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Environmental leapfrogging to
pro-environmental behaviours.
A case study of a structural
strategy in Taipei, Taiwan

By Jessica Clifton



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Environmental leapfrogging to pro-environmental behaviours, a case study of a structural strategy in Taipei, Taiwan

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Abstract

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It is now commonly agreed that low carbon living will be a future requirement for all countries across the globe. Anti-environmental behaviours continue to be one of the biggest barriers to transitioning to low carbon practices and therefore it is important to consider how pro-environmental behaviours can be encouraged in the early stages of development. Most research has focused on environmental values as the main driver of pro-environmental behaviour. However, there is increasing recognition of the role that external factors play. This working paper explores to what extent structural strategies, which change the external factors influencing behaviour, can increase pro-environmental behaviours and help achieve environmental leapfrogging for low carbon cities in the Global South. By exploring a case study of a waste management strategy in Taipei, Taiwan, this paper analyses the potential impact of changing external factors on the level of pro-environmental behaviours using a behaviour science framework. Following this, the paper uses regression analysis to model business-as-usual scenarios to analyse whether the city avoided environmental degradation and moved towards low carbon living, as defined by the circular economy framework. It was found that changing external factors increased pro-environmental behaviours, and that through this structural strategy environmental degradation was potentially avoided as the city was accelerated closer to a circular economy. These preliminary findings suggest that changing external factors could be beneficial in encouraging pro-environmental behaviours in Global South countries. However, structural strategies might encounter significant barriers such as knowledge development on these topics in such contexts, and a greater understanding of the influence of global systems is essential to further investigate the premise.

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Most research has focused on environmental values as the main driver of pro-environmental behaviour, however there is increasing recognition of the role of external factors, such as cost and ease.

01. Introduction

It is commonly agreed that anthropogenic actions are causing the global climate to change. High carbon usage remains a significant factor in this. Therefore, using low levels of carbon will be a future global requirement to minimise environmental degradation. This can be realised through the adoption of pro-environmental behaviours, defined as a behaviour that harms the environment as little as possible, or even benefits the environment (Steg and Vlek, 2009, p.309), such as reducing consumption, proper disposal of waste and recycling, and producing home-grown food (Steg and Vlek, 2009). Often these pro-environmental behaviours are in direct conflict with the growth of Gross Domestic Product (GDP) per capita (Bogner et al., 2007) which increases an individual's disposable income and leads to preferences for behaviours that are synonymous with wealth, such as consumption (Kaza et al., 2018). Additionally, GDP growth encourages migration to urban areas to realise available opportunities (Potts, 2016; Tacoli et al., 2015). These relocations cause rapid urbanisation which exacerbates time poverty and poor living conditions (Bogner et al., 2007; Tacoli et al., 2015). These impacts act as an explanation for the positive correlation between GDP per capita growth and anti-environmental behaviours, which can, in part, be seen in the development pathways of the Global North. Anti-environmental behaviours are defined as "all types of behaviour that change the availability of materials or energy from the environment or alter the structure and dynamics of ecosystems or the biosphere" (Steg and Vlek, 2009, p.309). The Global North is considered to be in a 'carbon lock-in' trap, which is defined by behaviour change inhibiting the abandonment of high carbon usage (Unruh, 2002) and making the transitions to low carbon economies costly and difficult (Perkins, 2003; Rip et al., 1998). Therefore, avoiding these 'carbon lock-in' traps in emerging economies in the Global South, through a focus on pro-environmental behaviour in urban areas, are integral to address the issues with GDP growth (Reckien et al., 2017).

In 2017, Global South countries, defined as low income per capita countries excluding China and India, were only responsible for roughly 25% of CO₂ emissions (Matters, 2019). This is rising, however, with emissions seen to be growing the fastest in rapidly urbanising areas (C40, 2020; Matters, 2019). It is now a concern that Global South countries are being led into the same

carbon lock-in. This is being exacerbated by the importation of retired, high carbon technologies from the Global North. Environmental Leapfrog theory is defined as the ability to bypass environmental degradation on the path to low carbon living and stable GDP, through introducing mitigation measures earlier in development pathways. Climate change mitigation in the Global South is often criticised by those who believe in a right to generate pollution and that without high levels of emission growth in Global South countries their development will be stunted (Gupta, 2010). However, the availability and advancements in knowledge and technology are now believed to be such that jumping to low carbon living is possible without hindering economic growth (Rip and Kemp, 1998). Furthermore, avoiding the creation of anti-environmental behaviours could save countries the money and resources that would be later required to escape the 'carbon lock-in'.

In the transition to low carbon societies it is vital that the Global South is not left behind.

There are a multitude of methods that can be utilised to encourage and sustain pro-environmental behaviours in the early development of urban environments. However, complexity lies in the reality that a behaviour may be beneficial for the environment on one level but harmful on another (Steg et al., 2012). Most research has focused on environmental values as the main driver of pro-environmental behaviour, however there is increasing recognition of the role of external factors, such as cost and ease (World Bank, 2015; Steg et al., 2012). Structural strategies are mechanisms that can be used to change external factors to promote pro-environmental behaviours (Steg and Vlek, 2009), and can be applied through the removal of anti-environmental options or by the use of choice architecture (Thaler and Sunstein, 2009). Both methods work through creating a green default, such that when acting under time poverty or stress - which is often experienced in areas that have undergone rapid urbanisation (World Bank, 2015) - the pro-environmental option will be chosen (Kahneman, 2012). Whilst these strategies are widely used in Global North countries, there is still a long way to go to understand their applicability and benefits across the Global South (Grilli and Curtis, 2021)¹.

NOTE 01

In the UK, The Behaviour Insights Team, otherwise known as the 'Nudge Unit' was founded in 2010. The team have harnessed behavioural science to achieve many successful interventions such as; small charges for plastic bags and opt out pension subscriptions. The team now have offices in many Global North countries (USA, Australia, France and Canada)

Therefore, in the transition to low carbon societies it is vital that the Global South is not left behind. It is also vital to look for what opportunities might lie in the transformative change needed to meet the environmental issues. Behaviour change remains one of the biggest barriers to achieving low carbon living, and if achieved in the early stages of development it might be possible to avoid environmental degradation and move faster to low carbon cities. The role of external factors promoting pro-environmental behaviours is often overlooked and a greater understanding of how the mechanisms work in Global South contexts could shed light on potential benefits and opportunities.

This paper addresses the following question: to what extent can adopting structural strategies in Global South countries increase pro-environmental behaviours and avoid the carbon lock-in trap. This paper will first explore the current literature to gain a theoretical understanding of development planning for decarbonisation, drivers and barriers to pro-environmental behaviours, and how structural strategies have been operationalised to

encourage pro-environmental behaviours. Drawing on these building blocks this study will propose an analytical framework which will be explored using the case study of a waste management strategy that was introduced in Taipei, Taiwan between 1997 and 2003, at a time when Taiwan would have been categorised as the Global South. The aim of the strategies were to encourage the pro-environmental behaviours of recycling and consumption; thus, it provides a useful study on general pro-environmental behaviours as they pertain to GDP growth and resource usage. Additionally, Taipei was chosen due to the authors previous experience interacting with the system. This study will analyse the potential impact of changing external factors on the level of pro-environmental behaviours using the COM-B framework². Following this, regression analysis will be used to model business-as-usual scenarios, defined by pre-strategy figures and global trends, to analyse whether the city avoided environmental degradation and moved towards low carbon living, as defined by the circular economy framework. Through this analysis this study hopes to better understand how effective a change in external factors can be in increasing pro-environmental behaviours in Global South contexts, and the barriers which might be faced. Additionally, this study hopes to ascertain whether encouraging pro-environmental behaviours at low levels of GDP could disrupt the need for costly transitions away from carbon intensive behaviours later in the development process.

NOTE 02

The COM-B framework was invented by Michie et al. (2011) as part of ongoing research into designing successful behaviour change interventions. It views behaviour drivers as complex and often multi-faceted. The model defines three essential conditions for a behaviour to be engaged in: Capability, Opportunity, Motivation.

The strong correlations that can be seen between anti-environmental behaviours and GDP growth, suggests that a focus on pro-environmental behaviours could be beneficial in realising environmental leapfrogging.

02. Building on existing knowledge

Development planning for decarbonisation

In a scan of the previous literature, a number of theories have been used to understand development planning for decarbonisation. The method of backcasting, defined as planning present development based on future needs or inevitabilities, has been a popular method for guiding development practices (Holmberg, 1998). It has been most commonly used in climate change adaptation methods, such as land-use planning for coastal encroachment (Robinson et al., 2011). However, there is growing recognition of its benefits in planning for low carbon economies (Ashina et al., 2012; Giurco et al., 2011; Neuvonen et al., 2014), and the value it can bring to achieving the transformational change, characterised by the redefining of existing systems, which is needed to tackle the climate crisis (Gillard et al., 2016; Roggema et al., 2012; Termeer et al., 2017). It is argued that the main benefit of backcasting is that it enables change to happen more slowly (Holmberg, 1998). Therefore the use of backcasting methods, to plan now for the future low carbon economies, could allow for slower transitions which studies show would benefit vulnerable populations (Roggema et al., 2012; Banerjee and Duflo, 2011; World Bank, 2015). However, it is important to acknowledge the ethical debates that surround the use of backcasting methods for climate change mitigation. Critics cite the dangers and potential harm that could be caused by making planning decisions based on uncertain and unpredictable climate change science (UNESCO, 2014).

Latecomer theory suggests that Global South countries can benefit from being able to learn from economies that have already advanced in the process of decarbonisation (Pang, 2007). Rip and Kemp (1998) argue that the technology and knowledge exists to allow for low carbon societies. If harnessed, as suggested possible by latecomer theory, Global South countries could move towards decarbonisation. Environmental leapfrogging as defined by Perkins (2003), builds on this to suggest it is possible for Global South countries to deviate from the development pathway previously taken by Global North countries down a pathway to lesser emissions. The theory is depicted using the famous U-shaped curve, coined as the Kuznets curve in 1995, which plots GDP growth against environmental degradation (Pang, 2007). Historically, the theory has referred to avoiding the period of the industrial revolution, but as environmental degradation still remains high in Global North countries (Reckien et al., 2017), it is possible that further environmental degradation could be avoided. However, a shortcoming of the theory is that it depicts only one country and omits any barriers which might be faced by power structures or existing systems, such as that between Global North and Global South countries as described by Dependency theory (Perkins and Neumayer, 2005).

Additionally, Leapfrog theory has been criticised for having ambiguous objectives such as the end goal of high stable GDP and zero environmental degradation (Evans et al., 2018; Goldemberg, 2011; Perkins, 2003). Stable GDP is yet to be accepted in societies which continue to strive for GDP growth (Costanza et al., 2009; van Griethuysen, 2010). Furthermore, the way to operationalise low carbon economies that minimises environmental degradation is still debated (Davos, 2020; Premalatha et al., 2013). The most recent advances are rooted in giving greater weight to systems and circular practices (Gómez-Baggethun et al., 2013). Circular Economy (CE) originated as an umbrella concept for decoupling economic growth from natural resource use, thus creating low carbon societies (EASAC, 2016; EEA, 2016; Moraga et al., 2019). It was first widely used by the Ellen MacArthur Foundation (MacArthur, 2013). Net-zero and carbon neutral are said to be the first steps towards CE (Korhonen et al., 2018), however others believe this intermediate step is delaying vital transformative change through its over-reliance on carbon capture technologies and offsetting (ActionAid, 2015; CarbonBrief, 2019; Eco-Business, 2020). Therefore, there is still a long way to go to understand how CE can be realised. The indicators developed in 2016 by the European Environmental Agency are said to be some of the most advanced and widely used, however these indicators are still weak on measuring reuse and upcycling of materials (Saidani et al., 2019).

The CE framework is being increasingly used in development planning for decarbonisation (...). However, operationalisation of these methods have focused primarily in technology (...).

Drivers and barriers to pro-environmental behaviours

The initial focus for understanding pro-environmental behaviours revolved solely around what are called internal factors (Steg et al., 2012), such as motivation, environmental knowledge, awareness, values, attitudes, emotion, responsibilities and priorities (Grilli and Curtis, 2021; World Bank, 2015). Theories such as the theory of Normative Conduct (Cialdini et al., 1991), Value-Belief-Norm (VBN) theory (Stern et al., 1999), Goal Framing theory (Lindenberg and Steg, 2007) and Affect (Redclift, 2004) have been successful in explaining pro-environmental behaviours such as not littering (Geller, 1989), opting for non-motorised transport (Gatersleben, 2007), and general pro-environmental behaviours (Nordlund and Garvill, 2002; Steg and Vlek, 2009). The availability heuristic, defined as an individual drawing on immediate examples to make decisions, has also been successfully used to explain the effect of exposure to environmental issues creating a stronger belief (World Bank, 2015). However, research continued to show that increases in internal factors do not always lead to increased pro-environmental behaviours (Kollmuss and Agyeman, 2002).

The theory of Planned Behaviour (TPB) by Ajzen (1991) was first to suggest that an individual's internal factors could face barriers to engaging in pro-environmental actions. Hines et al. (1987) later built upon TPB to incorporate the first notions of external factors under the terminology 'situational factors'. Followed by Diekmann and Preisendoerfer (1992), who showed pro-environmental behaviours were more likely when the cost was low (Kollmuss and Agyeman, 2002), in line with the theory of 'solution aversion' which describes how environmental problems could be deemed unimportant when the solution is unappealing (Steg et al., 2012). Campbell (1963) and Blake (1999) introduced the early notions of The Value-Action gap, which is defined mathematically by Rasch Analysis (Ogunbode et al., 2020). This states the likelihood of behaviour is the person's intention minus the difficulty, thus highlighting the importance of external factors in ensuring a pro-environmental behaviour intention is realised (Ogunbode et al., 2020). The field of research was then expanded by sociologist studies which showed that individual's pro-environmental behaviours are limited by external factors, defined as lack of time, money, and facilities (Banerjee and Duflo, 2011; Kollmuss and Agyeman, 2002; World Bank, 2015).

In the 2000's, Behaviour Change emerged as a new discipline, with roots in the disciplines of sociology and psychology. COM-B analysis is a framework developed by Michie et al. (2011) to understand further the barriers to behaviours, where COM- B stands for an individual's Capacity, Opportunity and Motivation to engage in a certain Behaviour. In this model, 'opportunity' represents all the "factors that lie outside the individual that make the behaviour possible or prompt it" (Michie et al., 2011, p4). This framework was the first to give external factors equal weighting to environmental values and provide a way of identifying how changing one component can affect behaviour (Gainforth et al., 2016; Addo et al., 2019). Across these theories, methods for measuring increases in pro-environmental behaviours continues to be a source of debate. Psychologists typically tend to focus on measuring the behaviour, using surveys, experiments and case studies (Steg and Vlek, 2009), whereas Environmental Scientists argue for measuring the impacts of pro-environmental behaviours (Schroeder and Chapman, 2012). This approach limits the understanding of individuals actions however is said to be more beneficial for informing policy decisions because it provides a collective overview (Steg et al., 2012).

Structural strategies for encouraging pro-environmental behaviours

Throughout the literature, policy interventions aimed at altering external factors have been categorized in a variety of ways (Grilli and Curtis, 2021; Michie et al., 2013; Steg and Vlek, 2009). However, 'structural strategies' used by Steg and Vlek (2009) is the broadest term. The literature shows policies can be enacted through nudges or the removal of anti-environmental options (Grilli and Curtis, 2021; Steg and Vlek, 2009). Nudges were first explored by Thaler and Sunstein (2009) and defined as subtly guiding choices. This approach is criticised for paternalism and lack of transparency (Barr and Prillwitz, 2014). However, it is thought that ethics are changing thanks to the urgency of climate change (UNESCO, 2014). 'Libertarian paternalism', which underpins nudge policies, is becoming more acceptable; particularly in neo-liberal contexts (Thaler and Sunstein, 2009; Grilli and Curtis, 2021). The environmental policy towards single use plastic through outright bans, as implemented in Rwanda and Bangladesh, or small taxes, adopted in the UK and Taiwan, highlights the different approaches (Convery et al., 2007; Global Citizen, 2015). Steg and Vlek (2009) argue that the effectiveness of each approach is determined by regulatory powers and existing values. Both approaches work by creating a pro-environmental default option. Defaults are effective because human thought operates in two systems famously outlined in experiments by Kahneman (2012). Automatic thinking, System 1 which "operates automatically and quickly, with little or no effort and no sense of voluntary control" (Kahneman, 2012, p20), is the system most susceptible to defaults and is most commonly enacted under time pressure or distraction (World Bank, 2015)³.

NOTE 03

On the other hand, Kahneman's (2012) System 2 refers to slow, conscious and deliberate thinking. This is often engaged to solve complex problems or effortful mental activity. System 2 is thought to be less susceptible to defaults due to the increase effort and consideration put into the action.

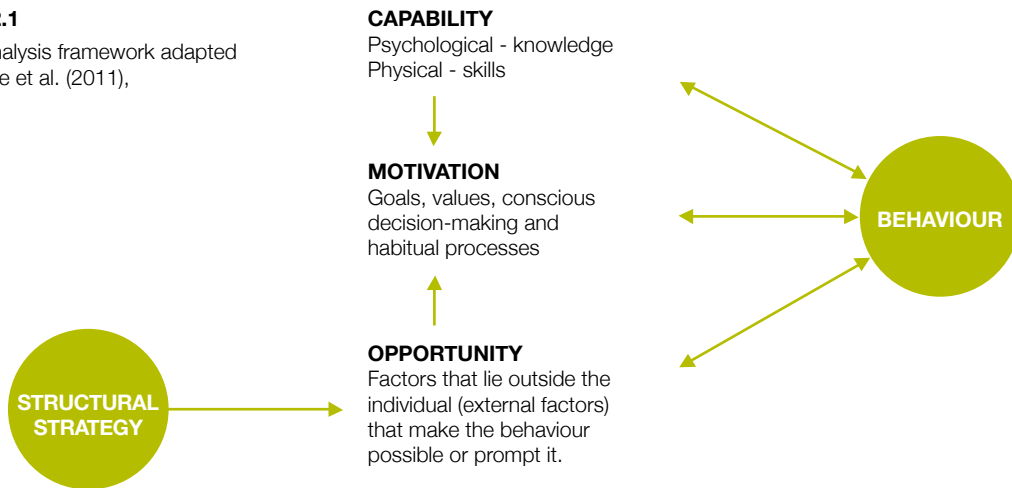
Structural strategies most commonly rely on the mechanisms of pricing, availability and legislation (Michie et al., 2011; Steg and Vlek, 2009). Pricing approaches have been used by environmental economists via the introduction of taxes. It is assumed that by raising the price of environmentally harmful activities people are loss adverse (Schubert, 2017) and will therefore automatically move away from these behaviours (Steg and Vlek, 2009). Studies show that raising prices too high can lead to reactionary damaging behaviours (Morrison and Dunlap, 1986). On the other hand, low prices of environmentally damaging activities are said to encourage use; energy usage (Grilli and Curtis, 2021) and resource use (Steg et al., 2012). According to the literature, changing salience or availability has been a successful way of changing external factors as to create default options; for example, citizens are more likely to recycle if recycling bins are the available and salient option (O'Connor et al., 2010). However, removing trash bins entirely could result in recycling being increasingly contaminated by unrecyclable trash (Barr and Prillwitz, 2014), highlighting the importance of considering context and culture when designing a structural strategy. Finally, the use of legislation can be successful in increasing pro-environmental behaviours (Steg and Vlek, 2009). The primary value of using legislation is thought to be the ability to create the sense of collective action, such that people will be more willing to take action if they could be assured that others will do the same (World Bank, 2015).

The majority of these observations are taken from structural strategy initiatives aimed at instilling pro-environmental behaviours in the Global North. A recent study by Grilli and Curtis (2021) shows a lack of behaviour studies in the Global South. One of the biggest criticisms of psychology studies is that they are primarily WEIRD: Western, Educated, Industrialised, Rich and Democratic (Nielsen et al., 2017), meaning that the findings from these studies might not be applicable in different contexts. This is supported by Steg et al. (2012), who continue to advocate that there is a need to "test the generalizability of findings and explore potential cultural differences" (Steg et al., 2012, p331). The inconsistent results of similar approaches in different regions shows that cultural and societal factors shape the design and outcome of structural strategies. This is also why comparisons across countries and attempts to replicate a strategy often results in difficulties. As a result, many studies favour a case study approach.

Analytical framework

The analytical approach will then build upon the COM-B analysis framework detailed in Figure 2.1, which considers external factors to be equally significant in influencing pro-environmental behaviours. The arrows in the diagram represent potential influence, such that changes to opportunities can influence capacity and motivation drivers. This study will follow the reasoning of Steg and Vlek (2009) that states that policy interventions under the category of structural strategy primarily influence external factors, or ‘opportunities’ as considered in COM-B framework.

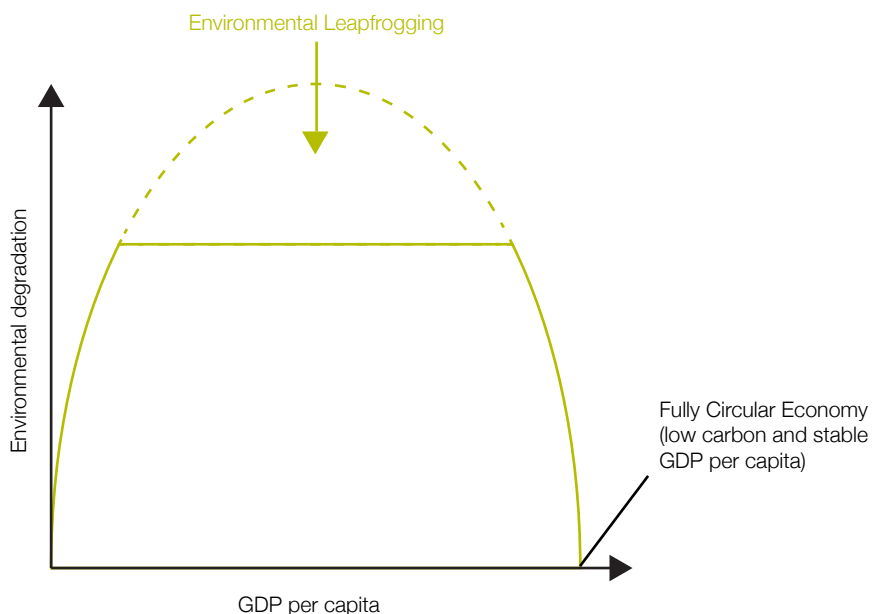
FIGURE 2.1
COM-B analysis framework adapted from Michie et al. (2011),



Following this, the study will draw on the theory of environmental leapfrogging as defined by Perkins (2003), where zero environmental degradation is defined by MacArthur’s (2013) circular economy framework, depicted in Figure 2.2.

Through this analytical lens this study will hypothesise that changes to external factors which influence decisions to engage in the pro-environmental behaviours, through the implementation of structural strategies, lead to effective behaviour change such that Global South cities can avoid environmental degradation in the journey towards sustainable societies.

FIGURE 2.2
Environmental Leapfrog framework adapted from Perkins (2003).



This study will initially review the implementation of the structural strategy in Taipei before exploring whether changes to external factors resulted in significant changes to levels of behaviour.

03. Exploring the impact of structural strategies

Methodology

This working paper uses the analytical framework outlined in Chapter 2 to examine the case study of a structural strategy used in Taipei, Taiwan. Recycling and consumption behaviours make an effective area of study because they are strongly linked to GDP growth (Bogner et al., 2007). The structural strategies of pricing and availability, as defined by Steg and Vlek (2009), were implemented over a 6-year period from 1997 to 2003 when Taiwan was still considered Global South. This provides a long enough timeframe to measure the impact. This study will initially review the implementation of the structural strategy in Taipei before exploring whether changes to external factors resulted in significant changes to levels of behaviour; as suggested by the COM-B framework. Changes to recycling behaviours will be determined by the recycling levels for the city from 1971 to 2017. In parallel, consumption rates will be observed over the same period by studying the trends in waste generated per capita. This approach has been chosen due to the lack of available qualitative data about attitudes towards recycling from before the introduction of the structural strategies. However, it is recognised that this approach results in limitations, such as influence of other variables and not being able to determine whose behaviours change.

To explore environmental leapfrogging in the context of recycling and consumption in Taipei this study will compare business-as-usual scenarios, defined by pre-strategy figures and global trends, to realised levels. Environmental degradation will be measured by tCO₂e, in line with the study by Schroeder and Chapman (2012). To predict business as usual consumption levels, this study will use Equation 3.1 from the regression model created by Kaza et al. (2018) which shows the expected waste generated per capita based on GDP per capita.

EQUATION 3.1

Waste generated per capita based on country GDP.

$$\text{Waste generated per capita}_{\text{year}} = 1647.41 - 419.73 \log(\text{GDP per capita}) + 29.43 \log(\text{GDP per capita})^2$$

This model will be used over the period following the structural strategies from 2001 to 2018, using GDP per capita values for Taiwan. Whilst the model predicts waste generation per capita for the country as a whole, due to limited data assumptions will be made that because of the small size of the Taiwanese island it is possible to suggest that the measure will be similar for Taipei City. In line with this approach, a regression analysis to determine the predicted recycling rate, based on GDP per capita according to global trends, will be conducted with an available standardised dataset by Greenfield (2016) of the recorded recycling rate of 35 cities across the Global North and Global South. The use of different sets of data for these two regression models is seen as a potential limitation and the use of a singular set would be suggested for future studies. In addition to this, in order to compare where Taipei sits today on the path to a circular economy, this study will consider the circularity indicators for sustainable resource use. This is defined by the European Commission under the following metrics for the year 2015, in line with available data for comparison (EU, 2017):

TABLE 3.1

Circularity Indicators (EU, 2017).

Circularity Indicator	Calculation
Material Footprint	Domestic Material Consumption (DMC)
Resource Productivity	Gross Domestic Product (GDP) / Domestic Material Consumption (DMC)
Municipal Solid Waste (MSW) Generation	Every day household waste type items
Municipal Waste Recycled	Amount of waste that has been recycled, composted and undergone anaerobic digestion

Case study background and structural strategy implementation

The Republic of China, commonly known as and from here on referred to as Taiwan, is a mountainous island between the South China Sea and the Pacific Ocean. The island has changed hands a number of times throughout its history, and whilst Taiwan now has a democratic leadership it struggles with its contentious sovereignty status within global institutions and international law. Despite these struggles, for the sake of simplicity, this working paper will refer to Taiwan as a country. During the post-WWII period, Taiwan underwent rapid industrial development, known as the ‘Taiwan Miracle’, and became known as one of the ‘Four Asian Tigers’ (Manthorpe, 2009). This sharp rise in GDP per capita led to rapid urbanisation causing space restrictions, time-poverty, and poor living conditions, along with increases in disposable income and long work hours (Maynard, 2018). As GDP grew, so did the amount of waste generated per capita in the capital city Taipei (Taipei City Statistical Yearbook, 2020a). It has been argued that this is due to a new preference for throw away items, time saving practices, and consumption as reasoned by Tacoli et al. (2015). In 1992, Taiwan generated approximately 21,900 tonnes of waste a day (Ngo, 2020) and only 70 percent of its garbage was collected, with the rest polluting the environment through littering or burning (Maynard, 2018). As a result of the waste build-up environmental hazards, such as flooding

The sharp rise in GDP per capita led to rapid urbanisation causing space restrictions, time-poverty, and poor living conditions, along with increases in disposable income and long work hours.

and disease, increased; giving the country the nickname “Garbage Island” (RapidTransition, 2019). Taipei’s waste disposal methods relied solely on land-fill sites, which released toxic chemicals and were likely to leak during typhoon season. In 1998, nearly two thirds of Taiwan’s landfills were either approaching capacity or already full (Maynard, 2018).

Coupled with the democratic movement in Taiwan, Homemakers United, an environmental NGO made up of 10 women from Taipei, sparked environmentalism in Taipei (Maynard, 2018). This bottom up pressure suggests environmental values in the city of Taipei were high. This could have been due to the practice of Taoism, which is popular in Taiwan and supposedly encourages environmental values (Miller, 2006), or through an awareness of the problem from the littered streets through the availability heuristic as described by the World Bank (2015). These environmental values were, however, not realised in pro-environmental behaviours (Taipei City Statistical Yearbook, 2020a), suggesting Taipei was suffering from Blake’s (1999) Value-Action gap due to external barriers. The bottom up pressure was followed by governmental commitment through stringent environmental policies; something that was possible due to Taiwan’s stable democratic government (RapidTransition, 2019). For the scope of this working paper the following policies that directly impacted citizens recycling and consumption behaviours in Taipei will be the focus.

FIGURE 3.1
Timeline of structural strategy implementations.

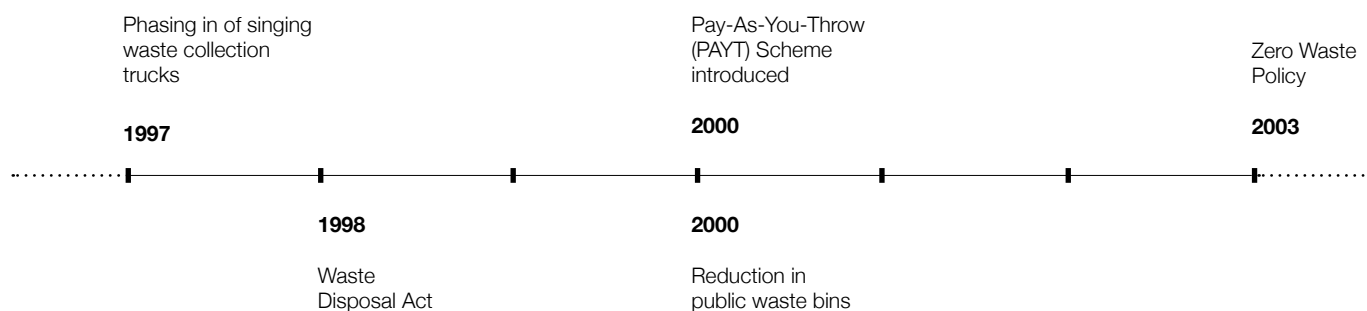


Figure 3.1 shows that curb side collection was phased out from 1997. This removed waste from the street which often sweated in high temperatures causing unpleasant smells and disease. Curbside collection was replaced with waste being taken directly to collection trucks passing through neighbourhoods three times a day, five times a week playing Beethoven’s Für Elise (Trufelman, 2016). The collection trucks use the main roads and where access is inhibited motor cycle trucks are used to navigate the smaller streets. In the

nationalisation of the system, the number of informal waste pickers decreased (Ngo, 2020). Waste picking often provides income for the urban poor in Global South countries (Medina, 2008). In this case study it has not been possible to determine the extent to which informal workers were incorporated into the new system and it is possible they were displaced. In 2000, a Pay-As-You-Throw (PAYT) scheme was introduced in Taipei, meaning that whilst recycling was free general waste could only be disposed of in purchased bags, specially labelled to prevent counterfeit production (Department of Environmental Protection, 2020). Waste bags could be brought from all local convenience stores at a cost of USD \$5 for a pack of twenty 25 litre bags (Trufelman, 2016). The low pricing approach could be considered a nudge, as defined by Thaler and Sunstein (2009). The low price of the bag and maintaining free recycling was adopted so as not to exclude any level of society (Ngo, 2020). A common criticism of PAYT schemes is that cheap and unrecyclable products could result in those on low incomes being forced to pay more for waste disposal (Manni and Runhaar, 2014). However, this is thought to have been mitigated by the Waste Disposal Act of 1998 legislation, which introduced an Extended Producer Responsibility (EPR) scheme that taxed producers based on how recyclable the product is (Ngo, 2020). A change in demand for recycling required sufficient infrastructure to meet the growing demand. Taiwan's Recycling Fund was created from PAYT taxes on citizens, but also through leverages on manufacturers and imports, and allowed Taipei to make sufficient investments in infrastructural improvements and maintain a nationalised system (Maynard, 2018). Private recycling practices continued alongside the national system; however, they were significantly reduced as they were labelled inefficient (Ngo, 2020).

The PAYT scheme was coupled with the removal of public bins in 2000. Currently the city of Taipei only has 1,700 bins, approximately one for every 1,500 citizens (Ngo, 2020). The ability to monitor littering and improper disposal was vital to the success of the strategy (Maynard, 2018). The maximum fine was USD \$200 (Trufelman, 2016), however data suggests that the number of fines for littering did not significantly increase despite the reduction in the number of bins in the city (Taipei City Statistical Yearbook, 2020b). It is thought that the process was governed by social shaming, which is a common cultural practice in Taiwan (RapidTransition, 2019). The 2003 Zero Waste policy took incineration and landfilling off the table, meaning the city relied on recycling (Ngo, 2020). The early adoption of such advanced policies could be explained by Taiwan's prohibited membership of the UN, WHO, and exclusion from global environmental institutions such as the UNFCCC climate finance mechanism; all of which makes it difficult for Taiwan to follow the same environmental policy routes as other countries. Without options such as offsetting, the high economic costs of carbon reduction measures, circularity and rapid carbon reductions become even more pressing issues (Ministry of Foreign Affairs, 2018).

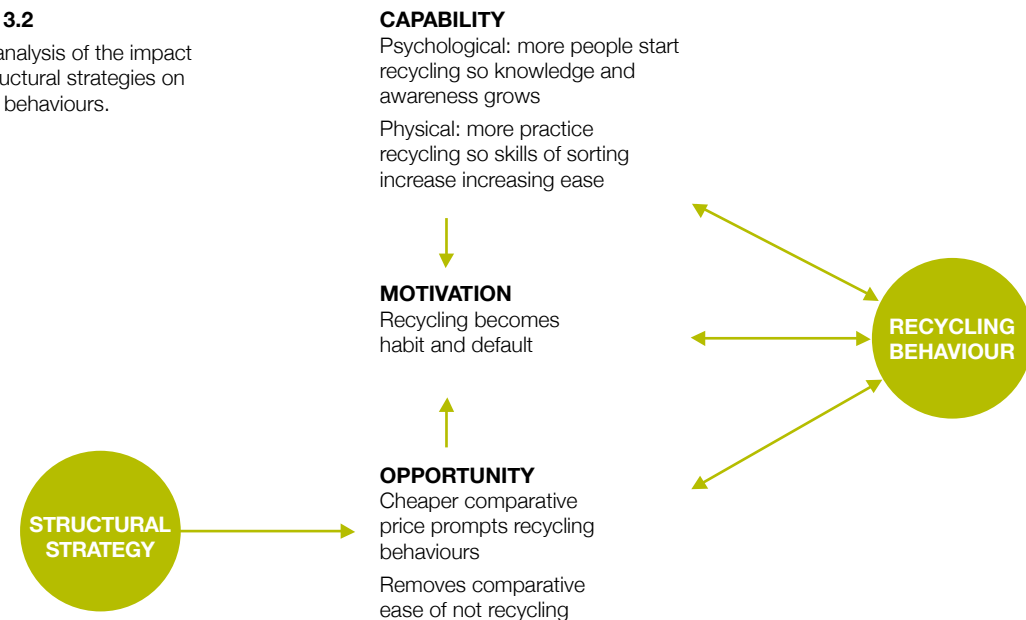
The PAYT scheme was coupled with the removal of public bins in 2000. Currently the city of Taipei only has 1,700 bins, approximately one for every 1,500 citizens.

Impact analysis using the COM-B framework

To consider how effective the structural strategies were in increasing pro-environmental behaviours this study will use the COM-B Framework; drawing on the reasoning of Steg and Vlek (2009) that structural strategies primarily change external factors; which are classified under ‘Opportunity’ within the framework. Whilst behaviour drivers are complex, drawing on the literature it is possible to suggest the potential effect of the structural strategy on recycling behaviours, as depicted in Figure 3.2.

FIGURE 3.2

COM-B analysis of the impact of the structural strategies on recycling behaviours.

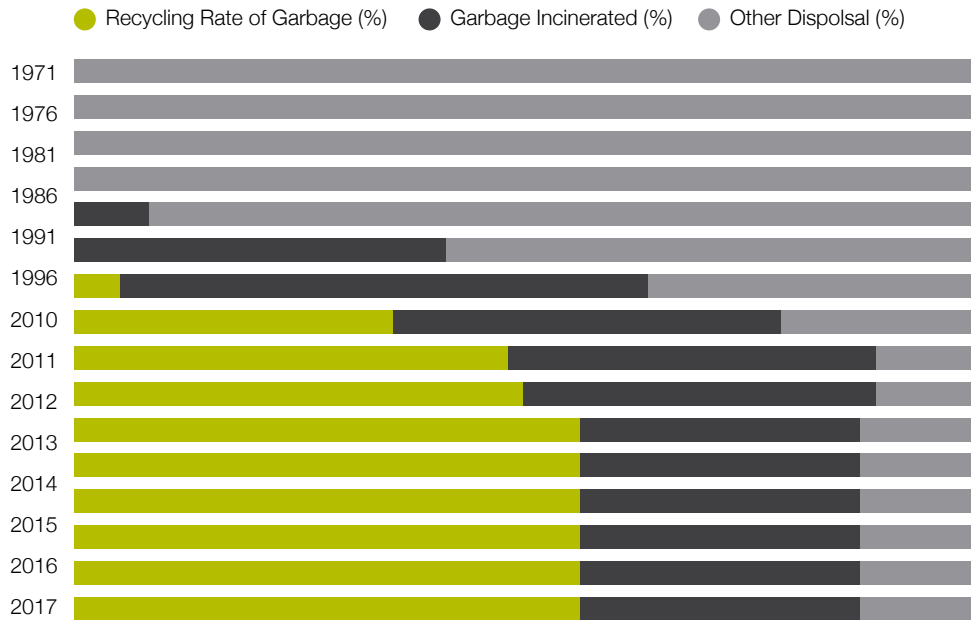


PAYT scheme ensures recycling is the comparatively cheaper option
 Removing public bins

The introduction of the PAYT scheme drew on the structural strategy of editing prices, described as a pricing (Steg and Vlek, 2009) or fiscal (Michie et al., 2011) strategy, such that recycling became the cheapest, and in this case free, option. Drawing on the theory of loss aversion earlier defined by Schubert (2017), the requirement to purchase waste bags might have created a feeling of monetary loss that deters people from this behaviour, it is thought that this effect is greater in low income households. The increased effort needed to visit the shop to make this purchase could also deter people from this option (Steg and Vlek, 2009). In apartment blocks in Taipei it is possible to pay a yearly waste fee as a means of avoiding purchasing these bags. Comparing the behaviours of those who have access to these options could provide interesting insights into whether this limited the impact of the strategy, however that is beyond the scope of this study. Additionally, recycling became free and easier, which from the mechanisms of solution aversion, as described by Steg et al. (2012), might have appealed to those who had the intention to recycle but were off put by high costs or effort. The requirement for sorting waste at household level and purchasing goods is thought to commonly fall on women (Xu and Lai, 2004), such that women’s behaviour might be affected more significantly than men. However, recycling sorting is also practiced in schools and offices. The simultaneous reduction of public waste bins drew on the structural strategy of availability, as defined by Steg and Vlek (2009), which again removed the comparative ease of general waste disposal in public areas such as shopping malls. According to the theories of Michie et al. (2013) these methods could have changed the attitudes towards general waste, through using effort and cost to create negative associations. Additionally, as the behaviour becomes a repeated habit, skills and knowledge grow (Steg et al., 2012), further increasing the ease of the behaviour. This is increasingly apparent when introduced at young ages, such as in schools (World Bank, 2015). This supports the notion within the COM-B framework that changes to external factors have indirect effects on other behaviour drivers.

FIGURE 3.3

Graph of Taipei City MSW Treatment (Taipei City Statistical Yearbook, 2020a).

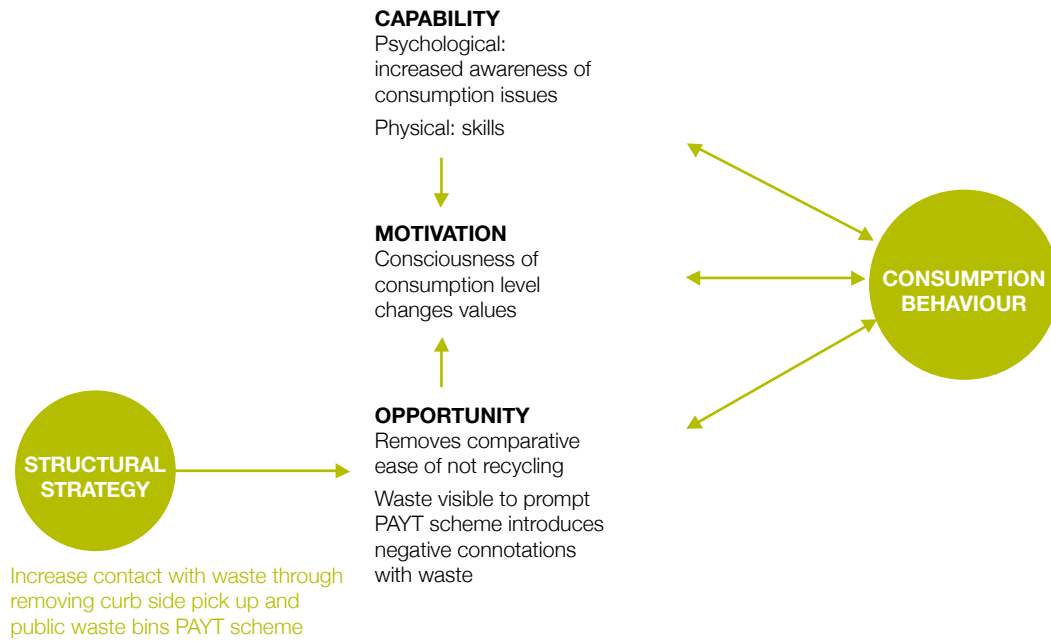


Drawing on this reasoning, it is possible to suggest that the structural strategies were significant for the increased levels of recycling in Taipei from 2001. Figure 3.3 shows there was a steep rise in formal state-recorded recycling levels in the city of Taipei, from 0% in 1996 to 62% in 2017 (Taipei City Statistical Yearbook, 2020a). The realisation of these behaviours was of course supported by appropriate infrastructure. However, this increase in recycling behaviour is in line with the expected timeframe for forming new behaviours following the changes to pricing introduced by the PAYT scheme implemented in 2000. It could be argued large increases in recycling could be explained through the creation of recycling as a default. According to Kahneman (2012), default decisions are relied on under stress or time pressure, which can be associated with urbanisation, such that these methods are highly applicable for use in urban areas. Additionally, as System 1 favours recycling, this behaviour could have become an ingrained habit under the reasoning of Michie et al. (2011). The general trends in behaviour suggest that the majority of Taipei residents follow this new default pro-environmental behaviour, however in recent years the levels of recycling are beginning to stagnate, suggesting other barriers exist. Obtaining current primary data, which is outside the scope of this paper, could offer greater understanding as to whether the existing barriers are behaviour related or a result of limitations in recycling capacity.

It could be argued that consumption behaviours were also impacted by the reduction in public waste bins under the structural strategy of availability. The reduction in opportunities to dispose of waste in public areas increased citizens' contact with their waste due to the need to carry it home in order to dispose of it (Ngo, 2020). This was enhanced by the introduction of a house-to-vehicle collection system where all household waste, both general and recycling, is required to be kept inside and personally carried to the singing vehicle as they pass by. Through this method, it is thought that the quantity of waste accumulated became more visible in households, with accumulation also limited by spatial restrictions. Additionally, it could be argued that the requirement to carry the waste to the truck, sometimes a 5-minute walk, introduced a sense of physical burden and also limited how much they are able to carry at a given time. These changes made the overall disposal of waste harder, inflicting a barrier which could deter the consumption of certain goods as a result of their packaging, in line with the reasoning of Michie et al. (2011). Additionally, making the process of waste disposal more visible could have led to increases in knowledge about where waste goes and the potential impact of high consumption levels on the environment. Figure 3.4 shows how these changes might have influenced consumption behaviour using the COM-B framework.

FIGURE 3.4

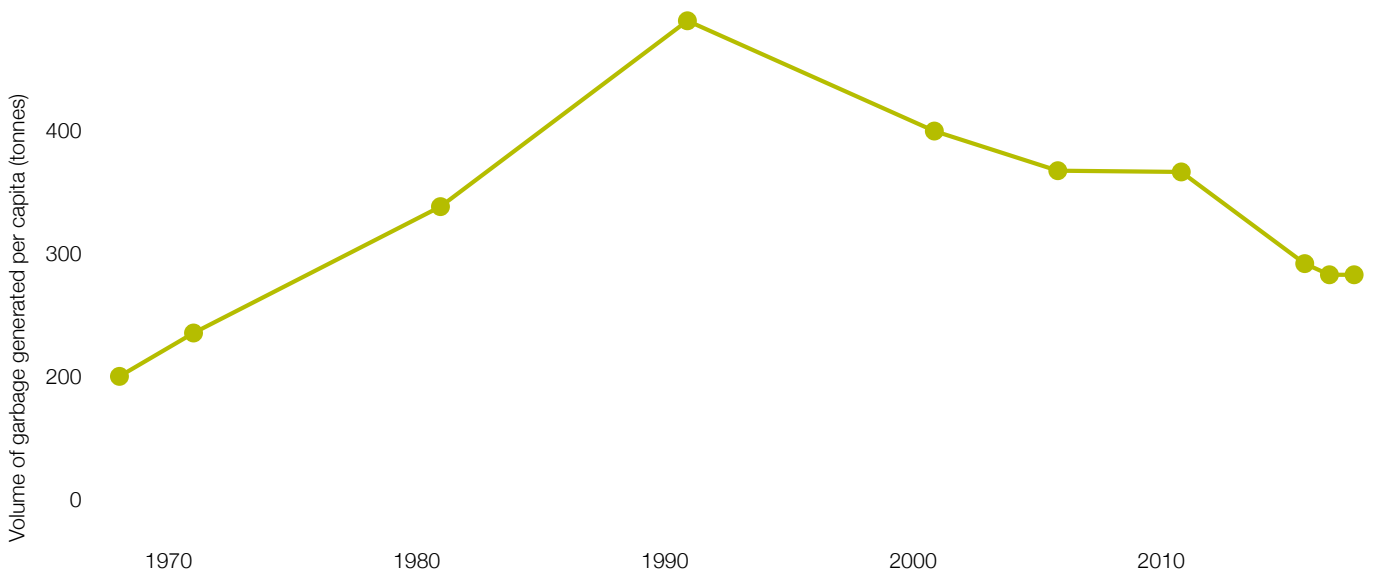
COM-B analysis of the impact of structural strategies on consumption behaviours



Waste researcher Nate Maynard argues that through this, purchasing habits have changed in Taipei (Ngo, 2020). This is supported by waste generated per capita data, which includes both general waste and recycling, for Taipei; as shown in Figure 3.5. Waste generated per capita fell by 18.3% from 1991 to 2001, and whilst conclusions are limited by the 10-year period between recorded levels, it is evident that changes before 2001, in line with the 1997 phasing in of house-to-vehicle waste collection and the removal of bins in 2000, had a significant impact on consumption levels. A decrease in consumption is often associated with a decline in GDP per capita, or a decline in disposable income. However, both are reported to have increased over this period (Taipei Statistical Abstract, 2018). The implementation of the structural strategy cannot, however, explain the plateau in consumption levels from 2006 or the steep decline in waste generated between 2011 and 2016, thus suggesting there might be other influences to waste generation.

FIGURE 3.5

Volume of garbage generated per capita in Taipei City (Taipei City Statistical Yearbook, 2020a)



With the assumption that, on the whole, motivation and capacity drivers remained largely unchanged by other factors, this study suggests that structural strategies which altered external factors, pricing and availability, led to sharp rises in levels of pro-environmental behaviours in the city of Taipei. This is a strong assumption, as individuals are influenced by a number of different factors on a daily basis. However the results from a survey of 1,780 households in 1993 shows high environmental values (Marans and Lee, 1993), which Figure 3.4 and Figure 3.5 suggest did not translate into changes in behaviours until after the changes to external factors. This reasoning along with the correlation between the timing of structural strategies and the changes in behaviour, suggest they were instrumental in the increase in realised pro-environmental behaviours. Therefore, whilst behaviour drivers are complex and often interlinked, reasoning suggests that implementation of structural strategies led to increases in pro-environmental behaviours, such that changes to external factors are equally significant in changing behaviours. Therefore, there could be potential benefits for exploring structural strategies further in Global South contexts and giving greater weight to external factors in environmental policies to increase pro-environmental behaviours.

Whilst behaviour drivers are complex and often interlinked, reasoning suggests that implementation of structural strategies led to increases in pro-environmental behaviours, such that changes to external factors are equally significant in changing behaviours.

Avoiding environmental degradation?

It could be argued that the benefits of structural strategies included avoiding environmental degradation. Global trends suggest that GDP per capita is highly correlated with consumption (Kaza et al., 2018), which is reflected in the World Bank regression model defined in section 2.4. The result of this model to predict Taipei's waste generated per capita based on GDP, without the implementation of the structural strategy, can be seen in Figure 3.6 with the numerical values listed in Appendix. 1. The results show that initially, in 2001, actual waste levels were higher in Taipei than the global average. This discrepancy could be due to the use of country GDP over city values, which tend to be higher. However, following the introduction of structural strategies, actual levels of waste generated per capita show a steady decline from 1997 to 2000. The predicted values of waste generated per capita, whilst initially lower, are gradually rising indefinitely with GDP growth, suggesting that without the implementation of the structural strategies Taipei might be experiencing much higher levels of consumption at its current GDP level, as well as experiencing higher levels of reliance on carbon. Therefore, these findings suggest that through the implementation of the structural strategies which encouraged pro-environmental behaviours, environmental degradation has been avoided.

FIGURE 3.6

Taiwan GDP per capita (CountryEconomy, 2020) and waste generated per capita (Taipei City Statistical Yearbook, 2020a).

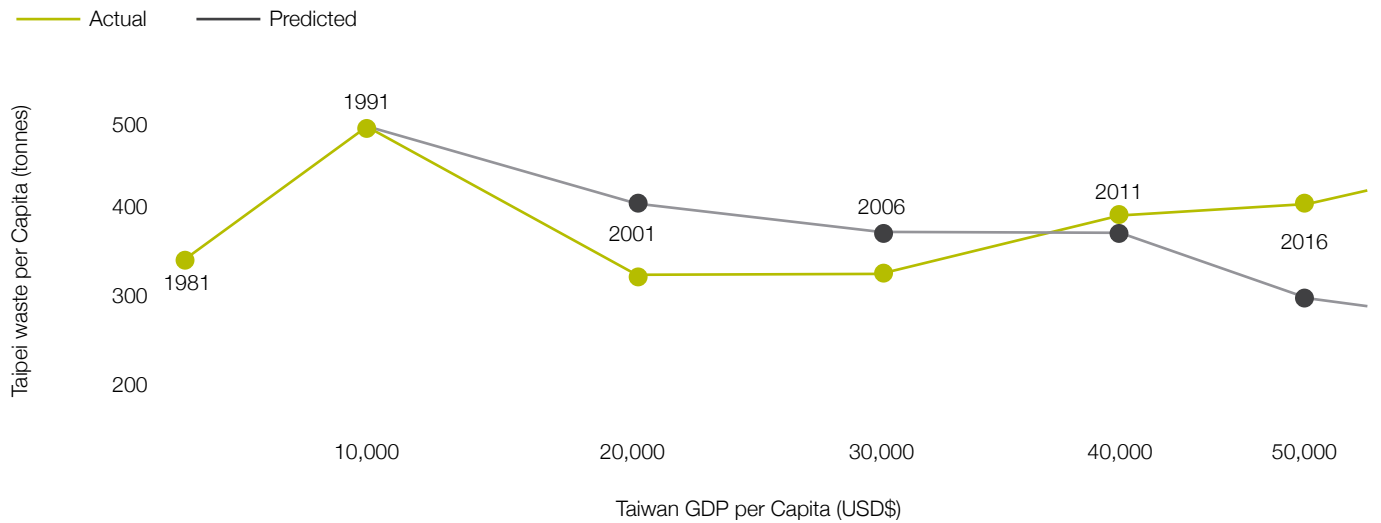
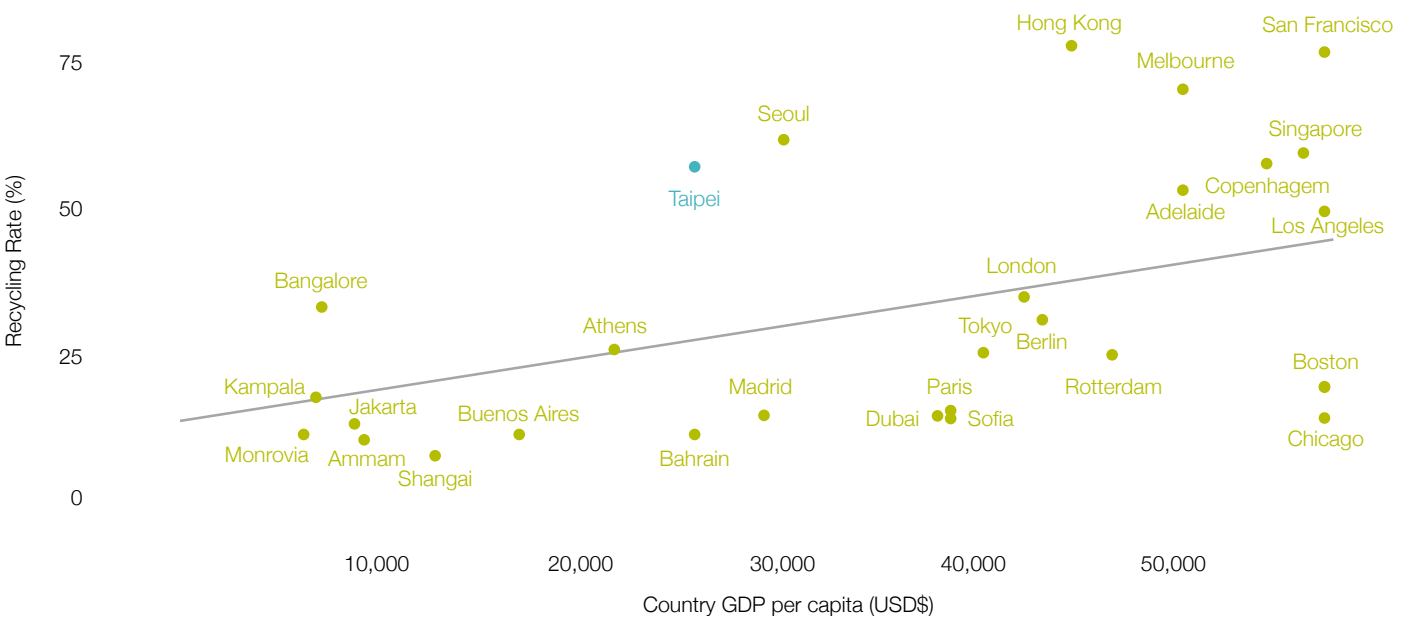


Figure 3.6 also shows that Taiwan's GDP per capita slowed after 2016, however findings suggest that this was not a result of a rise in pro-environmental behaviours but rather the uncertain political status of Taiwan (Brown, 2010). Further research into the effect of reduced consumption and other pro-behaviours on GDP growth could shed further light on this.

In a similar vein, the author undertook regression analysis of the recycling rate to consider recycling behaviours at city level (%) based on the country's GDP per capita using a dataset of 35 cities (Appendix. 2). Plotting Taipei against this dataset shows that the levels of recycling for Taipei based on the GDP per capita (shown in red on Figure 3.7) are higher than the global average. Global South cities with low GDP can be seen in the far left. Whilst Quezon City, Lahore and Bangalore show promising rates of recycling, most countries look to be following the general trend of not investing in recycling until high levels of GDP.

FIGURE 3.7

Average global recycling rates (Greenfield, 2016) for country GDP (CountryEconomy, 2020), 2016



As part of this study, a regression analysis was conducted by the author for the 35 cities, excluding Taipei, shows positive correlation between city recycling rates (%) and the GDP per capita for the country. The adjusted R_2 value of 0.242 suggests that this is a weak model and there are other determinants of recycling rate beyond that of GDP, such as infrastructure. To better understand the role of behaviour in the recycling model, other factors could be added to the regression model. However, this was not possible in this study due to a reliance on the availability of secondary data. Therefore, for the scope of this study the business as usual recycling rate for Taipei will be predicted using Equation 3.2 generated from the regression analysis:

EQUATION 3.2

Recycling rate based on country GDP per capita.

$$\text{Recycling Rate}_{\text{year}} (\%) = 12.62 + 0.000539 \text{ GDP per capita}_{\text{year}}$$

TABLE 3.2

Avoided tCO₂e from waste recycled instead of landfilled

Table 3.2 shows the predicted recycling rate based on this model, the actual recycling rate, and the actual waste generated in the city; from which the estimated tCO₂e avoided through improved recycling rates in the city of Taipei has been calculated.

	2001	2006	2011	2016	2017	2018
Actual Waste Generated (tonnes) (Taipei City Statistical Yearbook, 2020a)	1,049,394	957,721	959,025	783,269	755,026	750,275
Predicted Recycling Rate (%)	13.3	13.4	20.8	22.4	24.2	24.8
Actual Recycling Rate (%)	5.9	32.6	49.8	58.3	62	61.2
Metric Tons of CO₂ Avoided through improved recycling⁴	-228,306	540,614	817,664	826,709	839,075	802,914

NOTE 04

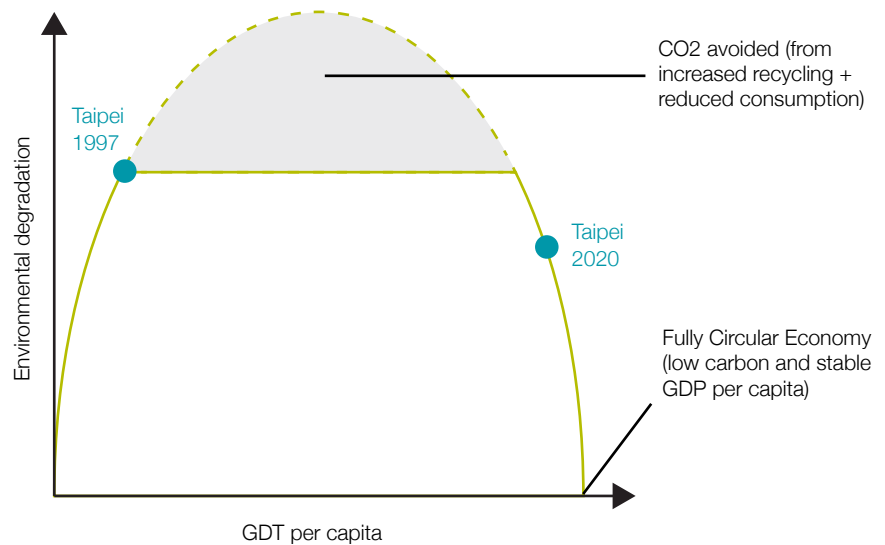
Where 1 tonne of waste recycled instead of landfilled = 2.94 metric tons CO₂ equivalent (EPA, 2016)

Table 3.2 shows that whilst Taipei was behind in recycling in 2001, from 2006 onwards the actual recycling rates are substantially higher than those predicted, resulting in avoided tCO₂e from recycling instead of landfilling. Whilst the regression model is weak, this large value, coupled with lower than average consumption levels, suggest that environmental degradation has been lower in Taipei than what has been experienced globally. Additionally, indirect benefits such as a decrease in diseases and contamination from removing the garbage from the streets and closing overflowing landfills, suggest more environmental degradation might have been avoided than highlighted through these measures of tCO₂e. However, the timing of the policies were driven less by strategy and more by the democratic movement (Maynard, 2018). At the time of implementation, waste levels and GDP per capita were higher than the current average levels in the Global South; reflecting high levels of environmental degradation that had already occurred. Therefore, it could be argued that earlier adoption could have been more beneficial in preserving ecological balances.

However, by using EU defined circularity indicators it can be seen that Taiwan - a newly developed country - for many sustainable resource management metrics was comparable to EU countries in 2015. Taiwan's Material Footprint is just above the EU average, but smaller than Sweden and Ireland (Appendix. 3). Taiwan scores low on Resource Productivity. This could be due to its comparatively low GDP per capita; however, it is still higher than a number of eastern European countries (Appendix. 4). Finally, in this comparison waste generated per capita for Taipei is higher than EU countries (Appendix. 5). Whilst this is expected due to the fact this study compares Taipei's city data to

FIGURE 3.8

Analysis of Taipei development using the environmental leapfrog framework.



other countries, it is significant that the amount of waste recycled is also higher. Recycling levels tend to be lower in cities, therefore this comparison shows Taipei to be excelling in recycling. These indicators show that whilst Taipei is comparative with EU countries, they all still have a long way to go to achieving circular economies. Whilst it has not been possible to compare indicators from before and after the intervention, due to availability of data, in 25 years Taiwan has gone from 'Garbage Island' to rivalling Global North countries. It is therefore reasonable to suggest that by changing external factors related to recycling and consumption behaviours, Taipei has been able to avoid environmental degradation and accelerate towards a circular economy as depicted in Figure 3.8. Global trends show strong correlations between consumption and GDP growth; however, the findings of this study suggest possibilities for decoupling these factors. This could save Taipei time and money in correcting these behaviours at a later date. Furthermore, findings suggest that tCO₂e from Taipei's waste management is comparatively low, with high levels of recycling and sustainable consumption behaviours. Suggesting through early implementation of circular objectives, Taipei is ready to meet future low carbon requirements in the field of waste management.

It is reasonable to suggest that by changing external factors related to recycling and consumption behaviours, Taipei has been able to avoid environmental degradation and accelerate towards a circular economy.

Findings suggest that increasing the barriers to anti-environmental behaviours, such as cost and effort, act as a deterrent.

04. Applicability for the use of structural strategies in Global South contexts

The case study of Taipei shows how recycling and consumption behaviours have been shaped through the structural strategies of pricing and availability to change external factors to avoid environmental degradation and accelerate Taipei closer to a low carbon city. These two behaviours of focus are far from the only behaviours coupled to GDP per capita growth; car use, air travel, and energy consumption are among the others. That is not to say that the same approach will work for every country on account of differences in social and culture behaviours. The different impacts of policies that are noted in Chapter 2 highlight that motivation and capacity, which can be shaped by culture, play a role in how the policy is realised and differ for each pro-environmental behaviour. However, by looking at what can be learnt from this case study it is possible to consider the applicability of such methods for pro-environmental behaviours in Global South contexts.

Changing external factors to create pro-environmental behaviours

The findings from the case study suggest that levels of pro-environmental behaviours can be increased through changing external factors. This study was limited by the absence of qualitative data and the reliance on secondary sources, such that the extent of behaviour change could have been influenced by other factors over the same period. Behaviour drivers are complex and still being discovered, however using the COM-B framework this study has drawn on the literature to highlight the possible ways in which external factors influence decisions to act pro-environmentally. Findings suggest that increasing

the barriers to anti-environmental behaviours, such as cost and effort, act as a deterrent. At the same time, by removing the same barriers for pro-environmental behaviours could encourage those who have environmental values but are not able to spend additional time or money. Additionally, findings suggest that the creation of green default behaviours is possible, which can become habitual and ingrained in every day practice under the mechanisms earlier described by Steg and Vlek (2009). This study also suggests that changing external factors can influence motivation and capacity drivers indirectly, as suggested by the COM-B framework. This means that by making processes and environmental issues more visible and increasing the feeling of responsibility through these methods, governments could indirectly increase awareness and change values. Opportunities for future research practice could include the use of qualitative data to better understand the psychology behind these changes and the influence of other factors.

External factors appeal to an individual's automatic thinking, System 1, through the creation of pro-environmental default options that don't require conscious thought; thus, suggesting this could be an effective method to raise pro-environmental behaviours without adding an extra strain on vulnerable factions of the community.

The reasoning of Banerjee and Duflo (2011), and the significant changes to behaviour that can be observed in the Taipei case study, raise the question of whether opportunities have a greater influence on behaviour than motivation and capacity in Global South contexts. In countries with low GDP per capita and high levels of poverty, price and ease of choices is said to be more important (Banerjee and Duflo, 2011). Furthermore, poverty causes stress and greater reliance on System 1 to enact decisions, which would fall reliant on the default option (World Bank, 2015). Whilst this is hard to compare with the use of a similar strategy in Global North countries, due to nuance of contexts (Steg et al., 2012), this could have implications for the current theories which frame external factors as having equal or less influence on the realisation of behaviours. This study also suggests that there could be other benefits for focusing on external factors. External factors appeal to an individual's automatic thinking, System 1, through the creation of pro-environmental default options that don't require conscious thought; thus, suggesting this could be an effective method to raise pro-environmental behaviours without adding an extra strain on vulnerable factions of the community. This is often not the case in policies that tend to focus on creating environmental values, often asking individuals to consciously change their behaviour (Steg and Vlek, 2009). Full consideration of this was outside of the scope of this study, however future research into the comparative burden of respective strategies could better inform the importance given to external and internal factors in policy decisions.

Furthermore, in the case study of Taipei environmental values are suggested to be high but were not translated into pro-environmental actions, such that before the strategy implementation they were suffering from the Value-Action gap as defined by Blake (1999). It could be argued that rising CO₂ levels seen across the Global South are a reflection of the same Value-Action gap. Bottom-up environmental movements are plentiful across Global South contexts (Dwivedi, 2001) and the impact of climate change is thought to be encouraging environmental awareness and values through the availability heuristic (World Bank, 2015). Furthermore, studies in Latin American contexts suggest that, whilst still not well understood, cultures also lend themselves towards environmentalism (Bronfman et al., 2015). And whilst many Global South countries are landlocked, bordered, and have strong ties with international actors, pressures of climate change are increasingly disrupting trade routes; leaving countries isolated. Therefore, whilst a deeper understanding of specific contexts is needed, it could be proposed that acceptance of environmental policies could be as high in Global South countries as it was in Taiwan. Therefore, changing external factors could be effective in translating environmental values into pro-environmental behaviours in the face of rising urbanisation and GDP levels. As previously mentioned, behaviour change studies are often based on WEIRD assumptions and experiments. This study shows that changing external factors could be highly effective in increasing pro-environmental behaviours and could even lead to other potential benefits in Global South contexts. More in-depth research in specific contexts, drawing on primary data, could validate these findings and explore theories of behaviour drivers outside of Global North contexts.

Barriers to structural strategies in Global South contexts

The case study of Taipei provides an example of structural strategies being implemented in a Global South country, showing the use of such policies is possible and could be effective. However, despite being classified as a Global South country at the time, it could be argued that certain structures existed in Taipei to facilitate the implementation of a structural strategy which might not be present across Global South countries.

The collective concerted effort to maintain pressure throughout, and concentrate the population's mind on reducing waste, was achieved in Taipei through strong institutional structures and a stable government. Many cities in the Global South suffer from weak institutions as a result of colonialism and global power relations (Perkins and Neumayer, 2005), hindering the implementation and long-term planning; which this study suggests is needed for structural strategy implementation. In the case study of Taiwan external factors have been changed using nudge approaches rather than banning the anti-environmental option. However, previous bans in Global South contexts, such as plastic bans in Rwanda, where institutions could be considered weaker, have proved more successful and easier to monitor, offering an alternative method to overcome this barrier (Clapp and Swanston, 2009; Convery et al., 2007; Global Citizen, 2015). Another option could include implementation on local levels through the engagement of community leaders. However, this of course increases opportunities for cheating, which this study suggests is detrimental to the realisation of pro-environmental behaviours. Further research of localised trials could offer greater insight into whether structural strategies would be effective if applied in this manner. Finally, in weak institutions it could be possible to draw on the notion of social shaming, which was used to some extent in Taipei and thought to be effective. However, this method continues to be controversial due to the potential to cause further marginalisation.

In the case study of Taipei, the implementation of the PAYT scheme and removal of bins were low cost policies aimed at decreasing consumption. However, accommodating the increase in recycling behaviours required

funding to ensure infrastructure kept up with demand for the pro-environmental option. In Taipei, this need was met through taxes on citizens, manufacturers, and importers. However, across Global South contexts, taxation systems tend to be weak and if taxation is passed onto the population due consideration should be given to how to support the most vulnerable. The impact this would have on the realisation of behaviour change is not well understood. Funding remains a continuous barrier for development in Global South cities and the gap is often filled by private actors (Castán Broto and Bulkeley, 2013). Private companies have no duty to abide by the prescribed system and are driven by keeping customers happy and maximising profits. Whilst private waste collection continued throughout the case study of Taiwan, it was drastically reduced and it is unclear the impact that this had on behaviours. The reliance of the Global South on private actors for operating in the infrastructure sector could be a significant barrier to the implementation of structural strategies unless they were willing to cooperate. This study provides an interesting example of how infrastructure costs can be minimised during transitions to sustainable alternatives. However, a focus on behaviours that do not require the support of large infrastructure investment, such as consumption, might be more applicable in Global South contexts.

Furthermore, Global South contexts are often defined by their high quantity of informal workers. The case study of Taipei suggests that for the strategy to work, formal systems are needed. Informal work provides income to many urban poor. Therefore, the removal or discouragement of informal practices should be given due consideration. If decided upon, measures should be put in place - where possible - to include these workers and their knowledge in the formal system or provide other opportunities to avoid marginalising this faction of the population. The case study of Taipei shows that structural strategies could cause unevenly distributed impacts. As with Taipei, in many Global South contexts household roles are gendered and therefore changes to household practices through structural strategies could potentially increase the time poverty of women and effect access to education and work (Rao et al., 2019; Xu and Lai, 2004). Incorporation of participatory planning workshops to understand the balance of responsibilities within households could help to better inform strategies. This study shows that the structural strategy implementation in Taiwan was successful due to enabling factors and required trade-offs. These same factors might be barriers to implementation in Global South contexts or require trade-offs that increase inequalities. Further research to understand the effectiveness of structural strategies on community scales, combined with measures to support the vulnerable, could provide more insight into the applicability and benefits of structural strategies in Global South contexts.

The case study of Taipei suggests that for the strategy to work, formal systems are needed. Informal work provides income to many urban poor. Therefore, the removal or discouragement of informal practices should be given due consideration.

Environmental leapfrogging: possibility or wishful optimism?

The regression models in this study suggests environmental degradation was avoided through the implementation of structural strategies. Whilst the models were limited in predicting the true scope of what Taiwan's waste management landscape would have looked like had the strategy not been implemented, as they were based on global averages and omitted context and cultural considerations, the findings are supported by the declines in consumption and increases in recycling outside of global trends. Declines in consumption levels, despite increase in GDP per capita, act as evidence that a decoupling of GDP growth and environmental degradation is possible; as suggested by Leap Frog theory. In Taipei, the timing of these behaviours being decoupled were driven by bottom up pressure rather than strategic planning. It could be argued that the earlier the implementation, the greater the opportunities are for countries to undertake slower and more considered transitions; ensuring equal benefits across the economic and societal spectrum. Additionally, whilst not considered within the scope of this working paper, further research into the catalyst effect of the early implementation of pro-environmental behaviours on green growth and green innovation levels could highlight additional opportunities for leapfrogging and avoiding environmental degradation. It is clear that balancing GDP growth and environmental degradation during development practices is an ongoing issue, however understanding this trade off could benefit from deeper knowledge of how anti-environmental behaviours are driven by GDP growth and urbanisation through time poverty and living conditions. Utilising this knowledge to determined how the timing of decoupling behaviours effects the ability to avoid environmental degradation could lead to the full realisation of environmental leapfrogging.

Declines in consumption levels, despite increase in GDP per capita, act as evidence that a decoupling of GDP growth and environmental degradation is possible; as suggested by Leap Frog theory.

In this study the environmental leapfrog framework is limited by its exclusion of global influences and trade. However, it is important to consider the larger systems that breach country, and even continental, borders when aiming for circular economy. These behaviours are all strongly associated with the Global North and signify wealth. To fully decouple these behaviours, Global North actors have a prominent role in denouncing these anti-environmental behaviours. Without this, Global South countries might have little motivation to limit their already small emissions and be convinced by the need for reduced consumption. Furthermore, environmental degradation in Global South countries is highly impacted by manufacturing, mining, deforestation and intense farming practices driven by global demand. These structures are often a product of the dependent relationship between the Global North and South. In this study, Taiwan's exclusion from the international sphere could, to an extent, have benefitted the ability to decouple environmental degradation from GDP growth. Therefore, where global influence is strong, decoupling GDP growth from

anti-environmental behaviours might be more difficult. Further research on the impact of external influence on behaviours could improve the understanding of external systems and power dynamics influence on a city's ability to create a circular economy.

This study suggests that by defining the end goal using circularity indicators, and environmental degradation using tCO_2e , environmental leapfrogging is possible. However, it is fully acknowledged that the circularity indicators used in this study do not yet fully encompass the complex systems governing environmental degradation. The end of the Kuznets's curve, where GDP is at a high constant and environmental degradation is zero, is not yet a reality or even well understood. Therefore, the possibility of achieving environmental leapfrogging depends on the parameters in which it is defined. However, the findings from this study suggest that the idea that Global South countries can follow a path of lesser emissions to achieve low carbon urban areas, which is the basis of this theory, is possible. With the inevitability for the requirement of low carbon usage, this should be a focus for development planning.

It is clear that balancing GDP growth and environmental degradation during development practices is an ongoing issue, however understanding this trade off could benefit from deeper knowledge of how anti-environmental behaviours are driven by GDP growth and urbanisation through time poverty and living conditions.

Further studies of external factors, and structural strategies which alter these, in Global South contexts could provide interesting insights for encouraging pro-environmental behaviours as the default option.

05. Conclusion

In conclusion, it is now commonly agreed that the future is low carbon and therefore countries in the Global South shouldn't fall into the same carbon lock-in trap as the Global North. It is vital to look at what opportunities will present themselves during this period of transformative change for accelerating development and achieving sustainable systems. It is evident that a lot of factors influence the determinants of anti-environment behaviours and geopolitical structures might often hinder the agency of Global South countries in correcting these. In this research I have shown that further studies of external factors, and structural strategies which alter these, in Global South contexts could provide interesting insights for encouraging pro-environmental behaviours as the default option. As the field of behaviour change is expanding there is a need to create a Global South knowledge basis to explore potential benefits and avoid imposing Global North assumptions. Furthermore, this research showed the potential benefits of decoupling GDP growth from anti-environmental behaviours. Further research could help better understand the relationship between anti-environmental behaviours and the processes of urbanisation to determine how well-placed strategies could be adopted to benefit countries in the Global South on their path to low carbon societies.

Appendix 01

Waste Generated per Capita (Predicted vs. Actual)

Waste generated actual
(Taipei City Statistical Yearbook, 2020a),
predicted calculated using World Bank regression model
(Kaza et al., 2018)

	2001	2006	2011	2016	2017	2018	Total
Predicted Waste Generated per capita (tonnes)	317	318	384	397	411	415	2242
Actual Waste Generated per capita (tonnes)	397	365	364	290	281	281	1998

Appendix 02

Data for conducting regression analysis

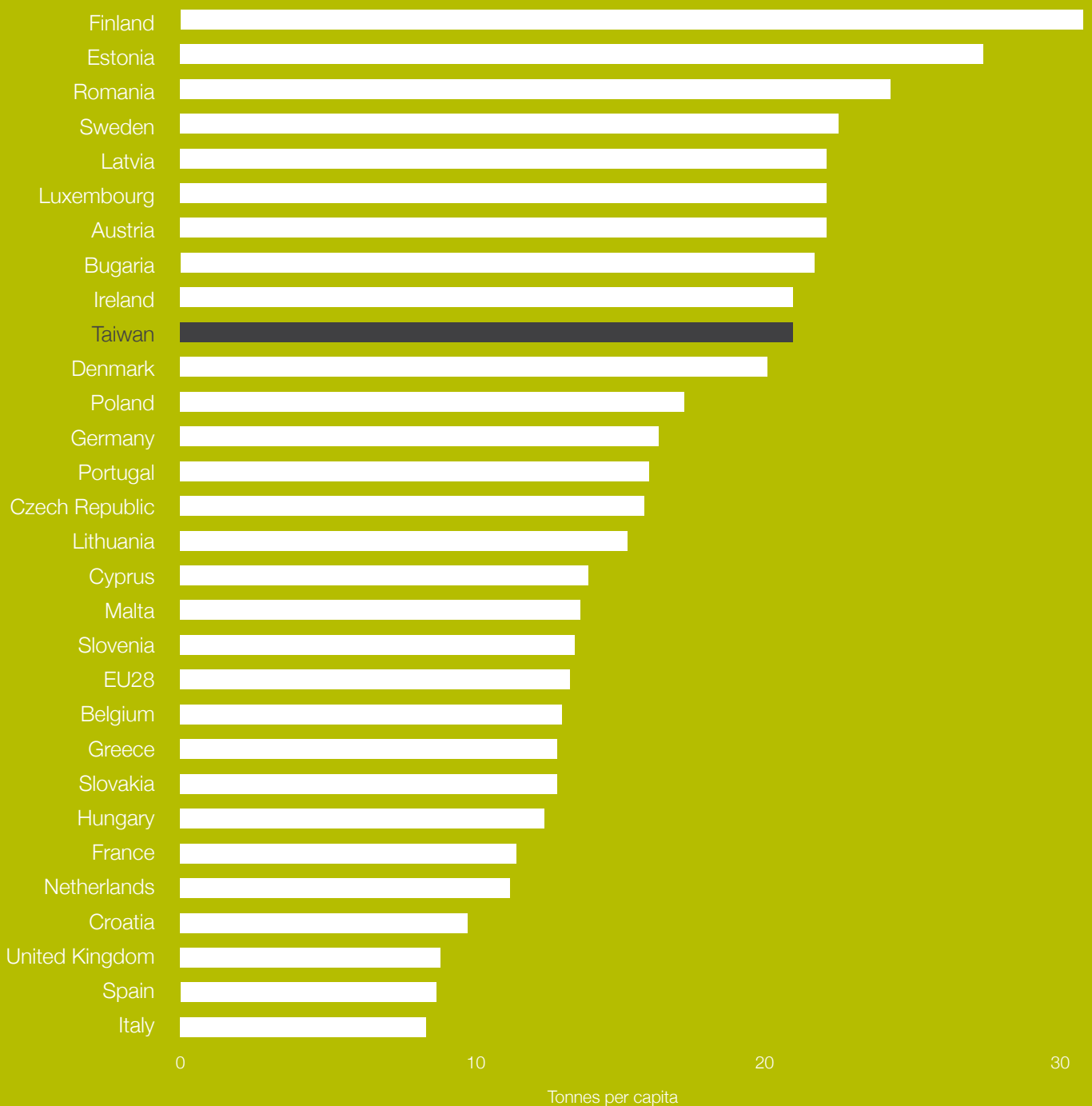
Data used by author to run regression analysis. Reported recycling rates taken from (Greenfield, 2016), country GDP for 2016 taken from (CountryEconomy, 2020)

City	Reported recycling rate (2016) [%]	Country GDP (2016) [USD\$]
Hong Kong	81.2	43734.2
San Francisco	80	57904.2
Melbourne	73	49971.1
Seoul	63.5	27608.2
Singapore	61	56724.2
Copenhagen	59	54664
Adelaide	54	49971.1
Los Angeles	50	57904.2
Quezon City	39	2941.21
Lahore	35	1368.45
London	33.9	41074.2
Bangalore	32	1729.27
Berlin	29.6	42098.9
Athens	24	18116.5
Tokyo	23.4	38794.3
Rotterdam	23	46007.9
Bishkek	18	1120.67
New York	17	57904.2
Boston	16.9	57904.2
Dhaka	15	1401.62
Lusaka	14	1280.58
Paris	12.5	36962.2
Madrid	11.6	26505
Dubai	11.5	36226.23
Chicago	11.1	57904.2
Sofia	11	36962.2
Kampala	11	608.71
Jakarta	10	3562.85
Bahrain	8	22619.1
Buenos Aires	8	12790.2
Guadalajara	8	8739.76
Monrovia	8	714.62
Amman	7	4103.73
Beijing	4	8078.79
Shanghai	2.5	8078.79
Taipei	58.32	22573

Appendix 03

Material Footprint of Taipei and EU Countries

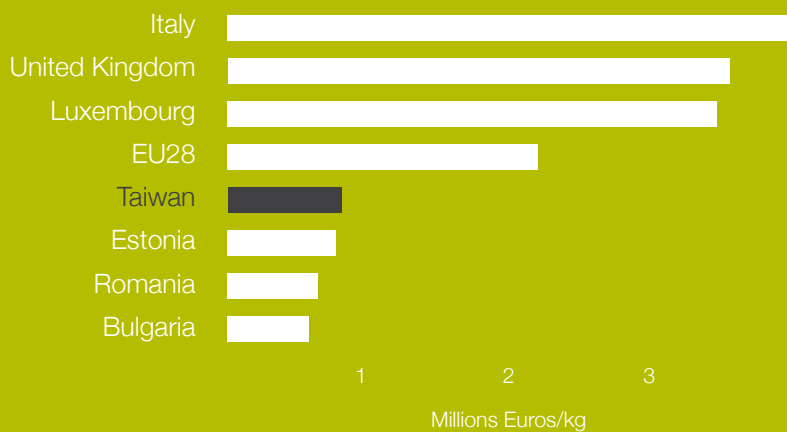
Remade from (EU, 2017) using data for Taiwan from (Chen, 2013), with a growth multiplier defined by (Wang et al., 2014) to estimate 2015 figures



Appendix 04

Resource productivity of Taipei and EU Countries

Remade from (EU, 2017) based on calculation for DMC from (Chen, 2013) and the growth multiplier defined by (Wang et al., 2014) to estimate 2015 figures



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