the CLIC model.

More in particular, by building financial, business, governance, management and impact frameworks based on a theory of change negotiated with all projects' key stakeholders from the beginning, impact investment can facilitate the shift to a symbiotic approach to heritage preservation and adaptive reuse, helping to align public and private interests around shared outcomes at a systemic level.

While this emerging asset class is still underdeveloped in connection to heritage projects, partly because of lack of recognition and of a common language among investors, policy makers and heritage organisations, as well as of more granular and updated data on funding the creative economy, evidence exists to support a call for more research and more impact investing in this area.

Indeed, impact investors, and particularly debt investors, are filling market gaps when it comes to much needed bridge finance allowing to i. Anticipate tax credits and other specific incentives, as well as grant funding; ii. Offer collateral and working capital to offset cashflow issues and raise bankability face to capital investments into assets acquisition or refurbishment iii. Lower the cost of repayable finance for invested organisations; iv. Increase management capacity of invested organisations, as well as their ability to negotiate better conditions with other commercial investors and attract further funding based on demonstrated socio-economic outcome achieved.

More in particular, we see three scenarios in which an impact investing approach could maximise its outcomes and which could be further explored in Europe:

- Adopting a portfolio approach, with an urban heritage fund aimed at promoting creative place-making at the city or regional level, pooling different resources to provide different types of capital (grant, debt, equity to fund both capital investment, the creation and growth of creative enterprises and community engagement action) which could be allocated based on needs and characteristics of stakeholders involved, leveraging on economy of scale. Of course, the combination with other incentives like those piloted in London and NY special economic zones for creative hubs would be highly beneficial in attracting

investment and talents. Ideally, non-economic values linked to circularity approach should be incentivised by linking the cost and/or availability of capital to impact performances.

- Anchoring impact principles to the upcoming InvestEU facility, incentivising operations such as the one piloted in the Treviso PPP to fund cultural infrastructures and in particular the adaptive reuse of heritage assets under both the infrastructure and the social window, while promoting collaboration with the successor of the CCS Guarantee Facility to provide debt capital to creative industries.
- Experimenting with outcome buying (including social impact bonds), which so far has never been used in the heritage sector, to allow public administrations to shift risks implied in funding impact projects on the private sectors, and, as in the case of PPPs, make much-needed funding available for adaptive reuse projects.

Chapter 3 MACRO: Circular System of Heritage and Tourism Market Permits

3.1 Abstract

Most of the investment and income in the tourism industry comes from accommodation, transportation, attraction and entertainment. However, all of the variables mentioned are also associated with pollution, strain and corrosion on national resources. If the true negative effects exceed the economic advantages, natural/historic centres will suffer from an alteration of their environmental, economic and social structure especially when significant fraction of the arrivals are concentrated in a handful of cities. To counteract this, we propose a circular method of permits which is focused on reducing negative externalities while simultaneously redistributing income from high strain cities to less frequented and underfunded towns with possible long run implication of incentivizing innovation. The objective is to assess the negative externalities caused by overtourism and setup a pricing model for externalities which can be traded among the cities using government created licences (tradable permits) where the price of permits (a variation for tourism tax) is determined by market mechanism.

3.2 Introduction

We suggest a pseudo-cap on externalities for a given time period where the price of permits increase as the externalities approach this cap (e.g. at peak seasons) limiting the number of visitors but in such a way that the revenues for the peak cities are minimally affected (inelastic demand for tourism). The idea is such that because cities have limited space/capacities, after a certain number of arrivals they are overstressed and that the externalities increase at a faster rate and with it the abatement cost of externalities. Our goal is to find an optimal point where limiting arrivals in peak seasons do not affect the annual revenues of peak cities while decreasing externalities at the same time, and also create a new source of revenue for the towns that are low or negative in these externalities.

3.2.2 Tourism Industry

The travel and tourism industry is one of the world's largest industries with a global economic contribution (direct, indirect and induced) of over 7.6 trillion USD in 2016 and growing every year. The total contribution of travel & tourism to GDP was USD 2.1 trillion (9.9% of GDP) in 2017, and is forecast to rise by 2.2% pa to USD 2.7 trillion (10.7% of GDP) in 2028. Travel & Tourism investment in 2017 was USD 216.2 billion, or 4.9% of total investment. This is estimated to rise by 4.3% in 2018, and rise by 2.9% per year over the next ten years to USD 300.1 billion in 2028 (5.6% of total) (WTTC, 2018). The worldwide T&T industry has been growing at a yearly rate of approximately 5%, surpassing the rate of growth of international trade (Gabbatis, 2018).

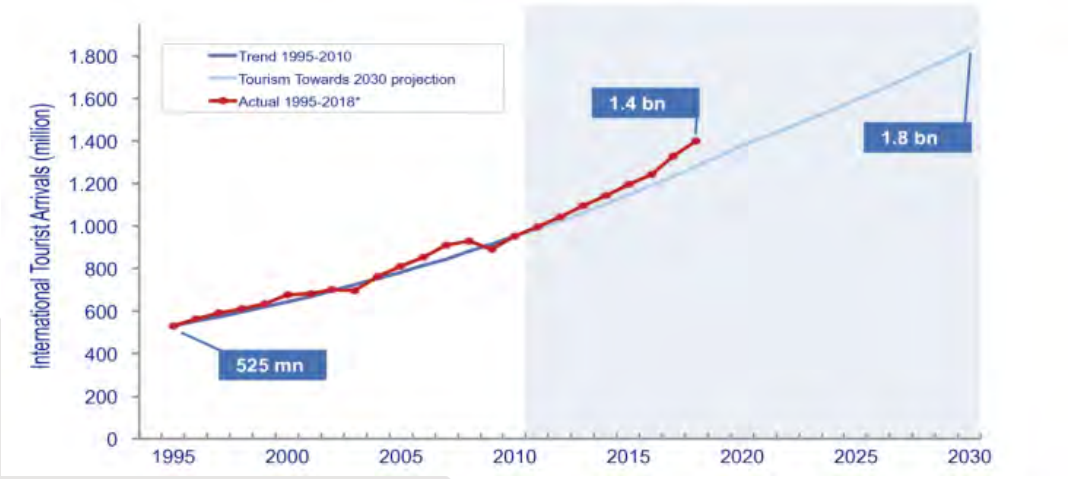
Table 3.1 Some key facts about the tourism industry in 2017

GDP direct contribution	3.2% of GDP
GDP total contribution	10.4% of GDP
Employment direct contribution	3.8% of total employment
Employment total contribution	11.6% of total employment
Visitor exports	6.5% of total exports
Investments	4.5% of total investment

Source: WTTC (2018)

International tourist arrivals increased by 6% year-on-year reaching 1.4 billion in 2018, according to the latest UNWTO World Tourism Barometer. International tourist arrivals in Europe were over 713 million in 2018, also 6% increase from 2017. The 1.4 billion tourist arrivals in the world every year, to put into perspective, is 2700 every single minute and is expected to increase over the years.

Table 3.2 Actual trends VS tourism 2030 forecast - World



Source: UNWTO (2019)

Worldwide tourism accounted for 8% of global greenhouse gas emissions from 2009 to 2013 (Lenzen, et al., 2018), making the sector a bigger polluter than most industries including construction or international trade. An extraordinarily large fraction of this is accounted for by transportation but also electricity, and housing facilities for tourists. Montanari & Staniscia (2017) mention that there are risks generated by an increase in the number of tourists, which have consequences on the quality of the tourist experience and on the quality of life of the residents. (Ahmad, et al., 2018) in their study on five provinces of China found that the negative impact from tourism and energy use in several sectors outweighs the positive effect in majority of their sample. Study by Grover, et al. (2017) found that the tourists and residents in New Delhi, India who frequently visited the tourist spots were more vulnerable to health disorders due to both indoor and outdoor air pollution. The degree of impact is subject to the type of tourism, activities and environmental management. Some countries like Thailand and Singapore however, have shown inverse relationship between tourism and environmental degradation (Khan, et al., 2018). And other regions that do not get a lot of tourist are more likely to benefit from marginal increase in tourism than the costs incurred by it.

3.2.3 Tourism in Europe

Europe is the world's number one tourist destination. Tourism not just a key sector of the European economy but also contributes to shaping a European identity and awareness on natural and cultural heritage. European tourism has been changing overtime in terms of seasonality, frequency, demography and destination preference (Eurostat, 2013). Peak periods are responsible for the high strain on cultural and environmental sites especially coastal regions,

islands and mountains. New trends emerge frequently due to globalization in culture and communication, internet sources and travel costs becoming more affordable (Lew, 2008). In 2012, more than half (57.4%) of roughly 545,000, accommodation organizations were concentrated in four EU member states (Italy, U.K., Spain, and Germany). Because the tourism density is concentrated in places of historic/cultural interests and natural heritage, increase in new building and infrastructure investments has increased both environmental and social pressure on the protected and other natural territories (Eurostat2, 2013).

3.2.4 How tourism affects environment and cultural heritage sites

The advantages of heritage sites in towns and cities is that they attract tourist interests which as a consequence promote the local economy by generating revenue and creating jobs. Hence, it would be rather inappropriate that visitors to be unwanted at heritage sites. Nevertheless, increased tourism brings as many issues as advantages. Despite the difficulties of quantifying the real impact of tourism on the environment, any increase in the number of tourists undoubtedly have an impact on environmental variables including air quality, level of non-biodegradable waste and energy consumption.

While it is true that tourism industry substantially contributes towards socioeconomic growth and development of tourism led economies, economic growth development led predominantly by tourism comes at the cost of environmental pollution and degradation[26]. Tourism puts strain on national resources through over-consumption, often in places where resources are already scarce. E.g. the popular reference an average golf course in a tropical country uses as much water as 60,000 rural villagers and 1500 kilos of chemical fertilizers, pesticides and herbicides per year. The excessive water use, increasing waste and local land use can lead to soil erosion, increased pollution, natural habitat loss, and more pressure on endangered species (UNEP, 2001). These effects can gradually destroy the environmental and cultural resources on which tourism itself depends.

Often it is difficult for the infrastructures to cope with increased rush that is exacerbated by heavy traffic in peak periods resulting in poor sanitation, overcrowding, increased risk of disease to the local people. Moreover, the encroachment of foreigners can cause disturbance to the local culture and sometimes create unrest among the residents. The locals may also be inclined to copy the global trends and lifestyles of the tourists through demonstration effects which can result in the loss of native traditions and customs. Pizam (1982) mentions that in places where the incidence

[26] *"Environmental degradation is the exhaustion of the world's natural resources: land, air, water, soil, etc. It occurs due to crimes committed by humans against nature. Individuals are disposing of wastes that pollute the environment at rates exceeding the wastes' rate of decomposition or dissipation and are overusing the renewable resources such as agricultural soils, forest trees, ocean fisheries, etc. at rates exceeding their natural abilities to renew themselves. Therefore, the environment's capacity to withstand the negative impacts due to human activities has diminished and environmental degradation has become a threatening issue"* (El-Haggar, 2007)

of tourism is high are associated with criminal activities against tourist increase in order to fetch easy money which leads to loss of religious and moral values.

There is no doubt that air pollution negatively affects cultural heritage since it is largely responsible for the surface corrosion of historical buildings and monuments and their impacts are large and usually irreversible (UNECE, 2015). This has been confirmed by several authors including Watt, et al., (2009) and Tidblad, et al. (2012) that it leads to loss of crucial parts of history and culture through corrosion, bio-degradation and soiling. In the EU-25, tourist transport by car was responsible for the largest impact in air quality and air transport accounted for the largest fraction of tourism related carbon emissions (this was 80% in 2000) (EEA, 2015). Car is still the dominant choice of tourist trips and air travel accounts for the largest share of miles traveled. ICAO (2013) estimated that global air passenger/km will rise to 13 billion in 2030. This was only 5 billion in 2010. And arrivals within the EU is still projected among the top five worldwide travel patterns between 2030 and 2040. As the economies around the world grows and the income and standards of living rise around the world, high-polluting industry such as air-travel and accommodation will become exceedingly problematic due to higher demand for luxury travel (Gabbatiss, 2018). A recent study of five UNESCO world heritage cultural monuments situated is European cities found evidence of corrosion of materials. Watt & Hamilton (2003) mention that in the historical centre of Western Europe cities, cultural heritage sites and also modern buildings had dark and soiled facades despite of frequent cleaning. Although there has been a decrease in the rate of corrosion by 50% since 1987, due to improvement in air quality through the LRTAP Convention measure, changes in the last decade have been insignificant. Furthermore, even though SO2 emissions have decreased, other pollutants including NO2 and particulate matter are making relatively larger corrosion damage (UNECE, 2015).

Archaeologist Salvatore Settis outlined how "*A rapacious tourist monoculture threatens Venice's existence, decimating the historic city and turning the Queen of the Adriatic into a Disneyfied shopping mall*". He outlined the considerable dangers to cultural heritage which is currently faced by Venice. On top of the constant risk of flooding, the cruise liners sail very close to the city. Venice is visited by more than 20 million tourists every year which consequently increase the demand for hotels in the centre (Settis, 2016). In the past 15 years, a number of state institutions, banks, judicial offices, medical practices, stores, judicial offices, etc have been closed to make room for hotels to accommodate tourists near the Grand Canal (Venice's main waterway). The UNESCO had considered in 2016 to put Venice on its list of World Heritage in Danger unless a substantial considerable effort is made to stop the degradation of the city and its heritage and ecosystem.

Figure 3.1 Image: Venice 1

Source: www.hello-italy.com

Figure 3.2 Image Venice 2

Venice (Source: Shutterstock)

Figure 3.3 Image Venice 3

Venice (Source: Shutterstock)

Figure 3.4 Versailis

Versailles (Source: pryzmat/Shutterstock.com)

Figure 3.5 Santorini 1

Source: http://www.ekathimerini.com

Figure 3.6 Santorini 2

Source: Greekcitytimes

Figure 3.7 Dubrovnik 1

Dubrovnik (Source: The Dubrovnik Times)

Figure 3.8 Dubrovnik 2

Source: https://www.flickr.com/photos/amanderson/10536512436

Figure 3.9 Majorca

Majorca (Source: Express.co.uk)

Figure 3.10 Barcelona

Barcelona (Source: Carl Court/Getty Images)

Venice is a prime example, but this is an ongoing issue faced by any well-known tourist destination and a large number of them are in Europe. It is essential to maintain the historical authenticity of the cities while also accommodating the tourists since they are advantageous to the economy. Constructing high rise hotels in such cities may look incompatible and risk compromising the cultural heritage in such a way that it contradicts the purpose of the heritage themselves. This problem can be mitigated to a large extent if the tourist destinations were more dispersed around a wider region rather than a concentration on selected few cities at the same time. Our method will provide a measure to incentivize such redistribution of tourism and investment. This will not only protect the residents and cultural heritage in areas with overtourism but also put into use the spare capacity of the regions that are less travelled.

Furthermore, the EU has a minimum 40% emission reduction target by 2030 (compared to 1990 levels) which includes the annual carbon reduction for the member states from 2021 to 2030 for the Effort Sharing sectors including buildings, agriculture and road transport. From the projections reported in 2018, EU-wide reduction in carbon is expected to fall short of 10% from the target if additional mitigation measures are not applied in which case it would still fall short of 8% as is indicated in the graph below. The projections also show a sluggish carbon reduction after 2020 both under the EU Effort Sharing and EU ETS (EEA, 2018). Our method could contribute to the planned mitigation measure through a permit system that puts a cap on negative externalities while redistributing income in different areas of a wider region.

3.2.5 Countries/Cities that use tourist tax[27]

Venice is planning to levy a tax of up to €10 due to its daily struggle with chronic crowding. The tax will be introduced in July 2020. It will vary between €3 in low season, €8 in high season and €10 during peak times e.g. summer weekends. The purpose of this tax is to make the visitors (day-tippers[28]) contribute to the maintenance of the city which includes compensating for the high charges that the local citizens pay for services like waste collection and management. In other cities in Italy the tax rate depends on hotel classification and is imposed only on a set of consecutive nights. E.g. In Rome the rate varies between 3 and 7 per day for up to 10 consecutive days.

In Spain, tourists travelling to Majorca and Ibiza pay twice the tax which was levied on 2017. For visitors who choose to stay in luxury hotels, mid-range hotels and apartments/cruise ships are charged €4, €3 and €2 respectively. Those who stay out of the islands in caravans and hostels are charged 1. These prices are charged at 50% rate if the traveler is visiting between November

[27] The information about tourism tax rates in EU countries are available at: https://www.etoa.org/destinations/tourist-tax-rates/

[28] Around 2/3 of tourists in Venice are day-trippers, many of whom use cruises, but make little economic contribution to the city, despite producing large amounts of trash and disruption.

and May which decreases by a further 50% after 9th consecutive day on the islands. These taxes are called “eco tax” which are used to protect the island resources.

The French tourism tax is called “Taxe de Sejour” which also depends on the standard/quality of accommodation. The tax varies between €0.2 and €4 per night, per visitor. Paris has an additional 10% on top of the standard rate which makes the range €0.22 - €4.4.

Germany has the so called Kulturförderabgabe (Culture Tax) or Bettensteuer (Bed Tax) which are some of several names used to address tourism taxes. German rates range from €0.5 to €5 per visitor, per night or 5% of the accommodation cost which depends on location, room bill and hotel type. E.g. in Berlin, the charge is 5% of room bill and is only charged for the first 21 successive days.

Visitors in Austria pay nightly accommodation tax which includes caravans. The charge varies among provinces and range between €0.15 to over 3% of the cost of accommodation per visitor in Vienna and Salzburg.

Similarly, Belgium has a several tourism taxes that come in different form and vary among cities. E.g. Antwerp has a fixed tax of €2.39 per night, per visitor, for hotel accommodations and 0.53 for caravans. In Bruges the rate is €2 per night, per visitor for all hotel accommodations while Ghent charges €2.5 city tax. In Brussels the structure is a bit more complex where the tax is levied on each room, annually according to borough, and size and classification of hotels. According to ETOA, e.g. a Novotel in Brussels will charge about €7.5 per night, per visitor.

Croatia has a tax called the “Sojourn Tax” which varies between 2 kunas to 7 kunas per night, per visitor also which depends on the season classification of accommodation. The cities are categorized from A-D according to its popularity. The charges are shows below.

Table 3.3 Tourism tax (Croatia)

	Early season	High season	Low season	Late season
Category "A"	5.50 kn	7.00 kn	4.50 kn	5.50 kn
Category "B"	4.50 kn	6.00 kn	3.50 kn	4.50 kn
Category "C"	3.50 kn	5.00 kn	2.50 kn	3.50 kn
Category "D"	2.40 kn	4.00 kn	2.00 kn	2.40 kn

Source: ETOA

The Dutch tourism tax is called the Toeristenbelasting which is levied on accommodation. This is charged in every municipality but varies among hotel classifications. Amsterdam has a city tax of 5.5% of the accommodation bill. This is expected to rise to 7%[29].

Portugal has introduced a municipal tourism tax of 1 per night, per visitor since the beginning of 2016. Porto has a higher rate at 2 and Algrave is being considered for introduction of a new tax[30]. The Slovenian tourism tax varies between 0.6 and 2.5 per night, per visitor depending on the location and hotel classification. According to ETOA, recently the tax in Ljubljana was increased 100% to 2.5 while in other towns including Vino, Fokovci, Moravske and Fokovci the rate is 1.01 per night, per visitor.

3.3 Literature review

Tradeable government permits have been traded/auctioned in a broad range of industries including fishing, broadcasting, construction and carbon. These industries are under regulation are reliant on marketable permits: "government licenses issued for various activities that regulated parties can purchase from the government or buy from and sell to other private parties. The intended goals of making regulatory permits marketable include harnessing the efficiency of the market to lower compliance costs, encourage innovation, and ease administrative burdens, all—in theory without compromising the policy objectives of the regulation (Schwartz, 2017).
Historically, tradeable permits have had a support of the bipartisan in a range of contexts, which began with the market for air pollution in the 70s and the 80s and exemplified in the Clean Air Act 1990 which created the acid rain market. Since this act, several other natural/environmental resources regulators have adopted this system of permit trading which includes, water quality trading, marketable, fish catching shares, and offset credits that land developers can purchase from third parties to mitigate their development projects' impacts on endangered species or wetlands (Schwartz, 2017).

Such arrangements have gained popularity among the regulated entities. E.g., in the US, there are 1,500 wetland mitigation banks, and over 50 percent of development projects purchase credits from those banks for their required wetland mitigation. Some 15,000 hectares are traded annually, with cumulative transactions worth over $3 billion (Schwartz, 2017).

Tradeable permits are not limited to the environmental context. "A presidential Executive Order instructs agencies broadly to consider the possible advantages of regulating through marketable permits across all policy contexts. There are marketable permit programs for motor vehicle efficiency standards, renewable energy credits, auctions for electromagnetic spectrum licenses, and secondary trading of airport landing slots. And that is just at the federal level; at the state and

[29] http://www.cijfernieuws.nl/toeristentax/
[30] https://www.theportugalnews.com/news/algarve-town-to-introduce-tourist-tax/38004

local level, marketable permit programs thrive for transferable property development rights, liquor licenses, and taxi medallions. Possible future applications, discussed by agencies and academics, include helping to manage satellite congestion or even to curtail the over-prescription of antibiotics". "Similarly, the Inspector General of the National Oceanic and Atmospheric Administration has found that information collected by the agency on fish catch share ownership and transaction prices was especially spotty in some regional catch share programs, preventing interested parties from making informed, efficient decisions in the market. There are even questions about the legal status of some programs. Some participants at a recent interagency workshop on water quality markets expressed concern that the lack of codified regulations establishing the water quality trading program may create uncertainty about the longevity and privileges of permits" (Schwartz, 2017).

Beyond environmental problems associated with poverty are those that can arise from economic growth itself. As countries become more industrialized, augment their agricultural production, and expend greater amounts of fossil fuels, the environment often suffers. The challenge facing policymakers worldwide is to manage economic growth in a way that maximizes its benefits and reduces its costs, in terms of damage to both the environment and to the free market system.
Since the Industrial Revolution, economic growth has required the burning of coal and oil as fuel for production in the economy. Burning coal contributes to the greenhouse effect, which it is hypothesized will raise the temperature of the earth, causing severe global climate problems. The degradation of the atmosphere is, to a certain extent, an unavoidable consequence of economic growth. However, if this growth is not carefully monitored, environmental problems will be incurred. Denying firms incentives to control or reduce the amount they pollute, the environment will surely suffer. Given that the environment (in this case, the atmosphere) is a public good, there exist no incentives for firms to reduce their emissions at the margin. This situation can be likened to a rancher grazing his herd on a public pasture. The rancher no incentive to graze the fewer head of cattle that is socially optimal. Thus, some incentive must be built into this public good so that there will be consequences for excessive degradation (Lynn, 1998) (in Dalhberg, 2000).
Policymakers have a much wider variety of tools at their disposal then they did 20 years ago, many of which could improve environmental protection at a relatively low cost. In the past, the typical approach was to regulate behavior, often through what are known as command-and-control approaches. Although these approaches are important, they can also be costly and difficult to enforce. More recently, policymakers have been using market-based incentives as a way to achieve environmental health goals. These incentives can take the form of subsidy reforms, taxes to increase prices to reflect social costs, or the establishment of new markets in which pollution permits can be traded (Dahlberg, 2000).

These increasingly popular market-based pollution permits aim to limit pollution at an optimal cost to industry. By deciding on the proper level of atmospheric pollution desired, we create a market mechanism so that the "invisible hand" efficiently allocates the right to pollute among firms. This

mechanism allows for firms to trade the right to pollute through emissions trading, Firms can reduce emissions by relying on renewable energy, reducing usage, employing new technologies, or developing other strategies. Firms that reduce their emissions below the number of permits they hold may trade or sell them to other firms or save them to cover emissions in the future. Allowance trading provides incentives for energy conservation and technology innovation that can both lower the cost of compliance and yield pollution prevention benefits. The market-based allowance trading system capitalizes on the power of the marketplace to reduce pollution cost-effectively and uses economic incentives to promote conservation and the development of innovative technology (USEPA, 1998) (in Dalhberg, 2000).

It has been asserted that tradable pollution permits achieve a desired level of pollution control at an optimal cost to society. But what basis do we have for these assertions? While these claims may seem intuitively true, they are also firmly grounded in economic theory. When the costs of producing a good or the benefits from consuming a good spill over to people whom are not involved in the consuming or producing of the good, an externality occurs. The production of goods that cause pollution is a classic example of a negative externality. Externalities that have a negative effect society are known as negative externalities. In the case of these negative externalities, the competitive market does not generate the socially optimal, or efficient, amount of the good. Producers do not take into account the external costs when calculating their costs of production. Therefore, the quantity produced is greater than the efficient quantity. If the external costs were taken into account, the producers would produce less (Taylor, 1998).

In a tax-based policy, a tax is set (usually in the form of a fine) for pollution beyond a certain level. When the marginal benefits and marginal costs of pollution control are known with certainty, the amount of the tax can be set to the efficient marginal cost of pollution and firms will choose to clean up an amount of pollution that is exactly efficient. In this situation, either an emissions tax or a tradable permit policy can achieve the same efficient level of pollution abatement. In terms of efficiency alone, the two policies are equivalent (Wilcoxen, 2008).

In practice, policymakers rarely know the marginal cost of pollution control before policy is formulated. In this case, a tax-based system makes it necessary to formulate policy based on an estimate of marginal pollution control costs. If the estimate is not an accurate one, the desired level of pollution control is not achieved. Determining the appropriate amount of the tax can be a very difficult undertaking. By simply setting acceptable levels of emissions among polluters, we fail to recognize that costs differ among factories. For one factory, it may be very inexpensive to reduce pollution emissions at the margin but for the other it may be much more expensive (USEPA, 1998). Secondly, the cost of regulating emissions from polluters is very high with command and control methods. In order to set some sort of socially optimal level, information must be obtained about the true cost of emitting. Obtaining information can be done in two ways. First it can be obtained from the companies in the industry, which have a vested interest in

overstating their reduction cost. Another way of obtaining information about emissions is to obtain it independent of the company, which can be very cost prohibitive (Dahlberg, 2000).
Because of these problems, pollution permits are often an attractive alternative to taxes. Marketable pollution permits get around these problems by perfectly reflecting the firms' willingness to pay and marginal pollution control costs. In fact, after the EPA started the permit auctions, they found that the true costs of abatement were much lower than they initially believed. Under a permit policy, one must first choose the desired level of abatement and create an according number of permits. Firms are then allowed to trade permits in a profit-maximizing manner, thus finding the minimal cost of pollution control. Pollution permits also give firms an incentive to develop new technologies aimed at inexpensively reducing pollution. These permits allow policymakers the ability to rest assured that whatever level of pollution control they choose, the "invisible hand" of the market will let firms to comply at a cost most advantageous to the firms and to society itself (Dahlberg, 2000).

3.4 Method of Allocation

The system of tradable pollution permits is a remarkably simple way to regulate pollution at a cost that is optimal to society. Perhaps the most difficult aspect of implementing a policy of tradable pollution permits lies in the initial allocation of the permits.

The most accepted method of allocating permits currently used by the EPA is the sealed bid auction. Under this method, buyers of permits must send their bids in a sealed envelope to the agency conducting the auction. The permits are sold to the highest bidders until there are no more bidders or the permits run out. There are two main features of sealed bid auctions that make them different from other methods. For one, they can be organized to prevent firms that control a large fraction of the permits from exhibiting monopoly power. And secondly, they enhance price stability, which adds rational planning of pollution control by the polluters. Silent auctions are most efficient when permits can be traded freely at any time. With free trade, the permits become an asset- firms who pollute too much can buy additional permits to cover their emissions at a price that reflects the marginal social cost of the pollution. One problem with this mechanism is that it is not popular from a political perspective. Firms which have freely polluted in the past will not be happy when this right is taken away. Another method is to award permits to firms based on the amount of pollution they have historically emitted. This method, however, seems to reward those firms that have polluted excessively in the past. In determining who should get pollution permits when they are initially allocated, it is necessary to contemplate the question of who owns the property rights to clean air. If it is determined that industry holds the right to pollute, permits must be allocated based on past pollution. If it is determined that no one has the right to pollute without compensating society for the cost of the pollution, then we may award the right to pollute to the highest bidder (Lynn, 1998) (in Dalhberg, 2000).

One final policy note must be mentioned regarding who is able to purchase the permits once they have been initially allocated. It is important that nongovernmental organizations be allowed to participate in the free trade and auction process. These organizations play an important role in determining the socially optimal level of pollution. If individuals or organizations feel strongly enough, they must be allowed to purchase permits, thereby reducing the allowable level of pollution. This feature ensures that the socially efficient outcome is attained regardless of the initial allocation of permits.

3.5 Tradeable Permits in the Tourism Market

Tradable permits (government created licences for limiting a particular activity) have been frequently used in environmental policies including greenhouse gasses, water quality trading, tradable fish catch shares and habitat banks that sell credits to project developers who need to offset their impacts to wetlands or endangered species. Evidence suggests that these permits are effective in lowering compliance costs, incentivizing innovation, and easing administrative burdens. Taxes on the other hand requires compliance from every polluter to remain within a specific standard. Tradable permits incentivize the market to identify the most cost-efficient solution of allocating the market privileges (Schwartz, 2017).

For instance, under the carbon trading scheme, the government sets a maximum limit on emissions within a given time period, and the individual regulated companies determines what amount to emit and how, based on their own marginal costs. They can emit as much as they can afford to, but they also have an incentive to emit as less as possible so that any unused permits can be sold for profit. Similarly, tourism taxes are imposed on visitors. This is effective in the sense that it can limit the inflow of tourists directly. On the other hand, if replaced by permits, secondary benefits could be achieved through incentive to reduce pollution.

3.6 Two City Model

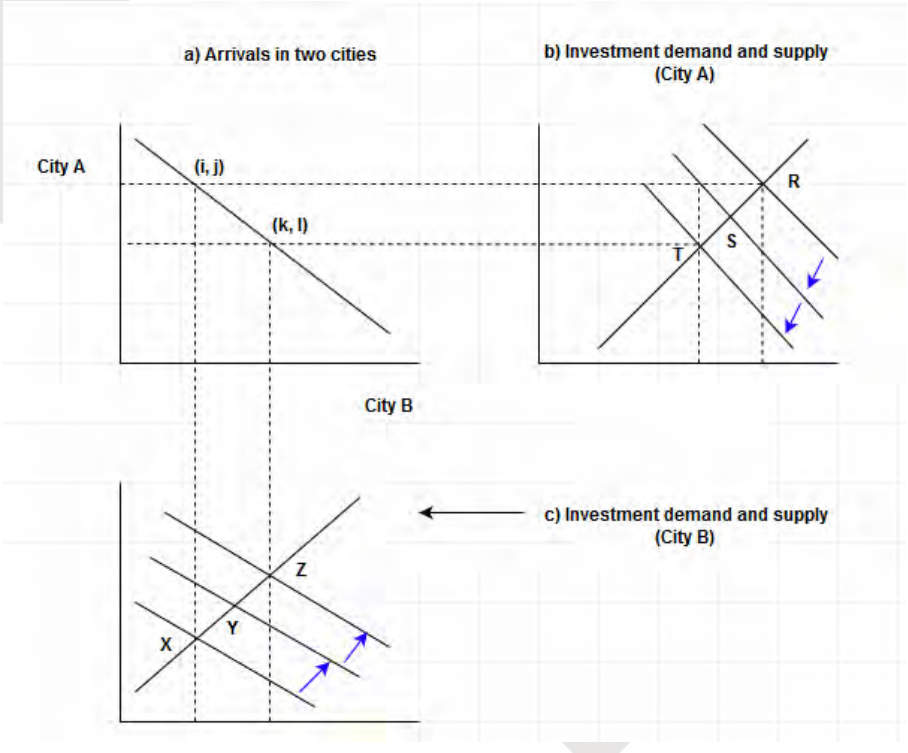
For simplicity and purpose of illustration we will focus on a two-city model. Please note that the mapping of the cities on the graphs are used for reference and not based on official statistics. The number of arrivals in City B and City A is given by (i,j) and (k,l) in periods t and t+1 respectively. In figure 3.11(b) we can see points R, S and T are the investment demand and supply in City A which correspond to the number of arrivals. Similarly, the corresponding level of investment in City B are given by points Y and Z in figure 3.11(c).

The optimal number for City A is l in figure 3.11(a). However, City A has experienced an influx of tourists that maintains the market equilibrium of the arrivals to j which is very high in terms of social disequilibrium. Here we do not assume any form of government intervention to limit the number of

tourists. The slope of the investment demand and supply will depend on how easy it is for the investors to create new facilities like hotels, restaurants, etc. to accommodate the tourists. City A is likely to have a steep supply curve while we expect City B to have a much flatter one. One way of thinking about this is that City A will produce much more negative externalities from an investment compared to an investment of similar scale in City B.

We also assume that the arrivals in period t and t+1 are the same. An increase in total number of arrivals in period t+1 would shift the curve in fig 3.11(a) towards the right but the rest of the market dynamic would reach the equilibrium the same way as constant arrivals. Constant arrival is assumed to make the graphical illustration and intuition simple.

Figure 3.11 Two City Model



Given that the current number of arrivals in City B and City A is given by (i,j) and it is found that at the current state of technology, the optimal numbers are (k,l). Introduction of permits will shift the investment demand in both City B and City A but in different directions. The shift can be broken down into two parts. First, from an increase in prices in City A, consumers reevaluate their travel destinations supplementary to their initial choices, and second, a flow of funds (permits) from City A to City B that affects the investment supply side of both cities.

3.7 Economic theory

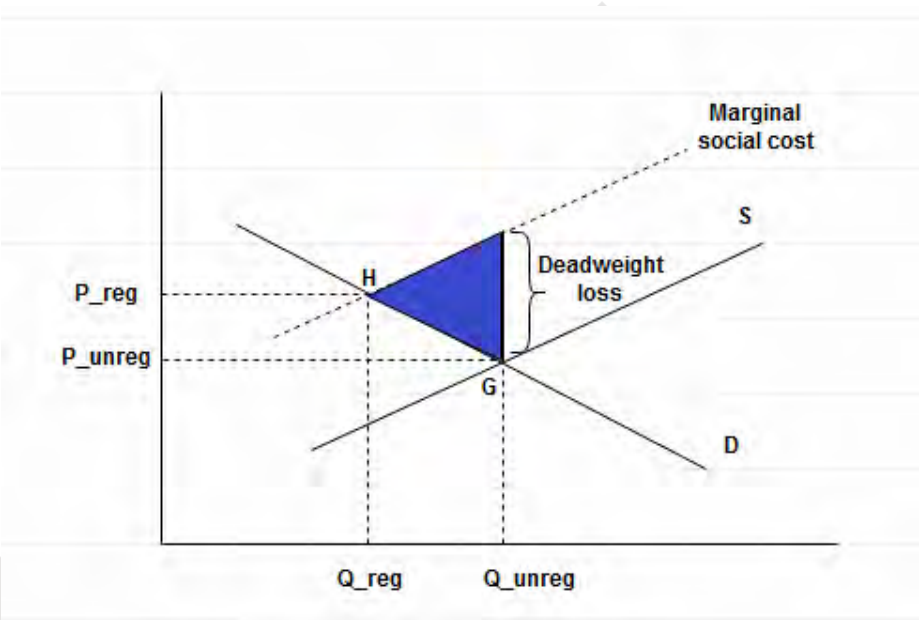
3.7.1 Negative externalities

Negative externalities occur when the consumption of one party reduces the well-being of others who are not compensated by the consumer. E.g. Using a car and that emits carbon contributing to global warming. There is a social marginal cost involved which includes the private marginal benefit to consumers plus any costs associated with the consumption of the good that are imposed on others.

The idea of applying permits to tourism market is based on understanding the deadweight loss that is present in the market that is not regulated or not fully regulated and so the costs were not allocated to the private buyers and sellers of that good. E.g. the socially efficient point (for a product associated negative externalities), where we should be producing is on H – the intersection of the marginal social curve and the demand curve. This is the full cost of the actions of the market participants.

When the market is unregulated, the quantity produced is at G. If we ignore the original supply curve S for a moment, we can see that H is the point at which the quantities should have been produced but the actual production is happening at G. This means extra units are being produced that should not have been produced because their costs exceed their benefits. If we extend the line upwards from G, we can see the deadweight loss - the shaded area. This is the equivalent of the units that were produced whose costs exceed their benefit, but they were produced anyways.

Figure 3.12 Negative externalities deadweight loss



Whenever we have an externality in the market, there are deadweight losses, and these can be and are usually corrected by using taxes to get the markets to produce at their socially efficient outcomes.

In the tourism market application, the producers are the cities and the consumers are of course the tourists. Except the difference in this area is that the tourists seldom bear the social cost involved in this market. This cost is incurred mostly by the residents and also by the cities themselves. And despite most big cities are regulated with tax to some extent, this has not fully appreciated the true social cost that considers the degradation/corrosion of heritage sites, impact to residents, and future costs. It would help to view the cities as the consumer and tourists as the product. Again, with the difference that unlike many products that generate negative externalities, tourism has its benefits until it exceeds a certain point.

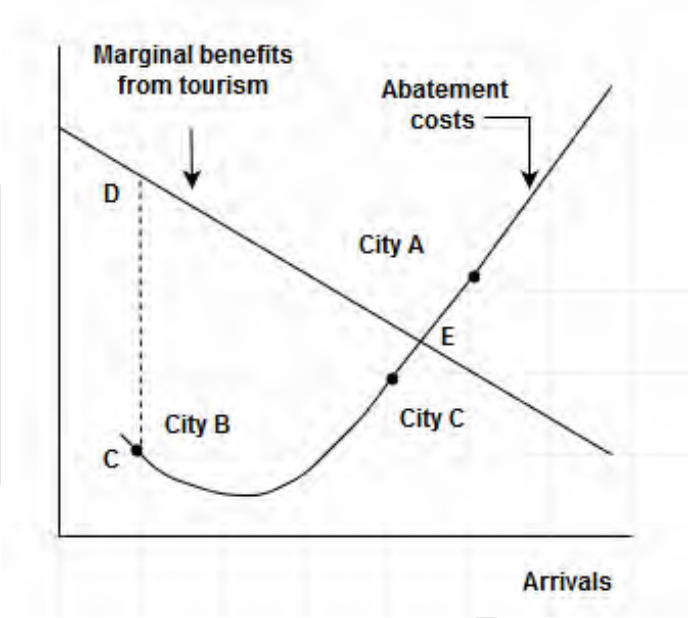
3.7.2 Two-city model

Consider the following example to adapt this idea in the tourism market. Suppose the current state of technology does not allow the existing level of arrivals without exceeding the "maximum acceptable level negative externalities" in City A. While due to modest arrivals in City B, its cost of maintaining a socially optimum level of pollution is much lower compared to City A. If the pollution is regulated through an exact tax, then City B would have minimal effect while City A would pay an amount that is exactly enough to cause an increase in prices to decrease the tourism demand in City A to a point that achieves maximum acceptable negative externality. In other words, City A will pollute only up to the point where paying tax exceeds the value of getting more tourists. In this case the maximum allowed externality of the whole economy is the same as what permits would achieve. This is because when cap and trade among the two cities on certain externalities exist, the market forces will reach an equilibrium to set a price of achieving the exact level of pollution as the tax. However, empirical evidence suggest that this does not hold in the real world (Smith, 2008). Regulators can put a shadow cost on the effects of the externality but cannot with certainty approximate the exact abatement cost of all the parties involved. In the case of permits with a hard cap however, a predetermined level of outcome will still be guaranteed. A side effect of this is that due to increase in demand for the permits, the compliance costs may be higher than expected.

The cost of reducing pollution interacts differently with tax and permits (Schwartz, 2017). If City A has a very high cost of reducing externalities, then paying tax will be opted. If all the cities in a region chose to pay tax instead of reducing externalities to maintain or increase their output, then the total externalities will be higher than expected. The tourists may opt to go to the next best city (e.g. City C) to avoid high costs in City A due to new tax, but this has a low impact on the towns that need revenue increase the most (e.g. City B). Under the permits, such towns will be able to benefit to a larger extent from not polluting as much as their high negative externality counterparts. The redistribution of income with an incentive to discover new technologies of negative externality abatement will benefit the region as a whole. The pattern will be the same with regards to the

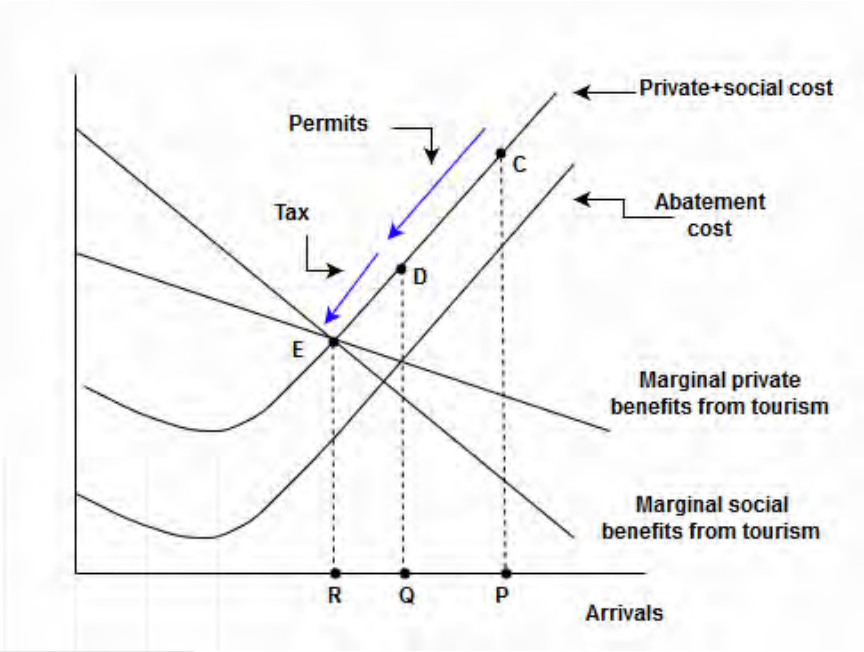
uncertainty involving future increase in tourism; permits will make sure the negative externalities do not exceed a predetermined level even if demand for tourism (or activities that increase environmental and cultural heritage degradation) increase. Taxes will still allow the cities and its agents to pay tax to pollute in order to increase their output.

Figure 3.13 MB of tourism and abatement costs of reducing negative externalities



We can think of two areas with huge differences in number of arrivals. City A for example has a problem of overtourism where benefits of tourism are outweighed by its negative externalities and City B does not get a lot of visitors and the attractions and cultural heritage on this town are insufficiently funded. An alternative way to think about this is in terms of abatement costs of reducing externalities and marginal benefits from added tourism as represented in the graph above. Here we assume that added tourism implies added negative externality linearly. The initial slump in the abatement cost curve is due to the fact that studies have shown some cities tend to reduce emissions through small increase in tourism. The system of permits is circular in the sense that market forces will modulate the amount of negative externalities through flow of funds from a city that is prone to corrosion to another that is depleting due to insufficient maintenance.

Figure 3.14 Cost-benefit curve of an individual city with a high negative externality (City A)



If we relax the assumption of direct pollution only from tourism and focus on the full cost-benefit structure of a polluting city, we can see that the permits will force the pollution down to the point where the abatement cost of the agents equal their private benefits from marginal pollution. However, there might be some residual negative externalities which can easily be corrected by a baseline taxation. E.g. we can see in the graph above; City A will purchase permits until the point D where the cost of abatement is equal to the marginal private benefit or benefit from marginal pollution. However, there still will be room for reduction in order to reach a social optimum. Levying a Pigovian tax will not only to fix this residual negative externality (shift from D to E) but also control the over-purchase of permits should it occur within the region. The equilibrium between permits and tax is also subject to modulation which can be set according to the long run objectives of the governing body.

3.8 Calculating the cost of negative externalities to set caps for permits

We want to compute the dynamic impact of tourism on GHG emissions, non-biodegradable waste, time lost by residents through congestion, water usage, environmental degradation through tourism related constructions, strain on cultural heritage sites (or funds required to maintain cultural heritage sites).

One way to do this would be to start with a ballpark number which would not be too harsh to any given city. Once the cap on tourism is set for a given region, it would be divided into allowances each of which permits the city to accept a given number of arrivals. Just like in the carbon market, these allowances can be distributed to the cities either for free or through an auction.

3.9 Methodology

3.9.1 Gaussian Process Regression

GPs can be viewed as an infinite-dimensional extension of the multivariate normal (MVN) distribution. The rationale behind this is that we observe a subset of data that is drawn from some infinite dimensional data and each finite subset follows an MVN distribution. Suppose we have a dataset $D = \{(x_i, y_i) \mid i = 1, \ldots, N\}$ where the input x is a vector of covariates of dimension D and y is a real valued output. A function f is a GP if any finite set of values $\{f(x_1), \ldots, f(x_n)\}$ has a MVN distribution, where $\{x_n\}_{n=1}^{N}$ are the inputs. The objective of GP regression is to predict f (x) from D which we will assume are noisy. GP is fully specified by a mean function and a covariance kernel. I.e.,

$$m(x) = \mathbb{E}[f(x)]$$

$$k(x, x') = (\mathbb{E}[(f(x) - m(x))(f(x') - m(x'))]$$

To run a GP regression, we begin with a prior. Often 0 is used to specify the prior mean as GP is capable of modelling the mean arbitrarily. For simplicity we will use a 0 mean on the prior.

$$p(\boldsymbol{f}|\boldsymbol{X}) \sim \mathcal{N}(\boldsymbol{f} \mid \boldsymbol{0}, \boldsymbol{K})$$

Because the observed targets are assumed to be noisy ($y = f + \epsilon$), we use σ^2 to denote the noise variance. The likelihood of the noise model is:

$$p(\boldsymbol{y}|\boldsymbol{f}) = \mathcal{N}(\boldsymbol{y} \mid \boldsymbol{f}, \sigma^2 \boldsymbol{I})$$

To obtain the posterior, first we need to calculate the marginal likelihood. We can get this by calculating the following integral over the latent variables f.

$$p(\boldsymbol{y}) = \int p(\boldsymbol{y}|\boldsymbol{f})\, p(\boldsymbol{f})\, d\boldsymbol{f} \;= \mathcal{N}(\boldsymbol{0}, \boldsymbol{K} + \sigma^2 \boldsymbol{I})$$

Once we have the posterior, the unseen test data can be predicted by calculating the predictive posterior.

$$p(y^* \mid X^*, X, y) = \int p(y^* \mid X^*, X, f)p(f \mid X, y)df$$

The unseen data is assumed to be an input output pair (X∗, y∗), where y∗ is a vector and X∗ is a design matrix. The expression$p(y^*) \mid X^*, \mathrm{X}, \mathrm{f}$, is the likelihood of the new data given function f, and the expression $\mathrm{p}(\mathrm{f} \mid \mathrm{X}, \mathrm{y})$ is the posterior over functions. It is possible to calculate the likelihood analytically by first obtaining the conditional distribution of $y^* \mid \mathrm{f}$ which is also a Gaussian.

$$p(y^* \mid X^*, X, f) \sim \mathcal{N}(y^* \mid \hat{\mu}, \hat{\Sigma})$$

$$\hat{\mu} = K_{X^*X}[K_{XX}]^{-1}f$$

$$\hat{\Sigma} = K_{X^*X^*} - K_{X^*X}[K_{XX}]^{-1}K_{XX^*}$$

$K_{X^*X^*}$ denotes the covariance between two test points and K_{X^*X} denotes the covariance between any pair of training and test p.

The predictive posterior is given by:

$$p(y^* \mid X^*, X, y) \sim \mathcal{N}(y^* \mid \mu^*, \Sigma^*)$$

$$\mu^* = K_{X^*X}[K_{XX} + \sigma^2 I]^{-1}y$$

$$\Sigma^* = K_{X^*|X^*} - K_{X^*X}[K_{XX} + \sigma^2 I]^{-1}K_{XX^*}$$

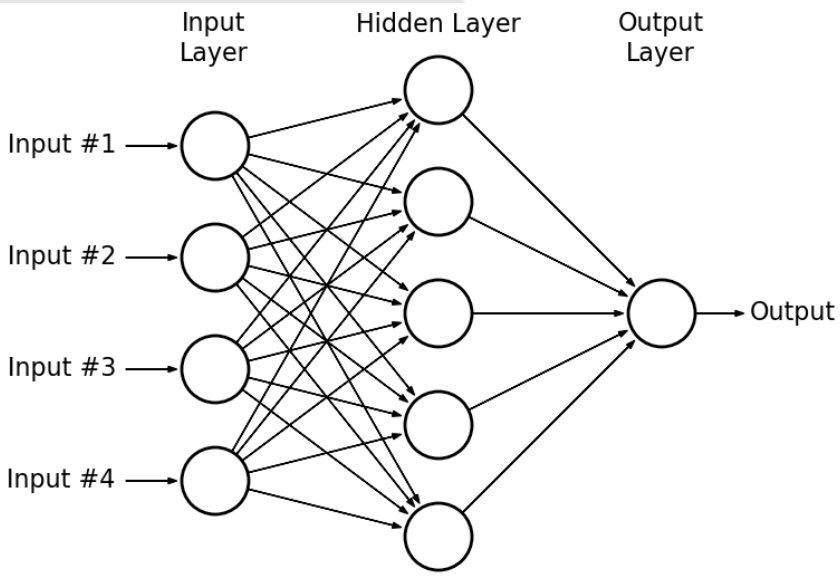
Predictions can be made using GP when we have equation (2.8). Covariances structure and the process of obtaining the posterior makes it clear that GP is a non-parametric method and it is also clear that it differs in the fundamental idea from other methods such as the Box-Jenkins regression models. In GP inference, the functions are regarded as the parameters. The posterior over functions is dependent on the training inputs X, which means that the size of the parameters increases with the size of training inputs. Looking at the predictive posterior, it is understood that the whole training data are needed for prediction. The means that the complete information set that is available to us can be utilized in prediction using new datapoints without restrictions imposed by a finite number of parameters as is the case in parametric models. This gives us an indication of the prowess of GPs compared to parametric models.

3.9.2 Neural Networks

In noisy time series data, observations are made up of systematic and random parts. Because we cannot observe these components directly, we use predictive methods to isolate the event signals that govern the systematic part. Multilayered perceptrons (MLP) are NNs with input, hidden and output layers that are commonly used in regression problems.

The inputs $\{x_1, \ldots, x_n\}$ are taken by the neurons which are then summed according to their appropriate weights $\{w_1, \ldots, w_n\}$. We start by randomly initializing the weights and biases. The inputs are multiplied with the weights and the bias added to it on all the neurons in the next layer they are connected to. A bias term *b* is added to the weighted sum which can be thought of as an intercept of a linear model. Bias units have influence on the outputs as they are connected to every hidden neuron even though they have no direct interaction with the main inputs. A transfer function is applied which activates the output at a certain level. This information is relayed to another neuron as a weighted sum of a non-linear activation (e.g. sigmoid or tanh) and continues until the final node is reached. The flow diagram below.

Figure 3.15 Neural Networks



NN architectures normally includes one or more hidden layers and one output layer. We use L to indicate the number of layer and l to address a single layer. Figure above shows a NN with one hidden layer, which means there are three layers in total. Every layer can include as many neurons as required. In the figure above there are 3 neurons in the input layer, 3 layers in the hidden layer and 1 neuron in the output layer. a_j^l is used to denote the activation function of the neuron j in layer l. The activation α can be represented by the following equation. It shows the functional dependency of activation in layer l to activation in layer $l-1$.

$$\alpha_j^l = \sigma(\sum_k w_{jk}^l \alpha_k^{l-1} + b_j^l)$$

$$\alpha_j^l = \sigma(z_j^l)$$

The expression can be rewritten in the matrix form as:

$$\alpha^l = \sigma(w^l \alpha^{l-1} + b^l)$$

where w^l is the weight matrix and b^l is the bias vector in the l^{th} layer. The elements in w^l are the entries in row j and column k of w_{jk}^l and the bias vector includes just one item per neuron in layer l. The vector of activation al consists of the activations of j^{th} neuron in layer l.

3.9.3 Backward propagation

The networks are trained using the backward propagation by which NN learns to map from arbitrary inputs to targets by optimizing the weights. As the gradient calculation begins backwards, the gradients of weights and biases in the last layer is calculated first. For every neuron, the error signal is computed and stored. Backpropagation computes the partial derivatives ∂C/∂w and ∂C/∂b of the cost function C w.r.t weights and biases. The cost

$$C = \frac{1}{2N} \sum_x \|y - a^L(x)\|^2$$

N = No. of training points
y = output
L = No. of layers
$a^l(x)$ = vector of activations output from the network

As the input to the neuron comes in, the neuron's weighted input is changed by $\frac{\partial C}{\partial z_j^l} \Delta z_j^l$. If $|\frac{\partial C}{\partial z_j^l} \Delta z_j^l|$ is large, then to lower the cost in the next iteration, the Δz_j^l will be chosen with the opposite sign to $\frac{\partial C}{\partial z_j^l}$. At optimality, $\frac{\partial C}{\partial z_j^l}$ is 0 or close to 0, and the cost cannot be improved further.

The error j in the l^{th} layer δ_j^l is defined as:

$$\delta_j^l \equiv \frac{\partial C}{\partial z_j^l}$$

δ reflects the change the error implies on the neuron. The error in the final layer is defined as:

$$\delta_j^L \equiv \frac{\partial C}{\partial z_j^L}\sigma'(z_j^L)$$

The matrix form of the above elementwise notation can be rewritten as:

$$\delta^L = \nabla_a C \odot \sigma'(z^L)$$

The component $\nabla_a C$ is the vector of partial derivatives $\partial C / \partial a_j^L$ that represents the speed of change in cost w.r.t output activations. The delta rule used to revise a neuron's allocated weight is stored as a copy of inputs to that particular neuron that is scaled by its delta.
The error as a function of the error in the succeeding layer is represented as:

$$\delta^l = ((w^{l+1})^T \delta^{l+1}) \odot \sigma'(z^l)$$

We can see that the error is moving backwards in the network. By computing the dot product $\odot$ $\sigma'(z^l)$, the errors are being moved in reverse order through activation in lth layer. Neurons in the final layer have their δ values computed first so that the neurons in the hidden layers can use it iteratively.

The error δ^l can be calculated for any layer by first computing δ^L and then δ^{L-1}. The process goes on to calculating $\delta^{L-2}$and so on until all the layers in the network are covered. Partial computations of the gradient from one layer are reused in the computation of the gradient for the previous layer allowing for efficient computation of the gradient at each layer.
The expression for the gradient of error w.r.t the weights and biases are given by two equations below respectively.

$$\frac{\partial C}{\partial w_{jk}^l} = a_k^{l-1}\delta_j^l$$

$$\frac{\partial C}{\partial b_j^l} = \delta_j^l$$

The equations above show how the partial derivatives should be calculated to be in terms of δ^l and a_j^{l-1}. The first round of calculating the output is likely to have high error so we need to back-propagate the error again until convergence. On each update, the magnitude of change in weight depends on the learning rate. A very low learning rate is likely to learn more thoroughly but will take much more iterations and therefore computation time whereas a very high learning rate trains the model faster but is prone to making snap judgements, leading to poor generalization quality. The tradeoff is between how accurate we want the predictions to be and how fast we want to train the model.

3.10 Forecasting Methodology

We have a set of N=10 time series each of length M_i, y_t^i. In this application, the indexes i and t denote the year and day respectively. The series is the sqenence of normalized externality variables during the period in question. The length of each series are identical and we shall view each time series as an independent input variable in the regression model as done by Chapados & Bengio (2007) with spread prices data. The rationale behind this method is that by representing each year as a separate time series of comparable length, the information from the preceding series can be learnt by the new series that we want to forecast.

We have observations from $i = 1, \ldots., N-1$ complete series. And from a partial last series, we have y_t^N, $t = 1, \ldots, M_n$. Our objective is to extrapolate the last series until a predetermined endpoint. This is done by characterizing the joint distribution of y_τ, $\mathrm{T} = M_{N+1}, \ldots, M_{N+H}$. We can also use some non-stochastic variable pertaining to each quarter (, e.g. rating and rankings from different indices) in every series, x_t^i where $x_t^i \in \mathbb{R}^D$. Our objective is to find $P(\{y_\tau^N\}_\tau = M_N + H|\{x_t^i, y_t^i\}_{t=1\ldots,M_i}^{i=1,\ldots,N})$, with i, t, and τ ranging, respectively over the forecasting horizon. See figure below.

Figure 3.16 Illustration of regression variables for the training period

A representation of “carbon level recorded date” are used as input variables (year, month, and day). I represent all the input information up to time t_0 of set i plus any lag values from 1 to Dth order. We also assume that all the prior series $\mathrm{i}^{\wedge\prime} < \mathrm{i}$ are fully included in I_(t_0)^i. To make forecasts we evaluate the mean and covariance with series i = N and the index t set to forecasting time frame τ. For the forecasting horizon, the lags are simulated using monte-carlo method and

the quarterly variable is either an official forecast or last known realization if estimates are not available. The mean and covariance functions in 2.1and 2.2 are equivalent to Gaussian process training conditioning on the I. For training we do not limit the amount of data in this model as M inducing inputs are used to speedup computation.

$$\mathbb{E}[y_t \mid \mathcal{I}_{t_0}] = f(y_{t-1}, y_{t-2}, \ldots, y_{t-10}, t, i, x_{t|t_0})$$

$$Cov[y_t, y_{t'} \mid \mathcal{I}_{t_0}] = f(y_{t-1}, y_{t-2}, \ldots, y_{t-10}, t, i, x_{t|t_0}, y'_{t-1}, y'_{t-2}, \ldots, y'_{t-10}, t', i', x_{t'|t_0})$$

For both setting above, we make one, two, and three quarters ahead forecasts. For NN implementation, the overall functional representation is given by the following equation.

$$y_t = f(y_{t-1}, y_{t-2}, \ldots, y_{t-10}, i, t, x)$$

3.11 Data Analysis Methodology

For data analysis, we use the carbon data of a hypothetical country ranging from January 20xx to December 20xx. Two transformations are made on the carbon data. First the data was scaled so that they are standard normal. While scaling the data each year were treated separately. Secondly, we subtract the numbers on each series by the closing price of the first day of the year from which we start our analysis. This is done to normalize the series to start from 0 so that we can avoid inter-year variation. There are three scenarios by which data is divided accordingly.

- Scenario 1: Train on complete observations from 2008 Q1 - 2018 Q3 and predict 2018 Q4
- Scenario 2: Train on complete observations from 2008 Q1 - 2018 Q2 and predict 2018 Q3 - 2018 Q4
- Scenario 3: Train on complete observations from 2008 Q1 - 2018 Q1 and predict 2018 Q2 - 2018 Q4

We can see in the table below that the date is split into series index i and t where i represents the year and t represents the day in the i^{th} year. Lags of order 1 to D are used for the training set. For the test set prices are simulated using the monte-carlo method.

Table 3.4 Data structure

Year	Month	Day	1^{st} lag	...	d^{th} lag	Arrivals	Projections
i	t	t	y^i_{t-1}	...	y^i_{t-d}	$\{x_t\}_1$	y_t
1 (2008)	1	1	28.86	...	y^1_{t-d}	0.9571	28.73
1	1	2	28.73	...	y^1_{t-d}	0.9571	29.08
1	...	...	...	...	...	...	...
1	30	360	21.57	...	y^1_{t-d}	0.4071	22.43
2 (2009)	1	1	22.43	...	y^2_{t-d}	0.4381	22.25
2	1	2	22.25	...	y^2_{t-d}	0.4381	21.90
2	...	...	...	...	...	...	
2	30	360	26.90	...	y^2_{t-d}	1.039	26.93
...	...	...	...	...	...	...	
10 (2017)	1	1	35.03	...	y^{10}_{t-d}	0.1661	35.33
10	1	2	35.33	...	y^{10}_{t-d}	0.1661	35.55
10	...	...	...	...	...	...	
10	30	180	40.37	...	y^{10}_{t-d}	0.1292	40.24
10 (2017)	1	181	MC		MC	Official	
10	1	182	Simulated	...	Simulated	estimates	???
10	...	...	data		data		
10	30	360					

3.12 Forecasting Strategy

We generally have two choices to make multi-step forecasts, direct and iterative [27]. In the iterative method, we train a one-step ahead model and make multi-step ahead forecast by using the previous forecast as part of the input for the next step, and so on. A single step ahead model is trained and then this prediction is incorporated in the next iteration to calculate y_{t+1}.

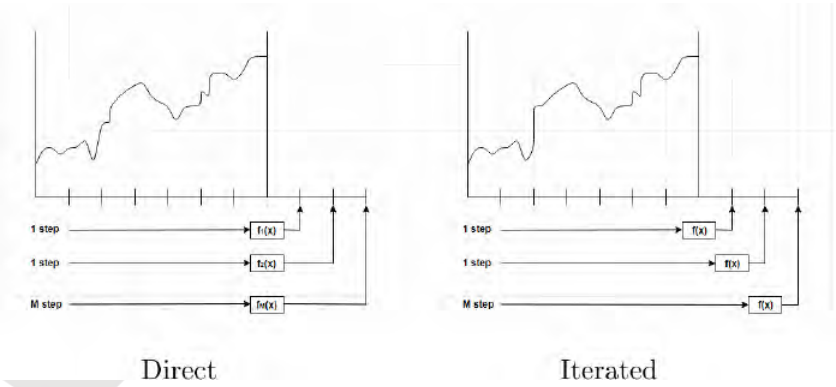
$$y_{t+1} \sim \mathcal{N}(y_{t+1} \mid \mu_1, \sigma_1^2)$$

In terms of the posterior $p(y^* \mid \mathbf{x^*, X, y}) \sim N(y^* \mid \mu^*, \Sigma^*)$ from equation 2.11, the equivalent of $\boldsymbol{x}^*$ would be $[y_{N-d+1}, y_{N-d+2}, \ldots, y_T]$, where the d is the order of lags. Similarly, we calculate the second step forecast using the same inputs from the previous forecast plus the information from the previous prediction which is $[y_{N-d+1}, y_{N-d+2}, \ldots, \mu_1]$. The mean μ_1 is used to approximate the prediction in the first one-step prediction.

$$y_{t+2} \sim \mathcal{N}(y_{t+2} \mid \mu_2, \sigma_2^2)$$

We repeat this process M times to get the M -step forecast. In contrast, the iterative strategy requires computing a different model for each prediction time step. In the case of forecasting carbon level for example predicting the prices for next two days would require a model to predict price on the first day and a different model for the second day. The forecasting process of the two methods are given in the figure below.

Figure 3.17 Recursive and direct forecasting methods



In such analysis, a direct computation of multi-step forecast strategy would be more suitable. I.e. for the whole forecast window, each step was computed separately without any conditional dependence between forecasts. Direct approach was preferred solely to avoid the possibility of error accumulation that can lead to rapid degradation of performance. The fact that our forecast windows are reinforces this decision.

3.13 Evaluation

To evaluate the model performance, root mean squared error *RMSE* and mean absolute scaled error *MASE* were used.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(y_{actual} - y_{predicted})^2}{N}}$$

RMSE is the standard deviation of the prediction errors. It measures how far from the actual values our predictions are on average.

$$MASE = \frac{\frac{\sum_{i=1}^{M} |y_{actual} - y_{predicted}|}{M}}{\frac{\sum_{i=1}^{N} |y_{actual} - \bar{y}|}{N}}$$

The above representation of MASE compares the forecast against a mean benchmark which is the mean absolute error on the training data. This method is scale independent since both numerator and denominator are based on values that are on the same scale as the original data [28]. The numerator is the MAE of the forecast and the denominator is the MAE calculated on the training set where the predictions are the average (0 in our case). If $MASE < 1$, the forecast is better than the dummy prediction on the in-sample data. Otherwise if $MASE > 1$.

3.14 Discussion and Conclusion

The graphs presented below are produced using dummy datasets only for the purpose of illustration and not real externality datasets. The purpose is to extrapolate such projections using machine learning models like Gaussian process and Neural networks in order to have a more precise setting of caps on externalities. The lines in the graphs are not arrivals but externalities associated with arrivals. Although the primary goal of the method of permits was explained in chapter 3.7, the forecast results is intended to be used to complement the economic model.

Figure 3.18 Gaussian process projections (dummy data)

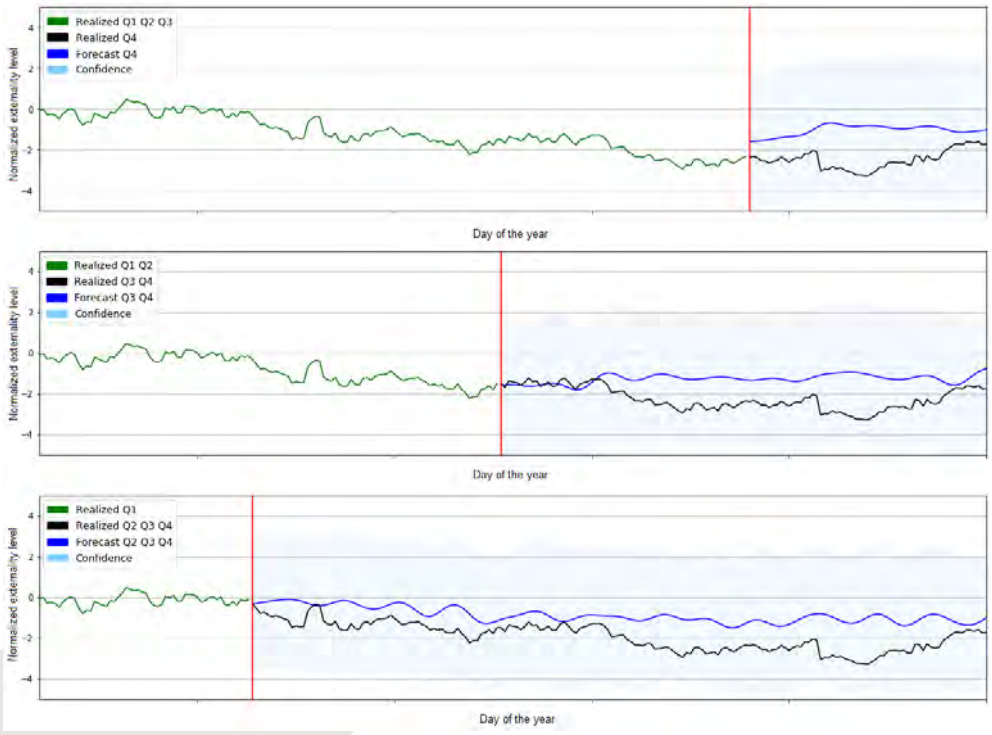


Figure 3.19 Neural networks externality projections (dummy data)

In the plots, the green lines are past values, the dark blue lines are the forecast, the red vertical line separates the forecast horizon from the past prices, and the black lines are the 'real' values of the forecast horizon which are included to compare with the ML projections. In the plots of GP predictions, the light blue lines are the confidence level. By looking at the direction of the externalities regulators can better plan ahead. For example, if there is an expected sharp decrease in externalities then the cap can be loosened so that the cost to the public is decreased while also maintaining a socially acceptable level of externality in order to not hurt the economy in the process. Furthermore, as mentioned in chapter 3.7.2, regulators can put a shadow cost on the effects of the externality but cannot with certainty approximate the exact abatement cost of all the parties involved. Although in the case of permits with a hard cap however, a predetermined level of outcome will still be guaranteed, with access to better projections, the government will have a better indication of how to set or change the caps that maximizes the social benefit under uncertainty of the abatement costs. A major advantage of probabilistic approaches like GPs is that it provides a predictive distribution. We can assess a model's performance by looking at mean values which are the point predictions. Point predictions are certainly useful on their own but the option to make use of the probabilistic distribution is an added advantage of GP which we do not have in neural networks. The added advantage is that we are able to get an idea of the uncertainty involving the predictions. From our results the 95% confidence interval was plotted in the figures of predictions. The approach will be expanded to make it more precise and applicable to different cities and externalities in larger cities as their cultural heritage are more vulnerable to corrosion and may be trading-off sustainable heritage preservation in exchange for economic growth.

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Acronyms

[APC]	[Author Processing Changes]
[API]	[Application Programming Interface]
[CC]	[Creative Commons]
[DMP]	[Data Management Plan]
[DOI]	[Digital Objective Identifier]
[DS]	[Data Sets]
[FAIR]	[Findable, Accessible, Interoperable and Reusable]
[GA]	[Grant Agreement]
[HUL]	[Historic Urban Landscape]
[OpenAIRE]	[Open Access Infrastructure for Research in Europe]
[**ORDP**]	[Open Data Research Pilot]
[PC]	[Project Coordinator]
[PM]	[Project Manager]
[PMT]	[Project Management Team]
[SDGs]	[Sustainable Development Goals]
[SR]	[Scientific Responsible]
[WP]	[Work Packages]

ANNEX

METADATA	
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