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# EDITOR'S NOTE

**Connections are everywhere. Robert Lang, a pioneering NASA researcher, understood this. A passionate origami practitioner, Lang discovered that there was more than just paper to his art, for he applied the folding of the wing of an origami spotted beetle to solve mechanical engineering problems to NASA's rocket ships. Lang's insight had ramifications in other fields, too, as his insight inspired bioengineers to pack DNA strands as if folding origami. Steve Jobs, another great innovator, also subscribed to Lang's philosophy, proclaiming: 'Technology alone is not enough. It's technology married with liberal arts married with the humanities which yield the results which make our hearts sing'.**

**Interdisciplinary thinking allows us to connect the dots between different fields, important problems, and great ideas. At The 1451 Review, we believe that interdisciplinarity is important for novel, world-changing, ideas to develop. Yet university students are often encouraged to specialise early in one field, making research parochial, and innovation elusive. Accordingly, new generations are left without the necessary skills to tackle many of the most complex problems.**

**This is troubling, given that we currently face unprecedented challenges, such as global warming, political unrest and health crisis. How do we build a sustainable future for our planet without the capacity to finance environmentally friendly policies? How can we limit political unrest without appreciating the intricate relationships between politics, finance and international crisis? And how can we truly understand the world we live in without grappling with our own cognitive biases?**

**Such complex problems require interdisciplinary insights to uncover solutions. These are some of the questions posed by the articles in this edition of The 1451 Review. The articles of this journal take many forms, whether it be a scientific hypothesis testing, analysis and debate or data-driven prediction making. But they are unified in their approach: each seeks to use insights from other, seeming distant, academic fields. And by doing so, they offer glimpses of opportunity to innovate and do things better. So our hope is that the 1451 Review will help you see the world as being connected and full of opportunities to break conventional wisdom, just as Lang and Jobs did.**

***Cameron Bell***

***Alejandro Serrano Saunders***

# Inequity and Climate Change: The Allocation of International Adaptation Finance

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Abstract: *Climate change affects livelihoods globally, but especially in the Global South where countries have had marginal contribution to the problem. Adapting to the impacts of climate change is crucial, but market failure and resource constraints lead to sub-optimal adaptation. Hence financial transfers are needed, and the UNFCCC states that the most vulnerable should be prioritised. This paper revisits the relationship of climate change vulnerability and aggregate adaptation aid, focusing on the recipient perspective not covered by previous research. A fixed effect panel data model is used to evaluate how equity and efficiency concerns affect the outcome of the adaptation aid allocation process. The results imply that efficiency is valued over equity. Across countries adaptation has a concave relationship with vulnerability, and within countries there is a convex relationship, meaning that increased vulnerability may lead to decreased aid. This may be due to insufficient data, donors not considering vulnerability as a dynamic concept, and lacking implementation capacity in vulnerable countries.*

## *Introduction*

Climate change is perhaps the most prominent global issue facing my generation. Even if all current and planned policies are implemented, global warming is estimated to reach 2.9°C above pre-industrial levels in 2100 (CAT 2019). However, it has been estimated that even a 1.5°C increase in global temperature poses significant climate-related risks to livelihoods and ecosystems (IPCC; 2018). Since some consequences of climate change have become unavoidable, climate change adaptation is a crucial policy tool, especially in the Global South where populations face a disproportionately high risk due to climate change (IPCC 2018).

Meanwhile 50% of the world's population in the lowest income class are responsible for only 15% of the global emissions (Hubacek et al. 2017). Therefore, the culprits lie in the Global North while vulnerable populations in the Global South face some of the most severe consequences of the greenhouse gases (GHG) emitted in the Global North leading to a 'double injustice' in climate change; Those who have

contributed the least will suffer the worst impacts. Scaling up financial transfers for climate change adaptation is crucial. Therefore, countries in the Global North pledged to mobilise USD 100 billion annually in new and additional finance for mitigation and adaptation (UNFCCC 2009).

However, in order to be equitable i.e. fair, adaptation aid should target the countries where it is most needed. Yet, several factors affect the allocation of adaptation finance including recipient need but also implementation capacity and donor interests (Betzold and Weiler 2017; Weiler et al. 2018). This paper sheds light on the literature by examining the relationship between aggregate adaptation aid and recipient need while paying particular attention to the different aspects of vulnerability.

Previous research provides mixed results regarding the allocation of adaptation finance. In particular; a) vulnerability affects adaptation aid allocation (Betzold and Weiler 2017), b) only the physical aspects of vulnerability have an effect (Weiler et al. 2018), and c) that vulnerability has a positive effect until a certain point, exhibiting a concave relationship with aid allocation (Saunders 2019). Furthermore, no research so far looks at aggregate adaptation finance, taking both multilateral and bilateral finance into account simultaneously, where most have only looked at bilateral finance. Yet multilateral donors represent an increasing share of adaptation aid, accounting for 41% of total adaptation finance in 2017 (OECD 2019a).

Therefore, I will look at aggregate adaptation aid flows and estimate their relationship with vulnerability, to assess whether adaptation aid is allocated equitably. To account for the complex nature of climate change vulnerability, recipient need will include estimates of both physical and structural vulnerability. Additionally, I will discuss the adaptation aid contributions against United Nations Framework Convention of Climate Change (UNFCCC) criterion for adaptation finance, which will allow me to combine the political framework with the economic and ethical arguments for adaptation finance allocation.

Using panel data regression analysis, and data on the received aggregate adaptation aid in 140 countries between 2011-2017, I find that the most vulnerable nations are not prioritised in adaptation aid allocation. Between countries, vulnerability has a concave relationship with the allocated adaptation aid, the most vulnerable receiving less aid than their less vulnerable counterparts. However, when controlling for country-effects, I find that increased vulnerability may lead to decreased aid. This could indicate that donors do not consider vulnerability as the dynamic concept it is.

This paper is organised as follows; part one reviews the literature and sets the research questions. part two outlines the data used as well as the empirical strategy. part three presents the results, relates them back to the literature and provides policy recommendations. Part four notes the limitations of the research. And finally, part five concludes.

## *Literature Review*

Climate change is already affecting livelihoods globally, hence adapting to the effects of climate change is crucial. Although the definition of adaptation is relatively straightforward, adaptation can happen in various ways and on two different levels. In short, 'adaptation is the process of adjustment to climate effects to moderate the negative and/or enhance the positive impacts of climate change' (Fankhauser 2017, 210). Examples of adaptation include building seawalls, changing to more climate resilient crops and even emigration (Betzold and Weiler 2018; Fankhauser 2017). Adaptation includes both creating the institutional capacity and knowledge to support adaptation and the actual delivery of adaptation actions e.g. building more climate resilient infrastructure (Stern 2007).

Adaptation is a complement to climate change mitigation, and both are necessary components of our response. There are limits to adaptation which calls for a concerted effort on both adaptation and mitigation. Without mitigation, the adaptive capacity of many systems will likely be exceeded (de Bruin et al. 2009). For example, many plants and species will be lost, placing pressures on people who rely on them, while areas may become uninhabitable forcing people to migrate elsewhere (Füssel et al. 2012). Yet, even if we implement more mitigation measures, uncertainty persists, calling for adaptation. Complex processes in the biosphere make predictions uncertain. For example, biosphere tipping points caused by thawing permafrost, accelerated ice loss around the poles, and fires in forested regions may cause a sudden release of GHG back into the atmosphere, exacerbating the warming effect. Tipping points could already occur between 1.5°C and 2°C of global warming, and they could start an irreversible global warming cycle (Lenton et al. 2019).

The impacts of 2°C warming is estimated to be drastic (IPCC 2018; CAT 2019). As we are on track to exceed 2.9°C, I would argue that current mitigation policies are insufficient, which makes adaptation even more important (CAT 2019). As de Bruin et al. (2009: 11) argue, 'the near-term impacts of climate change are already "locked in", irrespective of the stringency of mitigation efforts thus making adaptation inevitable'. Yet, policy makers and scholars devote considerably more attention on mitigation than adaptation (Fankhauser; 2017). Hence this dissertation will focus on adaptation while recognising mitigation as a crucial complement.

*Adaptation Measures*

Adaptation has been shown to be highly beneficial and adapting early may bear several advantages compared to action later on. Benefits exceed costs by a wide margin for various adaptation measures from enhanced meteorological services to sustainable agricultural land management, with as high as a 5:1 cost-benefit ratio for flood-risk management measures (Watkiss 2016).

Fankhauser (2017) explains why some adaptation action should be undertaken earlier rather than later. Firstly, it may be cheaper to factor in climate change into long-term decisions at the outset rather than adapting them later; this is especially relevant to long-lived infrastructure since it may be more expensive to risk-proof or retrofit already existing structures than to design resilient infrastructure to begin with. Secondly, some solutions might bear early benefits as they are 'win-win' for both adaptation and wider economic or environmental goals; especially true for ecosystem-based adaptation measures such as mangrove protection. Finally, some adaptation measures such as capacity building may only provide benefits in the long run, and therefore early investment is needed. Above all, 'pursuing place-specific adaptation pathways towards a 1.5°C warmer world has the potential for significant positive outcomes for well-being in countries at all levels of development' (IPCC 2018: 44).

Some adaptation can occur autonomously with funding from private sources. In other words, households and firms change their behaviour, adapting to new information about their environment (Fankhauser 2017). Private adaptation is thought to be more efficient than public adaptation as both the benefits and costs accrue to the same decision-maker; hence action is only taken when the benefits exceed the costs (Mendelsohn 2012). However, this is only true under the assumptions that there are no externalities, there is access to markets, private property rights exist and perfect information is available (Mendelsohn 2012). If any one of these assumptions is violated, market failure occurs, leading to sub-optimal adaptation undertaken by the private sector.

Firstly, market failure exists because adaptation creates (local) public goods. For example, the investment in a seawall creates positive spillovers for everyone living in the area, although they have not paid for it (Stern 2007). The presence of positive externalities leads to sub-optimal investment in adaptation by the private sector. Secondly, climate change is characterised by deep uncertainties; current climate information is subject to constant change. Furthermore, the level of uncertainty is much higher for adaptation than mitigation, because of the uncertainty of climate change impacts on the local level. There is also a lack of regional climate information, which is most relevant for adaptation (Fankhauser 2017; Heal and Millner 2014). Under imperfect information, it becomes impossible for actors to assess the costs and benefits of adaptation accurately (Stern 2007). Thirdly, developing countries may lack protection of private property rights, resulting in limited incentives to climate-proof the property when the risk of losing the property is high (Mendelsohn 2012).

Finally, people in the Global South may lack access to capital. Adaptation often requires a high upfront investment while developing countries tend to have general scarcity of resources. With lacking access to capital markets and/or a high cost of capital, investment in adaptation is unlikely to reach socially desirable levels (Stern 2007). Buhr et al. (2018: 4) show that vulnerability to climate change actually increases the cost of capital in developing countries. In particular, they found that 'for every USD 10 paid in interest by developing countries, an additional dollar will be spent due to climate vulnerability'. This would further exacerbate the capital constraints on adaptation investment and adds to the current economic challenges in developing countries.

Given the market failure, the state has an important role in providing adaptation. Fankhauser and Soare (2013) suggest three roles for the government. The government should a) create an environment that is conducive to private adaptation, for example by enhancing the security of property rights, b) provide climate-resilient public goods such as flood prevention measures, climate information services and resilient public infrastructure, and c) assist vulnerable groups who cannot adapt adequately themselves in order to minimise the implications of climate change on inequality. However, due to the resource constraints Global South governments face,

they may not be able to carry out these actions efficiently, or they have to prioritise other areas in public policy. Hence international adaptation aid should support these government actions.

*The Need for Adaptation Aid*

From a socio-economic and a biophysical perspective, the need for adaptation resourcing in the Global South is the greatest. This is both due to more severe physical impacts of climate change in warmer climates and the limited capacity to adapt. Countries in lower latitudes have higher temperatures, hence global warming may exceed the optimal conditions for climate-sensitive sectors, and poor people more often live in areas prone to extreme weather events. Furthermore, the livelihoods of the poor tend to be disproportionately dependent on climate-sensitive sectors such as agriculture or fishery (Mendelsohn 2012; Füssel 2012).

Additionally, there are several reasons why the capacity to adapt may be lower in the Global South. Governments and institutions in the Global South tend to be weaker, less likely to carry out effective public programmes for adaptation (Mendelsohn 2012). Poorer countries also tend to have limited financial assets and other resources enabling them to carry out adaptation actions (Füssel 2012). These are some of the reasons why financial transfers are needed to support adaptation in the Global South.

Both private and public finance is needed to support adaptation globally, but the focus here will be on public finance due to data availability. Although foreign aid could be defined in various ways, this study will focus on official development assistance (ODA) satisfying the following criteria: it should be a) concessional in financial terms, where the grant element needs to be at least 25%; b) coming from official sources i.e. governments; and c) designed to promote economic development and welfare (OECD 2019b). OECD has implemented Rio-Markers allowing to distinguish climate-specific aid spending (OECD 2019a).

From an ethical viewpoint, the Global North, predominantly responsible for climate change, ought to provide resources for adaptation. 'The primary duty of addressing the impacts of climate change lies with those who have caused it' (Füssel et al. 2012: 313). This is known as 'the compensation principle'. According to Hubacek et al. (2017), the need for adaptation is a consequence of global warming resulting from



the excessive GHG emissions predominantly created in the Global North. Considering the global income expenditure distribution and global GHG, the top 10% cause more than one third of global GHG emissions. Meanwhile, half of the world's population living on less than USD 2.97 (PPP) a day are responsible for only 15% of global GHG emissions. The majority of these people live in the Global South — in countries such as the Democratic Republic of Congo (DRC) and Madagascar where 99% and 98% of people respectively live in the lowest expenditure category. Although the Global South contributes marginally to the problems, it will bear the brunt of the impacts of GHG emissions created in the Global North. There is therefore a 'double injustice' in global climate change, and equity concerns underline the responsibility of the Global North in providing resources for those adaptation measures in the Global South.

*The Current Policy Framework*

The concerns of equity and resourcing have been taken into account in the framework of the UNFCCC. The convention has established that countries have 'a common but differentiated responsibility' according to their respective capabilities. Hence developed countries should 'take the lead in combating climate change and the adverse effects thereof' — according to the polluter pays principle (UNFCCC 1992; Schalatek and Bird 2017). The convention also stipulates that developed countries 'shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects'. Recognising the need for climate aid, the Copenhagen Accord promised to mobilise USD 100 billion annually for mitigation and adaptation by 2020 (UNFCCC 2009). This pledge was reinstated in the Paris Agreement, which called for a significant increase in adaptation finance and established that finance for mitigation and adaptation should be in balance (UNFCCC 2015).

Yet, there is evidence that the current allocation framework is not in compliance with the UNFCCC-set policy targets. Although there has been an increase in the provision of adaptation aid, in 2015-2016 it remained only 20% of all climate finance, highlighting that the balance called for in the Paris Agreement has not been reached yet (Carty and le Compte 2018). When accounting for both public and private sources of finance, it was found that all adaptation finance amounted to just USD 22 billion 2015-2016 (CPI 2018). However, the annual adaptation costs in developing countries could range between USD 140-300 billion by 2030 (UNEP 2016). Hence a global

adaptation finance gap exists, and adaptation aid is key in closing it. Although the USD 100 billion target of the UNFCCC is not exclusive to public finance, aid will be crucial since grants and loans with low interest rates will be acceptable to most developing countries (UNEP 2018). Both ethical considerations and the UNFCCC framework support the case of adaptation aid from the Global North to the Global South.

*Allocating International Adaptation Aid to Prioritise the Most Vulnerable*

In order to distribute adaptation aid as equitably as possible, it has been argued that the finance should be allocated based on how vulnerable a country is to the impacts of climate change. That is, recognising physical vulnerability of a country along with its adaptive capacity. Hence countries more vulnerable to the impacts of climate change should have a stronger claim on adaptation aid (Barr et al. 2010). Schalatek and Bird (2017) argue that special funding provisions should be made for Least Developed Countries (LDCs), Small Island Developing States (SIDS) and African States, reflecting their higher level of vulnerability. The UNFCCC policy framework also stipulates that 'developed country parties shall assist those that are particularly vulnerable to the adverse effects of climate change' (UNFCCC 1992). This echoes the arguments for prioritising recipient need in foreign aid allocation more generally.

The concept of vulnerability is contested in the literature, but the role of exposure, sensitivity and adaptive capacity has been recognised in many studies (Fig. 1). Indeed, the IPCC uses the following definition for vulnerability in their assessment report: 'Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt' (IPCC 2014: 128). Vulnerability is a dynamic concept which can be hard to quantify, posing challenges to optimal adaptation aid allocation based on vulnerability measures (Barr et al. 2010).

Adaptive capacity represents the socio-economic side of vulnerability, determined by factors such as income, institutional capacity, political stability and the quality of social services (Barr et al. 2010). Usually it refers to the capacity to respond to and cope with the impacts of climate change, which encompasses a country's financial capacity and the capability to use its resources effectively (Betzold and Weiler 2018). The capability to use resources effectively is also linked to implementation capacity, as discussed below. An increased adaptive capacity will decrease the level of vulnerability (Figure 1).



**Determinants of vulnerability**

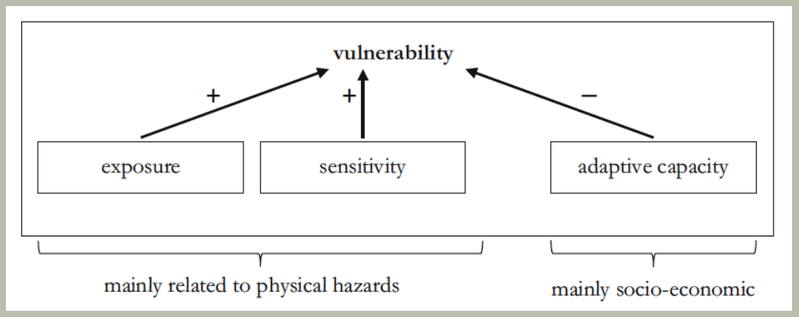


Figure 1.
Betzold, C. and Weiler, F. (2018). *Development aid and adaptation to climate change in developing countries*. Cham: Palgrave Macmillan, p 5.

Exposure and sensitivity concern the physical side of vulnerability, usually measured by indices on the severity of current and future weather events, topography and dependency on climate-sensitive sectors such as agriculture. Exposure considers *what could be adversely affected*, whereas sensitivity regards *the degree to which systems are affected* (IPCC 2013). Exposure and sensitivity are related concepts, and ideally both should be included in the analysis.

Yet efficiency may also drive adaptation aid allocation. As donors want to maximise the impacts of their aid, they may select countries where implementation capacity, 'the ability to manage and use finance effectively' is higher (Barr et al. 2010: 845). Efficient allocation would distribute funds where the net benefit of adaptation aid is the greatest (Betzold and Weiler 2018). As resources are scarce, taking efficiency into consideration is vital. However, these two principles may be at odds since the most vulnerable and poor countries often do not have the social and governmental structures to use aid effectively. Therefore, Barr et al. (2010) argue that while capacity to implement should be taken into account in adaptation finance allocation, a low implementation capacity should not disqualify a country from receiving aid. It would instead mostly signal the need for different implementation arrangements such as increased technical assistance in project delivery.

*Determinants of Adaptation Aid Allocation*

Although the policy framework supports allocation based on recipient need, results from the foreign aid allocation literature have shown aid flows to be driven by much

more than that. Usually the literature evaluates three arguments for providing and allocating aid; a) altruistic reasons i.e. recipient need, b) donor self-interest, and c) recipient features that may affect the effectiveness of aid. Most studies find both donor interests and recipient need to affect allocation to varying degrees (Hoeffler and Outram 2011). For example, Alesina and Dollar (2000) find donor interests, namely colonial history and UN voting patterns to be more influential than recipient need.

As adaptation aid has been found to be highly correlated with foreign aid flows (Betzold and Weiler 2018), a question arises as to whether adaptation aid has been allocated as fairly as possible, based on recipient need i.e. vulnerability. Following these conclusions in the foreign aid literature, scholars have examined whether similar drivers affect adaptation aid allocation. Next, I will summarise the findings, assessing whether vulnerability has been prioritised in adaptation aid allocation as the UNFCCC framework stipulates.

*a) Recipient Need Does Affect Adaptation Aid Allocation*

Several studies find that physical vulnerability has a significant effect on adaptation aid allocation. In studying the allocation of bilateral adaptation aid, Betzold and Weiler (2018) find that vulnerability matters for adaptation aid allocation and that the effect of physical vulnerability dominates over adaptive capacity. Betzold and Weiler (2017) use a pooled dataset of aggregate bilateral adaptation aid from the recipient perspective and find that physical vulnerability has a significant effect on allocation. Weiler et al. (2018) show vulnerability only plays a small role where more exposed countries as well as SIDS and LDCs receive more aid. Barrett (2014) concludes that areas with high physical vulnerability but relatively low socio-economic vulnerability receive the most finance sub-nationally. Similarly, Robinson and Dornan (2016) find a strong and significant positive relationship between the SIDS status and adaptation aid, although no robust relationship between physical vulnerability indicators and adaptation is found.

Betzold and Weiler (2018; 2017) find that adaptive capacity has a significant effect on adaptation aid allocation. However, they only measure adaptive capacity through GDP per capita, which can also signal the implementation capacity of a country. Hence the significant effect they find could also be explained through implementation capacity — more aid is given to countries with preconditions to handle investments effectively. For example, Betzold and Weiler (2017) find a quadratic relationship between GDP per capita and the allocated adaptation aid i.e. the poorest countries receive little aid potentially due their lacking implementation capacity.

Therefore, it remains ambiguous if donors truly concern the adaptation capacity of the recipient, or merely the correlated implementation capacity. Yet, it seems that physical vulnerability as well as GDP per capita may have a strong effect on adaptation aid allocation. Notably, some of the studies exclude sensitivity from their analysis due to multicollinearity issues (Bagchi et al. 2016; Weiler et al. 2018). However, sensitivity is what links exposure to vulnerability. For example, there may be an area that is very exposed to the impacts of climate change, but no one lives there, or an industry may be exposed but the country is not in fact very dependent on that industry. Therefore, including sensitivity would align the analysis more with IPCC's definition of vulnerability (Saunders 2019).

*b) Recipient Need Does Not Affect Adaptation Aid Allocation*

By contrast, looking at vulnerability as a whole, including exposure, sensitivity and adaptive capacity, Saunders (2019) finds that vulnerability has a negligible, or negative effect on adaptation aid allocation. The paper finds a concave relationship between vulnerability and bilateral adaptation aid where first diminishing and then negative returns to vulnerability are observed, both in the selection and allocation stage. A negative relationship is found between vulnerability and the selection as a multilateral adaptation aid recipient, indicating that multilaterals would prioritise vulnerability less than bilateral donors. Little evidence is found for multilaterals prioritising vulnerability in the aid allocation stage. Therefore, neither multilateral nor bilateral donors prioritise vulnerable nations in selecting adaptation aid recipients, conflicting with earlier findings (Betzold and Weiler 2018).

Furthermore, countries with similar levels of vulnerability have received different levels of aid, leading to an uneven distribution between recipients with same needs (Donner et al. 2016). In line with this, Remling and Persson (2015) analyse the projects of the Adaptation Fund, a major multilateral donor, and find that neither vulnerability nor cost-effectiveness drive adaptation aid allocation. Instead they find that the fund has applied an equality principle not responding to recipient need.

Moreover, it has been indicated that adaptive capacity, the socio-economic side of vulnerability, does not increase adaptation aid. Weiler et al. (2018) find that

although the country's SIDS or LDC status matters, adaptive capacity is not associated with increased per capita adaptation aid.

Finally, only looking at descriptive data, it seems that vulnerability matters little for adaptation aid allocation. Carty and le Compte (2018) and Dodd et al. (2018) conclude that adaptation aid fails to reach the least developed and the most vulnerable countries using the LDC status, level of poverty and the ND-GAIN vulnerability index measuring recipient need.

*c) Implementation Capacity and Donor Interests*

Two further determinants have been found to affect aid allocation — implementation capacity and donor interests. A complementing concept to vulnerability, implementation capacity, relates to the country's ability to use and absorb the funds effectively. Often this involves measurements of governmental performance, corruption, and business environment. Although implementation capacity and recipient merit are not entirely the same – with the former representing the capacity to manage the funds effectively, and the latter meaning implementation of 'good governance' i.e. democratic institutions — I will discuss them jointly under implementation capacity as the two are highly correlated.

Saunders (2019) finds that the effect of implementation capacity differs between the social, governance, and economic dimension. Although economic readiness has a positive effect, the social readiness coefficient was negative. This may be due to the close relationship between social readiness and adaptive capacity. Additionally, multilaterals appear to place much more emphasis on governance readiness than recipient need, likely due to the reduction in investment risk in countries with stable governance. Similarly, Weiler et al. (2018) find that recipients are rewarded for good governance; it has a positive and significant effect on allocation. Therefore, donors are likely to consider the recipient's implementation capacity to ensure the highest marginal effects of their aid.

The results regarding donor interests seem more ambiguous, and due to the methodology of this study, the effect of donor interests will not be measured. Hicks et al. (2010) and Betzold and Weiler (2017) find that donor interests far outweigh the importance of recipient need. Additionally, a colonial history is a significant positive determinant adaptation aid (Saunders 2019). Yet, it has been also suggested that recipient need is at least as strong a determinant as donor interests, and that donor interests have no effect at all (Weiler et al. 2018; Bagchi et al. 2016).

The literature leaves us with mixed results. Saunders (2019) argues that the contradictory findings owe much to the different definitions and measures of vulnerability. This paper will revisit the relationship between adaptation aid, vulnerability and implementation capacity to shed light on the varying effects of different dimensions of vulnerability, and the ability to absorb finance, on adaptation aid allocation. Most of the previous work focuses either solely on bilateral finance or on evaluating the allocation of a single multilateral donor (Remling and Persson 2015). Saunders (2019) was the first to incorporate both multilateral and bilateral finance in their analysis. Then again, multilateral and bilateral flows were modelled separately, and still focusing on the donor perspective using the share of the donor's adaptation budget allocated to a recipient as a dependent variable. Therefore, current studies are focusing on the decision-making process of donors rather than the outcome of the allocation process.

This research paper will examine the equity in the outcome of the adaptation aid allocation from the recipient perspective, combining both multilateral and bilateral flows. Ignoring the multilateral flows was perhaps justified earlier this decade, when their share was approximately 20% (Betzold and Weiler 2018). However, in 2017, the share of multilateral aid in total adaptation aid reached over 50% for Africa, Asia and Oceania (OECD 2019a). Hence leaving these flows out of the analysis would create biased results.

Additionally, it is essential to look at the outcome of the allocation process from a recipient perspective. In the end, even if single donors allocate adaptation aid based on recipient need, some donors may remain who allocate aid entirely based on their own interests; as such potentially negating the efforts of others for an equitable outcome. This perspective has not received adequate attention in the previous literature, given that the aggregate finance received by vulnerable countries is what will determine whether adaptation aid is allocated equitably as a whole. To the best of my knowledge, no work has analysed adaptation aid at the aggregate, combining both bilateral and multilateral flows from the recipient perspective, which is how this research will contribute to the literature. I set out to examine the following research questions:

1) *Does vulnerability affect adaptation aid allocation? Does this effect vary between the different dimensions of vulnerability?*
2) *Does implementation capacity affect adaptation aid allocation?*

## *Methodology*

In this section I will discuss the data and the empirical strategy of this research. The relationship between adaptation aid and vulnerability to climate change will be tested using a panel data set for 140 countries for the period 2011-2017.

### *Dependent Variable; Adaptation Aid per Capita*

The dependent variable has been constructed using the OECD-DAC statistics on climate related development finance commitments that specifically target adaptation (OECD 2019a). Data is reported at the project level, and it includes both bilateral flows straight to recipient countries as well as flows from multilateral donors to recipient countries. Multilateral donors include both multilateral development banks (MDBs) and Funds, where the data on MDBs is included from 2013 onwards. The OECD Creditor Reporting system reports commitments rather than disbursements, and although looking at disbursement data would be ideal for evaluating the outcome, analysing commitments reflects donor priorities better. One of the prominent drawbacks of the data is that it relies on donor self-reporting, but even then, it is the most comprehensive and reliable data on adaptation aid to date (Betzold and Weiler; 2018).

The data employs two methods to account for adaptation related financial flows. In 2010 the OECD introduced an adaptation Rio marker to monitor adaptation objectives in development cooperation, having previously implemented markers for climate change mitigation, desertification and biodiversity (OECD 2016). The aid project will be relevant for adaptation when 'it intends to reduce the vulnerability of human or natural systems to the current and expected impacts of climate change, including climate variability, by maintaining or increasing resilience, through increased ability to adapt to, or absorb, climate change stresses, shocks and variability and/or by helping reduce exposure to them' (OECD 2016: 8). A project can score either, 'not targeted', 'significant' or 'principal' based on whether adaptation is an objective, and whether other objectives motivate the project as well.



The activity is marked as 'principal' if adaptation is the fundamental motivation behind it, and 'significant' if adaptation is stated as one of the objectives albeit not the fundamental motivation (OECD 2016). I include both principal and significant flows into the analysis, recognising that adaptation often overlaps with other development objectives and hence may be reported under the 'significant' marker. However, these flows have been discounted by 50% to account for overstating. Firstly, donors tend to overstate their commitments relative to the actual disbursements. Secondly, independent assessment has found that donors overstate the relevance of their aid projects for adaptation, especially in projects where adaptation is only a 'significant' objective (Carty and le Compte 2018; AdaptationWatch 2015). The discount rate was selected to balance between overcounting and recognising that 'significant' flows also target adaptation to a certain extent, following the approach in Betzold and Weiler (2017).

Alongside the Rio Marker approach, MDBs have implemented their own climate components approach, which has been argued to be more useful in accounting for adaptation contributions in a more 'mainstreamed' approach where adaptation actions are also carried out through regular development projects (AdaptationWatch 2015). The given approach only accounts for the share of the project that targets adaptation directly, hence the adaptation finance contributions from MDBs are included in the analysis in full.

The dependent variable is constructed by pooling the data to obtain a total amount of adaptation aid received annually from both bilateral and multilateral sources. Although the adaptation marker was introduced in 2010, I only include data starting from 2011 since some donors had not fully implemented the marker in 2010 and therefore the data may be unreliable (Saunders 2019). After pooling the data, population is used to construct the total annual adaptation aid per capita, assuming that aid is allocated respective to the population of a country, consistent with what has been found in the aid literature (McGillivray and Oczkowski 1992). The dependent variable enters the model in a log-transformation to account for the high skew in the data.

**List of Variables**

| Variable definition | Variable name | Specification | Source |
|---|---|---|---|
| Total Annual Adaptation aid per capita | AidCapita | In constant 2016 USD, logged | OECD-DAC |
| Vulnerability to Climate Change | Vulnerab | 1-100 where higher values signal higher vulnerability, lagged | ND-GAIN |
| Sensitivity to Climate Change | Sen | 1-100 where higher values signal higher sensitivity, lagged | ND-GAIN sub-index under vulnerability |
| Adaptive Capacity | Capa | 1-100 where lower values signal greater adaptive capacity, lagged | ND-GAIN sub-index under vulnerability |
| Readiness | Ready | 1-100 where higher values signal higher readiness | ND-GAIN |
| Global Climate Risk Index | CRI | 0-126.17 where lower values indicate higher losses from extreme weather events | Germanwatch |
| Population | pop | Logged | World Bank |
| GNI per capita PPP | GNIcap | In current USD, logged and lagged | World Bank |
| Total ODA Disbursements | ODA | In constant 2017 USD, lagged and logged | OECD-DAC |

Table 1.

*Independent Variables: Recipient Need and Implementation Capacity*

Two complementing indices are used to measure recipient need. As discussed previously, vulnerability is hard to measure and including all the relevant components may lead to issues of multicollinearity (Betzold and Weiler 2018). The ND-GAIN index attempts to quantify the vulnerability to climate change each country experiences over time (ND-GAIN 2015). The Vulnerability sub-index will be used to capture a coherent view of vulnerability, including all the components identified by the UNFCCC: exposure, sensitivity, and adaptive capacity (ND-GAIN; n.d.). To the best of my knowledge, this measurement is the only one including all these components, while recognising the multidimensional and dynamic nature of vulnerability. Moreover, it has been widely used in measuring vulnerability to climate change (Saunders; 2019; Weiler et al. 2018).



The index has been constructed by measuring exposure, sensitivity and adaptive capacity across six life-supporting sectors; food, water, health, ecosystem services, human habitat and infrastructure (see Appendix 3). With regards to interpretation, a lower score indicates a better outcome. All the measures are weighted equally within the indices and the focus is on the long-term vulnerability to climate change. The entire vulnerability index is used in the main model, and the sub-indices on adaptive capacity and sensitivity are used in a partial model to assess the differences between physical and structural vulnerability. Indices have been scaled by 100 in order to assist with the interpretation of the regression results. As Saunders (2019) found a concave relationship between vulnerability and the share of adaptation aid budget received, I also include vulnerability in the squared form to see if the relationship is nonlinear.

Since the ND-GAIN focuses on long-term vulnerability, a complementing measure, the Global Climate Risk Index, will be used to represent short-term losses from climate variability (Germanwatch 2020). Although it is hard to attribute single weather events to climate change, it increases the likelihood of extreme weather events (Germanwatch 2019). Moreover, decision-makers may take recent weather events calling for adaptation into account when allocating adaptation aid, and the CRI is a well-known index to policymakers (Betzold and Weiler 2018). The data reflects the direct socioeconomic costs of extreme weather events including the economic losses in USD PPP and per unit of GDP as well as the number of deaths per 100,000 people.

I will include the long-term index utilising data from the past 20 years for each year in my analysis where lower values will indicate a higher degree of vulnerability. Hence consecutive years will have 19 years of overlapping data and therefore there is not a great deal of variability within individual countries. The data is from the Munich Re, one of the most robust and reliable sets of data on this matter (Germanwatch 2019). Correlation between the CRI and the other variables measuring recipient need is low (see Appendix 1), hence it is included in all models measuring the effect of vulnerability.

Additionally, GNI per capita is included as a rough proxy for the financial adaptive capacity the country has, and to complement the measures on vulnerability and readiness. GNI is chosen over GDP as it reflects the resources available domestically better since it includes net income from overseas investments and

remittances. GNI is included in both the models measuring the effect of recipient need and implementation capacity, as it could be measuring either one. The data has been obtained from World Bank and will enter the model in its logged form (World Bank 2020a).

Although vulnerability has been given priority in the UNFCCC policy framework, it is unlikely that it would remain the only allocation criterion. That is, capacity to implement may be just as important for adaptation as vulnerability considerations (Barr et al. 2010). Even though implementation capacity, namely good governance, is highly linked to one of the components of vulnerability — adaptive capacity, I include a separate measure for implementation capacity to examine whether equity (recipient need) or efficiency (implementation capacity) affects the outcome of the adaptation aid allocation more. The ND-GAIN index has a sub-index measuring readiness, or more specifically 'Readiness to make effective use of investments for adaptation actions thanks to a safe and efficient business environment' (ND-GAIN 2015: 4). Three dimensions of readiness are measured; social, economic and governance readiness (see Appendix 2).

*Control Variables*

Additionally, I will control for population as well as aggregate ODA flows in all models. It has been shown that adaptation aid follows foreign aid flows closely. This could be explained by path dependency, where a given donor is more likely to support a recipient if they have an existing aid relationship. The existing connection reduces transaction costs, meaning that recently established adaptation aid flows may follow the same donor's ODA allocation (Barrett 2014). The aid data represents total disbursements from the OECD-DAC database, and it enters the model in its logged form (OECD 2019b).

Although the dependent variable is adaptation aid per capita, a small country bias has been observed where small countries receive a disproportionately high amount of aid per capita (Alesina and Dollar 2000). It may be that smaller countries have better administrative capacities, or that donors want to see a large marginal impact of their aid which decreases when the population increases (Betzold and Weiler 2018). To control for this, population is included in its logged form (World Bank 2020b).



*Empirical Strategy*

A fixed-effects panel data model is used to capture both the cross-sectional and the time-dimension in the data. This also allows to control for unobserved heterogeneity between countries and over time, which would not be possible using a simple OLS (Wooldridge 2020). A correlation analysis was performed between the variables (see Appendix 1). It was observed that the correlation between variables is mostly low, besides the sensitivity and capacity which are components of the vulnerability measure, and therefore will not be used in the same model. However, the correlation between GNI per capita is relatively high with both vulnerability and readiness. Therefore, the variance inflation factors (VIFs) were counted, and the results gave no reason not to include GNI in the models, as all VIFs were below 5. The VIF quantifies the degree of multicollinearity in the model and as 10 is often chosen as the cut-off point, it is relatively certain that multicollinearity is not an issue. Three main models are used to answer the stated research questions, where $i$ represents the country-dimension, the 140 aid recipients, and $t$ represents time = 2011, 2012, . . . ,2017.

$$\log(AidCapita_{it}) = \beta_1 Vulnerab_{it} + \beta_2 (Vulnerab_{it})^2 + \beta_3 CRI_{it} + \beta_4 \log(GNIcap_{it}) + \beta_5 \log(pop_{it}) + \beta_6 \log(ODA_{it}) + \alpha_i + u_{it}$$

Model 2: Vulnerability

$$\log(AidCapita_{it}) = \beta_1 Ready + \beta_2 \log(GNIcap_{it}) + \beta_3 \log(pop_{it}) + \beta_4 \log(ODA_{it}) + \alpha_i + u_{it}$$

Model 4: Readiness

$$\log(AidCapita_{it}) = \beta_1 Vulnerab_{it} + \beta_2 (Vulnerab_{it})^2 + \beta_3 CRI_{it} + \beta_4 Ready + \beta_5 \log(GNIcap_{it}) + \beta_6 \log(pop_{it}) + \beta_7 \log(ODA_{it}) + \alpha_i + u_{it}$$

Model 6: Whole Model

Where $\alpha_i$ represents country-specific intercepts capturing unobserved heterogeneities between countries, and $u_{it}$ is the idiosyncratic error term. The country-fixed effects approach removes the effect of $\alpha_i$ by subtracting the average regression over time from the original regression, as $\alpha_i$ is time-invariant it disappears in this process

(Wooldridge 2020). Therefore time-invariant country characteristics such as a colonial history, culture, or topography are controlled for. The key underlying assumption behind this model is one of strict exogeneity, where the idiosyncratic error term and each of the independent variables are uncorrelated across all time periods. However, arbitrary correlation between $\alpha_i$ and the explanatory variables is allowed, since the fixed effects approach eliminates the effect of $\alpha_i$ by time-demeaning the data (Wooldridge 2020).

A Hausman test was conducted to see whether random effects should be chosen over fixed effects. The main difference between these models is that random effects assumes the correlation between the explanatory variables and $\alpha_i$ to be 0, whereas fixed effects allows some correlation as these time-invariant country features are controlled for. The results are in favour of the fixed effects approach, rejecting the null-hypothesis representing the random-effects approach at the 1% level of significance (See Appendix 4). Furthermore, in this context it seems unreasonable to assume that the explanatory variables such as vulnerability would not be correlated with country characteristics such as topography and colonial history (Saunders 2019).

Ideally, donor interests would also be controlled for. However, this would require a dyadic dataset that is beyond the scope of this research. Furthermore, leaving these variables out may not necessarily cause omitted variable bias. This would only occur if the variables are both a determinant of adaptation aid and correlated with one of the regressors. It is unlikely that trade flows would be correlated with biophysical factors relating to exposure, or even implementation capacity (Betzold and Weiler 2017). Furthermore, controlling for time-invariant country characteristics such as language and colonial history will control some of the effects of donor interests, as the role of former colonies has been shown to affect aid allocation (Alesina and Dollar 2000).

Yet, the country-fixed effects approach has some shortcomings; it limits my analysis to time variation in adaptation aid and the explanatory variables within each country (Wooldridge 2020). As the data in question is a macro-panel with a large N dimension and a small T-dimension, it may be that limiting the analysis to each country will not give a coherent picture of the adaptation aid allocation outcome. This is especially the case when many of the explanatory variables are slow-moving. Therefore, I also run each model using only time-fixed effects, the between estimator, to examine how vulnerability and readiness affect adaptation aid allocation. Notably, the between-estimator has the same assumption as random effects i.e. for $\alpha_i$ to be uncorrelated with the explanatory variables, which is argued to be unreasonable in this context. To mitigate this issue, the regressions are run with an added dummy variable on colonial history, but as this made negligible difference to the results or the goodness of fit, the original specification is used. Therefore, the models with only year fixed effects should be viewed as indicative and interpreted with caution.

To account for heteroscedasticity as well as serial correlation, robust standard errors clustered at the country level are used throughout. To account for potential information lags but also for issues of simultaneity, all the relevant explanatory variables are lagged by a year. Furthermore, the timespan from the donor commitment to fund a certain adaptation project to the actual impact showing in aggregate country-level measures such as the ones measured in the vulnerability index, would arguably be more than 10 years. As I have only 7 years of data, it is relatively certain simultaneity is not going to be an issue.

### *Results and Analysis*

In this part of the paper I will present the results and discuss the policy implications. To recall, the questions at hand concern whether vulnerability and implementation capacity affect adaptation aid allocation at the aggregate. A brief look into descriptive data will be followed by the evaluation and discussion of the regression results. Table 2 shows that in fact, all of the top 10 recipients of adaptation aid per capita are SIDS – a particularly vulnerable group. This may be due to their high exposure and sensitivity to imminent impacts of climate change such as sea-level rise; but it may also be that a small country bias has resulted in a disproportionate amount of aid to these countries, as previous research has found (Alesina and Dollar 2000).

Looking at the bottom 10 aid recipients, it seems that data availability as well as political factors may have affected the low measurements for these countries. Internal conflict and economic difficulty may be a reason for Venezuela, Syria and Libya receiving negligible amounts of aid. Surprisingly, particularly vulnerable countries are also in the list of bottom aid receivers; Equatorial Guinea and Eritrea are both well beyond the median in terms of their vulnerability score ranking (ND-GAIN n.d.). However, donors may be hesitant to give aid to dictatorships such as Eritrea for

political reasons and uncertainty on the effective use of the funds. They are also most likely taking into account the oil wealth in Equatorial Guinea.

Figures 2 and 3 present scatterplots of the average values of vulnerability and adaptation aid as well as readiness and adaptation aid. Some observations have been labelled to provide intuition on the results. In terms of readiness, there is a generally positive relationship with aid received, with a few outliers and diminishing returns. Vulnerability and adaptation aid seem to have more of a concave relationship with a turning point at around a score of 50 in vulnerability. Notably, it can be observed that some significantly more vulnerable countries receive less aid on average than less vulnerable countries e.g. DRC, Central African Republic and Sudan receive less aid than Paraguay despite being significantly more vulnerable. Additionally, SIDS seem to receive a disproportionate amount of aid considering both their vulnerability and readiness scores. The descriptive results are in line with the concave relationship found in Saunders (2019).

**Top and Bottom 10 Aggregate Adaptation Aid Recipients**

| Country | Aid per capita, aggregate over 2011-2017 | Country | Aid per capita, aggregate over 2011-2017 |
|---|---|---|---|
| Niue | 9754.00 | Venezuela | 0.19 |
| Tuvalu | 5605.28 | North Korea | 0.23 |
| Nauru | 1349.02 | Libya | 0.27 |
| Samoa | 962.40 | Malaysia | 0.49 |
| Palau | 950.30 | Equatorial Guinea | 0.55 |
| Vanuatu | 911.77 | Syrian Arab Republic | 0.82 |
| Kiribati | 680.36 | Belarus | 1.34 |
| Marshall Islands | 661.28 | China | 1.37 |
| Dominica | 631.97 | Turkmenistan | 1.45 |
| Tonga | 612.66 | Eritrea | 1.86 |

Table 2.



**Scatterplot of Vulnerability and Adaptation Aid Per Capita**

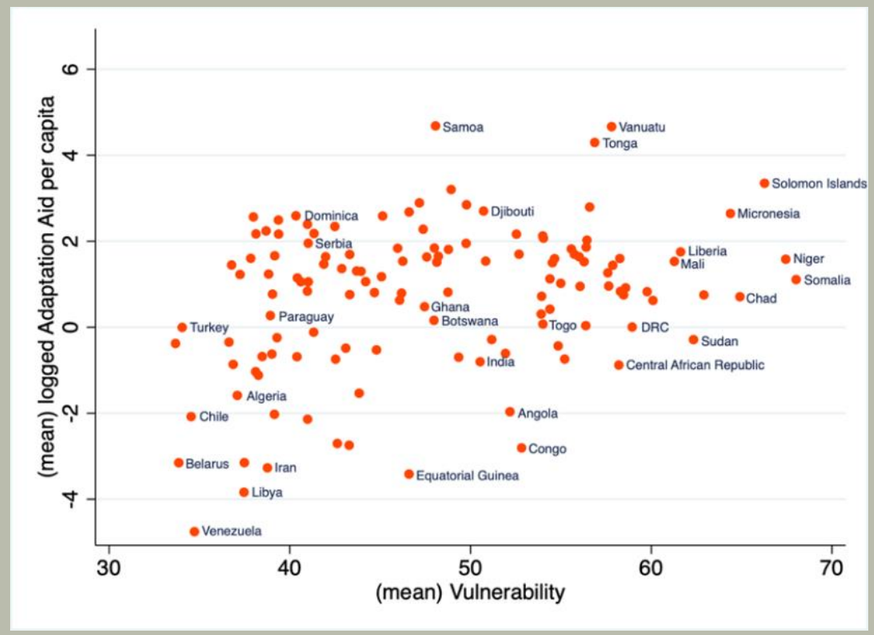


Figure 2.

**Regression Results with Different Specifications**

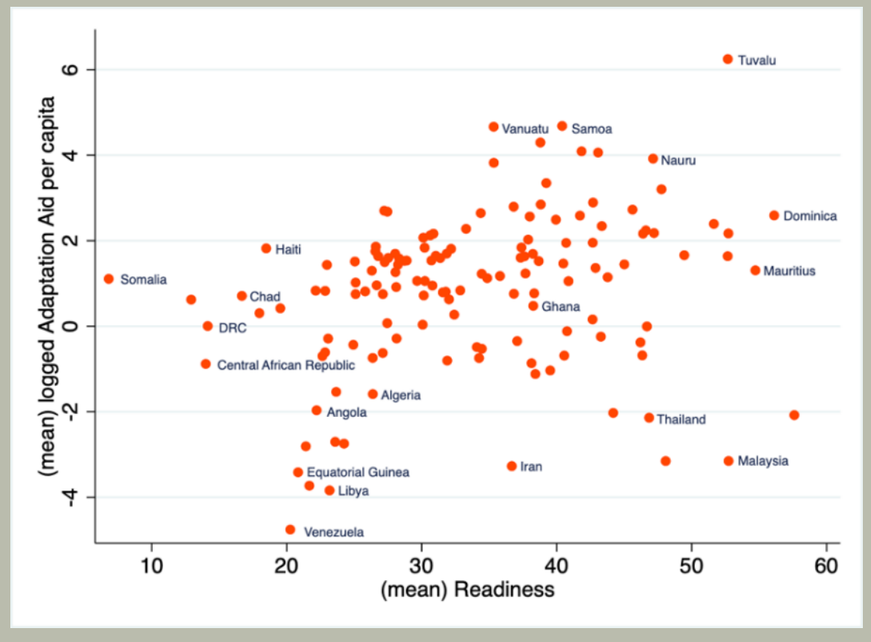


Figure 3.

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Vulnerab+ | 0.206<br>(0.159) | -2.660***<br>(0.863) | | | 0.390***<br>(0.145) | -2.288***<br>(0.902) | -1.414<br>(0.861) |
| Vulnerabsq+ | -0.002<br>(0.002) | 0.021***<br>(0.008) | | | -0.004***<br>(0.001) | 0.018***<br>(0.008) | 0.010<br>(0.008) |
| Sen+ | | | -0.096<br>(0.088) | | | | |
| Capa+ | | | -0.132*<br>(0.073) | | | | |
| Ready+ | | | | 0.155***<br>(0.038) | 0.077***<br>(0.017) | 0.113***<br>(0.041) | 0.081***<br>(0.039) |
| GNIcap+ (log) | -0.227<br>(0.157) | 0.265<br>(0.433) | 0.418<br>(0.439) | 0.463<br>(0.418) | -0.414***<br>(0.138) | 0.120<br>(0.450) | -0.028<br>(0.537) |
| CRI+ | -0.011***<br>(0.003) | -0.002<br>(0.002) | -0.0004<br>(0.002) | | -0.009***<br>(0.002) | -0.002<br>(0.002) | -0.002<br>(0.002) |
| pop (log) | -0.879***<br>(0.076) | 8.228***<br>(1.358) | 8.082***<br>(1.476) | 8.274***<br>(1.181) | -0.720***<br>(0.074) | 7.658***<br>(1.208) | 1.566<br>(2.230) |
| ODA+ (log) | 0.555***<br>(0.094) | 0.147<br>(0.145) | 0.089<br>(0.168) | 0.114<br>(0.137) | 0.490***<br>(0.081) | 0.157<br>(0.141) | 0.163<br>(0.137) |
| Country fixed effects | - | Yes | Yes | Yes | - | Yes | Yes |
| Year fixed effects | Yes | - | - | - | Yes | - | Yes |
| Adjusted $R^2$ | 0.381 | 0.560 | 0.547 | 0.594 | 0.433 | 0.565 | 0.574 |
| Observations | 830 | 830 | 777 | 899 | 830 | 830 | 830 |

*** p<0.01, ** p<0.05, * p<0.1
Robust standard errors clustered at the country level in parentheses
Variables with + have been lagged by one year

1= Vulnerability with year FE

2= Vulnerability with country FE

3= Partial vulnerability with country FE

4= Readiness with country FE

5=Whole model with year fixed effects

6= Whole model with country FE

7=Whole model with both



*Recipient Need*

As previous research has shown, vulnerability is positively associated with adaptation aid to a certain extent, similarly to the scatterplot in the descriptive results. The predictive margins for model 5 can be seen in Figure 4. However, this is only the case when only year-fixed effects are used, simply focusing on the cross-sectional variation in vulnerability. Additionally, the vulnerability variables are insignificant in model 1 where the effect of vulnerability has potentially been absorbed in the statistically significant CRI variable. This concave relationship may be explained by the trade-off between vulnerability and implementation capacity, i.e. there may be countries that are particularly vulnerable, but also lack implementation capacity. Therefore donors, both bilateral and multilateral, who want to maximise the returns to their aid, will not allocate as much to these countries as their level of need would dictate. By comparing the vulnerability scatterplot (Fig 2) and the matrix between readiness and vulnerability (Fig 5), we can see that many of the countries receiving less aid on average than their less vulnerable counterparts, also lack in readiness (e.g. Somalia, Niger and Sudan).

Interestingly, when country fixed effects are used, the coefficients on vulnerability change sign but remain significant. Moreover, the magnitude of the negative effect is over 5 times than that of the positive effect. Predictive margins for model 6 (Fig. 4) now show a convex relationship instead of a concave one. Country fixed effects control for unobserved heterogeneity across the entities, but also restrict the analysis on the time variation within the countries, not measuring the cross-sectional effect. Therefore, a change in sign is plausible. It may be that donors are path

**Predictive Margins for Model 5 and 6**

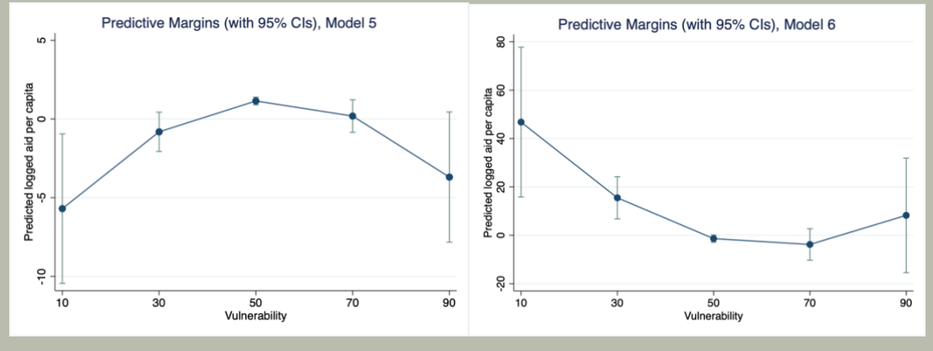


Figure 4.

dependent to the extent that small changes within a country's vulnerability score are not associated with more adaptation aid. Donors may simply pay more attention on cross-sectional data on vulnerability, ignoring the fact that vulnerability is a dynamic concept.

Although the assumption behind the regression results is that all other factors are held constant, in reality it may be that an increased vulnerability is associated with decreased readiness. It is unlikely that vulnerability has changed due to structural reasons by much during the 7-year time period, but an internal conflict (in the case of Somalia or Sudan) may affect both vulnerability and readiness, leading to decreased aid. However, it seems that if vulnerability increases at the higher end, it would still be associated with increased adaptation aid (Fig 4). When both country and year effects are applied in model 7, the vulnerability variables lose significance, most likely to the opposing effects from the time- and cross-sectional dimension cancelling each other out.

A partial model including both sensitivity and adaptive capacity was used to examine whether the effect of vulnerability differed across dimensions. Only adaptive capacity is significant at the 10% level, exhibiting a negative association between adaptation aid and adaptive capacity. Sensitivity is similarly negative but statistically insignificant, likely due to the exclusion of the time-invariant measure on exposure.

**Readiness-Vulnerability Matrix**

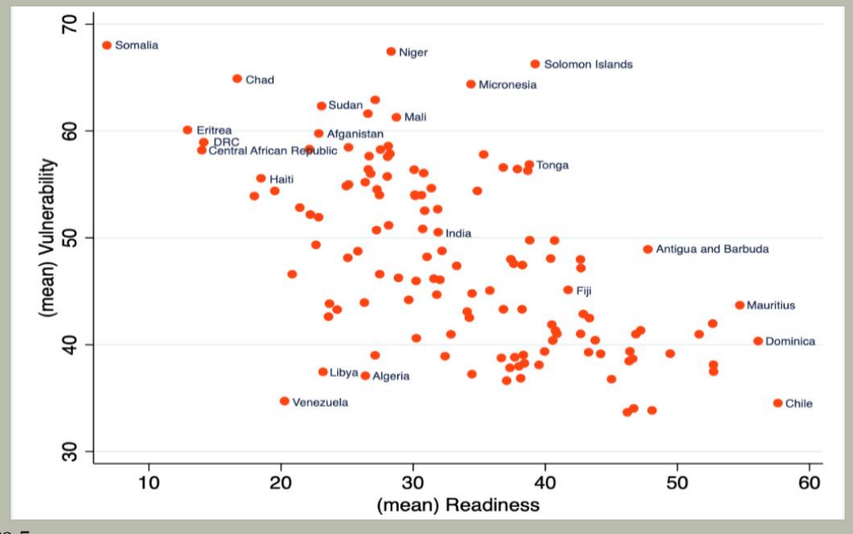


Figure 5.



Sensitivity acts as a qualifying measure. To illustrate, exposure sets out the physical impacts to certain sectors, and sensitivity measures what the consequences of that are i.e. to what extent the country is dependent on those sectors. As the only difference between model 2 and 3 is the inclusion of exposure, one could infer that physical exposure is the component of vulnerability that is most significant in the association between adaptation aid and vulnerability, which is in line with the previous results on the significance of physical exposure (Betzold and Weiler 2018; Barrett 2014).

The Global Climate Risk index measuring losses from weather events from the past 20 years is only significant when only year-fixed effects are applied and has the expected sign. A decrease in the CRI signals more losses from extreme weather events which would be associated with marginally more adaptation aid per capita. This is another factor supporting the effect of physical vulnerability in adaptation aid allocation.

GNI per capita is only significant in model 5 with just year-fixed effects, showing a negative relationship between GNI per capita and adaptation aid. This supports that GNI per capita is used as a proxy for recipient need rather than implementation capacity. With the latter there should be a positive relationship; the higher the GNI per capita, the better the environment for business and investment and therefore the higher the implementation capacity, inviting efficiency-prioritising donors to donate more. Then again, this result is merely indicative since the GNI variable changes sign and significance over the different specifications.

*Implementation Capacity*

Contrary to vulnerability, the coefficients on readiness stay positive and significant throughout different additional fixed effects. Readiness is the only variable that remains significant when both country and year fixed effects are applied. This would indicate that implementation capacity has a robust and positive relationship with adaptation aid allocation. An increase in the readiness score by one, is associated in an increase in adaptation aid per capita by approximately 8%, all other factors held constant. This would indicate that at the aggregate, efficiency concerns are prioritised over equity concerns in adaptation aid allocation. Particularly multilaterals have been found to place greater importance on implementation capacity previously (Saunders 2019). Multilateral adaptation aid has increased its share up to 50% in Asia, Africa and Oceania in 2017, hence this priority-setting is reflected in the results (OECD 2019a).

Although efficiency is an important consideration when resources are scarce, lacking implementation capacity should not disqualify countries from receiving aid. Some of the most vulnerable countries may require more resources. This is due to the additional attention needed in the implementation stage of the projects, offering technical assistance where countries have lacking current capacities (Barr et al. 2010). Some have suggested a trade-off between vulnerability and readiness which is also apparent from my results. In the allocation outcome, slightly less vulnerable countries with more implementation capacity receive more adaptation aid than their more vulnerable counterparts. However, Barr et al. (2010) argues that highly vulnerable countries should still receive the greatest share of adaptation finance.

*Policy Implications*

*International framework:* The results both question the legitimacy of the UNFCCC process, and call for better data. Although Paris reinstated the USD 100 billion goal and recognised the 'urgent and immediate' vulnerable countries (Huq et al. 2018), the results indicate that the goals have not been upheld in the adaptation aid allocation process. This delegitimises the UNFCCC process, especially from the Global South perspective. The LDCs were actively engaged in negotiations leading up to COP21. The heightened position of adaptation in the negotiations and recognising financing needs in the Paris Agreement were seen as wins for the poorest and most vulnerable countries (IIED 2016). If the promises are not followed through, there is little incentive in engaging in long multilateral negotiations. Additionally, good and transparent data is key in informing all stakeholders. The Rio-Marker methodology has been criticised for leaving room for inconsistencies and over-reporting, where instead a similar system to the climate components methodology used by MDBs should be employed (AdaptationWatch 2015). This approach would make it easier to incorporate climate risks into all development projects, crucial to achieve the scale of adaptation needed (Smith et al. 2011). Furthermore, data on disbursements in addition to commitments should be made available, as well as reliable data on private climate finance.



*Recipients*

LDCs and other particularly vulnerable groups rely on international funding to carry out crucial long-term adaptation solutions. Therefore, developed countries not abiding by their commitments on financing will have wide-ranging impacts on human welfare and societies in the Global South. Looking at the adaptation aid allocation outcome, there is reasonable evidence to show that efficiency considerations override recipient need (equity) in aid allocation decisions. Although according to the policy framework, adaptation aid should prioritise equity irrespective of readiness levels, improving the business environment, controlling for corruption and enhancing the quality of governance is generally beneficial. Therefore, Global South governments can focus on improving readiness to attract more investment from both public and private sources (Chen et al. 2018).

*Donors*

Firstly, along with increased aid, donors should consider increased technical assistance to the most vulnerable countries, to aid with project implementation (Barr et al. 2010). Additionally, it seems that vulnerability is not considered in the same way across time, as it is between countries. Vulnerability seems to matter to a certain extent in the allocation between countries. However, the fact that the country-fixed effects model shows negative returns to vulnerability may indicate that donors fail to acknowledge the dynamic nature of vulnerability within countries, or that efficiency concerns override equity concerns if a country experiences a decrease in vulnerability. This calls for better and more accurate data that are consistently measured across recipients to inform allocation based on recipient need. With increased finance but also a proliferation of multilateral donors (Nakhooda and Norman 2014), it is increasingly important for donors to coordinate in a transparent way and uphold the priorities of international agreements.

## *Limitations and Further Research*

It is important to note that this research has several limitations. A mixed multilevel analysis would allow combining some of the aspects of both fixed- and random-effect estimators, beneficial when observations are nested within countries. However, this methodology was beyond the scope of this paper. Future research could be carried out to increase the robustness of the results, especially when more data becomes available.

Endogeneity remains an issue, particularly in the year-fixed effects models and therefore the results should be interpreted as correlation rather than causation. However, with such complicated aggregated variables as vulnerability to climate change and implementation capacity, it is methodologically challenging to have no remaining correlation with the error term.

Furthermore, the OECD data on climate finance has several drawbacks. The data only became available in 2010, meaning only less than 10 years of data is available. This makes it challenging to draw any coherent conclusions on the change of the variables over time, especially as many of them only move slowly.

This research only considered the allocation of finance, but the actual impact comes from the effective use of the finances. Nevertheless, examining the effectiveness of adaptation aid requires more subnational data and longer time scales, which although is beyond the scope of this paper, remains an important question for future research. In conjunction, considering the allocation based on subnational but as robust vulnerability measures as the ND-GAIN would be another question for further research.

## *Conclusion*

Motivated by the double-injustice in climate change, this paper set out to examine how equity and efficiency concerns affect adaptation aid allocation at the aggregate, paying particular attention to the different dimensions of vulnerability. The results indicate that the outcome of the adaptation aid allocation process does not follow the priorities set in the Paris Agreement. Indeed, efficiency concerns seem to dominate allocation decisions rather than recipient need, meaning that the most vulnerable will not be prioritised. Vulnerable countries have called for increases in adaptation finance for years and the Paris Agreement reinstating the USD 100 billion goal was a major win along with the balance between adaptation and mitigation. Having those goals not reflected in the outcomes of climate finance delegitimises the UNFCCC in the eyes of many vulnerable countries. Better data on commitments as well as disbursements would make it easier to hold donors accountable. Further research should investigate both the allocation and the effectiveness of adaptation aid on a sub-national level.



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*Appendix 1*

**Correlation Analysis Table**

| | AidCap | Vulnerab | Ready | CRI | pop | GDPcap | ODA | Sen | Capa |
|---|---|---|---|---|---|---|---|---|---|
| AidCap | 1 | | | | | | | | |
| Vulnerab | 0.204 | 1 | | | | | | | |
| Ready | 0.152 | -0.623 | 1 | | | | | | |
| CRI | -0.007 | -0.068 | 0.081 | 1 | | | | | |
| Pop | -0.330 | 0.038 | -0.287 | -0.412 | 1 | | | | |
| GNIcap | -0.163 | -0.780 | 0.621 | 0.118 | -0.241 | 1 | | | |
| ODA | 0.011 | 0.332 | -0.352 | -0.342 | 0.716 | -0.486 | 1 | | |
| Sen | 0.231 | 0.773 | -0.476 | 0.056 | -0.032 | -0.747 | 0.260 | 1 | |
| Capa | 0.129 | 0.905 | -0.637 | -0.029 | 0.018 | -0.740 | 0.304 | 0.596 | 1 |

*Appendix 2*

**A List of Indicators Within the ND-GAIN Readiness Component (ND-GAIN, n.d)**

| COMPONENT | INDICATORS | | | |
|---|---|---|---|---|
| **ECONOMIC READINESS** | Doing Business (one indicator considering the following 10 sub-indicators) | | | |
| | *Starting a Business* | *Dealing with Construction Permits* | *Getting Electricity* | *Registering Prosperity* |
| | *Getting Credit* | *Protecting Investors* | *Paying Taxes* | *Trading Across Borders* |
| | *Enforcing Contracts* | | *Resolving Insolvency* | |
| **GOVERNANCE READINESS** | Political Stability and non-Violence | Control of Corruption | Rule of Law | Regulatory Quality |
| **SOCIAL READINESS** | Social Inequality | ICT Infrastructure (1, 2, 3, 4) | Education | Innovation (1, 2) |



*Appendix 3.*

**A list of Indicators Within the ND-GAIN Vulnerability Component (ND-GAIN, n.d)**

| | EXPOSURE | SENSITIVITY | CAPACITY |
|---|---|---|---|
| FOOD | Projected change of cereal yields (1, 2) | Food import dependency | Agricultural capacity (Fertilizer, Irrigation, Pesticide, Tractor Use) |
| | Projected Population Change | Rural Population | Child malnutrition |
| WATER | Projected change in annual groundwater runoff | Fresh water withdrawal rate | Access to reliable drinking water |
| | Projected change of annual groundwater recharge | Water dependency ratio | Dam capacity |
| HEALTH | Projected change in vector-borne diseases | Slum population | Medical Staff (physicians, nurses and midwives) |
| | Projected change in deaths from climate change induced diseases | Dependency on external resources for health services | Access to improved sanitation facilities |
| ECOSYSTEM SERVICE | Projected Change of biome distribution | Dependency on Natural Capital | Protected Biomes |
| | Projected change in marine biodiversity | Ecological footprint | Engagement in international environmental conventions |
| HUMAN HABITAT | Projected change of warm periods (1, 2, 3, 4) | Urban concentration (1, 2) | Quality of trade and transport-related infrastructure |
| | Projected change of flood hazard (1, 2, 3, 4) | Age dependency ratio (1, 2) | Paved roads |
| INFRASTRUCTURE | Projected change of hydropower generation capacity(1, 2) | Dependency on imported energy | Electricity Access |
| | Projection of sea level rise impacts | Population living under 5m above sea level | Disaster preparedness |

*Appendix 4.*

**The Hausman Test Results**

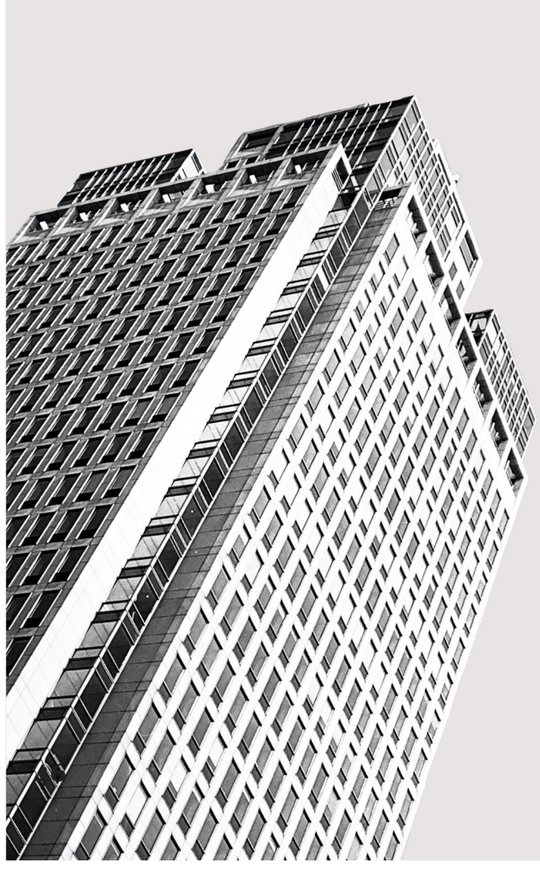
| Variables | $(\beta_c)$ FE | $(\beta_e)$ RE | $(\beta_c - \beta_e)$ Difference | Sqrt(diag$(V_c - V_e)$) S.E. |
|---|---|---|---|---|
| Ready | 0.1125 | 0.0944 | 0.0181 | 0.0367 |
| Vulnerab | -2.2879 | 0.5215 | -2.8094 | 0.9434 |
| sqVulnerab | 0.0181 | -0.0048 | 0.0228 | 0.0091 |
| GDPcap | 0.1210 | -0.4112 | 0.5322 | 0.3738 |
| CRI | -0.0017 | -0.0033 | 0.0016 | 0.0005 |
| Pop | 7.6577 | -0.5350 | 8.1927 | 1.4077 |
| ODA | 0.1574 | 0.3208 | -0.1634 | 0.0695 |

Test: Ho: difference in coefficients not systematic

$$\chi^2(7) = \beta_c - \beta_e{}'(V_c - V_e)^{-1}\beta_c - \beta_e$$
$$= 164.46$$

$$Prob > \chi^2 = 0.00000$$

The test looks for correlation between the regressors and the individual error terms, to determine whether the regressors are exogenous. The null hypothesis that the random effects model should be used where correlation between the regressors and the individual error terms is assumed to be 0. However, the null hypothesis is rejected at the 1% level and therefore fixed effects approach is taken over the random effects one.



# Lessons learnt, or Lessons lost? Contrasting Policymaker's Response to the Great Depression and the 2007/8 Financial Crisis

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Abstract: *Economic crises come and go. Each is different, yet all share at least one feature: they come at a great cost. Enough time has now passed since the last financial crisis, so I hope to discern how well and to what extent policymakers 'learnt the lessons' of the Great Depression when dealing with the financial crisis of 2007/8. I argue that, on balance, they did. However, I also note that many of the post-war institutions that have stabilised the international economy are increasingly unable to deal with resurgent forces, such as populism and nationalism.*

Keywords: Financial Crises, International Political Economy, Complexity and Chaos

## *Introduction*

Economic crises come and go. Each is different, yet all share at least one feature: they come at a great cost. Enough time has now passed since the last financial crisis, so I hope to discern how well and to what extent policymakers 'learnt the lessons' of the Great Depression when dealing with the financial crisis of 2007/8.

My argument will be outlined further in the text, but in summary: In the years immediately after the 2007/8 financial crisis, policymakers showed an awareness of the failings of the 1930s. Since then, however, there have been signs of growing complacency. Donald Trump's mantra of 'America First' typifies this attitude, ushering in a new era of isolationism, while other policymakers have openly questioned the spirit of multilateral institutions and trade (James 2017). This shows that while progress has been substantial, it is far from complete.

The concepts of anarchy and 'radical uncertainty' played a central role in shaping my analysis. The concept of anarchy is frequently used by international relations scholars, yet it is seldom applied to economics relations. Anarchy/radical uncertainty describes how uncertainty over an actor's intentions can lead to poor

decision-making from both parties (Carr 2001; King 2016).[1] Due to a lack of global sovereign, diplomacy has traditionally been uncertain and insecure. This environment was often harmful to nations and had destabilising consequences for the system (Tooze 2015). This was particularly apparent during the interwar period when insecurity often led countries to make poor choices. For example, because the order after the First World War lacked both functional institutions and the leadership needed to maintain them, nations often found themselves in zero-sum contests such as trade wars (Tooze 2015; Schenk 2011).

Instead of reflecting America's new dominance, the interwar order centred on Britain and France, yet both nations lacked the power to secure the utopian peace championed by Woodrow Wilson (Overly 2006; Carr 2001). Nye (2017) called this phenomenon the *Kindleberger Trap*: when a traditional power is too weak to enforce order, but the rising power is unwilling to accept leadership. The combination of American isolationism and the kind of 'Carthaginian peace' that Keynes warned of led to a fractious and anarchic political environment that was epitomised by debt diplomacy, zero-sum thinking and repeated international crises (Keynes 2007; Tooze 2014: 258).[2] Consequently, during the Great Depression (Depression) nations pursued policies that appeared self-serving yet ultimately proved damaging to themselves and the global economy (Tooze 2015: 442). The failings of the 1930s were, then, part of a systemic failure.

By contrast, the post-1945 international order has been considerably more successful at mitigating disputes and crises. This is because it has limited anarchic diplomacy through legal procedures and institutional norms. Equally, the current order is supported, promoted and actively defended by America (Ikenberry 2011). The foundation of the international system is therefore a combination of liberal institutionalism and American hegemony. This allowed policymakers to manage the initial Crisis of 2007 to 2009, as the Bretton Woods organisations and the G20 provided the infrastructure needed to cooperate (Schenk 2011: 180). America played its part too, by supplying unprecedented levels of monetary stimulus through dollar-swap lines and quantitative easing (QE) (Tooze 2018: 202 220).

The failings of the Interwar Order and the success of post-1945 show that a sustainable order must limit *economic anarchy*. This, however, is predicated on two factors:

1) A system must be based on cooperation and recognised norms.

2) The most powerful state must be willing to lead in times of crisis.

This essay will therefore show how systemic change since the Second World War has helped leaders reduce economic anarchy to mitigate the effects of the financial crisis of 2007/8.

### *The International Response to the Depression*

Keynes argued with remarkable foresight that the Post-War trading system would 'sow the seeds of destruction' and 'debt diplomacy' would emerge in the place of multilateral trade (Keynes 2007: 119). He was correct: of the reparations Germany paid to Britain and France in 1919, America received 60 and 80 % respectfully as debt repayments, and trade would become a tool of great power politics rather than a mutually beneficial process (Tooze 2015: 362). This failure to create a sustainable trading system resulted in an unfavourable political environment for economic diplomacy after the Depression.

The systematic flaws Keynes highlighted manifested in protectionist trading policies. Despite efforts from financiers like Thomas Lamont, then CEO of J. P Moran, the 1929 Tariff Act increased the price of 575 agricultural products and 900 manufacturing goods; and by 1932, tariffs on durable goods had increased to 59%. Subsequently, American imports and exports fell by 36% from 1929 to 1932 (Greenspan and Adrian 2019 :231). However, the tariffs did not go unanswered. European nations responded with a range of protectionist policies: Germany declared that it would become self-sufficient, Britain evoked a policy of imperial preference, and France engaged too (Eichengreen 1985: 925-946).

Nonetheless, there were no winners in this (trade) war. Tariffs are widely cited as a course for global trade falling by just over 36% between 1929 and 1932. They

[1] Carr and King's analysis of uncertainty influenced my argument. And although he does not use the term economic anarchy, Mervyn King's discussion on the effect of uncertainty in international economy was very helpful.

[2] The term 'Carthaginian peace' refers to when a victor forces a vanquished force to pay harsh reparations, such as after the First World War.

compounded the effect of the Depression on consumers as the price of tariffed goods increased, wages fell (Kennedy 1999: 35). Protectionist trading practices were therefore one of the leading policy failures of the Depression.

Competitive attitudes during this time extended to monetary policy, too. The gold standard (GS) historically provided stability, but its rigidity left leaders with few options after the Depression (Eichengreen and Temin 2010). German policymakers, for example, were fearful of inflation due to their experience of hyperinflation in the 1920s, so they willingly stomached deflation (Eichengreen 2015: 56). The same was true for the French. The economist Charles Rist illustrated this 'gold standard mentality' of many European central bankers. 'Expanding the money supply … [he said] would only encourage further speculative excess' (in Eichengreen and Sachs 1985: 197). But as Irwin (2012: 2) pointed out, France's adherence to the gold standard had far-reaching effects for the global economy:

> [France] increased its share of world gold reserves from 7% to 27% between 1927 and 1932 and failed to monetise most of this accumulation. This created an artificial shortage of gold reserves and put other countries under significant deflationary pressure.

In addition, policymakers failed to account for the fact that tightly regulated labour markets would make wages less responsive to price changes. This hampered demand and exasperated the global contraction (Eichengreen and Sachs 1985: 26).

Equally destructive was the Federal Reserves' (the Fed) decision to reduce the monetary base of the US by 33% from 1929 to 1933 (Freidman and Schwartz 2007: 21). Within the same period, inflation fell by 27%, whilst, as Bernanke (2004: 105; Wheelock 2009: 98) put it, adherence to the GS was 'badly flawed and . . . a major source of the fall in real output'.[3] In other words: the GS needlessly weakened liquidity, stifled wages and hampered growth.

Although Britain left the GS in 1931, its effects were long-lasting. By returning to the GS at $4. 25 per troy ounce of gold, sterling was overvalued, the exchange rate in turn made exports uncompetitive, and unemployment reached 21% in 1931 (Greenspand and Wooldridge 2019: 228). Meanwhile, industries such as steel and coal suffered, leading to widespread industrial action. (Greenspand and Wooldridge 2019: 229) Greenspan and Wooldridge note that this was indicative of a broader failure of the post-1919 order. Rather than accepting that the war had weakened their currency, the economic pride of nations like Britain led to overvalued currencies (Greenspand and Wooldridge 2019).

[3] By 'inflation' I am referring to the CPI index.



*Interwar Systematic Analysis*

The failings of the international currency system reveals much about economic relations in the 1930s. Firstly, in the mid-1930s there was little policy consensus. By 1933 America wanted to increase inflation after years of contraction, whereas German leaders were still fearful of inflation after their experience with hyperinflation in the 1920s (Eichengreen 2014: 53). Secondly, leaders were willing to bypass the international community to improve their economic prospects. With little consultation with other states, the Roosevelt administration devalued the dollar.[4] Thus America, the largest economy of the day, orchestrated a devaluation at the expense of other nations which led gold blocked countries to retaliate.

Still, the point is not that devaluation was inherently bad — in fact, some nation's currencies were overvalued — they were destructive primarily because they were uncontrolled and did not consider other nations *(*Eichengreen and Sachs 1985). If, as Eichengreen argues, the process had been coordinated, and if inter-state dialogue improved, then things might have turned out better. Instead, nations pitted themselves against one another in a destructive contest *(*Eichengreen and Sachs 1985).

*Comparing the Response to the Great Recession of 2007/8: a story of cooperation and American leadership*

In contrast to the leaders of the 1930s, the policymakers of the 2007/9 crisis inherited a system designed for multilateral policy. Organisations such as the IMF, World Bank and the EU were already in place, as were their liberal norms (Pilkington and Tran 2008).[5] But underpinning everything was American leadership (Tooze 2016: 142).

[4] Roosevelt did this by enforcing an embargo on gold exports and passing the Thomas Amendment which also helped to increase dollar price of gold by 59 per cent of its former gold content — which in turn led to sizable devaluation (Eichengreen 2014: 53).

[5] This is shown by Brown and Obama's support for a 'global response' in 2008 (Pilkington and Tran 2008).

The sentiment in the wake of the 2007/8 Crisis was markedly different from the 1930s. In a decisive move, the G7 expanded to form the G20. Although the initial Financial Crisis Meeting offered little policy, it was clear that leaders appreciated the globality of the crisis (Pilkington 2008). Barack Obama, then President-elect, announced that 'global economic crisis requires a coordinated global response'; and Gordon Brown and George Bush urged all countries to coordinate fiscal stimulus to mitigate the recession (Pilkington and Tran 2008).

By forming the G20, leading nations recognised that a global response was required. This had profound moral and material significance, making the process more legitimate and helping to create worldwide support. Equally, the G20 increased the reach of the G7 nations, with G20 encompassing 85% of the world's economy (Schenk 2011: 185).

G20 leaders met again on 2nd April 2009, reaffirming the importance of multilateral cooperation, declaring: '*we* face the greatest challenge to the world economy in modern times … [and therefore] all countries must join together to resolve it' (G20 2008). This time, however, policies were created: the IMF's resources were increased threefold to 750 billion dollars, and The Financial Stability Board's (FSB) mandate was increased (G20 2008).

Given the economic instability to come, increasing the IMF's resources was wise. Most notably, the IMF used these resources to mitigate the effects of the Euro-Zone Crisis. However, Bernanke, Geithner and Paulson argue that the IMF's flexible credit lines and standby arrangements helped to lower the chance of a series of sovereign debt crisis (Bernanke, Geithner and Paulson 2019: 198). The Fund and the multilateral effort that supported it therefore reduced economic anarchy by acting as an international crisis manager.

While the expansion of the IMF's resources was important, the creation of the FSB was likely the most salient feature of the meeting. The FSB helped to develop an international regulatory regime by working with governments and corporations to develop Basel III. The 2018 G20 Financial Regulatory Reforms Report shows that Basel III regulations have been successful because, since 2009, large banks have 'more than doubled their risk-based capital ratios, while their leverage has dropped by half'. Meanwhile the capital conservation buffer has been increased to 10.5% (Financial Stability Board 2019). The G20 report notes that the process will not be complete until 2022. However, the regulations have made a difference, with the Bank of International Settlements' Annual Report contending that Basel III has made the financial system substantially more durable (Financial Stability Board 2019).

As such, instead of undermining one another, leaders used multilateral organisations after the 2007/8 financial crisis to form a decisive response, and in doing so limited economic anarchy.

Rather than resorting to isolationism as it did in the interwar years, the U.S led the immediate response to the Great Recession. This was critical because the interwar period highlights how detrimental a lack of international leadership can be (Nye 2019). America's main contribution was through the Fed's efforts to increase liquidity to markets after the banks struggled to find short-term finance to service their debt (Wheelock 2010; Tooze 2018: 3).

By mid-2007 the Fed's response had begun as over-leveraged private banks looked to central banks after sources of short-term finance collapsed (Ben Bernanke, Timothy Geithner, Henry Paulson, Firefighting 2019: 32). Bernanke (2009) was aware of the danger illiquidity posed, noting: 'in the current environment, the Federal Reserve must focus its policies on . . . improving the functioning of private credit'.

**Financial Market Liquidity**

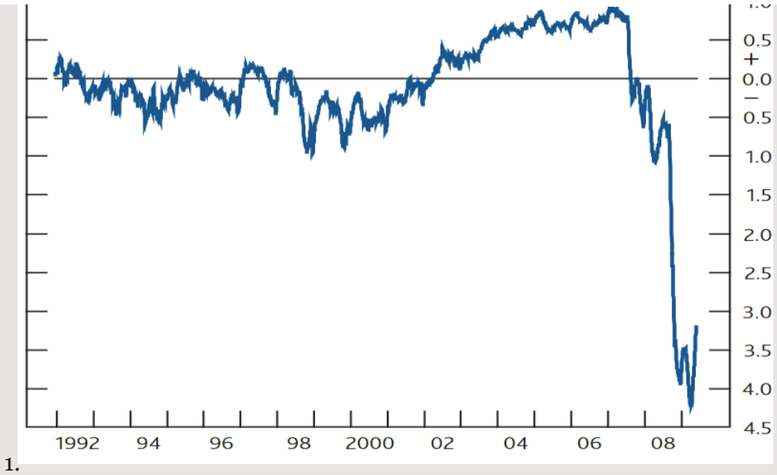


Figure 1.

Astley, M et al., (2009). Global Imbalances and the Financial Crisis. *Bank of England Quarterly Bulletin Q3*, p. 184.
'The liquidity index shows the number of standard deviations from the mean. It is a simple unweighted average of nine liquidity measures, normalised on the period 1999-2004'.

**Composition of the Federal's Reserve Assets**

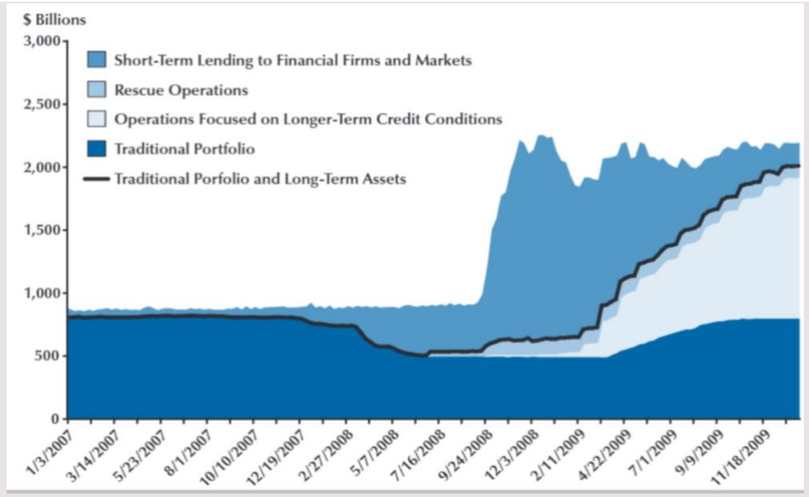


Figure 2.

Wheelock, D. (2010). Lessons learned? Comparing the Federal Reserve's responses to the crises of 1932-3 and 2007-2009. *Federal Reserve Bank of St Louis Review* 92, p.98.

As Figure 1 shows, liquidity decreased substantially from mid-2006 to 2007. To reduce the impact on banks, the Fed coordinated mergers and bailouts, supplied finance to struggling banks and initiated QE1 in 2009, which largely consisted of buying GSE-mortgage-backed securities and Treasury Securities (Tooze 2018: 146). These policies are illustrated in Figure 2, as short-term financing and 'rescue operations' increased the Fed's balance sheet considerably.

The Fed was also forced to support other nation's financial sectors. EU banks particularly needed dollars as the frailty of American Banks led to a surge for funding which increased costs (Tooze 2018: 146). Yet, many central banks had well below the dollar reserves needed to support markets William Allen and Richhild Moessner (2010). In October 2007, the Fed agreed to form reciprocal currency agreements to support selected central banks (Eichengeen 2014; Wheelock 2010: 94; Tooze 2018).[6]

The Term Auction Facility was an important source of funding, as it loaned a total of 6. 18 trillion dollars in short-term funding at low rates and without considerable stigma (Tooze 2018: 207). In addition, the Fed supported markets by setting up the Single Tranche Open Market Operation which loaned 855 billion dollars in December 2008 — 70% of which went to foreign banks; and the Primary Dealer Credit Facility (PDCF) offered overnight finance in return for wide-ranging collateral. All told, PDCF loaned 8, 951 trillion dollars (Tooze 2018: 208).

The cost of the process was dear — but the cost of inaction would have been catastrophic. No other nation or institution could mobilise the kind of response the Fed and U.S Treasury did in the years after the recession (Allen and Moessner 2010). Without America's vast resources, the financial system would have been severely damaged, and the global contraction would have been considerably worse (Bean 2010; Tooze 2018; Eichengreen 2014). While multilateral cooperation was crucial following the Financial Crisis, so was American leadership. The two enhanced one-another, but America's willingness to lead the global response was 'indispensable'.

### *Replacing Politics with Law: How the Current System Limits Economic Anarchy*

The response of policymakers in the aftermath of the 2007/8 Financial Crisis was considerably better than after the Depression. However, this is a testament to norms and institutional structure, rather than individual brilliance.

Due to the institutions created since Bretton-Woods, liberal values and market-based economics were widely accepted by the time of the Financial Crisis. Leaders such as Gordon Brown and Barack Obama called upon an extensive institutional framework to coordinate policy which allowed them to reject economic anarchy.[7] And in turn, they could cooperate because multilateral organisations created shared norms and eroded knowledge barriers. This helped to avoid several of the mistakes of the Depression. For example, the G20 helped to coordinate national economic strategies.[8]

This was not as easy in the interwar period, however, since diplomacy was often conducted in an anarchic and unilateral manner. In contrast to the G20 and the IMF, the League of Nations lacked the power needed to coordinate a joint response to an economic crisis (Boughton 2004; Carr 2001).

[6] There is quite a lot of debate around the degree of stigma attached to TAF loans. Tooze (2018) and Eichengreen (2014) assert that there was little, whereas Wheelock (2010) argues the opposite.

[7] Their statements at the time show a clear belief that they could use multilateral organisations to meet the challenges of the crisis (Pilkington and Tran 2008).

[8] I will discuss America's recent trade disputes later in the article.

Sharing institutions also created a combined understanding of policy and action requirements (Schenk 2011: 183). This helped world leaders come together and strategise, which was important in the wake of the 2007/8 crisis since there was an accepted need for monetary and fiscal stimulus (G20 2008). Again, this contrasts with the 1930s when many European policymakers favoured a defamatory response, whereas the Roosevelt administration favoured a Keynesian approach (Eichengreen 2014: 257). This highlights how the post-1945 system helped to limit economic anarchy through cooperation. It is also a testament to the consecutive generations of policymakers who helped to maintain and improve systems that entrench behavioural norms through legal procedures.

*A Limited Progression*

Although substantial improvements have been made, economic anarchy has not been eradicated. In fact, since 2016 populist campaigns and parties have enjoyed considerable success, and the nativist political forces that drove them have questioned the same norms and institutions that underpinned and solidified the post-1945 order. Equally, these forces have weakened America's desire to lead.

While institutions like the IMF, World Bank and G20 remain, nativist sentiments continue to shake the foundations of the post-1945 international structure. The causes of Britain's departure from the EU are complex, but it seems to represent a shift in British diplomacy. The vote indicates that the electorate wants British diplomacy to be conducted through bilateral arrangements rather than super-national bodies.[9] This is true in Europe, too — as Viktor Orbán and the Five Star Party's success shows.

Yet, the election of Donald Trump represents the biggest lapse in historical learning. By questioning free-trade and multilateralism, Donald Trump has shown limited historical understanding of America's role in the international political economy. The Trump administration has aggravated global trade, just as policymakers in the interwar period did. Furthermore, just as Thomas Lamont urged Herbert Hoover to veto the 1929 Tariff Act, Jamie Dimon, the current leader of J.P Morgan, has made pleas to Donal Trump (Greenspan and Wooldridge 2019: 2230; Politi 2019).

[9] That said, Bell and Srdjan (2019: 367-382) noted that some Brexit supporters support the idea of rekindling close ties with former commonwealth nations.



Instead of learning the lessons of the 1930s, Trump has begun trade disputes with China, the EU and the NAFTA countries, to name just a few. His administration's mantra of 'America first' is emblematic of the rebirth of reckless unilateralism, the type of diplomacy that led to nations in the 1930s to devaluate their currency at the expense of others (James 2017). Since 2016, America has rejected multilateral treaties such as the Paris Agreement for climate change. Like many 1930s leaders, Donald Trump has placed short-term interest above global welfare.

Likewise, Donald Trump's election represents the waning of American leadership. As has been shown, the 1945 order is predicated on American power and without it, the system would likely struggle. Given that he was elected under the mantra of 'America First', it is reasonable to question if America still wants to lead the liberal world order (James 2017). Equally, since the appointment of Jerome Powell in 2018, it is believed that he has submitted to Trump's demands to maintain very low interest rates (White, Ben and Guida 2019).[10] Hence, it is questionable if Powell could resist isolationist pressure and replicate the level of American leadership shown by Ben Bernanke.

This reflects the truth that many American policymakers have forgotten the significance of their country's leadership (James 2017). Although populists have been limited by the institutional structures created after the Second World War, many U.S policymakers have increasingly isolated America. This point is not to make predictions; instead, it is to show that American leadership has waned.

*Conclusion*

Despite recent setbacks, policymakers learnt many of the lessons of the 1930s. In the years immediately after the Great Recession, leaders revitalised the economy through monetary and fiscal stimulus, rather than using deflationary policies. In turn, the GDP contraction was substantially less severe than after the Depression.

On an international level, leaders worked with one another by reinforcing existing institutions like the IMF, and where necessary, created new organisations like the G20. This allowed policymakers to mitigate economic anarchy, as knowledge barriers were reduced, and cooperative norms maintained. That said, America

[10] This contrasts sharply with the 'imperil governorship' of Alan Greenspan (Mallaby 2016).

underpinned these efforts by using its vast resources to protect the financial system through QE and currency swap-lines.

A combination of American leadership and cooperative institutions, therefore, allowed policymakers to avoid inflicting self-defeating blows upon one another by conducting growth-stifling trade wars and competitive currency devaluations.

After 2016, however, several populist leaders have questioned the guiding principles of the post-1945 order. Paradoxically, this is perhaps the biggest testament to learning the lessons of the interwar years. By entrenching power in law binding agreements and entangling it in international bureaucracies, the current system has been able to withstand populist forces. In other words, even when some leaders have inflamed economic anarchy, the system itself has been able to limit it.



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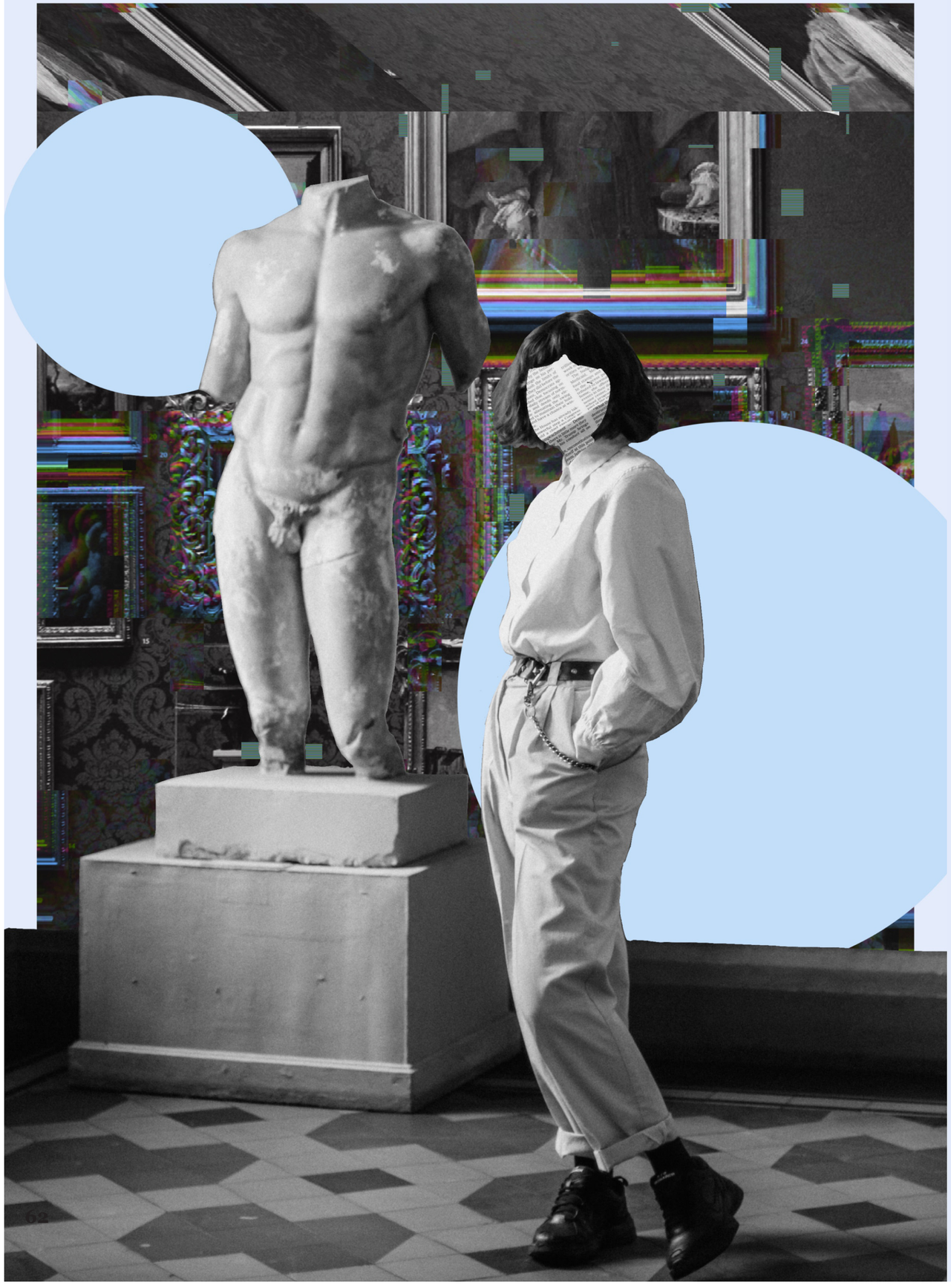

# Provenance and Meanings of Indigenous Objects in Museums: The Ethical Battlefield for Ownership

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Abstract: *Our museums today are full of items that were brought back from colonies, sometimes acquired in terribly violent ways. It is more than time for us to ask ourselves: do we really have the right to own and exhibit them? How do we decide who should morally be allowed to own cultural heritage? This essay reflects on these questions. The author bases their reflection on two different criteria: its provenance and its nature. They first start by exploring how the history of an object can impact a museum's right to own it. Them they go on by looking at how the nature of the object, what it is and the plurality of its meanings can also play an important role in this discussion. Finally, they open up the discussion on how to design repatriation guidelines based on these two criteria.*

## *Introduction*

Since the birth of institutional critique in the 1960s and the development of post-colonial thought, the legitimacy of museums' owning and displaying Indigenous objects – or what was traditionally called 'ethnographic objects', has repeatedly been called into question. Conscious of the connotations of the word *object*, too often used in opposition to *artwork,* I want to clarify that it is used here in a more neutral way, to bypass the artificial distinction between art and craft altogether. I also choose to use the term 'Indigenous' in order to make clear that I am speaking about objects from (ex) colonised peoples, rather than objects from the colonisers. Finally, the phrase 'Indigenous objects' is employed the broadest way possible, without considering its classification as artwork, ethnographic or curios. For the sake of this essay, this definition will include human remains, as these are considered, on the Western museological tradition, objects to be studied and collected as any other museum item. We then need to include them in our discussion in order to criticize and change this position.

**Ataï's skull as kept in the Musée de l'Homme in Paris, unknown date. Unknown photographer.**

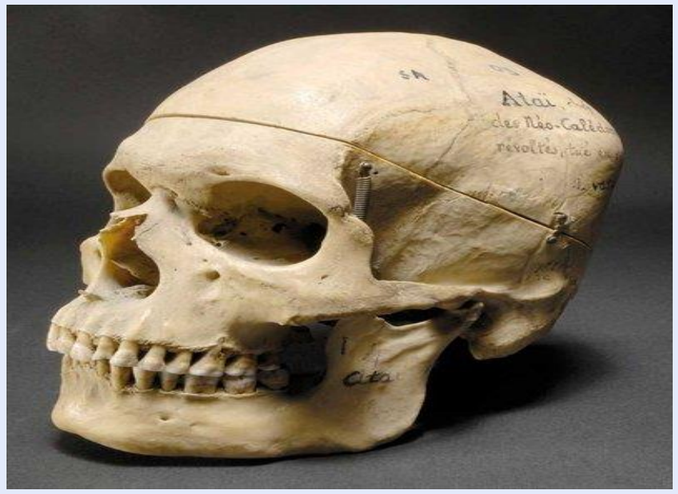

Figure 1.

L'Obs. (2020). Le Crâne Du Grand Chef Ataï Va (Enfin) Rentrer Chez Lui. [online] Available From: <https://www.nouvelobs.com/culture/20140827.OBS7278/le-crane-du-grand-chef-atai-va-enfin-rentrer-chez-lui.html> [Accessed 21 May 2020].

Many of these objects present in our museums today have a complicated history, tainted with colonial trauma. Their value and their identity within differs from the one they had within the source communities. The movement of objects from one place to another shifts their meaning and sometimes multiple and deeply different identities can crystallise around one single object. In essence, the meaning of an object depends upon its context and who is looking at it. This essay will explore how the provenance [OBJ|OBJ], that is its history, as well as its nature, that is what the object is, can challenge the moral right of Western museums to own it.[1] Firstly discussing different modes of acquisition, from lootings to gift, it will then look at these items' plurality of meaning and how this impacts their presence in museums. Based on these questions, I will finally propose a framework upon which to evaluate the possible change in ownership arising with repatriations requests.

Most of Indigeneous objects present in museums today were acquired during the colonial period, which implies that their story is often one of racism and brutality. Their relationship with violence is well-known and most obvious in the case of pieces

[1] Western museums designates European and North-American settlers (that is non-Native American) museums.



**Cass Brass Plaques from Benin City, unknown date. Unknown photographer.**

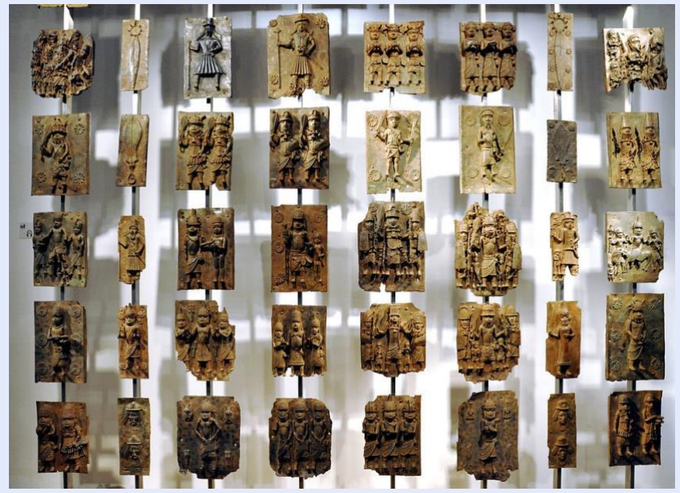

Figure 2.

At: London: The British Museum. Photo by Andreas Praefcke [public domain].

that ended up in European museums as a result of destructive lootings in the colonies. This is very well exemplified by the famous case of the Benin Bronzes. In 1897, the British troops sacked Benin City and seized, amongst other objects, the bronze plaques covering the royal palace (Greenfield 2007: 122-129). This punitive expedition, which marked the end of Benin's sovereignty, was well documented and photographed, which leaves no doubt as to how these objects were acquired. They were war trophies, brought back to Europe as a symbol of victory over the colonised enemy; exhibited within the British Museum, they became symbols of the United Kingdom's identity as a powerful Empire ruling over West-Africa. More than a century after they were looted, Nigeria requests the return of the palace plaques to recognise the British Empire's wrongdoings. Both because of their nature as royal artworks and their history of clear colonial violence, the Nigerian descendants of Benin City construct their identity upon these objects. To illustrate, in 2018 Godwin Obaseki, the governor of the Nigerian state of Edo where Benin City is located, declared that 'these works are at the essence of who we are (Squires 2018).

Yet not all violent acquisitions took the form of such looting and this is where the inclusion of human remains in the 'Indigeneous objects' category becomes interesting. In 1878 in New Caledonia, the Kanak chief Ataï led an unsuccessful insurrection against the French colonial power in place which saw him executed and

his skull sent back to France, where it remained for 136 years (Bolis 2014). In the same way as the Benin bronzes, its presence in a French museum materialises the colonial victory over the colonised Kanak and the dominance and control of their bodies. In this case, Ataï's skull (figure 1) was not looted, but its acquisition was not less violent. When researching such 'collections', we need to keep in mind that violence takes many forms and cannot be reduced only to lootings.

In both examples, the objects' presence in coloniser's museums is a sustained violence against peoples from which they were stolen. Faced with the brutal facts of their acquisition, repatriation of imperial plunder is a way for the ex-colonial powers to acknowledge their violence and the suffering of those they subjugated. While Ataï's skull was repatriated in 2014, Nigeria's request for the palace plaques currently in the British Museum (figure 2) has remained unsuccessful. Ex-colonies struggle for independence not just through political and economic means, but also by asserting independent cultural identities; as such the reclamation of their heritage is a key ideological battleground. In such examples, the objects' provenance is so obviously tainted with blood that there is little question that they should not belong to European museums. Their presence in these museums is a constant violence to those that were brutalised, and a way for colonisers to avoid acknowledging their past. There is no way to repair what has been done but repatriation definitely is a step towards the recognition of the past and a healthier relationship between European powers and their former colonies. As beautifully phrased by Bénédicte Savoy and Felwine Sarr, repatriation here is a 'symbolic reestablishment through a need for truth' which aims at 'repairing the relationship' (Savoy & Sarr 2018: 69).

That said, not all objects have such a clear history of violence. Amongst all Indigenous objects present in Western museums, some were also gifted or purchased. This was often the case during missionary presence in the Pacific, where the Native's abandon of what missionaries considered to be pagan 'idols' was seen as a sign of Christianity's progress (Thomas 1991: 152-153). This was thought to be the case with a female statuette kept at the Auckland War Memorial Museum, brought back from Tonga to London by the Reverend John Williams of the London Missionary Society where it was presented as a 'trophy of the moral conquest of the Gospel' (Williams 1837: 318-320). Mills (2015: 36-42) demonstrates how inaccurate this view was and how the chief Taufa`āhau actually staged this gift, which was more of a strategic diplomatic gesture than an actual sign of conversion. Despite this, the presence of such an object in a museum at that time was supposed to embody the missionary's cultural imperialism's success – but is that enough to question the museum's legitimacy to hold it? Surely the meaning ascribed to it was imperialistic and this needs to be acknowledged, but Taufa`āhau willingly offered this statuette to Williams; hence there does not seem to be any reason to question the museum's legitimacy to own it. As epitomized here, the source community's consent to give away objects is at the heart of ethical investigations into museums' ownership of such objects. For example, we can judge Nigeria's request for the British Museum's Benin palace plaques legitimate on the basis that the city's sack was, of course, hardly consensual.

Yet adopting consent as a litmus test to judge provenance claims immediately raises the deeper question of what can truly be viewed as free consent in the context of colonial oppression and coercion. The authority of the coloniser creates an essentially unbalanced relationship. Williams (1923: 5), an anthropologist in Papua New Guinea, wrote that 'there are many things which the native is genuinely unwilling to part with; but there is nothing which, with a little show of bluff or authority you cannot get out of him'. To judge a museum's right to keep an object, Savoy and Sarr (2018: 93) propose that, except where there are 'positive evidence of this consent', we should suppose that the acquisition of any object obtained under military domination was not consented. Objects that were sold by source communities would then, under this framework, be considered as legitimately held by European museums. But does a proof of purchase really act as a proof of consent?

In a colonial context, it is difficult to answer this question. Indeed, the strong economic inequality between both parties (i.e. the seller and the purchaser) should raise doubts about the seller's genuine consent to part with these objects. For instance, many objects were purchased during the French Dakar-Djibouti ethnographic expedition of 1930, including a zoomorphic mask from Segou, bought for 7 francs (figure 3). At that time in Paris, the average price for such a mask would have been between 200 and 2,300 francs (Savoy & Sarr: 96-98). In addition, the colonial foreigners, even when they part of the military forces, possess an inherent authority within the colonial system. Faced with the economic and colonial power of ethnographical expeditions, the Natives were left with no other choice but to accept any offer (Savoy & Sarr: 96-98). Under these circumstances, a proof of purchase cannot be seen as a proof of consent and does no legitimise Western museums' possession of those pieces.

**Zoomorphic Mask from Segou, Mali**

Figure 3.

(Before 1931). Vegetal Fiber , Guna Wood and Antilop Horn, 34,4 x 21,7 x 23 cm. Quaibranly.fr. (2020). History Of The Collections. [online] Available from: <http://www.quaibranly.fr/en/collections/all-collections/history-of-the-collections/> [Accessed 18 April 2020].

These expeditions took place in the 18th and 19th century (Savoy & Sarr: 94-100). Most the items brought back from these expeditions were purchased in the colonies for scientific purposes. Everything, from human remains to everyday or sacred objects, was coined as 'ethnographic' to rationalise the way in which they were acquired – scientific progress justifies it all. Hurley (1923: 379), exploring Papua New Guinea, claimed from example that 'in the cause of science, … even an unfair exchange is no robbery' and that, 'scientifically speaking', (Hurley 1923: 380-383) stealing stuffed heads was acceptable. What is important to understand is that it is this European categorisation of objects as 'ethnographic' rather than let's say 'artworks' that allowed them to collect and exhibit them. Imposing on indigenous objects an inherently European category such as 'ethnographic' or 'curios' provided a reason to own them (Curtis 2006: 119). Even if the physical nature of an object does not change, its meaning is not fixed, and being re-defined to fit different agendas (Skrydstrup 2008: 58). One single object can be a war trophy embodying British identity as an imperial power and a symbol for Native populations to construct a postcolonial identity *at the same time*. When it is exhibited in a European museum, its meaning changes to reflect European identity and concerns (for example 'ethnography'. Museum categorisation in itself



shifts meaning from, let's say, a mask imbued with healing powers to an interesting ethnological artefact. False Face Society masks from the Haudenosaunee (Iroquois) Federation, for example, were considered living beings and were used as a medium between humans and the healing powers of mythological entities (Gadacz 2010). They were not to be seen (let alone possessed) by non-members of the society. Unilaterally declaring that such an object is an ethnographical artefact rather than a living being provides Western museums with the moral right to own and exhibit it.

In essence, museums have constantly used this recategorization of objects not only to validate the way in which they were acquired, but also to legitimise their ownership. Here it is the nature of an object, its meaning, rather than its provenance that is taken as a basis to determine its righteous owner. With Ataï's skull, for instance, it was decided that, as a recognition of traumatising colonial provenance, it should belong to Ataï's descendants rather than to the Musée de l'Homme in Paris. At the same time, its nature (i.e. human remains) has undoubtedly played a large role in its repatriation. Generally speaking, institutions are starting to agree on the fact that human remains are more sensitive than other items and that they should not be on display or kept in a museum (Savoy & Sarr: 34). This might come from a difficulty, as human beings, to consider a skull, especially one with such a violent history, as an artefact; it is not as easy for Europeans as to declare that False Face Society masks are simply craft for example. In such a shocking situation, it would have been difficult to sustain that the skull was kept for scientific purposes. This consideration of human remains is recent, however, and Ataï's skull did sit in a museum for 136 years. Ultimately, with the recent exception of human remains, the meaning of the object for a museum is often very different from its original one and this was sometimes used to rationalise its presence in a European museum.

Despite anthropologists' past efforts to claim that the scientific value of an object prevailed over provenance in determining rightful ownership, museums' acquisitions are now legally limited. As an illustration, in 2002, France was forced to acknowledge that the Nok terracotta sculptures exhibited in the Louvre were Nigeria's property. These had been acquired in 1998 for the Quai Branly, despite the fact that Nigerian law prohibited their exportation and that they were on the ICOM's Red List of Cultural Objects at Risk (Savoy & Sarr: 103-104). Today, for a museum to legally acquire an object, it needs to have 'a provenance that goes back to 1970, the date of the UNESCO Convention [on the Means of Prohibiting the Illicit Import, Export and Transfer of

Ownership of Cultural Property]' (Montebello 2009: 69). The law then seems to base museums' right to acquire objects more on their provenance than on their nature and meaning. In response to this, Montebello has argued that museums should be able to purchase unprovenanced objects when they have 'an inherently outstanding contribution to make to knowledge' (Montebello 2009: 69). He gives the example of these:

> Third millennium copper alloy lion … that were purchased on the art market in 1948 by the Louvre and the Metropolitan, fortunately (figure 5). … Their inscriptions provided the earliest evidence that the city of Urkesh … had in fact existed. … The knowledge that the lions were said by the vendor … to have been purchased in a nearby town … led Professor Giorgio Bucellatti … to [a] site, … where they excavated and found Urkesh. And all thanks to the information provided by the vendor of the unprovenanced and unexcavated Hurrian foundation figures (Montebello 2009: 67-69).

His argument is in some aspects similar to that of the one used during anthropologic expeditions as it takes the inherent scientific value of the object rather than its provenance as basis for the museum's right to own it. Yet he adds a new layer to this reasoning by expanding its value to a universal level as the knowledge gained will apparently benefit humanity as a whole. Some institutions use this same type of idea to legitimise their ownership over contested objects. For example, in 2012, Neil MacGregor argued that the British Museum's role is 'to hold its collection in trust for everybody…. It [is] a universal museum aimed at a universal audience, for the use of the whole world' (MacGregor 2009: 40). Once again it is the objects' meaning, this time as universal works of art, that prevails to legitimise the museum's ownership. In 2002, nineteen of the world's most powerful museums, including the British Museum, signed the Declaration on the Importance and Value of Universal Museums (DIVUM). By declaring themselves Universal Museums serving 'the people of every nation', (ICOM et al. 2004: 4) they laid the basis upon which this whole argument rests: if they are universal museums, then they are the best placed to own objects with a universal reach.



As demonstrated by Neil G. W. Curtis, these museums deliberately emphasise the aesthetic aspect of these objects (Curtis 2006: 120). For them, this aesthetic reach prevails over any provenance issue. Despite their universal aspirations, this approach is deeply rooted in Western ideology and vision of art, and it is far from being universal. It does not mean that it is wrong to interpret objects this way, nor that Europe and North-America have the monopole over aesthetic appreciation. Rather, it proves that, despite their attempt to present themselves as universal, these museums actually adopt a 'very specific [Western] viewpoint' (Curtis 2006: 120) and cannot claim to be 'Universal Museums'. Even if we accept the premise that these objects do have an inherently universal value, it does not follow that these museums should own them.

**Foundation Peg in the Shape of the Forepart of a Lion, Akkadian, Tishatal of Urkish, Syria, probably Tell Mozan**

Figure 4.

(2200-2100 BC). Copper, height 4,5 inches. Metmuseum.org. (2020). Accessed 5 Mark 2020. Available From: <https://www.metmuseum.org/> [Accessed 11 July 2020].

This being said, the DIVUM does not only take the nature of objects as a justification for their ownership, but also answers the concerns raised by their provenance. Stating that they 'were acquired under conditions that are not comparable with current ones', (ICOM et al. 2004) the signatories ignore the question of colonial lootings and coerced sales. 'The past is the past', as declared by Montebello (2009: 69) and under the colonial domination, these acquisitions, not matter how violent, were legal (Savoy & Sarr 2018: 123). However, this seems profoundly unsatisfactory. 'To justify the plunder of the past based on a time period, and to claim that it differs from the current or recent plunder, is seen … as an insult bordering on historical mischief' (Abungu 2008: 37). We are not questioning the *legal* ownership of these objects, but the *ethical* basis for their possession. Hence this argument is irrelevant to the discussion and cannot legitimise European museums' holding of, for example, Ataï's skull or the Benin Bronzes. Neither the DIVUM signatories' claim of ownership based on the objects' universal nature nor on their legal provenance is satisfactory. This questions the idea that we could really base ownership claims solely on either the meaning of an object or its provenance. To answer this, I will explore two other examples.

Firstly, we should wonder whether the nature and significance of an object alone can challenge a museum's ownership. Objects have a plurality of meanings and identities - which one matters the most when it comes to deciding who is the righteous owner? The University of Aberdeen museum came with a very interesting answer to this issue. Confronted with multiple repatriation requests, they created a procedure to help a panel decide whether or not an object should be repatriated (Curtis 2006: 46). Its goal is to evaluate both 'the signification of the item to the claimant and to the University [and] the consequences of return to the claimant or retention by the University' (Curtis 2006: 46). Although this procedure does mention the provenance of the object elsewhere, it is not the basis on which the panel will judge the request. Instead, it is the significance of the object, its meaning, both in the past and in the future that is most important. Repatriation of culturally-sensitive items often stimulates a revival and renewal of cultural identities that were disappearing, as was the case with the repatriation to the Haida of 466 of their ancestors remains. For the Haida, this return led to the transfer and rebirth of carving skills, the creation of new burial rituals, an increase in research around the items as well as new inter-generational connexions (Simpson 2008: 71-74). As illustrated here, repatriation of



significant items can bring extraordinarily positive outcomes to communities. The ownership change sometimes leads to such revival of identities and histories that had been suppressed by colonisation and the systematic collecting of material culture. Comparing the present and future meanings of an object to both the source community and the museum then sometimes provides a great basis to judge who should own it and whether or not we should operate a transfer of ownership.

Savoy and Sarr's repatriation guidelines, on the opposite, focus on the history of the object. This can be explained by the fact that their work is centred more around questions of justice for historical wounds linked to lootings than on the pragmatic outcomes of a repatriation. They conclude their research by declaring that any object acquired during military or scientific missions, where there is no positive evidence of 'free, equitable and documented consent', (Savoy & Sarr: 105-106) needs to be repatriated. This covers examples of lootings and coerced sales that I have explored earlier in this paper and that would not always be covered by Aberdeen's guidelines. Indeed, the University's guidance does not take into account the fact that, in certain cases such as Ataï's skull, repatriation is also a highly symbolic recognition of past violence. In the same way, Savoy and Sarr do not really take into account the future material positive results for source communities that can by themselves justify repatriation.

This suggests that, to assess whether a museum is entitled to keep an object or not, our judgement needs to include both its provenance, problematic or not, and the possible outcomes for both the institution and the source community. I am convinced that this is possible, and that it will open the way for museums to acknowledge and teach the history of their collections, even when this is painful. It is time to change our vision on museum's categorisation of objects. This will also finally allow us to understand how these objects can still help source communities to forge new postcolonial identities. The museum, and more precisely the so-called ethnographic museum, will have to evolve to accommodate the plurality of meanings and voices that come with the objects they exhibit.

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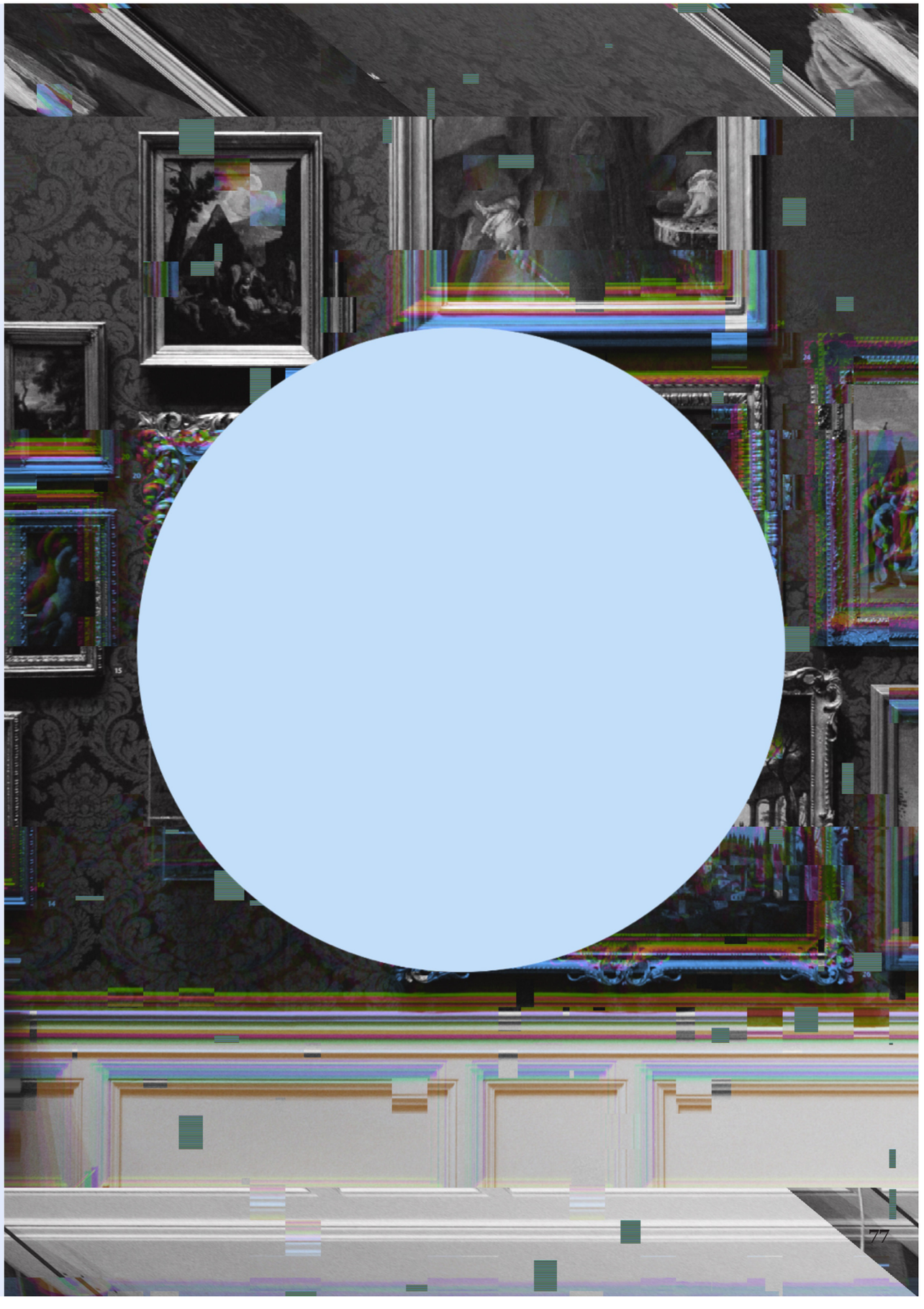

# ‘Faulty Powers’ Revised: A Constructivist Analysis of Russia’s decision to Invade Ukraine

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Abstract: The annexation of Crimea from Ukraine in 2014 by the Russian Federation was one of the biggest geopolitical events since the fall of the Soviet Union. In an article published in 2014, academics Mearsheimer and McFaul debate the potential reasons behind the annexation from a realist and liberal standpoint, respectively. This article responds to both standpoints by arguing that a constructivist position provides the greatest understanding for the events in 2014.

## *Introduction*

Russia’s decision to invade Crimea in 2014 was one of the defining moments of post-Soviet politics, yet there is little consensus on why Russia choose to do so. Michael McFaul (2014), the American Ambassador to Russia between 2012 to 2014, argued that Russia’s decision to annex Crimea was driven largely by domestic factors; this represents a liberal approach to international relations. It was a response to Mearsheimer’s (2014) argument that the Western powers largely caused the annexation. This represents a neo-realist argument: that Russia felt threatened by the possible expansion of the EU and NATO, and Crimea was a retaliation. Both arguments are unsatisfactory in explaining the annexation. Although no international relations theory can fully explain why the decision to annex Crimea was made, a constructivist analysis offers the most comprehensive explanation.

The salient aspects of both the liberal and neo-realist arguments will be analysed, showing the shortcomings of both theories. This will be followed by my constructivist argument, that the decision to annexe Crimea was driven largely by ideational factors. Russian identity is constructed within the polity, whilst also being formed by Russia’s relations with the West and ‘near abroad’. The dualistic nature of Russian identity formation gives a deeper understanding of the annexation compared

to liberal and neo-realist theories, which tend to be inward and outward looking respectively. Drawing on work from Tsygankov and Tsygankov (2010), this essay will show how Russia has begun to pursue a 'civilisationist' foreign policy. They posit that a civilisationist Russian foreign policy places Russia as the cultural centre of a distinct civilisation in the post-Soviet space. Hence Russia placed more importance on its relations with Ukraine, whilst viewing Western expansion as increasingly threatening. These two factors created conditions for the annexation. Finally, an analysis of Russian identity in relation to Putin's domestic support will be given, explaining why Crimea helped him maintain his control over Russian society.

### *McFaul's Liberal Argument*

The liberal assessment is that we must look at what was going on within Russia to understand why Putin made the decision to annex Crimea. Although domestic politics is important, this analysis overemphasises some points and is lacking in others. McFaul's (2014: 170) key argument is that Putin felt threatened by widespread protests in Russia when he returned to the presidency in 2012. The Euromaidan stoked Putin's fears as he thought civil unrest in Ukraine would spread to Russia. It is contentious to claim that the decision to annex Crimea was motivated purely by Putin's desire to maintain his popularity. Despite his approval ratings dipping by 2014, he had regained control over civil society and was still achieving approval ratings of above 60% (Bukkvol, 2016: 277; Götz, 2016: 258). It is obvious that the annexation would not have eased diplomatic relations between Russia and Ukraine. McFaul (2014: 171) argues that Putin was not aware of this and behaved with 'unconstrained, erratic adventurism'. This argument is unconvincing, as it ignores the distinct foreign policy that Russia has been pursuing since 2007. This emphasis on individual actors oversimplifies one of the most complex political events to happen in the Twenty First Century.

The liberal argument overemphasises the 'reset' in Russia's relations with Western powers. McFaul attributes this reset to a 'shift' in Russia's foreign policy following Medvedev's interim years as president. Although there was co-operation between Russia and the US during 2009-2012, this is unlikely to be due to Medvedev's presidency. Putin (2011) himself stated in 2011 that he envisioned a 'harmonised community of economies stretching from Lisbon to Vladivostok'. Tsygankov (2015: 287) argues that Russia co-operates with the West 'when its fundamental values and interests are not challenged'. This is more likely to explain the 'reset' than a change in



presidency — especially considering Medvedev is unlikely to conduct foreign policy without Putin's approval. By overemphasising the change in presidency, the liberal argument ignores the fact that Russia still viewed the West as threatening during this time. It is erroneous to claim that Putin was not reacting to NATO expansion. Russia has maintained its 'negative attitude towards NATO expansion' in every foreign policy concept since 2000 (Russian Foreign Policy Concept 2000, 2008, 2013, 2016). Sakwa (2015: 30) highlights how every EU country since 1989 has subsequently joined NATO. Kyiv contributed to this discourse, portraying the association agreement as a pro-Western 'civilisational' choice (Tsygankov, 2015: 289). By focusing on domestic politics, the liberal analysis obscures the symbolic importance of the association agreement — as it showed Ukraine's movement towards Western institutions and ideals.

### *Mearsheimer's Neo-Realist Argument*

McFaul's assessment was a response to the argument made by Mearsheimer, that the Ukraine crisis was 'the West's fault' (Mearsheimer, 2014). His neo-realist argument attributes the annexation to structural geopolitics. Mearsheimer states that Russia behaved as any other great power would, by removing a threat on its borders. Mearsheimer (2014: 4) argues that the West pursued a 'triple package of policies' that led to the annexation. These include NATO enlargement, EU expansion, and democracy promotion. This is convincing insofar as Russia does view these policies as a threat. Yet by defining power in material terms, neo-realists ignore the soft power that Russia has tried to implement in the 'near abroad' to counter Western influence. Nye (1990: 166) coined the term soft power and defines it as 'when one country gets other countries to *want* what it wants'. Western institutions wanted to expand eastward, and they attempted to make EU and NATO expansion a foreign policy goal for Georgia and Ukraine. When the Colour revolutions showed that this soft power was successful, Russia tried to counter it with its own policies. Roberts (2017: 29) argues that Putin's realism is overemphasised when analysing his foreign policy. Putin is guided by identity and labelling the annexation as reactionary ignores the ideational based justifications Putin gave for the annexation. Mearsheimer (2014: 2) argues that no action was taken against NATO expansion in the 1990s and early 2000s because Russia was too weak. Instead, a constructivist argument shows that Russian identity began to change in the mid-2000s. This altered what Russia viewed as a threat, whilst

giving a renewed importance to its neighbouring countries, particularly Ukraine. This led to a more assertive foreign policy and created conditions for the annexation.

*A Constructivist Argument: Russian Civilisationism and the Near Abroad*

The Rose and Orange revolutions in Georgia and Ukraine in the mid-2000s made Russia aware of the West's soft power in its neighbouring states (Feklyunina, 2016: 781). This combined with a refusal of the western powers to acknowledge Russia's interests increased the importance of the 'near abroad' in Russian foreign policy (Hopf, 2016: 244). This manifested itself in Russia attempting to use its own soft power by promoting a Russian identity abroad. Russia began to emphasise its cultural distinctness from the West, portraying itself as a regional leader of Slavic people. This identity discourse focused on 'traditional' values, orthodox Christianity, a glorified view of Soviet military history as well as the promotion of the Russian language abroad. Tsygankov and Tsygankov (2010: 3) label this discourse based on cultural distinctiveness as 'civilizationism'.

Contrary to what some critics believe, this turn to civilisationism and the eventual annexation of Crimea was not driven by imperialistic motives. Instead, Putin wished to present a superior civilisation to the West that Russia was the leader of (Tsygangov, 2015: 297). This was done in a variety of ways. In 2007, Putin launched the Russkiy Mir (Russian World) foundation, aiming to promote Russian language and literature abroad (Russkiymir.ru). Elites incorporated the notion of a distinct Russian world into foreign policy, and other discourses were weakened (Feklyunina, 2016: 783). Russia also began to use the term 'compatriots' in its foreign policy concepts. The definition of Russian 'compatriots' was kept purposefully vague, including descendants of the Soviet Union, Russian speakers as well as anyone with cultural ties to Russia (Feklyunina, 2016: 782). Finally, Russia began to emphasise the 'shared history' it had with its post-soviet neighbours. Ukraine had an important role to play in this foreign policy. As a neighbouring country with close cultural ties to Russia, a shared history as well as a high population of Russian speakers, it was a key area in which Russia could exert its soft power.

*Civilisationism, Crimea and the West*

The ideas that encompass Russia's soft power — the Russian language, the 'compatriots' issue and Soviet military history — were all used as justifications for



Crimea. Putin argued that the Ukraine proposal to reduce Russian from a national to a regional language was discriminatory against Russian speakers (Rotaru and Troncotă, 2017: 33). As Russia had positioned itself as a defender of Russian 'compatriots', he said the annexation was protecting the Russian minority in Crimea. The reliance on a 'shared history' is particularly important to Russia's foreign policy, Putin often relies on politicised selection of past events (Rotaru and Troncotă, 2017: 337). The Crimea incident offers a case in point: Putin accused Kyiv of siding with fascists who had fought against the Soviet Union in World War Two (Tsygankov, 2015: 293). Furthermore, he called Crimea a 'city of Russia's military glory', using historical patriotism to lay claim to the peninsula (Kremlin.ru: 2014). Pearce and Yuchshenko (2018: 91) argue that the reliance on the Soviet past blurs territorial integrity and is then used to breach sovereignty. Putin has been utilising a Russian civilistionist identity to exert soft power abroad since 2007. This discourse culminated in Crimea, where Putin gave himself plausible deniability under the guise of 'protecting' Russians. This was indicated in his Crimea acceptance speech: 'Standards were imposed on these nations that did not in any way correspond to their way of life, traditions, or these peoples' cultures' (Kremlin.ru: 2014).

By emphasising the cultural differences between the West and Russia's 'near abroad', Putin lays claim to the post–soviet countries. This allows him to discount western involvement, saying that they do not understand the distinct culture and history of the East in the same way Russia does.

Western institutions played an important role in the annexation, too, as their expansion cultivated Putin's civilisationist discourse. Identity formation helps a state define its threats. Hopf (2016: 228) argues that western policies have played a significant role in 'reconstituting Russian identities'. This is particularly true regarding Russia's portrayal of western institutions. Since the colour revolutions, Russia has attempted to depict the EU and NATO as imposing their 'western' values onto Russia and the near abroad. Williams and Neumann (2000: 361) argue that there were only two stances Russia could take regarding NATO expansion after the end of the Cold War. It could either be an 'apprentice' seeking to join NATO, or a 'counter-civilisational force' that was opposed to enlargement. By 2007, Russia had decided on the latter. This was shown during Putin's speech at the 2007 Munich conference, in which he stated that NATO was 'trying to impose new dividing lines and walls on us [Russia and the post-soviet space]' (Kremlin.ru: 2007). The US dominated institution

of NATO began to be symbolic of the West discounting Russia's interests (Roberts, 2017: 43). Morozov (2015: 104) argues that ontological insecurity leads to resentment which results in Russia antagonising the West.

This is a core aspect of Russian identity — western Europe, and with that its institutions, became the essential 'other' for the construction of the Russian 'self' (Morozov, 2015: 105). Antagonising the West helps reinforce Russia's civilisationist discourse, which in turn gives justifications for a more assertive foreign policy. Russia benefited from portraying NATO as a 'symbolic betrayal' of Russia — Ukraine relations in 2010, when the goal of NATO accession was removed from Ukraine's security strategy (Feklyunina, 2016: 790). Yet four years later, the Euromaidan symbolised the persistence of the Ukrainian public to align with western Europe. Putin saw this as a betrayal of the values of the 'Russian world' he had tried so hard to create. The liberal argument proposes that the annexation must be driven by domestic factors because Russia had not responded aggressively to NATO's expansion into the Baltic states (McFaul, 2014: 167). A constructivist argument shows that this was because Russian identity was 'in flux' during the 1990s (Roberts, 2017: 49). By 2014, Russia had consolidated its identity and viewing western institutions as a the 'other' was an integral part of this. Furthermore, the near abroad now had an important role to play in constituting the Russian 'self'.

*Russia's Foreign Policy Discourse*

The Euromaidan represented the failure of Russia's identity discourse. Despite concerted Russian efforts since the Orange Revolution in 2004, many Ukrainians still identified with the western idea of Europe. Although Medvedev and Putin often favoured the notion of a 'civic' multi-ethnic Russia, they let ethnonational identity dominate the Russia — Ukraine discourse (Hopf, 2016: 245). Putin's emphasis on shared history and cultural ties meant that Russia and Ukraine were presented almost as one nation (Rotaru and Troncotă, 2017: 33). A 2013 poll conducted five months before the annexation shows that 61% of Russians surveyed did not view Ukraine as a foreign country (Levada-Center: 2014a). Russia had portrayed itself as the leader of a civilisation that was distinct to the West. As a neighbouring Slavic nation that shared historical, linguistic and cultural ties with Russia, Ukraine was an important part of the Russian 'Self'. The Euromaidan threatened this identity. If Ukrainians aligned with the western 'Other' over the Russian 'Self', Russia's position as a leader in the post-soviet space would be lost. This could have severe consequences — namely Russia losing its influence in other post-soviet states, as well as an identity crisis at home. Grigas (2016: 29) argues that Russia uses soft power to pave the way for hard power rather than using it as an alternative. Although Russian soft power had not been successful, the annexation would not have been possible if Russia had not made a distinct turn to a civilisationist foreign policy.

Putin portrayed the leaders in Kiev as suppressing the Russian minority in Ukraine in favour for a corrupt, pro-western rhetoric. By annexing the Crimean Peninsula, which is home to many ethnic Russians, Putin maintained his image as a protector of Russian compatriots. In his Crimea acceptance speech, he stated:

> It pains our hearts to see what is happening in Ukraine at the moment … Our concerns are understandable because we are not simply close neighbours but, as I have said many times already, we are one people. Kiev is the mother of Russian cities. Ancient Rus is our common source and we cannot live without each other (Kremlin.ru, 2014).

Reiterating the idea that Ukraine and Russia were still one people helped Putin gain control of the narrative around the Euromaidan. He portrayed Ukraine as being corrupted by a 'pro–western' identity that it did not belong to. The 'compatriots' issue, the politicised use of history and the idea of a 'Russian world' all helped Putin legitimise the annexation (Grigas, 2016: 29). In doing this, he showed the West that Russia would not tolerate interference in its 'zone of privileged interests'. This reinforced Russia's identity as a leader in the post-soviet space, sending a message to the near abroad that Putin can and would interfere if he saw this discourse being threatened.

*Russia's Domestic Identity Discourse*

Not only did the annexation reinforce Russia's identity discourse abroad, but it also did so at home. Wood (2016: 99) highlights how spikes in Putin's popularity have correlated with acts of aggression against perceived enemies. Furthermore, Putin often legitimises his actions by relying on historical patriotism (Pearce and Yuchshenko, 2018: 99). A combination of both was used in Crimea, where Putin presented himself as defender of a 'city of Russia's military glory' against threatening western powers

(Kremlin.ru, 2014). This can account for Putin's spike in popularity – going from 65% approval just before the annexation to 83% just after (Levada-Center, 2018). Furthermore, a 2016 survey showed that 79% of Russians thought that Crimea signified Russia returning to 'its traditional role of super-power and asserting its interests in the post-soviet space' (Levada-Center, 2016).

The dualistic approach of examining Russian identity goes further than a liberal analysis in that it shows how the annexation led to domestic control. Another benefit to Russia's civilisationist discourse for Putin is that it excludes western involvement in Russian affairs. Russia replaces international standards with domestic ones – and therefore escapes western critique (Hopf, 2016: 244). The Western sanctions that followed the annexation were perversely beneficial to Russian identity discourse. It allowed Putin to pursue isolationist policies – reiterating the difference between Russia and the West (Götz, 2016: 255).

This is extremely beneficial with regards to democratisation. Putin can claim that a 'western style' democracy does not fit Russia, as it is so distinct to these nations. This is exemplified in a 2014 poll asking the question 'Do you think that Russia needs western style democracy?' The two most articulated answers were negative, with 45% saying western style democracy would be destructive for Russia, and another 39% saying it was suitable but required 'substantial changes linked to the special character of our country' (Levada-Center, 2014b). The decision to annex Crimea was not driven by domestic factors. However, identity construction must have domestic support, or it would be meaningless. Crimea indicated the strengthening of Russia's civilisationist identity; showing how Putin has utilised this to maintain his domestic support and control.

## Conclusion

It would be an oversimplification to attribute the annexation of Crimea to either domestic factors or great power politics. By utilising a constructivist approach, the complex factors that led to the annexation become clearer. Russia's civilisationist identity was the driving factor in how it conducted its foreign policy with regards to Ukraine. Putin's turn to civilisationism meant he viewed the post-soviet states as part of a Russian zone of 'privileged interests.' This was evidenced by his repeated attempts to use soft power in the near abroad by promoting a common identity. Western expansion eastward came to be viewed as increasingly threatening, as Russia continued to define itself as the antithesis to the West. When Russia's soft power proved to be too weak, Putin annexed Crimea, with the aim of showing both the near abroad and the West that he could not accommodate western powers 'imposing' their identity on Russia's neighbouring countries. This had important ramifications on the international stage, as the ideational justifications Putin gave demonstrated Russia's power in the near abroad. By reinforcing this identity discourse abroad, Putin saw his domestic support increase at home — allowing him to pursue isolationist policies and maintain authoritarianism.

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# Psychobabble or Substantial? How Sustainability Psychologically Impacts Consumer Preferences

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Abstract*: Sustainability has become an important influence on consumer choice. Thus, the purpose of this study is to investigate how information on sustainability affects consumer purchasing behaviours. All the participants rated clothing items based on their personal preferences. Then, they completed a preference-based decision-making task, which consisted of choosing amongst two different clothing items. In half of those trials, but fully interleaved, the clothing items had labels giving information on sustainability (labels-on). In contrast, in the other half, no information on sustainability was given (labels-off). In the end, participants completed a self-reported questionnaire where they revealed their attitudes and behaviours towards sustainability. Results show that people made more sustainable choices when sustainability information was available, even when it involved choosing the less-preferred item. Similarly, people took longer to make a decision when their preference for the item and the sustainability information were incongruent. Henceforth, these results indicate that sustainability plays a crucial role in consumer purchasing behaviours as a result of the sustainability bias affecting the decision-making process. The findings of this study may have significant implications not only on understanding how information on sustainability alters consumer choices, but also in prospective marketing strategies.*

## *Introduction*

Reducing the impact that society has on the environment has become one of the most pressing concerns of our time. In particular, the retail industry has a massive impact on environmental degradation. Further than moral responsibility, it has been suggested that implementing sustainable practices, which are not detrimental to future practices from taking place, can become a win-win opportunity for retail organizations given customers' increasing interest in sustainable products.

For this reason, many marketing experts have changed their businesses practices to be more sustainable. This way, not only are they having a positive

impact on the environment, but also increasing profitability due to consumers' preferences. In a survey conducted by The Nielsen Company (2019), 73% of the global consumers reported that they would definitely, or probably, change their buying habits if those decisions would reduce their environmental impact.

In general, it has been argued that producing and marketing products with sustainability characteristics can become a promising strategy for the differentiation of products. In other words, consumer preferences for environmentally favourable practices have increased in recent years (Han et al., 2009; Jang et al., 2011). Therefore, research regarding the impact of sustainability labels in food choices has expanded, with findings generally indicating that organically produced foods have experienced a vast increase in availability and demand (Annunziata & Vecchio 2016).

In particular, Schäufele and Hamm (2017) conducted a review of 34 articles that studied consumers' choices of wine products. This is an interesting product to look at, due to its differentiated nature and complexity. Overall, sustainable wine was believed to be of higher quality, but results also indicate that specific segments of consumers were willing to pay an extra price for such a product, given the positive perceptions of sustainable production methods. It was also suggested that social desirability[1] could have played an important role in purchasing behaviours when hosting friends or when buying wine as a present (Orth 2005). These results suggest that marketers, retailers and producers can influence customers' purchasing behaviours by increasing their knowledge about the sustainability of their products.

For other food products such as seafood (Jaffry et al. 2004), it has been found that there are many potential benefits available with the development of sustainability labels compared to other types of labels (i.e. brand, the origin of the product, price, quality and certification). For instance, the existence of a label conveying that a fish product comes from a sustainably managed fishery increases the possibility of that product being chosen by 6.61% when compared to the same fish product without the sustainability label. Similar results have been reported for sustainable meat consumption (Van Loo et al. 2014). Van Loo's and colleagues' (2014) study compared different types of sustainability labels and stated that the largest segment of consumers, which was almost a 19%, had positive preferences towards products with sustainable labelling. This suggests that consumers like being informed about the characteristics regarding the sustainability of the food that they consume.

Moreover, Van Loo and colleagues (2015) studied how sustainability labels impact coffee choices without using self-reported questionnaires, but rather by utilizing eye-tracking technology to measure visual attention to the sustainability labels. This innovative study demonstrated how visual attention to specific labels (i.e. sustainability labels) is related to the importance and preference towards these attributes. Results showed that consumers who cared more about the sustainability features of food valued these features more and visually attended more to this information during the decision-making process. Nevertheless, participants cared more about other attributes of the coffee, including flavour, price, type of roast, and in-store promotions. Sustainability was not one of the most important qualities when making a decision, but a 58% of the sample was found to be 'sustainability and price-conscious', hence attaching importance to both the price and the sustainability labels during their purchases.

Motivations of ethical consumers have been extensively researched. Consumers that care about ethical matters behave accordingly and translate these values into their consumption behaviour. They are socially aware of the world's issues and understand which firms source their products sustainably (Clavin and Lewis 2005). Hughner et al. (2007) identified the five main personal motives that are influencing consumer preferences for organic foods; health concerns including nutrition and safety, better taste, environmental concerns, animal welfare concerns, and support of the local economy. However, social motivators have been found to have a greater impact than personal motivators. That may be because ethical purchases can lead to an individual and a symbolic feeling of advantage, that relates to a specific lifestyle and personal identity (Moisander, 1991 in Niinimäki, 2010).

As shown, market research reveals that consumers want and favour environmentally sustainable products. However, these desires do not always translate into consumers purchasing the sustainable option. There appears to be

[1] By social desirability, I am referring to people's propensity to present a favourable image of themselves on questionnaires

a considerable gap between consumers' explicit attitudes towards sustainable products and their actual purchasing behaviours, with a study suggesting that even though 40% of consumers reported a willingness to buy 'green products', only 4% actually bought them (United Nations Environment Programme 2005: 15). Likewise, Carrigan and Attala (2001) defend that despite the fact that consumers care about how ethical firms are, the extent to which they care does not convert into purchasing behaviours that support sustainable companies. This phenomenon is even more extreme when the ethical choice conveys an inconvenience for the consumer. That is to say that consumers are not willing to sacrifice price, value, trends or brand image to support sustainable companies.

In addition, sustainable products sometimes lack success in the marketplace due to the perception that qualities such as form, function, or price will have to be sacrificed (Goucher-Lambert and Cagan 2015). This occurs because consumers know that manufacturers operate under budgetary constraints, meaning that if a product is superior in one attribute, it will be inferior in others (Chernev and Carpenter 2001). These results are supported by Luchs and his colleagues' (2010) research. They demonstrated that consumers associate higher product ethicality with gentleness-related attributes, and lower product ethicality with strength-related characteristics. As a consequence of these associations, the positive effect of product sustainability on consumer preferences is reduced when strength-related qualities are valued, sometimes even resulting in preferences for the less sustainable product alternatives.

When trying to understand the brain mechanism and source of the deliberation process while making a decision between two alternatives[2] such as any purchasing decision, economics and psychology have proposed a three-step model. Initially, the brain calculates the values of the different stimuli, assessing the outcome values that each action will potentially generate. Secondly, the brain calculates and evaluates the cost associated with each option. Finally, these two calculations are integrated to determine the overall value of each action. When the different action values are known, these values can be compared with each other, and a decision can be made (Rangel and Hare 2010).

[2] Defined as a binary-value-based decision



It has been argued that in binary-value-based decisions, humans accumulate evidence in favour of the different choices before making the final decision (Rangel et al. 2008; Rangel and Hare 2010; Gerstner et al. 2012). According to sequential sampling models, neuroimaging experiments have postulated that value-based and preference-based decisions are formed by a random accumulation of relative evidence until a decision is made (Philiastides et al. 2010; Basten et al. 2010). For example, the diffusion model assumes that decisions are made by a noisy process in which information is accumulated over time. Behavioural data (such as choice and reaction time (RT)) is decomposed into internal components, and the rate of the accumulation of information is called the drift rate (v), which depends on the quality of the information taken from the stimulus.

Recent modelling studies found that evidence is built up progressively over time when making value-based choices (Rangel et al. 2008; Rangel and Hare 2010; Gerstner et al. 2012). Pisauro et al. (2016) combined high temporal resolution, single-trial, EEG with fMRI and computational modelling. An Electroencephalogram (EEG) is a test that notices the electrical activity in the brain by using small electrodes attached to the scalp. On the other hand, the functional Magnetic Resonance Imaging (fMRI) measures and maps the activity of the brain by detecting changes in the blood flow. In this sense, EEG, fMRI and computational modelling were combined to understand the evidence accumulation process and identify the cortical area in the posterior medial frontal cortex (pMFC) involved in the process. The pMFC has been found to be responsible for monitoring performance issues and interacts with other brain regions to implement adaptations when needed. Their results showed indeed that when forming a decision, this area of the brain was linked to other brain regions of the human valuation system. Meanwhile, these regions exhibited the dynamics of 'accumulation-processes'. These findings suggest that the brain encodes decisions in the same sensorimotor areas, which guides the actions that implement the choice being made (Pisauro et al. 2016).

To better understand the steps involved in value-based decision-making processes (Figure 1), computational models suggest that these decisions take place in five stages: representation, valuation, action selection, outcome evaluation, and learning (Rangel et al. 2008). First of all, humans compute a

representation of the decision problem, which includes identifying the internal and the external states to the person, as well as the possible options that exist. As such, fMRI studies have placed humans in simple decision-making situations and have found that BOLD (Blood oxygenation level dependent) activity in the medial orbitofrontal cortex (mOFC) correlates with behavioural measures of stimulus values (Plassmann et al. 2007; Valentin et al. 2007; Hare et al. 2008). Note that the OFC is involved in the cognitive process of decision-making, and more specifically, the mOFC is responsible for creating associations between stimulus-reward and for reinforcing some behaviours. These results indicate that the mOFC is where several variables are integrated into a single representation of the value.

Secondly, each potential course of action gets a value that should be representative of the benefits of such action. Evidence that the information is integrated into a single value comes from an fMRI study, which looked at charitable decision-making. In this study, it was found that activity in the OFC correlated with behavioural measures of the value that participants assigned to each charity. Moreover, that the OFC was responsible for integrating inputs from other brain regions (Hare et al. 2010).

Thirdly, there needs to be a comparison between the different options for the decision to take place. The brain cannot immediately access the information on the value of the various courses of action, so it has to calculate it based on the sequential random samples values from a normal distribution. Henceforth, decisions are not only optimally made but also dynamically, as information from the samples is integrated into a relative action value signal. The process finishes when the value given to one of the choices is sufficiently biased (Usher and McClelland 2001; Ratcliff and Smith 2004; Bogacz 2007).

After the decision has been made, the brain has to calculate the desirability of the results. For example, a study proved that activity in the mOFC in response to the consumption of wine depended on the consumer's beliefs about its price (Plassmann et al. 2007). These suggest that cognitive processes that regulate expectancies and beliefs modulate the outcome-valuation system. Lastly, feedback is received in order to update and improve future decisions. When learning happens, the value of the action is changed by a measure proportional to the predicting error. In the right conditions and after time, the animal learns to assign the correct value to each action (Rangel et al. 2008).



**Basic Computations Involved in Decision-Making**

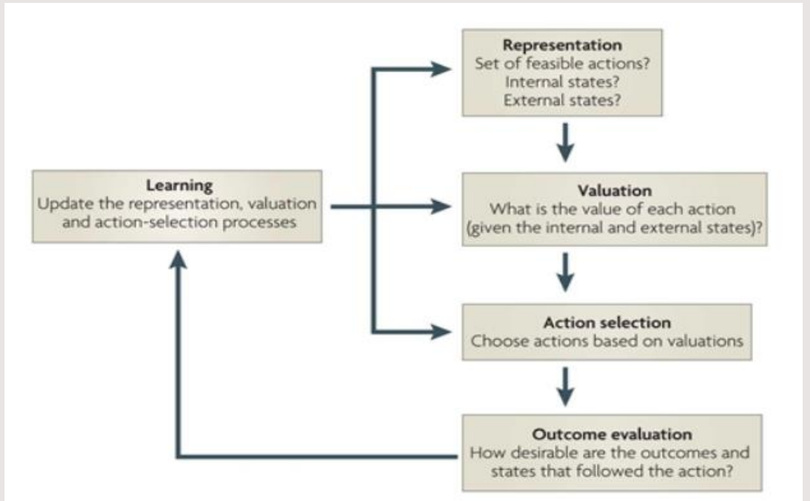


**Figure 1**.

(Rangel, A et al., 2008, p.546). Basic computations involved in making a choice.

But how do consumers make decisions when purchasing clothing items? Connell and Kozar (2014) add that understanding customer behaviours when buying clothes is complicated as both internal and external factors, to the consumer, influence the decision-making process. The decision-making process when purchasing clothing items can be affected by psychological, moral and cultural factors (Brécard and Salladarré 2009). Berglung and Matti (2006) indicate that individual decisions depend on ethical values and beliefs, culture, customs, and other types of social, political and moral values. Institutional settings are also shaping the individual decision-making by supporting, or not supporting, some behaviours and attitudes. Other factors such as beauty, fashion, trends, emotions, desires and social acceptance have been found to influence the decision-making process itself (Niinimäki 2010).

Similarly, when it comes to clothing, it has been concluded that price, style, and quality are the primary factors impacting purchase; while sustainability is a secondary factor influencing purchase (Iwanow et al. 2005; Joergens 2006). Furthermore, it has been found that despite consumers holding environmentally conscious attitudes, most consumers rarely consider the environmental impacts of their clothing purchasing behaviours (Butler and Francis 1997). The reason for this may be due to consumers making clothing-related buying decisions based on different factors (i.e. price, style, fit, and fashion) which outweigh environmental concerns. The generally negative perception that sustainable clothing is less stylish has also decreased sales for these products (Connell 2011).

Respectively, it has been found that in ethical purchasing, it is much easier to choose the organic food option compared to the sustainably produced fashion option (Joergens 2006). That is because the food choices that we make affect our health, with sustainable food products having health benefits for the consumer. In other words, more ethical commitment has been observed in consumers when the purchase itself influences their health or their wellbeing. However, in the case of clothing purchases, unethical decisions will not necessarily affect the consumer's health directly. Nevertheless, Sneddon and colleagues (2009) found that ethical concerns are incredibly relevant for consumers when deciding which item to purchase.

Given the lack of consensus in the area, it is crucial to study the extent to which sustainability information affects purchasing behaviours, as well as the relationship between consumers' explicit attitudes towards sustainability and their real actions. Binary-value-based decisions involve a comparison process between items' values whereby the relative evidence (the difference in values) is accumulated over time to a decision boundary representing the selected item. We want to demonstrate, using an objective quantitative approach, that sustainability information can influence this comparison process by introducing a bias towards the sustainable items, likely by assigning greater weight to values of sustainable items, discounting values of not sustainable items, or both. In turn, this bias leads to a choice bias for items with sustainability labels, with the most prominent bias effects arising when the item preference and sustainability factor conflict. In other words, we expect people to make more sustainable choices when sustainability information is available, even if it means choosing the less-preferred item. We also expect people to take longer to respond when their preference for the item and the sustainability information are incongruent (i.e. the sustainability bias makes the decision more difficult). Henceforth, we hypothesize that on preference-based decisions, sustainability information will create a sustainability bias leading to participants choosing the sustainable item, even in cases when it is not the preferred one; and also, that participants will take longer to make a decision when their preference for the item and the sustainability information do not coincide. We also hypothesize that there will be a relationship between participants´ explicit attitudes towards sustainability and their actual behaviours.

## *Methods*

### *Participants*

Thirty female volunteers were recruited for this study; the mean age was 21.22 years, and the range was 18 to 25 years. Participants were undergraduate students from the University of Glasgow and no monetary compensation or credits were offered for participation. All the participants had normal or corrected-to-normal vision, were right-handed and reported no history of neurological problems. Informed consent was obtained following the procedures approved by the local ethics committee of the University of Glasgow School of Psychology. All participants were anonymized and given a pseudonym for the duration of the study and data analysis. Following the completion and submission of this study, all physical and electronic data will be destroyed.

### *Stimuli*

Participants were presented with a set of 180 images of clothing items (see Figure 2), that had been previously obtained from the Internet. All the images were resized to a 500 × 500 pixels and then placed on a grey unicolour background. Moreover, labels that indicated 'sustainable' or 'no information' were added to the corner of the images in the main task of the experiment.

**Examples of the Clothing Items Presented to the Participants**

Figure 2.

*Behavioural Paradigm*

Without any time constraints, participants were presented with 180 clothing items (Figure 2) and were asked to rate these items using a scale that ranged from −3 (really dislike) to 3 (really like) in increments of 1 unit. Each of the clothing items were presented individually and in the centre of the screen with no information other than the rating slider. To move the slider, participants had to use the arrows on the keyboard and then press enter to submit their preferences (Figure 3).

For the main task of the experiment, participants were asked to make choices between two clothing items within a timeframe of one second. To create the pairs of items, we generated a continuum of the difference between the ratings of the two presented items (the sustainable clothing item minus the normal clothing item). The difference between both ratings determined the difficulty of the task. In other words, when no information on sustainability was given, choosing between pairs of items that have a high positive or high negative difference are considered as 'easier', while choosing between pairs of items that have a difference closer to zero are considered as 'harder'. The hardest condition being when the rating difference was equal to zero, as both items were liked or disliked to the same extent (point of indecision). It should be noted that when information on sustainability was given, negative values for the rating difference represent a clash between the preferred item and the sustainability information (incongruent trial for labels-on). That is because the rating given for the sustainable item is lower than the rating assigned for the non-sustainable item. In these cases, the sustainability bias would appear if participants picked the sustainable option rather than the preferred one. On the other hand, a positive value for the rating difference appears in cases when the preferred and the sustainable item coincide (congruent trials for labels-on).

Because the rating scale ranged from -3 (really disliked) to +3 (really liked), the values for the difference between ratings could range from -6 to +6. This meant having a total of 13 rating conditions. However, to ensure that we collected enough trials per condition and to keep the duration of the experiment within sensible limits, we decided to choose only the seven conditions that ranged from -3 to +3. In particular, 700 unique pairs were created. That is to say, 100 pairs per condition, of which 50 had information on sustainability (labels on) and 50 had no information on sustainability (labels off).

Thereby, seven blocks of trials were run, each with 100 pairs. Half of those pairs, but fully interleaved, had labels giving information on sustainability and half had no information on sustainability (Figure 3). All participants completed the seven blocks of trials and had self-paced breaks in between the blocks. For each trial, participants were presented with a pair of items on the screen, that appeared equidistant to the right and left of the fixation cross at the centre of the screen. Participants were asked to make a response as soon as they made a decision, and pairs were only present for 1,5 milliseconds. When a decision was made, participants clicked the right or the left button of the mouse according to the position of the item on the screen. After the decision was made, the pair disappeared from the screen, and a new pair appeared after the inter-stimulus interval (or fixation cross). The inter-stimulus interval lasted from 1,250 to 1,750 milliseconds across trials.

**Rating Scales & Consumer Choice Selection Screens**

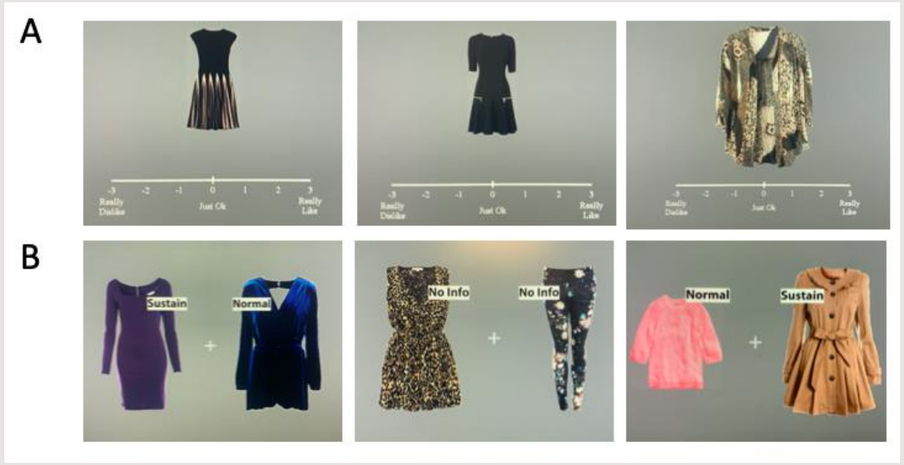


Figure 3.

Experimental task. A**.** Participants were presented with 180 clothing items and were asked to rate these items using a scale that ranged from −3 (really dislike) to 3 (really like) in increments of 1 unit. B**.** For the main task of the experiment, participants had to make choices between two clothing items within a time frame. Items had either information on sustainability (Sustain, or Normal) which represents the labels-on condition, or no information at all (No Info) which represents the labels-off condition.

After participants finished the seven blocks, they were asked to complete a self-report questionnaire in order to understand their explicit attitudes and behaviours regarding sustainability. The questionnaire had the two following questions:

1) On a scale from 0-10, with 0 being 'not at all' and 10 being 'absolutely', is sustainability something that you care about?
2) On a scale from 0-10, with 0 being 'not at all' and 10 being 'absolutely', is sustainability something that you consider directly when making purchasing decisions?



*Behavioural-Data Analysis*

For each participant, we calculated the proportion of sustainable-items choices and the mean reaction times. Significant effects were tested for these two behavioural measures using a 2 (labels-on vs labels-off) × 7 (task difficulty) repeated measures analysis of variance (ANOVA). Hence, we did two different 2x7 ANOVAs, one for the reaction times and one for the proportion of sustainable choices. We also used a correlation analysis to study the relationship between the questionnaire scores and the proportion of sustainable-item choices. This would allow us to understand the relationship between participants' explicit attitudes towards sustainability and their actual behaviours when making the binary-value-based decisions. For this, we calculated the difference between the labels-on condition minus the label-off condition for the choices proportion. Then, we averaged these differences across the seven conditions into a single one. This enabled us to study the relationship between the choices and the questionnaire average responses.

*Results*

In the condition where the labels were off (see the black line in Figures 4 and 5), participants made their decisions solely based on their preference for the clothing items. For both behavioural measures, reaction times (RTs) and proportion of sustainable choices, the results were relatively symmetrical around the indecision point (when both items were equally liked). That is to say that participants selected the sustainable clothing items repeatedly in the cases when the sustainable item was preferred over the non-sustainable item and vice versa. At the indecision point, which represents the most difficult condition, participants' choices were equally distributed between sustainable and non-sustainable items. For the proportion of sustainable choices, the main effect for the rating differences, also called task difficulty, was: $F(6,174)= 46.10$, $p < 1x\ 10\text{-}33$ (see Figure 4 for the proportion of sustainable choices).

In contrast, for the condition in which the labels were on, the sustainability information created a bias on the participants' choices, which we call the sustainability bias. In this case, participants generally chose the sustainable clothing item over the non-sustainable one significantly more in the labels-on block compared with the labels-absent block, $F(1, 29) = 47.51$, $p < 1 \times 10{-}7$.

For the labels-on condition, there were two possible case-scenarios depending on the item that had the sustainable label. The information of the trial could either be 'congruent', when the preferred clothing item had the sustainability label attached, or 'incongruent', when the less-preferred item had the sustainability label attached. There was a significant interaction between the two conditions (labels-on and labels-off) and the item rating differences, $F(6,174) = 5.99$, $p < 1 \times 10\text{-}5$. Here, the sustainability bias became more evident as the incongruence between the sustainability information and the item preference increased. Basically, the sustainability bias was more pronounced when there was a conflict between the preference for the item and the sustainability information (in the case of negative ratings), leading to the asymmetry around the indecision point.

A similar interaction was present in the reaction time data, $F(6,174) = 5.68$, $p < 1 \times 10\text{-}5$. As it can be observed in Figure 5, the reaction time for participants was slower when the sustainable item was not the preferred one (i.e. trials in which the less-preferred clothing item was the sustainable one).

Lastly, there was a small overall increase in the reaction times in the labels-on condition when compared to the labels-off condition, $F(1, 29) = 0.03$, $p < 1 \times 10{-}5$ (see Figure 5). In this case, participants probably spent longer time balancing the information on sustainability and how much they liked the items. Post hoc t tests revealed that this difference was significant (all Ps < .05)

Reaction times also increased with time difficulty, $F(6,174)= 14.89$, $p < 1x 10\text{-}13$, and results also remained relatively symmetrical around the indecision point as it can be observed in Figure 5.



**The Relationship Between Item Rating Differences & Proportion of Sustainable Items**

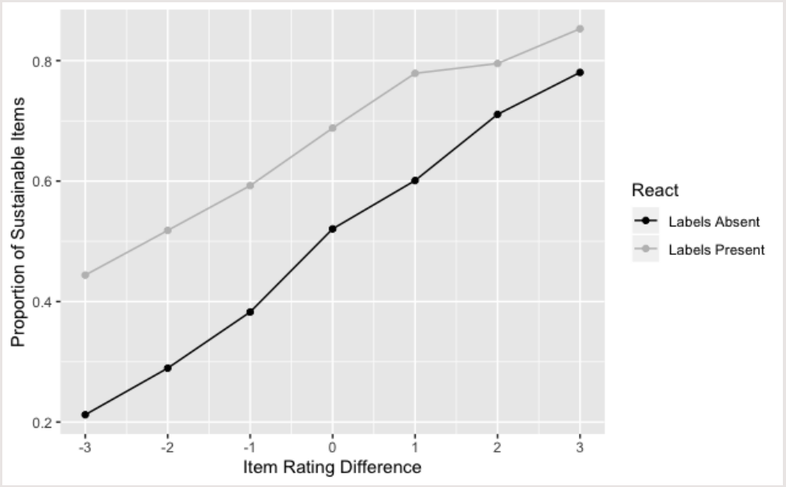


Figure 4.

Behavioural results for the means of proportion of choices of sustainable items (over non-sustainable items) in the condition in which the labels were on (grey line) compared to the condition in which the labels were off (black line). The zero point on the x-axis represents the hardest trials as both items are equally liked or equally disliked (point of indecision). When labels were off, choosing between pairs of items that have a high positive or high negative difference are considered as 'easier', while choosing between pairs of items that have a difference closer to zero, or equal to zero, are considered as 'harder'. When labels were on, negative values for the rating difference represent a clash between the preferred item and the sustainability information (incongruent trial for labels-on). On the other hand, a positive value for the rating difference appears in cases when the preferred and the sustainable item coincide (congruent trials for labels-on).

**The Relationship Between Item Rating Differences & The Mean Reaction Time (ms) When Rating Each Item**

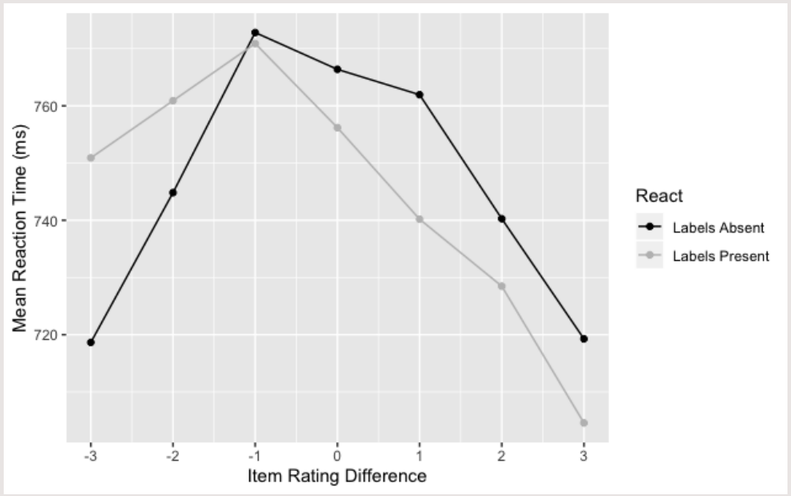


Figure 5.

Behavioural results for the means of reaction times in the condition in which the labels were on (grey line) compared to the condition in which the labels were off (black line).

A Pearson product-moment correlation coefficient was computed to assess the relationship between the explicit attitudes and behaviours (questionnaire scores) and the proportion of sustainable choices. There is a trend towards what we expected. Those participants who had a higher sustainability bias when making decisions, would have higher results in the questionnaire scores. That is to say that, those who reported positive attitudes towards sustainability, actually had a greater sustainability bias. Hence, suggesting that there is a small correlation between consumers' explicit intentions or attitudes and their actual choices [r =0.32, n = 30, p <0.1]. A scatter plot summarizes the results (Figure 6).



**The Relationship Between the Explicit Attitudes & Behaviours (Questionnaire Scores) & The Proportion of Sustainable Choices**

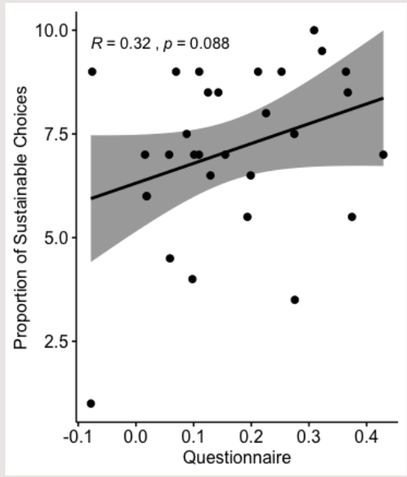


Figure 6.

Pearson product-moment correlation coefficient between the explicit attitudes and behaviours (questionnaire scores) and the proportion of sustainable choices [r =0.32, n = 30, p = 0.08813].

## *Discussion*

### *Results and implications*

Our findings confirm that sustainability information influences the preference-based decision-making process by creating a bias towards sustainable items. This happened either because participants assigned greater weight to values of sustainable items, discounted values of the not sustainable items, or both. This sustainability bias led to a choice bias for items with sustainability labels, with the most prominent bias effects arising when the item preference and the sustainability factor conflicted. As hypothesised, participants made more sustainable choices when sustainability information was available, even when it meant choosing the less-preferred item. Participants also took longer to respond when their preference for the item and the sustainability information were incongruent, as the sustainability bias made the decision harder. These results

are consistent with other studies that examined the relationship between sustainability labels and decision-making behaviours in clothing purchases (Iwanow et al. 2005; Joergens 2006; Sneddon et al. 2009), but also in food consumption (Jaffry et al. 2004; Van Loo et al. 2014; Schäufele and Hamm 2017).

More importantly, our study presents strong support to the idea that sustainability information impacts the decision-making process in value-based decisions, using an objective and quantitative approach. Most of the previous research on the field has studied the nature of these decisions using self-reported questionnaires. However, it has been argued that it is complicated to examine the real attitudes that consumers have about sustainability because consumers tend to give more positive responses than their actual consumption behaviours (Lea-Greenwood 1999). When self-reporting their behaviours, consumers will likely give the socially acceptable response, or what they consider as the 'correct answer', rather their most honest responses (Niinimäki 2010). Since in our study participants had to make time-bounded decisions between two items that they had previously rated, we were able to eliminate the social desirability bias that could have affected the results. Hence, utilising a more objective approach to studying decision-making.

Consumers want a 'win-win' situation which benefits all the parties involved, including consumers getting a good value for their money (Han et al. 2009; Niinimäki, 2010; Jang et al. 2011). Thus, using a 'sustainability approach' creates promising marketing opportunities (Carrigan and de Pelsmacker 2009). According to our results, we also found that there is a relationship between participants' explicit attitudes towards sustainability and their actual behaviours. The more that our participants reported caring about sustainability when purchasing items, the more they actually chose the sustainable option. In the words of Carrigan and Attalla (2001: 577):

> Perhaps new generations of consumers will not only think more ethically, but also act more ethically, and while product value, price and quality will always be key consumer issues, future consumers may also consider good ethics to be equally crucial.



Intriguingly, our results may have significant implications on identifying the influence that information on sustainability has on consumer choices and on informing marketing strategies of the future.

When making everyday purchasing decisions, consumers are exposed to rival products and have to make quick decisions (Philiastides and Rattcliff 2013). Therefore, being able to differentiate products from competing products has become quite challenging (Birtwistle 1998). Providing consumers with information on sustainability has become an essential attribute of marketing strategies for product differentiation and offers an important window of opportunities (Sneddon et al. 2009), especially when targeting future generations (The Nielsen Company 2019).

Additionally, to increase consumer's awareness and their consumption of environmentally sustainable products, apparel firms should increase their educational marketing, because a link between attitudes and behaviours has been showcased. As such, our results indicate that the more customers report caring about sustainability, the more they chose the sustainable item. It would also be necessary for fashion companies to highlight the multiple personal benefits that customers can gain when buying sustainable apparel. Increasing customers' awareness and knowledge might make customers take ownership of their purchasing behaviours and understand the positive impact that they can have on the environment. That is to say, that educating customers can change their attitudes, which may consequently change their purchasing behaviours.

### *Limitations and future research*

Nevertheless, this study is not without its limitations. To start with, all our participants were female university students, whose age ranged between 18 and 25. A previous study reported that gender has an important effect on environmentally sustainable behaviours (Schahn and Holzer 1990). This limits the generalizability of our results and impedes us from drawing conclusions to all the population. Even within the consumers that purchase sustainable items, there is already evidence that supports that distinct groups of ethical clothing purchasers and users exist (Dickson and Littrell 1996; Auger et al. 2003). Future research could use a wider sample that includes males to moderate the effect that

gender has on sustainable purchasing behaviours. Older adults, both male and female, could also be included.

Moreover, although the main task itself was able to measure the extent to which the sustainability bias played a role in consumers purchasing behaviours, in real-life situations consumers are presented with much more information. When purchasing a clothing item, many other factors are affecting the decision-making process such as brand (Philiastides and Ratcliff 2013) as well as price, style, fit, and fashion (Butler and Francis 1997). Henceforth, future studies should take into consideration other attributes of the clothing items that could impact the decision-making process. Accordingly, participants could be presented with a similar experiment, but other product attributes could be added and combined appropriately (e.g. brand, quality, price, etc.). This way, the importance of sustainability in a real-life situation could be better understood and compared with the importance that is given to other attributes.

When studying various attributes, it would be key not to only isolate each of the product attributes, but also to evaluate how consumer choices are eventually based on the combination of weighting the values of all the attributes together. This could be accurately measured using non-invasive neuroimaging techniques (Basten et al. 2010; Gluth et al. 2012). For these reasons, it would be interesting to use electroencephalography (EEG) or functional magnetic resonance imaging (fMRI), to comprehend what is happening in the brain when the decision-making process is taking place. Being able to map the brain areas involved in these preference-based decisions could even clarify whether sustainability alters early sensory representations in the brain, later decision-related processing, or a combination of both.

*Brain Areas Involved*

The binary-value-based decisions that our participants faced involved a comparison process between items' values whereby the relative evidence (the difference in values) was accumulated over time to a decision boundary representing the selected item.

When making these decisions, the human brain may have emphasized the process of distinguishing between in-group and out-group membership. It should be noted that sustainably produced items could have been considered as in-group



items because participants reported caring about sustainability. In-group has been defined as a structure of interpersonal relationships or as a depersonalized social category (Mamat et al. 2014). This emphasis on in-group membership may have happened at a preconscious level, and that is when the sustainability bias played a role. Based on the source, the neural systems within the cortex (medial and lateral prefrontal cortex) could have filtered the information that participants encountered (Ochsner et al. 2005) placing a higher value on the information from the in-group or the sustainable item. The prefrontal's cortex (PFC) has long been suspected to play a crucial role in cognitive control, in the ability to coordinate thought and action according to one's internal goals (Miller & Cohen 2001).

During the preference-based decisions, the ventromedial prefrontal cortex (vmPFC) may have also suffered an increase in activity as this region is responsible for computing the subjective value across different modalities (Plassmann et al. 2007; Rangel et al. 2008; Bartra et al. 2013; Rangel 2013; Clithero and Rangel 2014). As such, the different qualities of an item need to be integrated to construct a valuation signal (Smith et al. 2014), so that the vmPFC can later compare the various choices by weighting the different values attributed to each item (Rangel 2013). A previous study also found that the vmPFC is a critical arbitrator between rewards and adaptive decision-making (FitzGerald et al. 2012), something that might have happened as participants made more and more decisions.

Another brain region that may have impacted the decision process is the orbitofrontal cortex (OFC). The OFT is responsible for encoding the value of an outcome, monitoring behaviours, and ensuring a socially appropriate behaviour. Evidence supporting this comes from patients with damage to the OFT, who despite having intact cognitive abilities, have impaired abilities when making everyday decisions (Wallis 2007; Funayama and Mimura 2012). For instance, a patient with OFT damage spent hours deciding where to go for dinner as he took hours looking at the menu options, the restaurant's tables, the atmosphere, etc. Patients with OFC damage struggle when integrating multiple attributes that are crucial to making a decision (Fellows and Farah 2005). In effect, patients lose the capability of deciding by their gut feelings (Wallis 2007). In our experiment, the OFT may have encoded the value for both outcomes: the sustainable item and the non-sustainable item. Afterwards, despite the sustainable option being the less

preferred one, the OFT may have ensured that a socially appropriate decision was made.

## *Conclusions*

In this paper, we have used a novel approach which integrated an objective and quantitative approach to investigate the impact that sustainability labels have on consumers' binary-value-based decisions. Drawing on the combined results from previous research and our findings, results indicate that sustainability impacts the decision-making process on preference-based choices introducing a positive bias towards the sustainable items. We also examined the relationship between consumers' explicit attitudes towards sustainability and their actual purchasing behaviours. Despite recent evidence suggesting that there is a gap between consumer attitudes and actions, our study found that there is a positive relationship between these two variables. Overall, this research presents the foundation to pursue follow-up work that can better understand and simulate real-life situations to comprehend the intricate role that sustainability plays on preference-based decisions.



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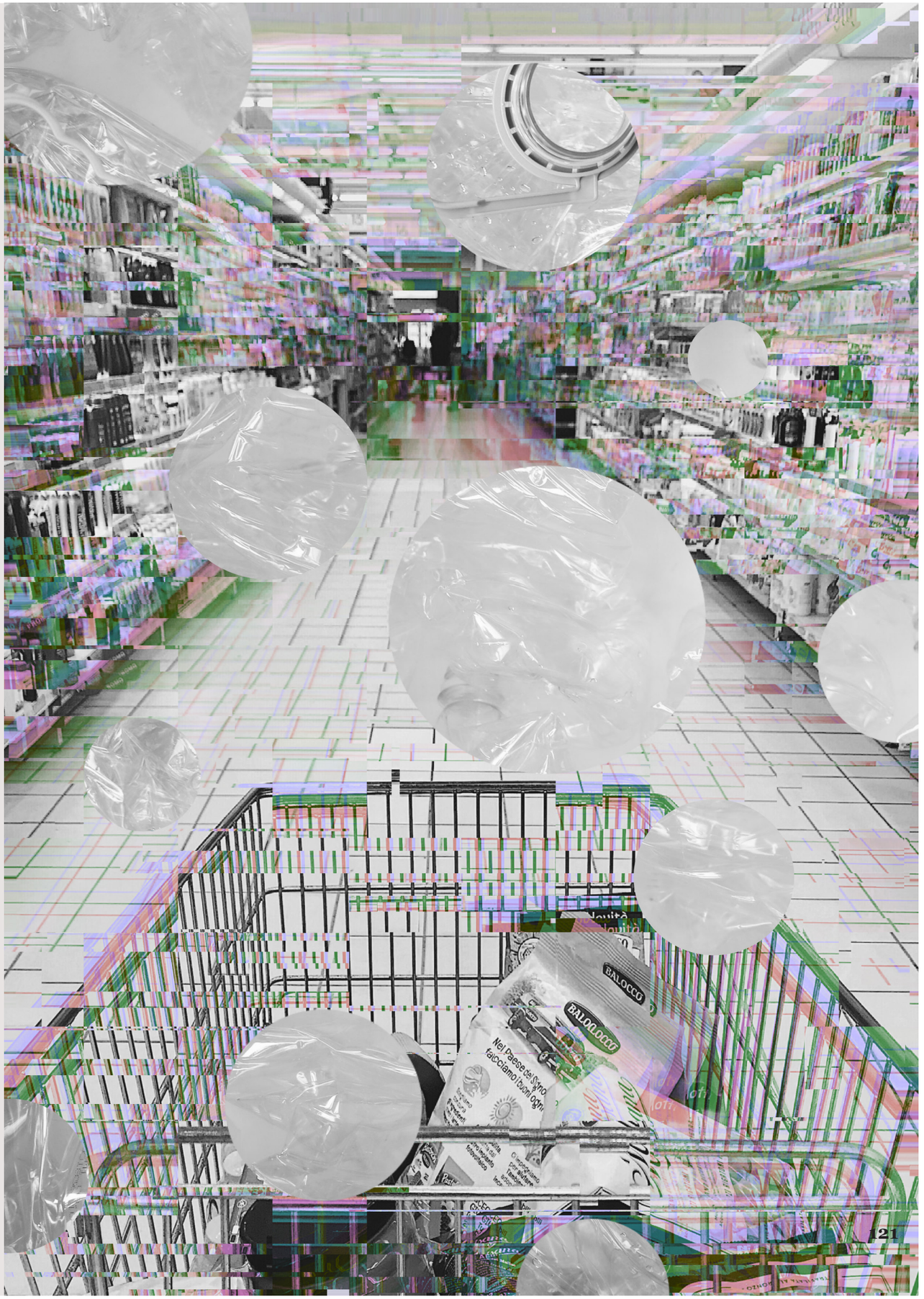

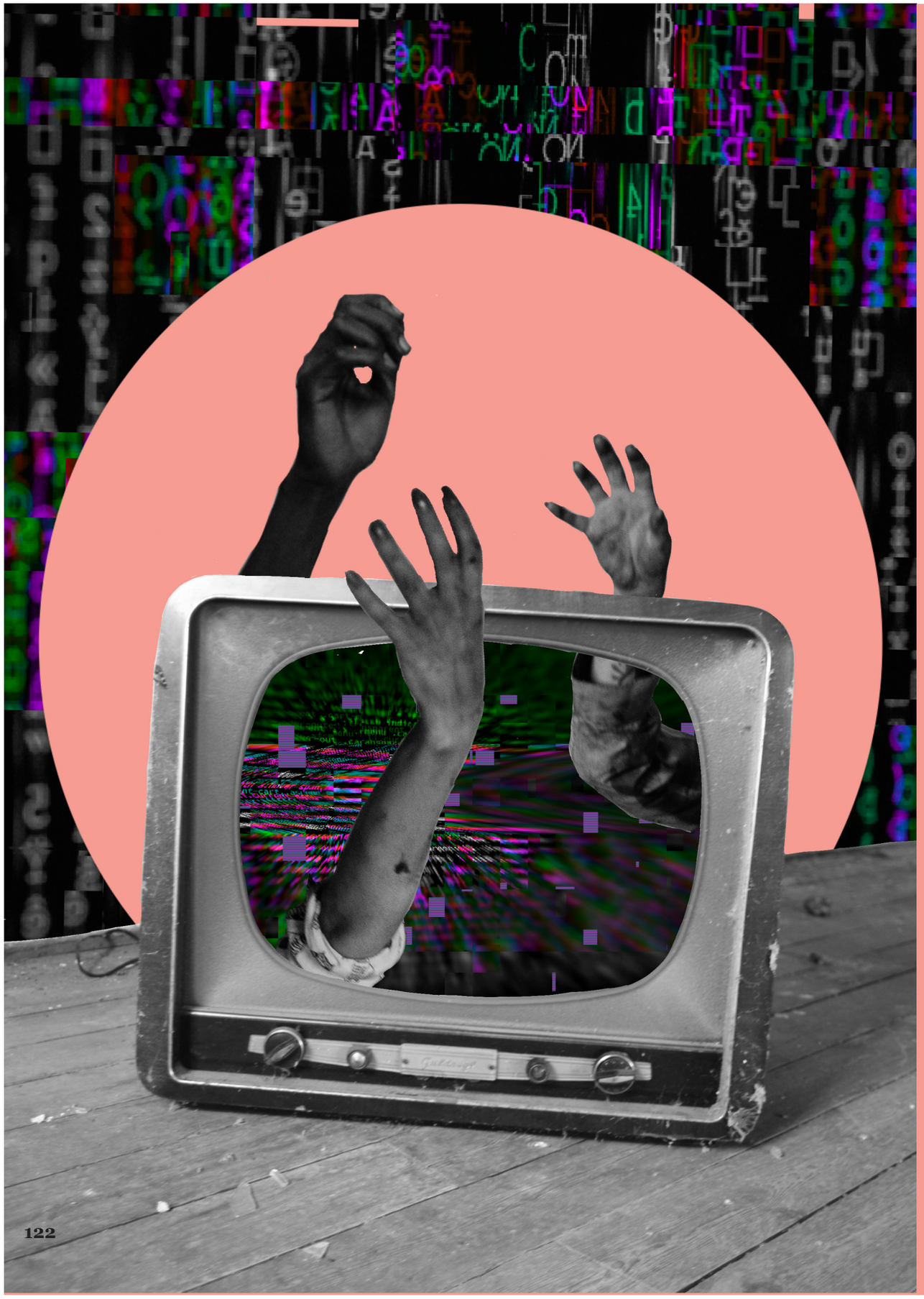

# Coding the Apocalypse: A Scientific Assessment of Realism and Outcome from a Simulated Zombie Outbreak.

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Abstract: *Techniques from statistical mechanics can be utilised to model the spread of disease; they can also be applied to more exotic systems. The purpose of this project is to use such techniques to simulate a zombie apocalypse. The use of a fictitious disease, prevalent in popular culture, provides a novel medium through which the dynamics of the disease can be analysed and highlights the role of statistical physics in modern epidemiological research. Three distinct approaches were implemented to carry out this simulation; a deterministic model comprised of coupled differential equations, a stochastic model based on the Gillespie algorithm and finally an Agent-Based Model. In order to determine humanity's chances of survival, investigation was performed on disease parameters, population size and critical behaviour, which provided a comprehensive analysis of each model. Results indicate that zombies are favoured to be the victors of such a pandemic, although there is hope for humanity if they can stop the spread of the disease early in the simulation. This project ends by considering a more complex version of the initial zombie model, the objective: to determine a situation where the odds move towards mankind's survival.*

## *Introduction*

Computer models are ubiquitous in modern life with applications in the financial industry, government policy and manufacturing (United Kingdom Government 2018: 7). They are also critical within areas of physics including nuclear, particle and astrophysics, and have given rise to computational physics — a discipline of its own. The approach to theory and experiment has also been greatly influenced, as it is now commonplace to simulate a proposed experiment via a computer model before implementing it in the 'real world' (Andalor, Donzelli & Sperndeo-Mineo 1991: 244). Branches of physics that make significant usage of modelling are statistical mechanics and statistical physics. Statistical physics is a broad field and can be used to describe situations if they exhibit a stochastic (random) nature and so encompasses biology, chemistry, neuroscience and even areas of sociology (Raducha & Gubiec 2017: 428). Techniques from statistical physics are also utilised in epidemiology to develop mathematical models that attempt to predict and control infectious diseases (Wang &

Li 2014: 3512; Wang et al 2016: 3). The aim of this project is to implement such techniques to develop a computer model of a zombie apocalypse.

The recent outbreak of a novel coronavirus (COVID-19) and its subsequent classification as a global health crisis ('Coronavirus declared global health emergency by WHO' 2020) underpins the importance of modern epidemiological research. Current research efforts into COVID-19 centre on containing its spread and the production of a vaccine (Li et al 2020: 1203). However, this type of research is not limited to 'real' diseases and interesting work has also been carried out on less traditional systems; examples of this include modelling the spread of rumours and extreme political ideologies (Amaral & Arenzon 2018: 1) and the spread of a zombie invasion (Alemi et al 2015: 1; Munz et al 2009: 133).

Zombies are a useful toy system to investigate the applications of statistical physics, without having to consider the medical details of a true disease. Furthermore, zombies currently dominate in popular culture across a variety of media (Lamb 2013). In film, 'Shaun of the Dead' is considered a cult classic (Shaun of the Dead 2004), and in literature 'World War Z' spent four weeks on the New York Times Best Seller list ('Best Sellers: October 15 2006' 2006). This amounts to an entertaining and engaging subject matter with broad appeal. As such, zombies pique the interest of a typical reader far more than discussion of a 'real-life' disease. Indeed, the appeal of zombies makes them a popular tool for outreach, with zombie epidemics being used to teach mathematical modelling (Logfren 2016: 2).

To achieve the goal of simulating a zombie apocalypse, three distinct approaches were utilised. The first: a deterministic model of coupled differential equations, the Susceptible-Zombie-Removed (SZR) model, that borrows heavily from the traditional Susceptible-Infected-Recovered (SIR) model (Kermack, McKendrick & Walker 1927: 702). The second approach implements the Gillespie algorithm (Gillespie 1997: 2341) to introduce an element of randomness into the simulation, resulting in a stochastic model. The final method of simulation was an Agent-Based-Model (ABM) that is based on the individual interactions between human and zombie, while also incorporating a spatial component represented by a continuous lattice or a populated grid. Analysis of each model is also conducted, with emphasis on disease parameters, population size and critical behaviour. This builds a comprehensive view of the dynamics of each model and determines the situations in which humanity has a chance of survival.



Finally, a more complex version of the initial SZR model is developed and implemented, the objective of which is to determine a scenario which favours mankind's survival.

### *Deterministic Model*

A deterministic model is defined as "one in which the values for the dependent variables of the system are completely determined by the parameters of the model" (Rey 2015: 787). This type of model is implemented in epidemiology as a means of predicting the spread of a disease and their advantage is that deterministic models are well suited to mathematical analysis. Therefore, by carrying out simulations with varied inputs and parameters, one can establish an understanding of the disease in question (Sattenspiel 2009: 27). The first work done on simulating a disease with a deterministic model was by Kermack and McKendrick (1927), who developed the standard SIR model, that provides the basis for the deterministic zombie model employed in this project. The set of ordinary differential equations that describe the SIR model are given below. Here $\frac{dS}{dt}$, $\frac{dI}{dt}$ and $\frac{dR}{dt}$ represent how the susceptible, infected, and recovered populations change with respect to time. While $\beta$ and $\mu$ are constants that govern infection and recovery rate, respectively.

$$\frac{dS}{dt} = -\beta SI \tag{1}$$

$$\frac{dI}{dt} = \beta SI - \mu I \tag{2}$$

$$\frac{dR}{dt} = \mu I \tag{3}$$

### *SZR Model*

The SZR model in this paper follows the same approach as Alemi et al (2015) and is comprised of three distinct classes. S is the susceptible population (uninfected humans), Z represents the infected zombie population and R denotes the removed class (terminated zombies). Again, $\frac{dS}{dt}$, $\frac{dZ}{dt}$ and $\frac{dR}{dt}$ indicates how the respective sub-

populations change over time. Within this model there are two allowed transitions: a human becomes a zombie when bitten by one and a zombie becomes removed when they are 'killed' by a human (in the film 'Shaun of the Dead' (2006) one can kill a zombie by "removing the head or destroying the brain") . Note that this model does not consider the Dawn of the Dead (1978) scenario, in which previously dead humans are reanimated as zombies by some mysterious force. The bite parameter β dictates the probability that a zombie will bite a human, and the kill parameter κ defines the probability that a human will kill a zombie; both β and κ have units of per individual per unit of time. One could consider β and κ to represent the 'strength' of the zombies and humans, respectively. When β is larger than κ we expect to have fast and aggressive zombies, such as those in World War Z, facing off against weak and vulnerable humans. Whereas when κ is larger than β, this describes the bumbling dull zombies observed in Shaun of the Dead, attempting to invade a population of highly equipped special force soldiers. The set of ordinary differential equations that describe the SZR model are:

$$\frac{dS}{dt} = -\beta SZ \tag{4}$$

$$\frac{dZ}{dt} = (\beta - \kappa)SZ \tag{5}$$

$$\frac{dR}{dt} = \kappa SZ \tag{6}$$

From inspection one observes that the SZR model exhibits density dependent transmission. For a density dependent disease, as the carrier density increases, so too will the rate of contact, which in turn results in an increase of disease transmission (Begon et al 2002: 148). Intuitively, it makes sense that the SZR model presents this behaviour: zombies require direct zombie-to-human contact for them to spread their disease successfully, so an increased number of carriers would help to facilitate this. If



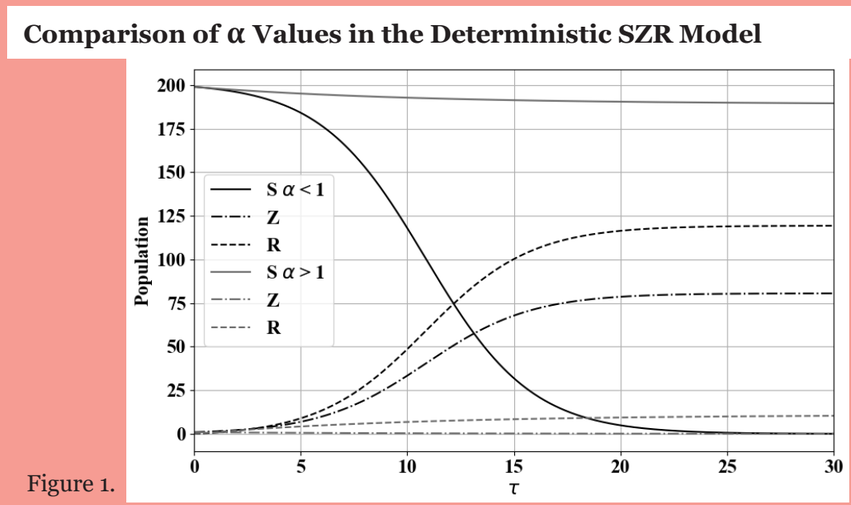


Figure 1. *Results of SZR model for $\alpha < 1$ and $\alpha > 1$. Zombies always win for $\alpha < 1$, with no humans in the end state. Humans always win for $\alpha > 1$ and take minimal casualties before stopping the zombie invasion. Initial population was 199 susceptible individuals and 1 zombie.*

instead the SZR model was to present frequency-dependent transmission, we would require the contact rate to remain constant, regardless of host density. This is exhibited by diseases that allow for indirect transmission, where contact occurs from contaminated surfaces and objects or from vectors such as mosquitoes and rodents (Delaware Health and Social Services 2011). Fortuitously, the humans in the current model need only worry about zombies biting them and do not have to consider zombie rats, or zombies that sneeze and refuse to wash their hands.

*Results and Analysis*

To provide an analysis of the SZR model, the equations that describe it are nondimensionalised such that the time dependence (t) is removed and we now deal with rates of change with respect to τ. This simplifies the solution and helps to focus on the dynamics of the model. This is achieved by introducing a population size N, a dimensionless time parameter $\tau = t\beta N$ and a dimensionless virulence parameter $\alpha = \kappa/\beta$ that determines the relative strength of humans and zombies. By dividing both sides of equations 4, 5 & 6 by βN and substituting as necessary for τ and α we now have:

$$\frac{dS}{d\tau} = -\frac{SZ}{N} \tag{7}$$

$$\frac{dZ}{d\tau} = (1-\alpha)\frac{SZ}{N} \tag{8}$$

$$\frac{dR}{d\tau} = \alpha\frac{SZ}{N} \tag{9}$$

The SZR model differs from a traditional disease (that is, one modelled by SIR) in two respects: first, it arrives at a stable configuration when either the human or zombie population loses (S = 0 or Z = 0), and secondly it permits an analytic solution. The latter is investigated in the work of Alemi et al (2015); significantly they determine that for $\alpha < 1$ zombies will always win and for $\alpha > 1$ humans will always win. The results of the SZR model using these parameters are presented in figure 1.

Results of figure 1 are in keeping with the analysis of α. The simulation for $\alpha < 1$ ends with a final state of only zombies and removed and the simulation for $\alpha > 1$ ends with a final state of only susceptible and removed. Already we have our first condition of human survival, although there is the caveat that it relies on weak zombies and a populace of well trained and well-equipped humans. To better visualise the differences

**Results of SZR & SIR Models**

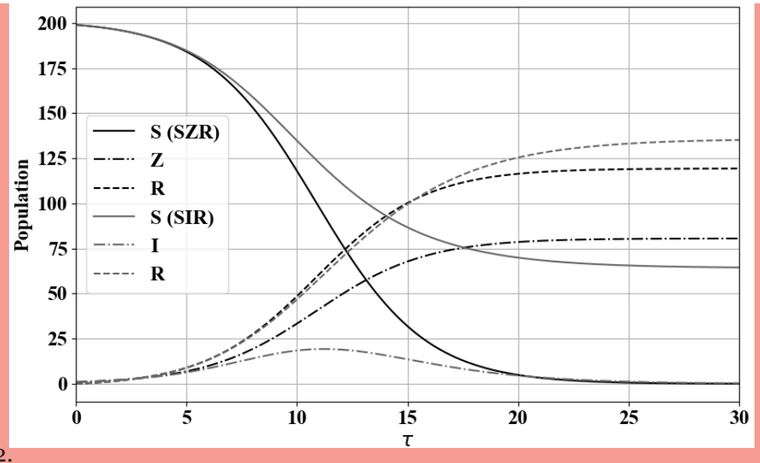


Figure 2.

*Initial population of 200 individuals of which 199 are susceptible and 1 is a zombie/infected. The separate dynamics of the models results in differing end states. Humans are wiped out in SZR whereas a significant number survive in SIR.*



between SZR and SIR models, figure 2 presents the results of both models that were conducted using the same parameters.

We observe that for the SZR model the final state contains zero individuals in the susceptible class, the entire population has been exposed to the disease and there are no lucky survivors. This is not true for the SIR model, where the end state is comprised of the removed state and susceptible individuals who have not been exposed to the disease at all. In this way the SIR model is self-limiting, and the progression of the disease naturally terminates.

*Discussion*

The deterministic SZR model provides a good framework through which to make initial investigations of a zombie apocalypse. However, it is fundamentally limited by its deterministic nature, as the end state is always pre-determined by the input parameters. This results in a lack of realism since no randomness is accounted for in the model. To rectify this, a stochastic approach must be taken.

*Stochastic Model*

The deterministic approach is an effective first step at modelling a zombie invasion. However, by omitting random variations that are present in small populations, it ignores significant scenarios that impact the progression of the zombie horde. For example, even an extremely aggressive zombie may be killed in its first interaction with a human, thereby ending the apocalypse before it even began. Therefore, a more sophisticated zombie model must take a probabilistic approach that can account for these individual human-zombie interactions.

The problem presented here also arises in studying the kinematics of chemical reactions. The law of mass action views chemical reactions to be continuous and deterministic (Gilmore 2006) and so parallels the deterministic SZR model. Clearly this is a reduction in complexity, as it is known that reactions involve discrete random collisions between individual molecules. This mirrors how the SZR model is comprised of many individual conflicts between humans and zombies. Therefore, stochastic methods of simulation have been devised in order to study these reactions in a more realistic manner. One such method is the Gillespie algorithm (1978) and is the foundation on which the stochastic SZR model is built.

*Stochastic SZR Model*

We can reinterpret the SZR model as a chemical reaction system, enabling the application of the Gillespie algorithm to simulate its dynamics. The Gillespie algorithm considers individual human and zombie 'reactions' as discrete events and employs a Monte Carlo step to determine the probability of a human or zombie being the victor of said event. The reaction system has two possible transitions, with two rate equations governing the probability of occurrence:

$$(S, Z) \xrightarrow{\beta SZ} (Z, Z) \tag{10}$$

$$(S, Z) \xrightarrow{\kappa SZ} (S, R) \tag{11}$$

The first transition given by equation 10 describes a susceptible human becoming a zombie after being bitten by one. The probability of this occurring in a small interval of time dt, is given by the bite rate β and the number of individuals in the susceptible and zombie populations (βSZdt). The transition given by 11 describes a human killing a zombie so that it becomes removed, the probability is given in the same way as before, this time using the kill parameter κ (κSZdt).

**Results of Stochastic SZR Model**

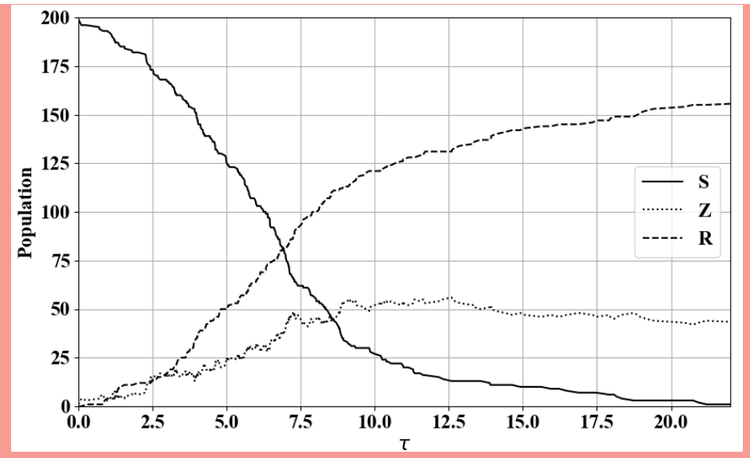


Figure 3.

*Example of a single run of the stochastic SZR model utilising a stochastic approach and the same parameter settings as used in figure 2. The dynamics match that of the deterministic SZR model, but with local variations as individual interactions are simulated.*



*Results and Analysis*

Comparing with the deterministic results from figure 2, it is observed that the stochastic model produces a 'jittery' trajectory, due to local fluctuations in the population of each state. The result of these fluctuations is that at specific points of the simulation, humans can be more effective at killing zombies than as predicted by the standard SZR model. Overall, the stochastic results mirror that of the deterministic model with similar trajectories and end state. Based on these similarities, one may question the necessity of the stochastic model. If the Gillespie based approach merely replicates the results of the straightforward deterministic model what are the benefits of the increased computational demand?

The advantages of the stochastic approach are apparent when considering multiple simulations, as significant deviations between it and the deterministic model are observed. For the deterministic model, an α value <1 represents a supercritical outbreak in which zombies win every time. This is not the case for the stochastic model, where an α value of 0.6 means that zombies win only 40% of the simulations, giving humans a better chance of survival. It is significant that for α of 0.6, 60% of the

**Probability of Extinction with Increasing α**

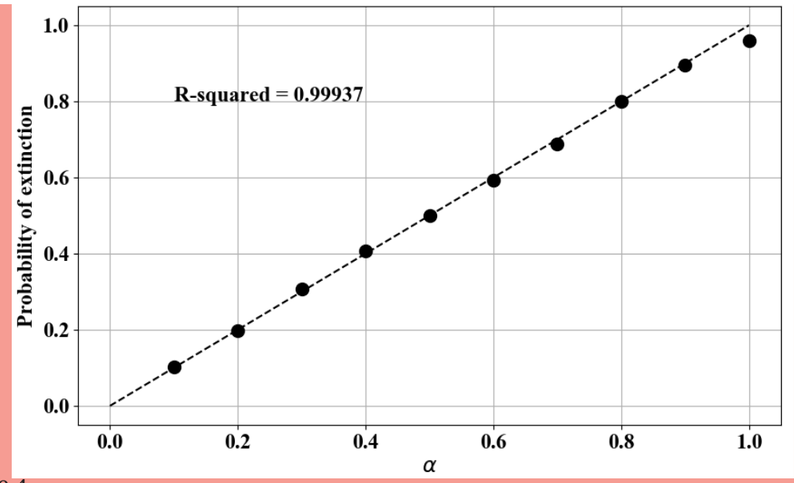


Figure 4.

*Observed extinction probabilities $P_{ext}$ for varied α values. Results for each α come from the average of four iterations of 1000 simulations. The initial state of each simulation was 199 susceptible individuals and 1 zombie. Black circles represent experimental results and the black dashed line represents the expected linear relationship between α and $P_{ext}$. With an R-squared value of 0.99937, it is clear that the experimental results agree extremely well with the expectation that $P_{ext}$ goes with α.*

**Probability of Extinction with Increasing Initial Zombie Population**

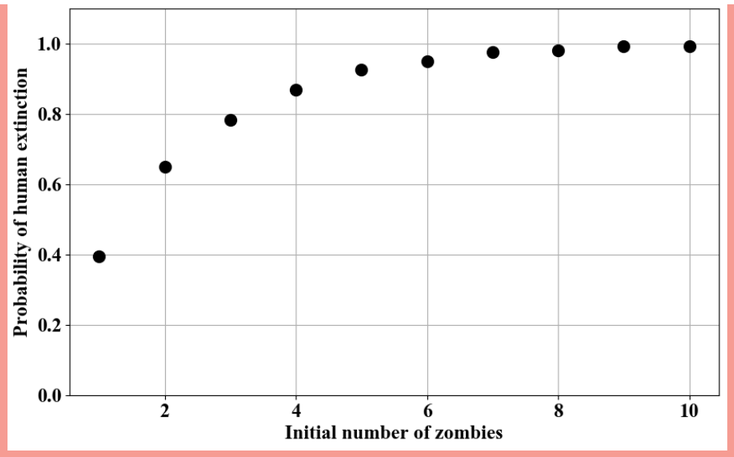


Figure 5.

Observed fraction of simulations that result in human extinction, based on 1000 runs of 200 individuals with α = 0.6 and varying the initial number of zombies. We observe that only small changes to initial zombie population is required to almost guarantee human extinction.

simulations end in zombie extinction. Indeed, from the work of Alemi et al (2015), we expect a linear relationship between the probability of extinction $P_{ext}$ and the value of α. This prediction is tested by varying α over numerous runs and observing the affect this has on $P_{ext}$; figure 4 presents the results of this investigation.

Observations indicate that the cases in which humans contain the outbreak occur when the zombie population is eliminated early in the simulation. It appeared that after a certain number of humans had been bitten, there was no chance of a resurgence in which they could fight back from the brink of extinction, as is so often portrayed in zombie movies. This behaviour was investigated by varying the initial number of zombies and is presented in figure 5.

Figure 5 indicates that the probability of human extinction grows with $P^{N}_{\text{Human Ext}}$ where N is the initial number of zombies, such that we observe an exponential increase in the number of human extinctions as the initial number of zombies increases. Each zombie represents a new chain of transmission that must be eliminated so that the outbreak can be contained. Figure 5 demonstrates that with just three zombies the chance of containment falls to 20% and with five zombies the outbreak is essentially at the point of no return. This mirrors problems experienced in modern epidemiology



**Distribution of Zombies Present in the End-State**

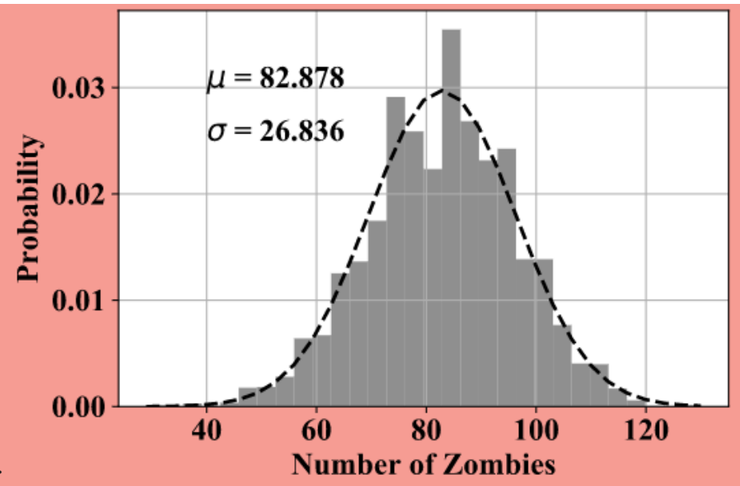


Figure 6.

*Histogram displaying number of zombies in the end-state for 10,000 runs of the stochastic SZR model with α =0.6. Displayed are the 40% of runs where zombies 'won' as humans were unable to contain the outbreak. From the histogram we observe a normal distribution centred at 83.*

when dealing with local transmission of a disease, stressing the importance of early identification, containment, and tracing. A final implication of the stochastic model is that the end-state is no-longer fixed, which can be observed from figure 6.

In the deterministic model the end state contained 81 zombies and no surviving humans. This is a stark difference to the stochastic model, where the number of zombies remaining is a normal distribution centered at 83. The fact that the distribution centered close to 81 is interesting, as it indicates that the dynamics of the deterministic model are generally maintained in the stochastic case.

*Discussion*

The stochastic model is an improvement over the deterministic model as it introduces increased complexity (the element of randomness) and realism (the individual human-zombie interactions) to the simulation. Most notably, it allows for the possibility of humanity containing the zombie pandemic even in the case of $\alpha < 1$, which previously represented a supercritical outbreak. An output of this work is to identify humanity's best chances of survival for the outbreak case, so already there is reason to be optimistic that zombies will not spell the end of civilisation. Unfortunately, this model is not without its limitations: the lack of a spatial factor in

considering how the disease spreads from one individual to another. A more realistic model must include said spatial factor and for this an Agent-Based approach is implemented.

*Agent-Based-Model*

A significant failing of both the deterministic and stochastic SZR models is the lack of a spatial component in considering how the zombie invasion spreads. The implication of this is that the previously studied populations were 'fully-connected', in that any zombie could bite any human with equal probability. This is a striking departure from reality, as it suggests that a zombie in London could bite a human in Glasgow. Furthermore, due to the mechanics of the models, the interactions between humans and zombies are influenced by the size of the entire respective populations. Therefore, a zombie attempting to bite a human is more likely to be successful if there is a larger total number of zombies, regardless of where these additional zombies are situated.

Techniques from network science (Vespignani 2018: 528) have been applied in fields such as neurology, social science, and statistical physics (Danon et al 2010: 8). These techniques can be readily applied to epidemiology and a variety of methods can be implemented in the study of the spatial spread of a disease. Diseases such as influenza can spread rapidly across the globe due to easy infections and connections provided by long distance flights. Humanity is fortunate as this is not the case with the zombie pandemic; barring the somewhat unlikely scenario where a zombie successfully boards a plane, infects all the passengers and then arrives at its destination without the plane falling from the sky, due to zombie-related malfunction. This is an important distinction to make, as it adjusts which approach must be taken to most accurately model how the zombie disease spread.

*Small World Lattice Approach*

A forest fire presents a real-life parallel of how the zombie disease spreads across a population; via direct contact, short connections and in two-dimensions. As such it is sensible to adopt the same small world lattice approach as utilised in modelling forest fires (Alexandridis et al 2011: 635).

The implemented model makes use of a two-dimensional square lattice where each node of the lattice contains an agent that represents an individual. An individual exists in one of three states: S, Z or R. Zombies can bite or be killed by a susceptible human in the four adjacent sites; therefore, interactions occur via nearest neighbour bonds. Following from the stochastic model, rate equations describe the possible interactions. $\beta Z$ (where $\beta$ is the bite parameter and Z is the number of nearest zombie neighbours) describes the probability a human is bitten and $\kappa S$ denotes how often a zombie is killed by a human (where $\kappa$ is the kill parameter and S is the number of nearest susceptible neighbours). At the start of a model step, each agent is randomly activated; if the agent is a susceptible individual, they will check their neighborhood and if zombies are present, a 'battle' will occur with the probability of victory given by the rate equations. The model was developed with the python Agent-Based modelling library MESA (Mesa: Agent-Based modelling in Python 3+ 2016).

Varying $\alpha$ in the lattice model results in considerably varied behaviour. While it follows the general trend of the stochastic model, in that smaller $\alpha$ indicates a more aggressive outbreak, the trend is no-longer linear, and a critical value emerges. Figure 7 identifies the critical value. The critical value is identified to be $\alpha_c \sim 0.83$, as it is the value beyond which zombies no longer dominate the end-state. After this point zombies comprise of less than 50% of the final population, indicating a phase

**Identifying the Critical Point**

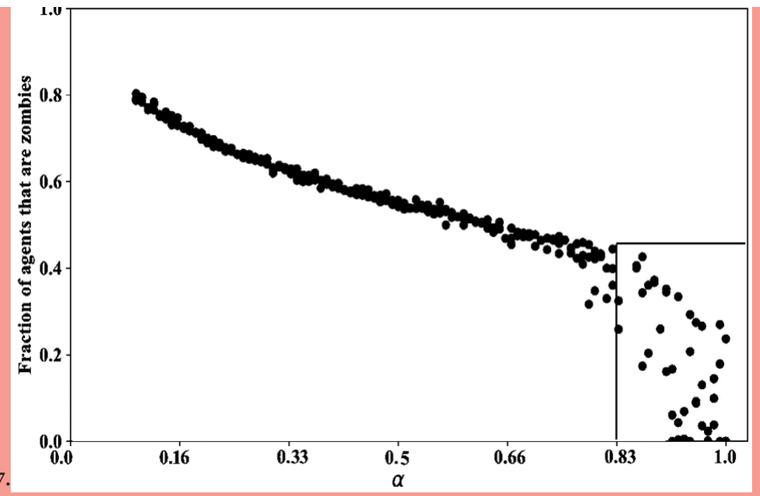


Figure 7. *The effect of varying α on the fraction of agents that are zombies in the end state. 300 simulations of 10,000 individuals on a 100 x 100 lattice were carried out to generate these results. The box indicates the results where the critical point has been exceeded.*

transition between a zombie apocalypse and human survival. Below $\alpha_c$ we have a situation where zombies can spread across the entire lattice, whereas above $\alpha_c$ humans are more effective at containing the infection. This behavior is visualised in figure 8.

**Lattice End-States for Different Values of α**

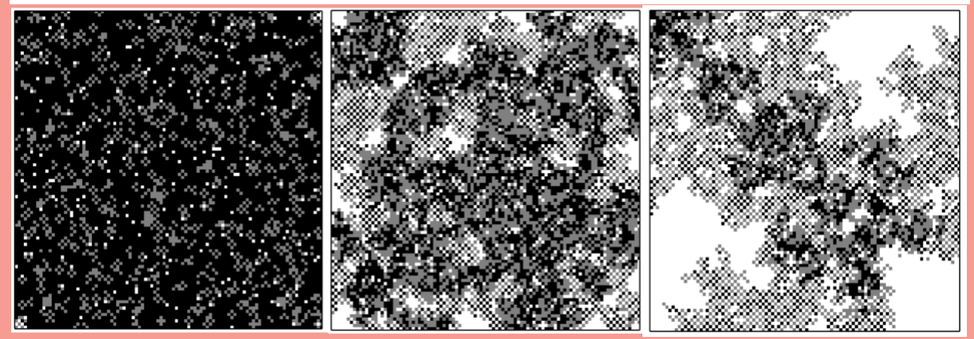

Figure 8.

*From left to right: lattice end-state for super-critical outbreak ($\alpha = 0.1$), outbreak at the critical value ($\alpha = 0.83$) and contained outbreak ($\alpha = 0.95$). White points are humans, black points are zombies and grey points represent removed zombies. The simulations were carried out with 10,000 individuals on a 100 x 100 grid. The patient zero zombie is placed in the centre of the lattice.*

In the supercritical outbreak case zombies dominate the entire lattice, with large connected regions demonstrating how effectively they were able to infect the lattice. While there are numerous patches of the removed state, these are small and mostly isolated indicating a poor fight back by the human population. Significantly, there are surviving humans in the end-state which is a notable deviation from the previous models where either humans or zombies are eliminated. Unfortunately for these survivors their existence is very much a post-apocalyptic one, with only 234 surviving humans (2% of the initial population) limited to single sites.

The critical value case presents a far more balanced picture between the three sub-populations. Although the number of zombies is still large, the number of terminated zombies is very similar. The parity between these states demonstrates how even the conflict between human and zombie is at the critical value. The most pronounced difference between the supercritical and critical values is the greater number of surviving humans, with significant communities observed at the edges of the lattice. Numerous pockets of human survival are also observed towards the center of the lattice, a common feature of these pockets is that they are surrounded by terminated zombies. This draws parallels to the forest fire model, where fire breaks and burned trees are used to prevent the spread of a fire, dead zombies are used as a morbid protective barrier for humans.



In the contained case, large populations of humans untouched by the spread of the disease are present, with over 5000 survivors in total. These patches dominate the lattice and represent areas where humans have been particularly effective in fighting zombies. A non-trivial number of zombies are still present, mostly concentrated in the centre of the grid due to the disease originating from this area. However, for each zombie they are matched, if not exceeded by the number of defeated zombies that surround them. In each case, we observe 'emergent behavior' as the agents on the lattice interact to form complex fractal patterns, despite their individual interactions being governed by simple rules.

### *Small World Inhomogeneous Lattice Approach*

Utilising an inhomogeneous lattice is an alteration of the simulation that results in another step towards realism. The previous approach results in an extremely high population density that favours the density dependent zombie disease. Furthermore the 'barriers' of dead zombies that protect humans seem far-fetched, as zombies are often presented as adept at breaking down or circumventing physical impediments in film and literature.

**Zombie Progression Across the Inhomogeneous Lattice**

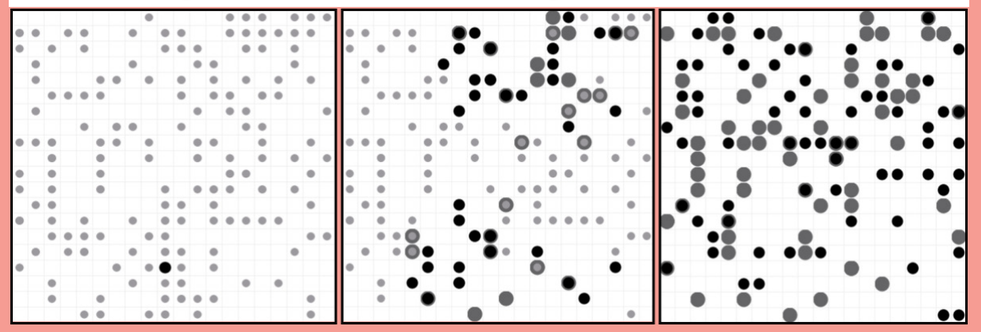

Figure 9.

*The progression of the zombie infection in the small world inhomogeneous lattice. Left image is the initial lattice with 199 susceptible agents (light grey circles) and 1 zombie (black circle). Middle is an intermediate state of the lattice; at this point the susceptible population have failed to contain the outbreak. Right is the final state of the lattice comprised entirely of zombies and removed agents (dark grey circles). The grid was 20 x 20 in size and $\alpha = 0.6$.*

The inhomogeneous lattice corrects for this by introducing empty lattice nodes that allow the human population to be more spread out, areas of greater density are also possible as multiple individuals can inhabit one point. Zombies are now able to

diffuse across the grid acting like a true carrier of a disease, where previously the disease spread through chains of individuals while the zombies themselves remained motionless (similar to how a wave propagates through a medium). When a zombie enters a site that contains a human, they will interact based on the same rate equations used in the initial lattice model to determine a 'winner'. For this simulation humans remain stationary, as it is probable that a zombie outbreak will cause a shutdown of transportation networks.

Clearly, moving to an inhomogeneous lattice has had a significant effect upon the outcome of the Agent-Based SZR model. In the homogenous case the end state was comprised of all three sub-populations. This is no longer possible, as once again the end state indicates a clear winner between humans and zombies: either humans contain the outbreak in the early stages or zombies spread through the entire lattice, eliminating the human population. Interestingly, the behaviour exhibited here mirrors the predictions of the stochastic model, which is observed in figure 10.

**Results of Inhomogeneous Lattice Model and Distribution of Zombies in the End-State**

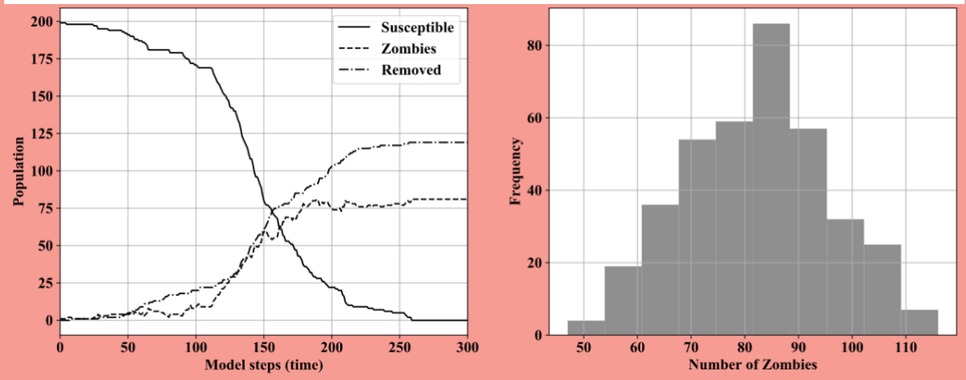


Figure 10.

*Left: trajectories for single run of small world inhomogeneous lattice model; trajectories here are visually similar to stochastic model indicating the models produce similar behaviour. Right: distribution of number of zombies in final state for 1000 simulations of the small world inhomogeneous lattice model. In 40% of the simulations the zombies overwhelm the human population and are victorious; again, exhibiting the same behaviour as the stochastic model. Initial population of 199 susceptible individuals and 1 zombie with $\alpha = 0.6$ for both cases.*

The trajectories presented in the single run track closely with those of the stochastic single run, the only significant difference being the increased time scale over which they occur (which is logical as the zombies now have to travel through space to be able to bite humans). Furthermore, the histogram of multiple runs of the inhomogeneous model is very similar to the stochastic model, exhibiting a Gaussian distribution centered at z=83. The significance of these findings is highlighted by considering the 'robustness thesis' (Huppert & Katriel 2013: 1000). Comparisons can be made between the predictions of a simplified model, and with those made by a more elaborate model (that includes features that the simple model did not). If similar estimates are made, then we gain confidence in the robustness of the simplified model. Therefore, given the very close alignment between results of the stochastic and inhomogeneous lattice models it is concluded that the predictions of the stochastic model are robust, despite not including a spatial factor.

*Discussion*

The inclusion of a spatial factor introduces an increased degree of realism and character to the simulation; this is important as it makes the model less abstract and easier to conceptualise. Instead of systems of equations we now deal with agents that more closely represent humans and zombies, which gives more credence to any predictions that are made. Unfortunately, this increased realism has not improved humanity's chances of survival, indeed it appeared to have the opposite effect. In the case of the homogeneous lattice, the $\alpha$ value that favoured human survival increased to $\alpha > 0.83$ as it no longer followed the linear response of the stochastic model. The results were even more disappointing in the inhomogeneous lattice case, as it removed the possibility of humans surviving in an outbreak case and reaffirmed the predictions of the stochastic model, due to the robustness thesis. Therefore, adaptions must be made to the base SZR model to tilt the odds in favour of humanity.

## *Adapted Models*

The base SZR model has now been implemented via deterministic, stochastic, and Agent-Based approaches. The results of these implementations are clear, and we are yet to determine a model (without large $\alpha$) where the survival of humanity is favoured. Reasonable adaptions must therefore be made to the SZR model. The intention of which is to increase realism and the chances of human victory.

*Deterministic Adaptions*

The first stage of altering the SZR model follows the work of Aron and Schwartz (1984: 666) and extends the model by including a latent 'exposed' state (E). This exposed state denotes a human who has been bitten by a zombie but is yet to join the ranks of the undead, as such they are not symptomatic or infectious. After some time, governed by the latency constant $\eta$, the exposed individual will succumb to the disease becoming a zombie that will go on to try and infect susceptible individuals. The purpose of the exposed state was to bring the model in-line with zombie diseases commonly presented in media, such as in 'Shaun of the Dead' where a human could exist in an exposed state for several hours. Inclusion of the exposed state forms the SEZR model, the set of differential equations that describe it are presented below. As before, these equations describe the rate of change of a parameter with respect to time and S, Z & R indicate a susceptible, zombie and removed individual, respectively.

$$\frac{dS}{dt} = -\beta SZ \tag{12}$$

$$\frac{dE}{dt} = \beta SZ - \eta E \tag{13}$$

$$\frac{dZ}{dt} = \eta E - \kappa SZ \tag{14}$$

$$\frac{dR}{dt} = \kappa SZ \tag{15}$$

The major difference here is that equation 5 of the SZR model has essentially been split across two different populations. It is now the exposed state that reduces the susceptible numbers and the zombie population is drawn from those exposed individuals becoming zombies, minus zombies killed by humans. The exposed state results in a more complex and realistic model but does little to improve the chances of human victory; to account for this the 'quarantined' state (Q) was implemented, a modification adapted from Tomczyk (2015: 26). The quarantined state represents an exposed individual, or zombie that has been isolated or captured, after a time determined by the recovery constant $\Omega$, that individual is considered cured and transitions back to the susceptible population. As it is easier to isolate a cooperating exposed individual than it is a rabid zombie, the likelihood of an exposed individual becoming quarantined (as per the exposed quarantine constant $\xi = 0.1$) is greater than a zombie becoming quarantined (given by the zombie quarantine constant $\sigma = 0.05$). Inclusion of the quarantine state forms the SEZRQ model, the differential equations that describe it are presented below.

$$\frac{dS}{dt} = -\beta SZ + \Omega Q \tag{16}$$

$$\frac{dE}{dt} = \beta SZ - \eta E - \xi E \tag{17}$$

$$\frac{dZ}{dt} = \eta E - \kappa SZ - \sigma Z \tag{18}$$

$$\frac{dR}{dt} = \kappa SZ \tag{19}$$

$$\frac{dQ}{dt} = \xi E + \sigma Z - \Omega Q \tag{20}$$

The key modification in this set of equations is that the susceptible population can be replenished somewhat, due to the addition of quarantined individuals becoming normal humans again. Changes are also made to the zombie and exposed conditions as their numbers are reduced by the newly introduced quarantined state.

*Results and Analysis (I)*

In the SEZR model the exposed latency period may have been great enough that humans were not overrun and could therefore contain the zombies at an early stage. This was not the case, as once again there are no susceptible individuals in the end state, signaling humanity's demise.

**Results of Adapted Deterministic Models**

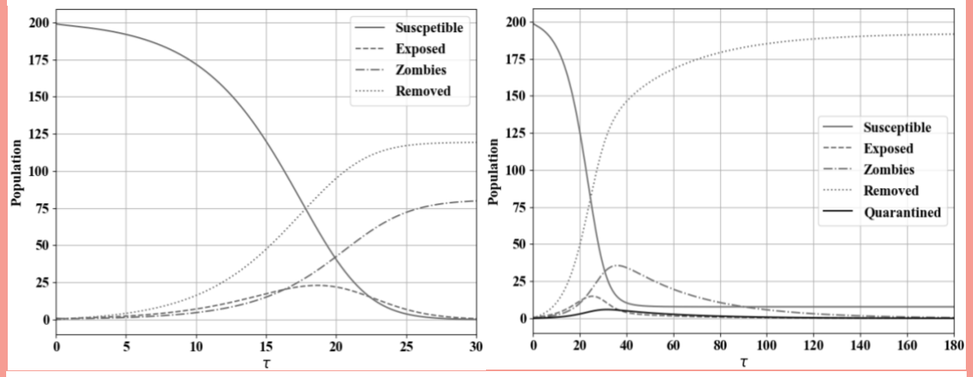


Figure 11.

*Deterministic trajectories for SEZR (left) and SEZRQ (right) α = 0.6 in both cases. The SEZR model results in a human defeat, whereas the SEZRQ model allows for a small number of humans in the final state and no zombies.*

Conversely, the SEZRQ model marks a significant improvement for the susceptible population, with it being the first deterministic model that has surviving humans in the end state. The quarantine measures limit the zombie population to a small peak, containing the outbreak, before it gradually declines to zero. Unfortunately, despite allowing for survivors, the deterministic SEZRQ model still paints a bleak picture for humanity. With only 8 humans in the end state, the mortality rate of the zombie apocalypse is 96%, which if scaled to real human populations (even at the level of countries or cities) it would result in millions of deaths and certainly the breakdown of human society. We therefore look to implement this model using Agent-Based simulations, specifically the small world inhomogeneous lattice approach, in the hope that the increased complexity for the sake of realism will result in a more favourable outcome.

*Agent-Based Adaptions*

The Agent-Based SEZRQ model builds upon the simple inhomogeneous SZR model. Interactions between human and zombie follow the same approach, with 'fights' occurring when a zombie enters a node occupied by a human(s) and the probability of the winner based on the α value and respective number of nearest neighbours. For the exposed and quarantined transitions, a more intuitive method, that does not rely entirely upon rate equations, was implemented.



The latency period of a real disease is not constant, instead it manifests as a range of values, with different patients starting to exhibit symptoms at different times. To replicate this, instead of determining the length of exposure time with a constant, each exposed agent is given an 'exposure counter' which is an integer drawn randomly from 1 to 20. At the end of each simulation step the exposure counter decreases by 1, with the exposed becoming a zombie when it reaches zero. A quarantine represents a geographical location where patients with a disease are physically isolated from the population. To mimic this in the simulation, a small number of nodes of the lattice are specified as a 'quarantine zone'. If an exposed or zombie agent wanders into such an area, they have a chance of becoming a 'quarantined patient' as per the ξ (for exposed) and σ (for zombies) constants. A quarantined patient will then move across the grid and will transition back to a susceptible after 5 model steps (this is to prevent a buildup of stationary susceptible agents in the quarantine zone).

*Results and analysis (II)*

The Agent-Based implementation of the SEZRQ model exhibits the same general shape of the deterministic case, with no zombies present in the final state and many

**Result of Agent-Based SEZRQ Model**

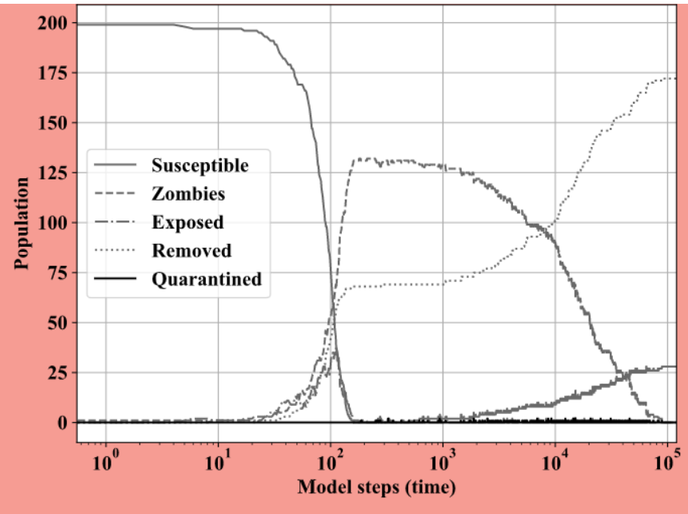


Figure 12.

*Left: trajectories for Agent-Based SEZRQ model, one quarantine zone was used and α = 0.6. Results indicate that humans are the victors; more significant is that human numbers have recovered in the latter stages of the simulation. The simulation takes place over a much longer time scale as the quarantine measures allow humans to constantly make progress against the zombie horde.*

terminated zombies (removed). Initially the susceptible trajectory is also very similar, with a rapid decrease in the early stage before it levels off. At this point the models deviate, as in the ABM case the susceptible population begins to recover. This is unique in the models analysed in this paper, as it has always been the case that once humans are unable to contain the outbreak they are overrun, and their extinction is guaranteed.

The recovery of the human population enables a more favourable end state for the Agent-Based SEZRQ model. For multiple runs of this simulation the number of susceptible individuals in the end state ranges from 20 to 39, with 30 being the mean value. Although this still represents a fatality rate of 80-90%, it is still an improvement on the 96% of the deterministic case. It is also worth noting that this is a 'worst case' scenario, with only one quarantine zone, where the likelihood that an exposed or zombie becomes quarantined is significantly reduced. The fatality rate from 30 simulations carried out with 20 quarantine zones (a minimal 5% of the grid), ranges from 67-79%. Therefore, if the theoretical government combating the zombie crisis can mobilise quickly and establish large quarantine zones the outlook for the human population is quite optimistic (and that is without considering the case where the invasion is terminated early and the fatality rate is ~2%).

*Discussion*

With the SEZRQ model we have finally established a situation in which the survival of humanity (at $\alpha = 0.6$) is favoured. Considering the robustness thesis, we can conclude that the deterministic SEZRQ model is indeed robust, as despite the variation in susceptible end state, the general trends exhibited by it and the Agent-Based approach are similar, improving our confidence in the model. The way that the Agent-Based SEZRQ model was implemented stresses the flexibility of this type of modelling. Alterations could be made without having to manipulate complicated equations and moreover the adaptions enhanced the realism of the simulation, with a more physically grounded approach. Although the quarantine used in this model is highly idealised (where quarantined patients have a 100% chance of being cured), it does go to demonstrate how effective a quarantine can be in fighting the spread of a disease. This holds true in real life, as the countries that have had the most success in containing the recent COVID-19 outbreak have done so via mass testing and isolation of those positive cases (McCurry 2020)



*Conclusion*

Through the framework of developing a computer model of a zombie apocalypse, various aspects of statistical physics have been applied and investigated.

The first method of modelling was the deterministic SZR model that utilised coupled differential equations to determine the progression of the zombie disease. Comparison of the SZR to the SIR model revealed that a zombie apocalypse would be far more deadly than a standard disease, with an outbreak case ($\alpha < 1$) resulting in no surviving humans. To include an element of randomness, a stochastic SZR model was developed. This treated the transitions between states as a two-body chemical reaction, enabling the Gillespie algorithm to simulate how the apocalypse progressed. This added character to the model, where in the deterministic case the result was predetermined by the selected parameters, the stochastic SZR model gave humanity the chance of eliminating the zombies early on. Finally, moving to an Agent-Based approach meant that the system was no longer considered 'well-mixed' allowing for the influence of a spatial factor to be considered. In the homogeneous lattice case, evidence of a phase transition was identified and the behaviour of the model before, at and beyond this critical point was investigated. The inhomogeneous lattice case was also useful, as it allowed for consideration of the 'robustness thesis' which indicated that the stochastic SZR model was indeed robust and therefore produced reliable results.

A common thread throughout this work is the implication of each model with regards to the chances of human survival. While there were glimpses of hope, these relied on lucky humans, weak zombies or existing in parallel with zombies akin to the 'Walking Dead' (The Walking Dead 2010). The SEZRQ model, that built upon the SZR model with an exposed and quarantined state, was developed to remedy this. This model was applied to both a deterministic case and to an Agent-Based inhomogeneous model case. Results from the model are far more positive, with humanity successfully containing the zombie outbreak, and with enough quarantine zones some semblance of a functioning society remains. Therefore, in the (unlikely) case of a real zombie outbreak, it follows that the leaders of the world should implement a similar approach.

Although a zombie apocalypse is fictitious, the work done in this paper is still relevant, as it stresses the importance of statistical physics and the various applications it has within epidemiology. With the recent outbreak of COVID-19, governments are using computer models to make decisions that could potentially save or condemn tens of thousands of human lives. Significantly, a model developed at Imperial College London (Ferguson et al 2020: 1), that advocates for greater use of non-pharmaceutical interventions, has had a significant impact on the United Kingdom's approach to containing COVID-19 (Bruce-Lockhard, Burn-Murdoch & Barker 2020). With the potential for such drastic impact, it is critical that these models are developed to a high standard to ensure accurate predictions.

Future work on this project would be to extend the Agent-Based approaches to consider a geographical area, thereby simulating the spread of disease across cities, countries, and continents by utilising GIS data (Alemi et al 2015). This was attempted with the Mesa-Geo Python package but was unsuccessful as the package had not been maintained and was incompatible with the current python release. NetLogo is a coding language designed specifically for ABM and includes built-in GIS support. Although it would require converting the Python code to a different language, this is a viable option to implement the geographical simulations.



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## Appendix

Github repository for all Python code written for this report.

https://github.com/conal97/zombie_physics



# Wrongful Convictions Caused by Mistaken Eyewitness Identification Evidence: is Corroboration the Answer?

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*Abstract: This paper challenges the generally accepted notion that the corroboration requirement in Scots law is a sufficient safeguard against the risk of wrongful conviction. This view is challenged in particular regarding eyewitness identification evidence, where the corroboration requirement is applied in a relaxed manner by the courts despite this type of evidence's inherent unreliability. The article identifies the psychological and practical risks associated with eyewitness identification evidence. It is recognised that some of the risks are outwith the control of the criminal justice system, such as the 'weapon focus' effect and cross-racial bias. However, the corroboration requirement fails to address the ways in which the pre-trial identification process can exacerbate the operation of these psychological phenomena, and does little to prevent jurors' over-reliance on this problematic evidence. Reforms are then recommended to prevent mistaken eyewitness identification leading to wrongful convictions. These reforms include legislatively enhancing pre-trial identification procedure to reduce suggestibility and introducing a mandatory judicial direction when eyewitness identification evidence is introduced at trial. Judicial education regarding the risks associated with eyewitness identification evidence is also imperative if the latter of these reforms is to be effective.*

## *Introduction*

Mistaken eyewitness identification has been identified as the leading cause of wrongful conviction in the US, contributing to approximately 76% of wrongful convictions revealed by post-conviction DNA evidence (Garrett 2012: 48). Psychological research has shown the impact of several variables that result in this evidence being unreliable. The fallibility of human memory is compounded in practice by misconceptions held by factfinders about the reliability of eyewitness identification evidence, leading to their misguided over-reliance on it.

Corroboration has been hailed as 'an invaluable safeguard in the practice of our criminal courts against unjust conviction' (Morton v HM Advocate 1938: 55) and has been accepted in Scotland as a sufficient safeguard against mistaken eyewitness

identification (Ferguson 2014: 44-45). However, corroboration in its current form as applied by Scottish courts is an insufficient answer to the risks associated with mistaken eyewitness identification. A two-pronged approach could enhance reliability and mitigate over-reliance by jurors: pre-trial identification procedure should be subject to legislative procedural guidelines to reduce suggestibility, and there should be a mandatory judicial direction regarding eyewitness identification evidence if it is introduced at trial, the substance and timing of which should be regulated.

### *The Corroboration Requirement*

The Scots law corroboration requirement requires two independent sources of evidence for each crucial fact, including the identity of the accused (Davidson 2007: para 15.10). This can be satisfied by positive identification of the accused by two witnesses, but may also consist of wholly circumstantial evidence (i.e. evidence that does not directly identify the accused but from which the identity of the perpetrator as the accused can be inferred) (Davidson 2007: para 15.12).

As such, the courts have taken a flexible approach to what can amount to corroboration in this context, stipulating that once a positive identification has been made, 'very little else is required' (Ralston v HM Advocate 1987: 472). This flexibility is exhibited extensively in case law, where corroboration has been satisfied by a second witness testifying that the accused has the same hair colour as the perpetrator (Murphy v HM Advocate 1995), or merely that the accused resembles the perpetrator in 'basic looks' (Adams v HM Advocate 1999). Although this relaxed approach can be justified for other reasons, such as in the prosecution of sexual offences where evidence identifying the perpetrator may be scarce, it considerably weakens corroboration as a safeguard against wrongful conviction resulting from mistaken eyewitness identification (Davidson and Ferguson 2014: 17).

### *Psychologically Identified Risks of Eyewitness Identification Evidence*

The fallibility of human memory and the factors affecting accurate identifications have been emphasised by psychologists since the early 20th century (Wells et al., 2006: 47). These factors can be categorised as estimator and system variables (Simon, 2012: 65-66).



### *Estimator Variables*

Estimator variables are factors that the criminal justice system has no control over, but which affect the accuracy of identification. Estimator variables stem from the circumstances of the crime itself and can operate both at the time of the offence and afterwards during the identification procedure.

The presence of a weapon (Fawcett et al. 2016: 258) and high stress experienced by a witness at the scene of the crime are both known to decrease a witness' ability to accurately process and recall memories (Deffenbacher et al. 2004: 699). The presence of a weapon entails a 'weapon focus' effect. A study by Maass and Köhnken (1989) involved half of the subjects being approached by someone brandishing a syringe in a threatening manner while the other half were approached by someone holding a pen. The subjects approached with the syringe were significantly less able to identify the person holding the object than those approached with the pen (Maass and Köhnker 1989: 406-407). Therefore, a witness' ability to accurately identify a perpetrator of a crime involving a weapon is significantly lower than their ability to identify a person holding a non-threatening object or nothing at all (Rabner 2012: 1266-1267). This decrease in accuracy results from the witness' increased focus on the weapon, rather than the perpetrator's face or other significant details of the perpetrator's appearance (Cutler, Penrod and Martens 1987: 240). Meanwhile, Morgan III et al. (2004) conducted a study examining the effects of high stress on the ability to recall perpetrators. In the study, military personnel were subject to two interrogations, with one involving physical confrontation (high stress) and the other verbal interrogation only (low stress) (Morgan III et al. 2004: 268). It was found that a witness' ability to accurately identify their interrogators was generally better in the low stress situations (Morgan III et al. 2004: 276). Therefore, situations of high stress (such as witnessing a criminal act) actually decrease a person's ability to recall information about the event (Morgan III et al. 2004: 276). It is therefore clear that circumstances common to witnessing a crime, such as the presence of a weapon or intense feelings of stress, can significantly detriment a witness's ability to accurately identify a perpetrator.

Estimator variables also operate during pre-trial identification, with psychological biases such as cross-racial bias and unconscious transference (recognising someone from a different context, e.g. from seeing them in the local area, but confusing them with the perpetrator) adversely impacting accuracy (Baxter, 2007:

178). In their analysis of three decades' worth of studies, Meissner and Brigham (2001: 21) found that cross-racial bias has been shown to negatively affects a person's ability to accurately identify a perpetrator of another race. Therefore, if an offence is cross-racial, there is an increased chance of mistaken identification.

*System Variables*

System variables are factors inherent in criminal justice procedure over which the system does have control, including the suggestiveness of pre-trial identification procedure, and conduct of officials before, during and after identification (Wells et al., 2006: 46; Simon, 2012: 65-66). System variables compound and exacerbate the distortive effects of estimator variables. For example, where an offence is cross-racial, there is already an increased chance of mistaken identification. Furthermore, positive feedback from a line-up administrator can serve to inflate an eyewitness's confidence in their identification (Simon, 2012: 83-84). As will be seen below, this can cause issues as factfinders often hold the (incorrect) opinion that a witness's confidence in an identification correlates with the accuracy of the identification. The estimator and system variables operative here can lay the foundations for a wrongful conviction to flourish, as happened in the well-known Ronald Cotton case in the US.

*Practical Risks Associated with Eyewitness Identification Evidence*

Misconceptions held by jurors about eyewitness identification and their over-reliance on this kind of evidence compound the psychological risks. It is this 'absence of healthy skepticism' that turns the theoretical risks associated with mistaken eyewitness identification into a rather large practical problem: wrongful conviction (Baxter 2007: 180).

One of the main misconceptions held by jurors is that they often equate the confidence displayed by a witness with the accuracy of their testimony (Dufraimont 2008: 267). However, studies have shown that confidence is not correlative with accuracy of identification (ibid). Jurors' belief that it is results in over-reliance on the evidence of a confident eyewitness and the neglect of consideration of other factors actually indicative of accuracy, including *inter alia* weapon-focus and the interval between the incident and the identification (Cutler, Penrod and Stuve 1988: 53-54).

Furthermore, some of the psychological risks associated with eyewitness identification evidence are counterintuitive. These include those risks outlined above,



such as stress negatively affecting the ability to process and recall memories. People generally believe that situations that are highly unusual or stressful would increase our ability to remember them with accuracy, but this is not the case.

Jurors' misconceptions about what is indicative of accuracy, alongside their lack of knowledge about the counterintuitive psychological risks associated with eyewitness identification, present difficulties in practice when seeking safeguards against wrongful conviction.

*The Corroboration Requirement as a Solution*

Corroboration has been generally accepted as a sufficient safeguard against the risks of mistaken eyewitness identification in Scotland (Ferguson 2014: 44-45). However, corroboration does little to combat the psychological variables that can induce mistaken eyewitness identification nor juror misconceptions and over-reliance. The requirement of two pieces of evidence that can be of minimal independent probative value does not stop jurors relying on them on the basis of an erroneous assessment of reliability (Ferguson 2014: 48-50). By the time corroboration operates, the damage has already been done: a mistaken identification has potentially been made and might have developed into a confident account by a witness, which is over-relied on by factfinders based on their misconceptions.

*Recommended Reforms*

It is imperative that pre-trial safeguards are present due to the inherent frailty of human memory and scope for its distortion by system variables. Safeguards at trial, like corroboration, must operate in a wider system seeking to enhance the reliability of eyewitness identification evidence and factfinders' understanding of it, and should be a last resort protection for accused persons (Dufraimont 2008: 265). There are various safeguards that could be introduced in Scotland, such as exclusionary rules, expert evidence or abolishing or restricting dock identification (Ferguson 2014; Baxter 2007: 166-167, 186-189). However, two safeguards could be a sufficient protection for the factually innocent, without substantially infringing the criminal justice system's crime control purpose of convicting the factually guilty.

Firstly, the pre-trial identification procedure used by Scottish investigators should be enhanced by legislation. The VIPER procedure currently used in Scotland involves the use of photographs, successively shown to a witness at 15-second intervals

(Ferguson 2014: 45). The photographs are produced by entering basic descriptors of the perpetrator into a centralised database. The database then suggests various foils based on these descriptors, from which investigators can choose between five and eight to use in the line-up, with foils being selected on the basis of their resemblance to the suspect (Memon et al. 2011: 712). In order to minimise the risk of mistaken eyewitness identification leading to wrongful conviction, the VIPER procedure should adopt 'double-blind' identification whereby an unconnected police officer conducts the line-up and is unaware of which of those present is the suspect (Wells et al. 1998; Ferguson 2014: 57). The police officer in charge of the case should not be present and the witness should be informed that the suspect may not be present in the line-up (Ferguson 2014: 57). This would ensure that there is no suggestion before, or positive feedback immediately after an identification, preventing a witness's confidence immediately becoming inflated. It is important to prevent a witness' confidence becoming inflated because of jurors' misconceptions that confidence correlates with accuracy of identification. This, among other procedural enhancements such as introducing a minimum of eight foils, should be imposed by legislation to ensure enforceability as the Police and Criminal Evidence Act 1984 in England and Wales is (Ferguson 2014: 57). System variables, controllable by the criminal justice system, must be targeted to enhance the reliability of eyewitness identification evidence collected and presented to factfinders.

Secondly, a mandatory judicial instruction should be issued if eyewitness testimony is introduced at trial (Ferguson 2014: 60-61). This instruction should seek to address and minimise the operation of jurors' misconceptions and explain the nature of estimator variables to ensure jurors are equipped to evaluate eyewitness identification evidence appropriately. Judicial instructions are sufficient and preferable as a practical solution compared with expert evidence. This is because judicial instructions are less time consuming and do not require extra expense for the defence, which is often unavailable (Dufraimont 2008: 288). For maximum effectiveness, judicial instructions must highlight the potential unreliability of eyewitness evidence, but also the specific factors present in the particular case that could impact reliability as identified by psychological research (Leverick 2016: 580-581). Furthermore, judges must be educated regarding the dangers associated with eyewitness identification evidence (Fawcett et al. 2016: 262). This is so that effective instructions can be given to juries, but also because the vast majority of Scottish criminal cases are decided through summary procedure without a jury present (Cusine 2013: 79). If education is to act as a safeguard, it must do so in all courtrooms, not just those with a jury. Directions and education should serve to dispel, or at least mitigate, misconceptions about eyewitness identification evidence and hinder over-reliance by factfinders (Fawcett et al. 2016: 262).

These safeguards would provide better protection against the risks associated with eyewitness identification than corroboration, because they target both the accuracy of the evidence itself and over-reliance on it.

### *Conclusion*

It is conceded that, due to the inherent issues with reliability of eyewitness identification evidence as identified by the psychological literature, it may be impossible to ever have absolute protection against wrongful conviction resulting from mistaken identification. However, corroboration in its current form is not the answer to the problems posed by this evidence, particularly due to the relaxed way in which Scottish courts apply the requirement. Other means are better suited to address these problems - an enhanced and enforceable pre-trial identification procedure alongside a judicial direction and education of factfinders would be a better answer to the psychological and practical risks posed by eyewitness identification evidence.

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# Thinking with Class: A Pragmatic Approach

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*Introduction*

The purpose of this essay is not to provide a survey of research into social class. Instead this essay will establish a solid intellectual grounding on which a usable concept of class is possible. It is not useful to write out a list of all the things that people have said class is or is not, and then claim that an individual's possession of class is some bundle of those attributes. Rather, this essay will attempt to draw out why class can be an incisive category for sociological analysis and what it can illuminate about patterns of social and economic stratification.

Section one will layout a meta-theory of class that attempts to establish how we should think about and use the class concept. This meta-theory begins with a rejection of the 'spectator theory of knowledge' (Baert 2005: 131) as applied to class, this being the idea that the purpose of a class concept is to perfectly mirror some 'real' class formation. Instead, it is argued that class is useful as a tool for thinking about how patterns of economic stratification are replicated in other observable aspects of social relations. To answer the question, what is class, we need to start from the question, why is class useful?

The second section of this essay will consider how this approach to class can be deployed in analysing specific historical processes. Most examples will be drawn from Britain, but reference will be made to other societies where the class process diverges in significant ways. A historical understanding of class can highlight different mechanisms that are specific to the class process as well as the role of class in the formation of other social relations such as race, gender, and nation. A final section will attempt to further develop an analysis of three specific mechanisms that thinking with class can reveal. Firstly, the mechanism of opportunity hoarding, as found particularly in the work of Tilly. Secondly, exploitation as a mechanism of class control. Lastly, to

an analysis of the symbolic meanings of class distinction, in the vein of Bourdieu. This three-part structure will convey the foundations of the class concept, and the key processes that thinking with class can reveal.

To outline what a class is, it is necessary to outline some important theoretical assumptions. Class is a concept that we can use to selectively organise various empirical phenomena (Mills 2014a: 437). While we might believe that a theory of class, such as classes as defined by groups with similar 'life chances' (Weber 1978: 927), is useful for certain purposes, it is not possible to deductively test that theory to identify 'real' social classes. The simplest answer to the question '*what is class?'* is that a theory of class is a specific way of thinking about stratification. Purely nominal categorisations of stratification such as the concept of 'socio-economic status' (SES) might divide a social structure by income level into ten deciles. These categorisations do not imply that these deciles are relational groups with differing interests, nor that these deciles necessarily have any cohesive identity or culture. To think with class, by contrast, is to suppose that patterns in the division of labour tend to 'reproduce' themselves in other areas of social relations. To this extent, we may speak of relational 'collectivities with a greater or lesser degree of demographic, subcultural, and social identity' (Goldthorpe 2000: 1572). Whether class is deployed in sociological analysis, or as a folk typology by individuals to refer to a group they feel that they belong to, this remains true.

So, classes cannot be said to exist 'out there', but the concept is valuable as it can help us to analytically group certain causal processes that can be observed. How we might measure and attempt to think about what social class processes are important, depends on the questions we wish to answer. This leads to an obvious issue posed by one commentator on a schema which defined classes in relation to employment contracts:

> How can you have a sense of solidarity or consciousness when you're [class] 5 or 7...The history of all hitherto existing societies is the history of little internecine wars between class groups 1 and 2 and class groups 3 to 7?' Doesn't have the same ring to it (Anonymous in Wright 2005a: 1).

If we think of class as a concept that is developed as a theory of the middle-range, (Merton 1968: 51), that is, as a limited or 'special' theory, developed to empirically investigate specific sociological questions then we will inevitably emphasise certain clusters of mechanisms and marginalise others. Not everything can be in focus at the same time (Mills: 2014b). This is only a problem if we subscribe to the belief that there is a single 'correct theory of class' and a 'correct' method for identifying classes (Crompton 2008: 8). Pragmatism presents a viable alternative. The function of ideas in a pragmatist framework is not to perfectly 'mirror' what is 'out there' but instead to provide useful insights about the empirical world through an ongoing and updating process of inquiry (Baert 2005: 131). There are ideas about class which we must abandon if we commit to this principle. Grand theories of history might be desirable to some, but they are not useful (Baert 2005: 155). The same can be said of typologies that are conceived without reference to identifying any specific class mechanisms (Mills 2014a: 439).

There needs to be clearly defined limits to how we use and think about the concept of class, if we are the to explain anything. Nevertheless, it is a contention of this essay that radically different contributions to the literature on class can make statements that are on some level incommensurate, but both valuable and, in some pragmatic sense, true. We can argue, as Goldthorpe (2000: 1574) has done, that class conflict and class mobility are both important and indeed related processes, while also acknowledging that attempts at integrating mechanisms of conflict and mobility into a single sociological schema have tended to be unsatisfactory. We might analogise this theoretical relationship as the difference between a painting and an x-ray of the same person. They are both legitimate images that highlight different aspects of that person. We might think in a similar way about differing conceptualisations of social class. An attempt to lay out a meta-theoretical background of the class concept has been laid out with an argument in favour of a pragmatic engagement with the class concept. To provide a useful answer to the question, 'what is class?' it will be more productive for the rest of this essay to reframe this question, consistent with the pragmatist engagement, as 'why is class useful?' In doing so, the next section of this essay will consider the formation of classes as historical formations.

In all capitalist societies that have thus far existed, for some people to own capital, it has been necessary that others do not own capital and instead sell their labour. We can call these two sections of society 'classes'. We can label these relational groups 'Capitalists' (owners of capital) and 'Proletarians' (a class of labourers). There is no

legal requirement in Britain that some people must own capital while others must work for it, but it is not possible to privately organise the means of production if this is not the case. For there to be capitalism, there must be an organisation of labour which fulfils the needs of capital, and we can call this rubric a ‘class system’.

The key aspects of any class system are not transcendental, they emerge from specific historical conditions. In Britain, the development of an ‘Atlantic-wide division of labour’ (Inikori 1987: 785), particularly in the expansion of slave economies at the periphery of the empire, had major structural implications for the making of the working class in Britain. To take one example: ‘The early history of the Calcutta jute industry cannot be separated from that of the industry at Dundee’ (Chakrabarty 1989: 15). Dundee as a key centre of British linen production, depended upon reliable imports of jute from Bengal, which were of course established and underwritten by British colonisation of India. As such, the proletarianisation of the Scottish factory worker, was deeply intertwined with the expropriation of surplus value from India.

Similarly, Britain also imports a significant supply of labour from other parts of the world. This is not new a development. Leaders of Irish and African descent (such as William Cuffay) played a significant role in the early development of Chartism in the 1830s (Virdee 2014: 30). To this extent, one journalist writing in *The Times* declared of the movement: ‘We doubt if there are half-a-dozen Englishmen in the whole lot’ (Fryer 2010: 242). Viewed from the longue durée (Braudel 2009: 171), the British working class has always been a multi-racial formation.

Classes then, broadly constituted, are necessary components of capitalist societies. They are also formations distinct to those societies (Przeworski 1977: 347). There is no general class teleology that applies in both India and Britain. To think with class, we need to be attentive of the varied non-economic factors that also shape the formation of classes. As Thompson (2013: 213) points out, classes as demographically coherent entities do not emerge via ‘spontaneous generation’ from the economic structure: ‘The Industrial Revolution… [was] imposed, not upon raw material, but upon the free-born Englishman — and the free-born Englishman as Paine had left him or as the Methodists had moulded him’.

English working-class revolt in the early nineteenth century was not driven by a simple downward trend in material conditions caused by industrialisation, which paradoxically improved in the early nineteenth century (Thompson 2013: 486), but by the destruction of self-identity among artisans that was caused by the severed relationship between workers and reciprocal rights pertaining to land. For example, Luddism, was not an atavistic reaction to progress, but an attempt to resist and eventually negotiate the destruction of this 'moral economy' of English society (Thompson 2013: 593-598; 1976: 129). To understand the making of the working class, and indeed the development of capitalism, we might note that capitalism does not simply replace old societies with new ones. Pre-capitalist traditions, and the people that maintain them, do not simply disappear, and in certain cases, can be essential to the maintenance of capitalist class-ties.

If we think of class as negotiated with and against pre-existing symbolic relations, such as that of the ‘free-born Englishman’, we must also take seriously that class is not constituted separately from other social relations, particularly race and gender (Thompson 2013: 213). Class action is formed in mutually constitutive relations with race and gender. This kind of process is stated clearly by Du Bois, who articulated in his study of American reconstruction that there can be no race concept without capitalism, and no meaningful analysis of capital without class:

> Theoretically we [Black Americans] are part of the world proletariat in the sense that we are mainly an exploited class of cheap laborers; but practically we are not a part of the white proletariat to any great extent. We are the victims of their physical oppression, social ostracism, economic exclusion and personal hatred (Du Bois 1921: 151).

For Du Bois, this situation is the product of struggles both within classes and between classes. He argues that a coalition of southern planters and northern elites could always threaten to revoke the 'psychological wage' (*Ibid* 1998: 700) of white supremacy, as a tool for maintaining the support of the white working class and to continue the division of the proletariat. In Du Bois' account, the cause of race oppression is not ignorance. Instead, it is a calculated, self-interested move by the elite classes to maintain their own exploiting power over both the black and white sections of the proletariat (*Ibid* 1998: 12). Following Pzreworkski (1985: 70), we can state the class struggle in America was an example of a struggle about who could be working class, as much as it was a struggle between classes.

Classes then are continuously formed through historical processes that are specific to time and place. If we are going to think with class, it is necessary to consider the interaction of economic, social and cultural processes that shape the class relations of any given society. By being attentive to these issues, thinking with class can illuminate a variety of mechanisms at various levels of analysis. The final section of this essay will attempt to outline how we might define and consider a limited number of these class mechanisms: class as opportunity hoarding, class as exploitation, and class as symbolic distinction.

The control of many resources and opportunities in a capitalist society is zero-sum. There is a finite amount of resources and differing interests about how these resources should be organised. These individual interests can be thought of as collective interests to the extent that they cannot be achieved without collective action. For example, the desire among many workers at various points in time has been to create 'closed shops' where the supply of labour in a production process is controlled solely by the Unionised workers working within the organisation. This is at odds with the capitalist profit motive as it has the effect of increasing the price of labour. It is here we might suggest that there is a conflict of which group has the right to take control and organise resources. This is a process of 'opportunity hoarding' (Tilly 1999: 10), whereby a group sets out to gain control of a resource and restrict access to it, or in the case of many working-class struggles, expand access to it.

Opportunity hoarding is a central mechanism of class politics, but as a process is rarely drawn purely along lines of class. As Virdee (2000: 547) argues, there is no reason that we should see the Trade Union movement as a straightforward expression of a unified class-consciousness. Trade Unions are the expression of a sectional, defensive desire for opportunity hoarding for their members. As such, when a union is primarily dominated by white-male workers in a time of growing industrial participation of migrants and women, they can deploy exclusionary strategies against other workers (Virdee 2000: 549). An explicit class consciousness can exist alongside a sectional interest with no apparent contradiction between these interests in the minds of the Union members.

Historically, however, these strategies of trade union racism were not inevitable, and indeed while Unions deployed strategies of exclusion, the very same Unions also deployed strategies of solidarity (Virdee 2000: 549). Many of the same dockworkers who went on strike in support of Enoch Powell, would later declare solidarity with the strikers at the Grunwick factory, a workforce predominantly composed of Asian women (Virdee 2014: 134). To understand why those workers at one time believed that their interests were best served by attacking other workers, and at others by engaging in solidarity, we need to consider processes of class exploitation.

Opportunity hoarding is strongly related to exploitation, but they are necessarily distinct process. It is simply not possible to have a complex society without certain resources being restricted. For example, the title 'doctor' is restricted to those that have completed a rigourous medical course. This is not exploitation in any sense that the term is normally used. The most powerful form of opportunity hoarding is private property. In a society where the means of production are privatised, the ability to sell one's labour is for those that do not own property, the only way to survive. In this context, new sources of labour can be seen to jeopardise the security of those established workers. The strategy of trade union racism is only a rational strategy insofar that it is not imaginable that the dominant monopoly of rights accrued to the owning-class can be upended or usurped. To return to Du Bois' example, the desire to maintain a white 'labour aristocracy' is as much about the exploiting power of the owning-classes, and their ability to control the working class by threatening a segment of it with a worsening of conditions both materially and symbolically, as it is about intra-class processes of opportunity hoarding (Du Bois 1998: 701).

We can define exploitation analytically by arguing that it is the moment in class relations whereby class-power is directed towards the control and extraction of value from the labour of other classes. The white-male workers in the prior example dominate but do not exploit black-male labour as there is no extraction of value in their relationship (Wright 2015: 10). As an aside, women in the same position could be said to be both dominated and exploited by this same practice. Men directly exploit women as part of patriarchy, and this relationship (fundamental to the class system) has been sustained in part due to the frequent preference in male-dominated Unions for keeping women in the home, and out of paid-work (Hartmann 1979: 16). All three sections of the working class described above are exploited by the owners however, as the ownership and enforcement of private property rights necessitates a system whereby the working-class must sell their labour to survive, and at a rate which generates profit for the owning class (Wright 2005b: 23). Exploitation is a central mechanism in any class system and plays a key role in mediating class boundaries. It

is not just that profit is accrued to some and not others, the system of private capital depends upon some people being forced into a situation where they must sell their labour just to survive.

While there are numerous divisions and further complication within this relationship such that we can state that there could be more than two classes. The relations of exploitation described above are a fundamental division between classes, and a mechanism that thinking with class can unveil. The discussion of class so far, has largely been about the formation of distinct class groups and the distinct relationships that define class systems. Class is also lived however, as a 'sense of one's place' (Goffman in Bourdieu 198: 75). It is necessary then, to consider what the symbolic meanings of class distinction might be and what function they may serve in a classed society.

For Bourdieu, a group of workers who work in the same organisation and live in the same neighbourhood will likely develop connected social and cultural networks that have their own set of rules and practices (Bourdieu 1987: 5). The 'sense of one's place' developed over time has implications for the reproduction of class relations. In *Coal is Our Life (*Dennis, Henriques, Slaughter 1956), *a* study of a Yorkshire mining community conducted in the 1950s, it was found that the 'vast majority' of mining families wanted their children to go to Grammar School, and to avoid a career in mining (Dennis et al. 1956: 234). To this goal, the purchase of supplementary educational materials was common but very few children of the miners did end up going to Grammar School. The fundamental difficulty lay in the tension between the different kinds of practices and behaviours that were necessary to 'get on' in the school and in the home. The children of well-educated parents were already more familiar with the kinds of subjects being taught and with the patterns of speaking that were necessary to succeed in school before they had even left home. The children of miners were more likely to replicate the working class social and cultural habits of their parents which were necessary to 'get on' in the family and neighbourhood. We do not need to establish the full edifice of the 'habitus' (Bourdieu 1987: 5) concept to grasp this point. Subjective formations of class can in a cyclical way serve to maintain and reproduce economic class stratification. Working class culture was, and is, a barrier to social mobility into the middle-class insofar as middle-class social norms were necessary to succeed in formal education.



It is true that subjective aspects of class, such as vernacular, can be a means by which access to opportunities is controlled. However, if everyone in Britain spoke with what Nancy Mitford (1996: 334) called the aristocratic 'U' Speech, it would not follow that everyone would be able to join the elite. Some resources are zero-sum. There is not enough wealth for everyone to be a millionaire, just as it cannot be the case that everyone could have enough power to make their vision of society real (Weber 1978: 926). For Bourdieu, the categorisation of working-class speech patterns as incorrect has a specific social function in the context of the exploitative system previously discussed. In a very simplified way, where a practice in society is generally accepted as legitimate, for example certain styles of speech, the practice attains the status of what Bourdieu calls 'symbolic capital' (Bourdieu 1987: 15). Like financial capital, it is a resource that can be used by an individual to gain and control opportunities. This is a significant mechanism of class power insofar as the cultural and social practices of the elite are usually recognised as the legitimate practices over those of the lower classes.

As Bourdieu points out, official sanctions on language (through education) or on any aspect of class culture are not about beauty or form in the sense of a pure Kantian judgement (Bourdieu 1984: 33), but are actually about power and controlling who can wield it. Language is just one means through which this process of 'symbolic violence' takes place. The cultural distinctions that Bourdieu describes reflect a dynamic of class relations in a complex society. There is no singular way in which this process takes place and we need to be attentive in particular to the 'reflexive' knowing strategies through which these judgements of class legitimacy are negotiated and often resisted in historical context (Skeggs 1997: 11). Nevertheless, thinking with class allows us to comprehend the ways in which symbolic distinctions are also essential to the wielding of power in a classed society. In particular, the sub-cultural norms that develop in a complex society can be deployed in processes of opportunity hoarding, exploitation, and indeed social mobility if they are recognised as legitimate.

## *Conclusion*

This essay has not attempted to document every way in which thinking with class can be sociologically useful. Instead, an attempt has been made to develop a way of approaching class that can be deployed effectively to a wide variety of cases. A pragmatist understanding of class has been developed as an alternative to ontologically realist conceptions of class. Pragmatism as an approach to social science

avoids the 'pseudo-debates' of identifying 'real classes' by instead focusing on observable mechanisms, of which class can be conceived as the theoretical link (Crompton 2008: 7). This approach has been developed through the analysis of specific historical cases. A historical approach to class can reveal the contingent aspects that shape the formation of class groups. In particular, the ways in which formations of class, race, and gender are mutually constituted.

In the final section of this essay, three specific mechanisms that this approach to class analysis can unveil have been briefly analysed. Firstly, processes of opportunity hoarding, whereby class-based formations frequently organise to capture some opportunity or resource for their members. Secondly, the related mechanism of exploitation, whereby conditions exist which allow for a broadly constituted owning-class to control and expropriate value from the labour of other classes. From this discussion of exploitation as a relation between classes, an analysis of the symbolic legitimacy of this relationship has been performed, with reference to the ways in which judgements about language are used to symbolically legitimise processes of opportunity hoarding and exploitation. As such, when deployed in the analysis of specific sociological questions, class can be a useful, and indeed necessary, category of analysis.



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