Green Food Price Index - A Novel Metric to aid a Nation's Transition Towards a Green Economy?

A New Zealand Case Study

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The future development of certified green production processes and their measurement is an important area of interest for the Tiaki Institute, and the institute aims to build on this initial proof of concept with the intention of making this method of measurement more widely spread and adopted. The methods used and ideas behind this research is largely based off Webb's (2016) Green+ document, which can be accessed through the following link: https://web.archive.org/web/20190606084126/http://challenge.institute/wp-content/uploads/2016/05/Green-For-Review.pdf

Kind regards,
Marcel de Vries

Abstract

To measure the progress towards a sustainable future/economy, it is important to have a tool that clearly indicates - from an economic perspective - if we collectively are on track, and are making progress towards this goal. Given the complexities of measuring all sectors of a nation's economy, this paper proposes a tool for measuring one sector, in this case the food sector with a specific focus on the nation of New Zealand. Moreover, the food system's current production and consumption habits are having significant impacts on both people and planetary wellbeing. The specific focus of this paper will be on measuring the price difference between conventional and green food items (certified organic), to paint a picture of current sustainability levels and where improvements can be made.

In the literature some frameworks to measure the green economy are discussed, but are yet to be taken up collectively. This paper proposes a new method for measuring the sectors which constitute an economy, by determining its level of greenness based on certification standards which are compiled into green metrics. The researcher uses the New Zealand food sector as a proof of concept for this framework. The green metric developed for the scope of this paper is a green Food Price Index (gFPI), which represents the price difference between a conventional food basket and a green food basket, both containing the same food items. This research adds to existing literature through the development of a new method of measuring the greenness of an economy.

A mixed methods approach was implemented comprising quantitative elements (primary price data, secondary price data) and qualitative aspects (semi-structured interviews with representatives from Statistics New Zealand and certification body AsureQuality). The food baskets used in this study were based on a typical New Zealand diet, and a more sustainable alternative which has emerged from the literature on sustainable food systems, namely the Planetary Health Diet (PHD). Statistical methods were conducted for the calculations of the various price indices in order to understand the price differences between these baskets.

As a result, the findings of this paper show that historically, and currently, the price of green food items are more expensive than their conventional equivalents for New Zealand consumers. Current figures indicate that both the green Typical basket (+ 21.62$NZD) and PHD basket (+ 3.62$NZD) cost the New Zealand consumer more than their conventional equivalents. Based on the historic PHD figures (from 2018 to November 2021), the green basket costs on average between 31% to 51% more than the conventional basket. There is no clear trend that green food item prices are reducing over time, further reinforcing the importance of measuring this to provide the information to raise awareness for those able to enact change. The interviewees reinforced this by suggesting that the gFPI tool would most likely have the potential to create actionable outcomes in the realm of public policy, by encouraging more sustainable ways of producing and consuming food items. Further implications of the gFPI are discussed surrounding the possible impacts on producers and the adoption of green production processes, and for consumers regarding consumption habits.

It is hoped that this paper provides policy makers and others with a valuable metric to measure sectors of a nation's economy and determine what level of greenness is present, and where it could be improved, ultimately leading to a more sustainable world. Future research could build on this paper through applying the methods proposed to other sectors of the economy, or other nation's economies outside of New Zealand.

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1. Introduction

Collectively, global citizens, corporations and governments are almost at the completion of our second year in the 'Decade of Action' (United Nations, 2021). This decade of action encompasses the transition of nation's making progress towards the sustainable development goals (SDG's[1]), which provide a collective global agenda in tackling and making progress towards overcoming many of today's wicked problems (van Tulder, 2018). By supporting a vision to end poverty, rescue the planet and build a peaceful world, paired with a broad and ambitious scope targeting all aspects of a nation's economy future prosperity, the SDG's encompass a monumental paradigm shift (United Nations, 2021). Many SDG's turn out to be interconnected in nature, and relate in one way or another to the global food system. For instance; SDG 1, 2, 3, 6, 12, 14 & 15 amongst others. The fact that food is situated at the base of Maslow's hierarchy of needs, as a basic physiological need (Maslow, 1943), further strengthens the importance nations, and subsequently governments must place on providing these basic needs in a manner that aligns with the vision and attainment of the SDG's.

Global food production is a process that is constantly in flux, shifting dietary patterns, evolving production methods and many other factors push and pull the global food ecosystem. Over the recent decades many positive impacts of the global food ecosystem have been felt, not least; pulling many (the majority from developing nations) out of poverty, reducing global hunger and subsequently child mortality rates, whilst improving the average life expectancy (Willet et al. 2019). Granted these benefits and the associated positive externalities from the innovation and development of food systems should not go unmentioned, it is important to portray the overall big picture, the current state of affairs in the global food ecosystem. This unfortunately paints a far bleaker picture, as outlined below, by the impacts felt by both people and planet.

The current dilemma the world faces as a result of the food ecosystem created by commercial entities and consumer consumption is a paradox of sorts. Developing nations are still largely plagued with food insecurity, resulting in >820million people remaining undernourished (FAO, IFAD, UNICEF, WFP and WHO, 2018) and >2billion individuals micro-nutrient deficient (WHO & FAO, 2009). Contrastingly, in more developed nations food environments have evolved to provide a vast array of highly available and calorically dense (processed) foods. This affects people's health in an equally negative way, obese and overweight adults number at 2.1 billion, whilst negative health impacts of non-communicable diseases have skyrocketed, for instance diabetes has practically doubled in a span of three decades (WHO, 2016). Unhealthy diets now pose a greater risk to morbidity and mortality than unsafe sex, alcohol, drug and tobacco use combined (Willet et al, 2019).

Food and the associated agricultural practices not only impact people's health and well-being but also our planet's environmental health and well-being. The current state of global food production is threatening climate stability and ecosystem resilience, acting as the single largest driver of environmental degradation and transgression of planetary boundaries in the Earth's system (Rockström et al. 2013). Current agricultural practices are estimated to occupy 40% of global habitable land (Foley et al. 2005), produce 30% of total greenhouse-gas emissions (Vermeulen et al. 2012) and consume 70% of freshwater use (Viala, 2008). Species' biodiversity loss is largely a result of land use changes from natural ecosystems to agricultural cropland and pastures (Tilman et al. 2017). Furthermore, the monocropping of land in conjunction with misuse application of fertilisers (nitrogen and phosphorous) is degrading soil

[1] For an overview of the Sustainable Development Goals see: https://sdgs.un.org/goals

health whilst eutrophication inhibits fresh water stocks (Diaz & Rosenberg, 2008). Marine ecosystems are not immune to the effects of global food production either, with catch figures of marine fisheries declining since 1996, no doubt a by-product of around 30% of world fish stocks being overfished (FAO, 2012).

In summary, the global food system is considerably impacting both people's, and our shared planet's health. A transformation of the food system is required, to reduce these negative impacts, help transition towards more sustainable systems and a more prosperous future. "This transformation will not be achieved without people changing how they view and engage with food systems. This change in thinking should recognise the inextricable link between human health and environmental sustainability and integrate these separate concerns into a common global agenda to achieve healthy diets from sustainable food systems." (Willet et al., 2019, p. 449). This research aims to tackle this transformation through the investigation of how the **pricing** of certain foods and diets contributes to supply and demand sided outcomes, as explained below.

1.1 Problem Definition & Research Question

Clearly significant impacts are being felt by both people and planet from the status quo in the food and agricultural system. This begs the question; how to ensure a transition towards more sustainable consumption and production (SDG12)? In relation to the food ecosystem, consumption relates to individuals' food purchasing and consumption habits, whereas production refers to the way food items are produced along the entire supply chain. Research has shown price is noticeably the largest hinderance in consumers switching to more sustainable products, Gleim et al. (2013) found that 43% of respondents highlighted this as the main barrier to buying green, followed by quality (14%). Price not only dictates which food items consumer purchase, but also how food items are produced along the entire supply chain. Therefore, this study attempts to understand the price difference between conventional food items and more sustainable (green[2]) food items. Furthermore, this research aims to represent the price differences between particular consumption habits by comparing New Zealand's current food consumption habits constituting a *Typical Diet,* against a scientifically tested sustainable alternative, created by Willet et al, (2019) named the *Planetary Health Diet* (PHD). Ultimately, the economic findings of each production process and consumption pattern will be compiled into a monetary figure represented as a Food Price Index (FPI), with the intention to analyse the results from a macro-economic perspective, in relation to a nation's (in this case New Zealand) sustainable development trajectory. This leads to the following research question which this study aims to address:

RQ*:* "*Can the creation of a novel green food price index act as an accurate and actionable economic metric for the transition towards a green economy, for New Zealand's food system?"*

Due to the complexity of the global food system and the monumental task of obtaining the required data, the scope of this research is limited to a national scale, namely the New Zealand food system. The choice of New Zealand for this research is twofold. First the researcher's current residence and childhood has ties to the nation. Secondly, the researcher's association with New Zealand sustainable development think-tank *Tiaki Institute*. *Tiaki* places a large

[2] This distinction of a sustainable (green) food item is based on the assumption that certified organic foods provide environmentally friendlier production practices than non-certified foods (as explained in section 2.4.1).

emphasis on developing green metrics in order to understand current sustainability developments and trajectories, hence this research will act as a proof of concept for the measurement methodology of the greenness of a given sector of the economy. Testing the clean green image New Zealand portrays, while aligning well with the developments in New Zealand public policy surrounding the transition towards a more sustainable nation. The reader should keep in mind that the methods used in this research could be equally applied to other nations too. This research is acting as a proof of concept, before being applied to other areas of the economy and other nations.

1.2 Relevance of the Study

1.2.1 Theoretical Relevance

In terms of theoretical relevance, the following research aims to provide valuable contributions to the business literature in the field of green economy measurement techniques. To date, globally there has been little unanimous uptake of a measurement method which clearly defines a good or service as (more) sustainable. This study attempts to overcome this by proposing a novel method based on the utilisation of already existing certification programs. Through the use of recognised certified production processes, one could subsequently classify a good or service as a more sustainable alternative to an uncertified equivalent (see section 2.2.3). This will be applied as a proof of concept to the New Zealand economy, more specifically the food sector of the economy. Ultimately, this study creates a novel economic metric in the form of a green Food Price Index (gFPI) which could stimulate further research in the fields of green economy measurement and transitions towards more sustainable food systems.

1.2.2 Practical Relevance

The practical relevance of the paper can be explained through the potential impacts felt by government, commercial entities and societal actors.

As the (green) food price indexes created in this study are based on national statistical office methods, this could provide a potentially relatively straightforward implementation in public policy. By utilising data from certification bodies - which is readily available - this directly links the information to the instrument in which change can occur. Governments and regional city councils will be able to see the extent to which sustainable food items are more costly, and can potentially create subsidies/incentives to increase their competitiveness in the market. Furthermore, the methods proposed in this paper could be expanded to other sectors of an economy. Thus, allowing governments to have a more comprehensive idea of how much of their economy is actually sustainable.

Price indices are used by businesses to track the price trends surrounding a product or service. The gFPI has relevance for those operating in the New Zealand food ecosystem, as it represents the trends and current costs of: conventional food items versus green (certified organic) food items, and a typical New Zealand diet versus a sustainable diet (PHD). The gFPI could act as a source of education for businesses wanting to adopt more environmentally friendlier production practices. While, the metric could also be utilised as a marketing tool for businesses in the New Zealand food sector.

Societal relevance revolves around the awareness for consumers to make immediate actionable choices when purchasing food items. Firstly, by knowing which food items have the smallest price divergence (between conventional & green), potentially allowing for improved consumption habits with minimal extra expenditure. Secondly, the overall scope of items constituting the food basket and subsequently the cost of each is made clear to the reader. This indicates how transitioning from current consumption habits to more scientifically sustainable preferences could benefit a consumer by having to spend less disposable income, whilst benefiting the environment, the overall health of our shared planet and the New Zealand food ecosystem.

In addition, the results of this research will be incorporated and elaborated upon by the Tiaki Institute - a New Zealand based think-tank the researcher is associated with - in measuring a nation's green economy components. This research aims to act as proof of concept for the future development of green economic metrics, coupled with certification standards, potentially creating the building blocks for an already well understood, robust and implementable "green" economic metric which could influence public policy and private ecosystems. The green FPI - and possible future green CPI - could inform New Zealand's sustainable development trajectory, by providing an understandable and actionable way of measuring a nation's green economy, as initially proposed by Webb (2016): https://web.archive.org/web/20190606084126/http://challenge.institute/wp-content/uploads/2016/05/Green-For-Review.pdf

1.3 Structure of the Research

The research is structured as follows: literature review, research methodology, results stated and discussion of findings. The literature review conceptualises the important constructs in this research and provides a practical application to the nation of New Zealand. The research methodology outlines how the study was conducted, which methods were used in data collection and how the data was analysed. The results section highlights the main findings of the research and provides figures for each index created. Then a discussion of the results will be covered, followed by the theoretical and practical implications of the research. Lastly, the limitations of this study will be considered and future research areas suggested.

2. Theory

In this literature review my intention is to begin with more broad macro topics and then transition towards concepts more specialised in scope. Initially, I elaborate on the concept of a green economy. Next, an overview of methodologies and metrics which aim to measure a green economy are introduced and defined. Then I will introduce the importance of the food (systems) sector and its relation to a green economy. Lastly, a (green) food price index is defined and the researcher shows how such a tool could potentially aid in measuring a nation's transition towards a green economy. When possible and relevant, direct links to New Zealand will be made, although the intention is to describe each construct in a global sense too, as this research method could be applied in other geographies outside of New Zealand.

2.1 Green Economy

Before defining the green economy, it is beneficial for the reader to understand the hierarchy & interactions of green economy concepts; Green New Deal, Green Growth & Sustainable Development. These differences are depicted in *Figure 1* and are further explained in the text which follows.

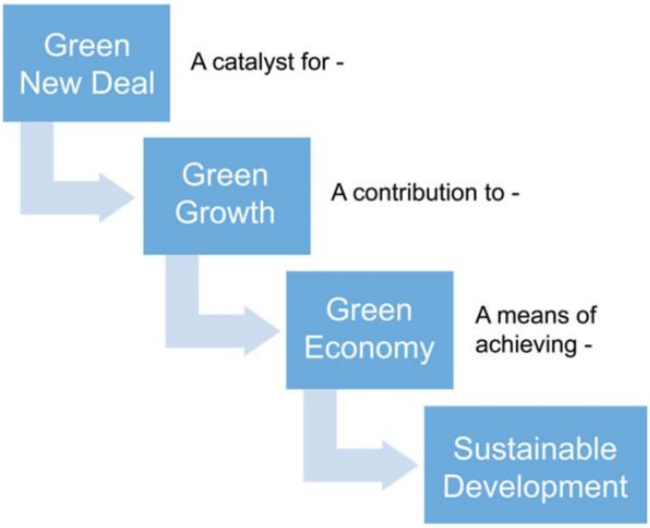

Figure 1: Green Economy Concepts

Source: Georgeson, Maslin & Poessinouw, 2017.

The concept of a green economy (GE) was first mentioned by Pearce et al., (1989) in their report for the United Kingdom's Department for Environment - *Blueprint for a green economy*. Counterintuitively, the report had no mention of the term apart from in the title, leaving the initial conceptualisation to Jacobs (1991) in his book - *The Green Economy*. The initial conceptualisation of the green economy was dictated by the political ideology (green parties) and the academic discipline of environmental economics (Georgeson et al. 2017). However, there was little uptake of the GE concept throughout the 1990s and 2000s, with it scarcely being mentioned in scientific literature and institutional settings, it almost "disappeared from common usage in international development circles" (Brown et al. 2014, p. 246). This changed following the 2008 financial crisis, where key international organisations - most notably the United Nations - saw the potential to utilise the GE concept as a policy response to the crisis (Death, 2015). The GE was framed as an operational strategy that would promote economic recovery whilst enabling future sustainable growth. Furthermore, around this time the construct of sustainable development (SD) was losing its impact on economic policymaking (Jacobs, 2013). GE discussions were seen as a means of overcoming the lack of traction and action surrounding SD, enabling a response to ‘the environmental problems that current socio-economic systems were (and still are) encompassing’ (Merino-Saum et al. 2020, p. 2).

In 2008, the United Nations Environmental Program (UNEP) launched the Green Economy Initiative, which further increased awareness surrounding the GE concept, and ultimately stimulated the 2009 call for a Global Green New Deal (Barbier, 2009). The UNEP defines a GE as “one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities” (UNEP, 2010, p. 5). This definition became popularised through the Green Economy Report (UNEP, 2011). The report gained global attention and helped push the GE into the international policy agenda spotlight, as well as in academic circles (Merino-Saum et al. 2020). Although the concept has gained increasing traction, it has remained without a consensus agreeing on a definition. In Merino-Saum et al’s (2020), review of the literature on the GE, 95 different definitions were found.

This study builds on these arguments and suggests a newly adapted definition of the GE concept for the scope of this research based on the adoption of Ferguson’s (2014) typology, which categorises GE discourse into either, weak, transformative or strong (see *Appendix 1*). Each categorisation incorporates a macroeconomic trajectory (growth), economic/social/environmental indicators, levels of consumption (un/sustainable) and the focus of security disclosure (Ferguson, 2014). Generally, the weak green economy offers little difference from the status quo development paradigms, such as green growth, whereas the strong green economy still only exists within academic literature and is yet to materialise in the real world in a practical sense (Georgeson et al. 2017). Thus, “the transformational green economy appears as the contemporary definition that is both possible and forceful enough to deliver genuine progress (and perhaps significant transformations would render strong green economy discourses feasible in the future)” (Georgeson et al. 2017, p. 9). Hence, the transformative GE is the basis of the GE concept in this research as a means of moving from weak to strong discourses, and consequentially actions.

A transformational green economy is growth agnostic, the focus is not on emphasising new economic opportunities, but rather “on bringing socio-economic patterns (in particular consumption behaviors) in line with planetary boundaries” (Merino-Saum et al. 2020, p. 14). An appropriate frame for the transformational green economy is that of economic security, rather than economic growth (Ferguson, 2014). Building on the analyses of various scholars in the GE field, for the scope of this study a GE is defined as the following: *a transformative concept that has the reach to shift existing systems onto alternative development pathways providing economic & social security within planetary boundaries*. In order to track such a transformation, measurement is necessary, as we cannot hope to manage what we cannot even measure (UNEP, 2011). This is discussed in the following section as current measurement techniques are briefly explained, shortcomings highlighted, and a novel method utilised in this study based on certification is proposed.

2.2 Green Economy Measurement

Given the ambiguities that surround the GE and its conceptualisation, it is not surprising that there has been an equal level of ambiguity as to how to measure the efforts made/progress towards a GE. This section first suggests the need to move away from strictly using GDP as an economic measure. Next, some of the more recognised frameworks that attempt to measure the GE are identified and briefly outlined. Some limitations of these frameworks will also be noted.

Hereafter an argument will be built as to why utilising certification into green statistics as a measurement of the GE could be a potential solution. As outline through the example of the measurement of the food sector of New Zealand's economy.

In order to allow and track the GE 'transformation', measurement of economic and environmental elements is crucial (Georgeson et al. 2017). Nellis and Parker (2004) highlight the importance of understanding the interconnected nature between the flow of national income and the nation's stock of wealth, encompassing social and natural capital. This broader scope of measurement aligns with the progress required by the SDG's agenda and the importance placed on environmental/social elements from the GE. This suggests a shift from the traditional method of measuring an economy - Gross Domestic Product - to more comprehensive and inclusive methods (Georgeson et al. 2017). Some of these proposed methods are highlighted below, with their pitfalls noted.

2.2.1 OECD Green Growth Monitoring Framework

The Organisation for Economic Co-operation and Development (OECD) has developed a comprehensive set of 30 GE indicators. These indicators cover economic opportunities and policy responses, natural assets, environmental quality of life, sustainability and equity, environmental and resource productivity (OECD, 2011). Whilst being adopted by 23 countries by 2014 is a promising sign, the proxies and justifications used throughout the data collection process in the published reports by National Statistic Offices has been questioned by scholars (Georgeson et al. 2017). This is due to not all indicators being currently measurable and severe limitations in collecting data on others, inherently leading to first choice indicators being substituted with indicators lower in relevance (Georgeson et al. 2017). For example, in Statistics Korea report 'Annual rainfall per capita' and 'Contribution of aquaculture to fish production' are used as indicators for sustainability in fish resources and freshwater (Statistics Korea 2012). Moreover, in the Netherlands report, society and inclusivity indicators were excluded (Statistics Netherlands 2011). The flexibility of the Green Growth Monitoring Framework makes international comparisons problematic, as different countries can use different indicators (or proxy indicators) to measure the same categorisation. This amounts to some considerable limitations, therefore this represents more of a weak GE concept, and is thus important to move away from when attempting to measure a transformative GE (Ferguson, 2014).

2.2.2 UN System of Environmental-Economic Accounting (SEEA)

The United Nations Statistics Division (UNSD) largely took the lead in creating the SEEA framework, which acts as a 'multipurpose conceptual framework for understanding the interactions between the economy and the environment, and for describing stocks and changes in stocks of environmental assets' (United Nations 2014, p. x). The 'SEEA assesses trends in natural resource use, the extent of emissions and discharges to the environment resulting from economic activity and the amount of economic activity undertaken for environmental purposes' (Georgeson et al. 2017, p. 12). Ultimately, the SEEA attempts to organise physical and monetary data in such a way that allows for direct comparison in relation to already developed and understood classifications (Webb, 2016). Recognition as an international standard reiterates the importance of SEEA as to how the GE will be measured, however, this method too is not without its shortcomings[3]. Arguably, SEEA could be seen as a narrow

[3] For a more in-depth overview of SEEA, see Webb (2016) and for shortcomings on the method, see Georgeson, Maslin & Poessinouw (2017).

approach towards measuring the GE, aligning more towards more weak green economy concepts (Georgeson et al. 2017). Furthermore, social elements and their measurement/outcomes are severely lacking in comparison to other approaches (for instance, compared to the OECD Green Growth Approach) (United Nations, 2014). These limitations, in combination with the rigidity of data collection, could result in the incorrect measurement of trade-offs, and consequentially promote ill-informed decision-making surrounding GE transitions of socio-economic aspects (Georgeson et al. 2017).

Scholars argue that current measurement techniques are not fulfilling their role; data collection methods are limited and there seems to be a tendency towards using weak green economy management concepts, indicating that the transition towards more truly progressive transformative measurement techniques may be hampered by approaches to protect the status-quo (Georgeson et al. 2017, Pelling & Manuel-Navarrete, 2011). In the following section, the novel measurement approach used in this study is explained, and the potential for challenging the status-quo is highlighted.

2.2.3 Green Measurement Based on Certification (Green Statistics & Green Metrics)

The method this study implements to measure the GE is based on Webb's (2016) idea of certified green production processes, which allows for the creation of certification based statistics, leading to the development of green metrics (such as the gFPI metric in this research).

Certified green production processes aim to value the environment by representing a product on the market which has been produced in an do no/less harm environmental manner, compared to a product that is an uncertified (conventional) alternative (Webb, 2016). There are many certifications which represent this do no harm approach, many are classified as eco-labels when representing this information to consumers[4]. In Meis-Harris et al's review on eco-labels role in a circular economy, the authors found that "eco-labels on their own are an information-based communication tool that is unlikely to create significant shifts in consumer choices or production." (2021, p. 1). This suggests that more than just certification in the form of a label is needed to shift consumer purchasing and production practices towards more sustainable methods.

The measurement method used in this study aims to overcome the limitation of current certification impacts stated above by providing the possibility to reach into institutional settings. It does so by how green certification relates to official statistics, this link is the novel innovation of this green measurement method as this is something that has not been considered and developed in the past (Webb, 2016). By using the price data from certified green products to compile official statistics, this allows for measuring the price trends of these green products in comparison to their conventional equivalents. Thus, it becomes clear - in an economic sense - the price convergence/divergence of green products in comparison to their conventional equivalent. For this study, this price difference will be represented by the gFPI figures. The methods used in the creation of the gFPI (see section 2.4) largely align with the procedures used by the national statistical office (Statistics New Zealand) in their creation of food price indices. This means the data of green certification/statistics/metrics could positively nudge national statistic offices to become involved with measuring the green economy, without having to do all the data collection/aspects themselves. Once the method is fully developed, streamlined data would be able to be provided directly by certification bodies to those interested in measuring the outcomes (National Statistic Offices). This is an important

[4] For an overview of current eco-labels see: https://www.ecolabelindex.com/ecolabels/

proposition given that statisticians have stated it is not their intention to determine whether a particular good or service should be classified as sustainable (green) (Webb, 2016). By linking the information of certified green products - which is pragmatic in nature, as it measures real economy figures (food prices in the case of this study) - to the institutions and instruments that are able to dictate change, measurement of the weak green economy could be transitioned towards more transformative capabilities, helping to challenge the current status- quo.

The measurement of a GE based on the methods proposed above coincide with the calls from the Green Growth Knowledge Platform (GGKP) (2013) for indicators to provide 'opportunity' rather than solely focusing on challenges or minimising risks. It does so by allowing those who meet the requirements for green production processes and attain green certification to confidently market a recognised sustainable product. For instance, the certification used in the scope of this study, *certified organic*, promotes actors in the food system to act in accordance with environmentally friendly practices, whilst likely obtaining a price premium. Clearly the (positive - opportunistic) framing of green certification is key, for those involved in the relevant sector to want to participate and create uptake of such standards.

The certification used in this study stresses more the environmental aspects of well-being. However, in the future through either novel certifications or the combination of certifications with a more rounded internalisation of socio-economic elements could be accounted for. For instance, combining organic certification with either a living wage certification or a fair-trade certification (see section 6.3.2). In the scope of this paper *organic certification* (NZ) will be utilised as a measurement of the food sector of the (green) economy, the reasoning and justification for such a choice is elaborated on below (see section 2.4.1).

2.3 Food Systems

Given that a (green) economy is multifaceted and requires measurement over a wide range of sectors, this creates a rather large data collection and evaluation task. Thus, the scope of this paper is limited to the food sector of a nation's economy, as reasoned for earlier. Therefore, acting as a proof of concept as to whether the methods utilised in this paper prove useful insights, they could then potentially be applied to other sectors of the economy in the future, measuring more of the GE. This section of the literature review describes the food sector of an economy.

The scientific research panel for the UN Food Systems Transformation Summit 2021 defined food systems as follows; "Food systems embrace the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal (loss or waste) of food products that originate from agriculture (including livestock), forestry, fisheries, and food industries, and the broader economic, societal, and natural environments in which they are embedded." (von Braun et al. 2021, p. 30). Essentially, a food system encompasses all the actors and processes which ensure an individual's food security.

However, the current paradigm in the global food system is still largely based on a linear process, and as outlined in the introduction, this is creating serious environmental and social difficulties, not least the transgression of planetary boundaries (Rockström et al. 2009). Similar impacts are felt in New Zealand. Like other more developed nations, New Zealand's' population is encountering a rising rate of obesity and related non-communicable diseases (MOH, 2011 & 2015). Food choices and consumption play a key role in these developments and are currently contributing to significant health implications for individuals, families and the nation (Jones et al. 2019). Environmental impacts of the food system are also felt: soil degradation, loss of biodiversity, damaged ecosystems, diminishing fish stocks, with greater change to come (Hollis, 2014 & Rockström et al. 2016). Furthermore, New Zealand ranked fifth-highest for per-capita green-house gas emissions amongst OECD countries in 2011, with significant contributions coming from the food sector (OECD, 2017).) Clearly, the food system paradigm needs to shift towards more sustainable production and consumption.

2.3.2 Sustainable Food Systems

"A sustainable food system is one that contributes to food security and nutrition for all in such a way that the economic, social, cultural, and environmental bases to generate food security and *nutrition* for future generations are safeguarded" (von Braun et al. 2021, p. 30). Nutrition and sustainability have emerged as high priority areas on the global political agenda (WHO, 2017). Research indicates that, while supply-sided strategies, when executed throughout the entire supply chain, can lead to crucial emissions reductions (Fischer & Garnett, 2016). There is also far greater potential to reduce emissions through demand-end approaches, meaning a change in individuals' food choices could lead to a reduction in consuming greenhouse gas intensive food items (de Coninck & Revi, 2018 & Hollis, 2014). This indicates that an individual's food purchasing habits are immensely important in transitioning towards a more sustainable food system, and consequentially a greener economy.

This study attempts to address both the demand and supply-side aspects highlighted above, for the context of New Zealand. Regarding the supply-end, this study attempts to classify production processes as sustainable/green (based on organic certification as explained below). Whereas on the demand-end, this paper proposes a clear distinction between a typical New Zealanders' diet and a more sustainable alternative. To date a range of possible sustainable diets exists, based on various sustainable characteristics contributing to human and planetary health (Burlingame, 2019). This paper adopts the sustainable dietary characteristics provided by the EAT-Lancet Commission (Willet et al, 2019). The authors propose a reference global planetary health diet, namely the Planetary Health Diet (PHD), which is healthy for people (meets nutritional adequacy) and planet (remains within planetary boundaries). The planetary boundary (PB) framework proposed by Rockström et al. (2009) includes nine boundaries: Climate change, Ocean acidification, Stratospheric ozone depletion, Atmospheric aerosol loading, Biogeochemical flows (interference with Phosphorous and Nitrogen cycles), Global freshwater use, Land-system change, Rate of biodiversity loss and Chemical pollution. If humanity is able to remain within these boundaries then humanity can expect to operate safely into the future (Rockström et al. 2009). The food system has direct and indirect impacts on each of these nine earth system processes. For instance, land-system change is measured based upon the percentage of global lad coverage which is converted to cropland. Another direct example of global food system impacts on a PB is that of global freshwater use. Where the food system is estimated to consume 70% of total freshwater use (Viala, 2008). The PHD consists of whole grains, vegetables, fruits, legumes, nuts and unsaturated oils (Willet et al, 2019). For the most part protein is recommended to be sourced from plants, although low to moderate amounts of seafood and poultry are acceptable. A very low (and sometimes none at all) amount of red meat, processed meat, added sugars and refined grains should be consumed. Dairy consumption is optional, when consumed, moderate levels are recommended, around 250 g/day (Willet et al, 2019). Through the creation of the PHD and it being grounded in scientific evidence, this now allows for estimating the environmental and health impacts of an alternative to typical current diets (Jones, Wham, & Burlingame, 2019). Precisely this comparison is what this study strives to achieve, by comparing the PHD to a typical New Zealand diet and incorporating the element of sustainability - through *organic certification* -

impacts for people and planet can begin to be understood. How this will be understood is explained in the following section through the creation of a green food price index (gFPI).

2.4 Food Price Index

By clarifying the role a (sustainable) food system plays in the transition towards and future attainment of a green economy, a method for measuring the system's current level of sustainability is imperative. This section outlines how this could be achieved by revising an already developed metric , namely, a food price index, and combining this with certification to suggest which food items are sustainable. First, a food price index and its relationship to a consumer price index will be explained, followed by a description of the certification used in the creation a green food price index - *certified organic* - and its properties.

In its simplest form an FPI is a measure to indicate the (monthly) change in prices of a given food basket (FAO, 2021). It essentially maps the price trends of food items allowing those interested to understand whether the costs of particular food items are increasing or decreasing over time. There are many FPI's in circulation today, measuring a vast range of food items. Most notably are the FPI's produced by national statistics offices (such as Statistics New Zealand) and the United Nations Food and Agricultural Organisation (FAO) Food Price Index. The FAO index takes a global approach, measuring the monthly price change of the major five commodity groups: Cereal, Vegetable Oil, Dairy, Meat and Sugar (FAO, 2021). National statistic offices, on the other hand, are more interested in national and regional scales which are more aligned with the scope of this study. For instance, Statistics New Zealand publishes a monthly FPI measuring the changes in price which households in New Zealand pay for a representative food basket (Statistics New Zealand, 2020). This basket represents average New Zealand consumption habits (see section 3.3.2) and forms the basis for two of the indices being created in this study (Index 1 & 2), which will then be compared with the PHD indexes (Index 3 & 4).

A FPI has a strong relationship to nationally published Consumer Price Indexes (CPI), as the food price index figure and data are the inputs for the food section of the CPI figure. In New Zealand, food (food price index) contributes 18.72% to the national consumer price index. This equates to the second largest expenditure class after housing & household utilities (Statistics New Zealand, 2020a). A CPI 'measures the rate at which the prices of consumption goods and services are changing from one period to another' (Graf, 2020, p. 1). The items included are representative of what a household spends their income on, for instance food, transportation, housing etc, essentially amounting to the cost of living. Given the comprehensive coverage and the frequency of its publication - generally monthly – this CPI is widely used by governments as a proxy measure of inflation of an economy. This has implications for economic (monetary) policy making, generally for adjusting payments (i.e. wages, social security etc) for the effects of inflation (Graf, 2020). Thus, having financial implications for households, governments and businesses.

The relationship and similarities between a CPI and FPI are important as evidenced by the fact that the CPI was highlighted by the United Nations Statistics Division (UNSD) as a core green economy indicator (UNSD, n.d.). As the CPI plays an important role in (economic) policy considerations and decision making, there is clear relevance for its utilisation as a GE indicator. However, as some scholars suggest, a green CPI (gCPI[5]) would align more closely with the GE

[5] This unfortunately is out of the scope of this research but could be an interesting area of future research (see section 6.3).

concept (Webb, 2016). The recognition from the UNSD signals that a CPI has (institutional) legitimacy as a green economy related indicator. As the (green) FPI figures created in this study follows the best practice methods of creating a CPI, it could also be considered a legitimate metric which could possibly be institutionalised (see discussion section).

2.4.1 Green Food Price Index based on Certified Organic Certification

Clearly, the distinction between a conventional and green FPI is of importance for the scope and results of this study. The basis for making such a distinction follows the logic outlined in the aforementioned green measurement section (see section 2.2.3) and can be utilised to classify a production process, and subsequently a product, as green. Because the focus of this research focuses on the New Zealand food system, *Certified Organic* was selected as the certification method which determines to what extent a food item can be considered to be green. This will be rationalised in the following section which also includes a description of some limitations of the certification approach.

"Organic agriculture is a holistic production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system" (FAO & WHO, 1999, p. 2).

Organic production systems adhere to specific standards which strive to create optimal agroecosystems, resulting in social, ecological and economic sustainability (FAO & WHO, 1999). Environmental impacts differ between organic and conventional systems, largely due the differences in soil management techniques (Clark & Tilman, 2017). Organic methods avoid using synthetic fertilisers and pesticides, and instead use manure as a nitrogen input, applying more of a circular process. Clark & Tilman's (2017) comparative analysis of organic versus conventional production systems found some environmental benefits from organic production. Namely, a 15% reduction in energy use and a 4% lower greenhouse gas emission. Furthermore, organic systems have been found to increase on-farm/near-farm biodiversity, whilst enhancing the long-term soil fertility (Mäder et al. 2002). OECD (2016) data indicates that organic systems have positive environmental effects on soil, biodiversity and water, creating a sense of alignment with the primary goal of organic agriculture which is "to optimize the health and productivity of interdependent communities of soil life, plants, animals and people" (FAO & WHO, 1999, p. 2).

Compared to conventional systems, the value of organic production within ecosystem services yields environmental advantages of an estimated US$220-270 per hectare per year (UNEP, 2011a). The majority of this value is obtained as organic systems avoid negative externalities such as soil erosion and pesticide contamination (US$150-200). Smaller contributions are made from carbon sequestration (US$40) and biodiversity services (US$30) (UNEP, 2011a). Social benefits can also arise from organic farming practices. Due to its more labour-intensive nature, organic systems provide an increased number of jobs compared to conventional systems. In addition, these jobs reduce employees' health risks because of the non-exposure to fertilisers and pesticides (OECD, 2016).

However, it is important to note that certified organic is by no means a perfect representation of a sustainable food item as it too comes with limitations. There is some evidence suggesting larger environmental impacts of organic production methods in comparison to conventional production methods - although very much dependent on the food item/group investigated (see *Appendix 2*). For instance, yields tend to be 8% to 25% lower on average in organic systems (Reganold & Wachter, 2016). This means that a larger amount of land is needed to ensure a similar yield conventional systems achieve. Clark & Tilman (2017) suggest a 25% to 110% increase in land use in order for organic systems to provide the equivalent yield of a conventional system. Furthermore, there is also the limitation that a magnitude of food items is already produced in accordance with organic principles/guidelines which lack official certification. This means such a product is not deemed certified organic which essentially crowds out (small-hold) farmers who cannot afford the certification costs, or have some other reason for not being certified (FAO, 2021a). Although this is largely an issue in developing nations (FAO, 2021a), this must still be considered applicable to New Zealand as there are still a magnitude of small hold farmers, and hence a limitation of this study. Lastly, it should be of importance to note the current scale of certified organic agriculture has yet to reach 1% of global agricultural land **(**Arbenz, Gould & Stopes, 2016).

Organic agriculture on the whole relates to a set of improved production practices when compared to conventional systems, generally reducing environmental impacts whilst operating in a circular manner. These factors together with the reasoning stated above provide the basis for suggesting that organic certified food products, on average, tend to be more sustainable than conventional food items. Hence the adoption of green food items being those which are certified organic. To ensure stringency, which leads to reliable results, and generalisable findings, the organic certification used in this study is based on two of New Zealand's largest and highly regarded auditing and certification bodies - Biogro[6] & AsureQuality[7].

2.5 Conceptual Model

The conceptual model links together the data sourcing of food item prices, compiling these prices into various indices, and the possible outcomes on government, consumers & producers.

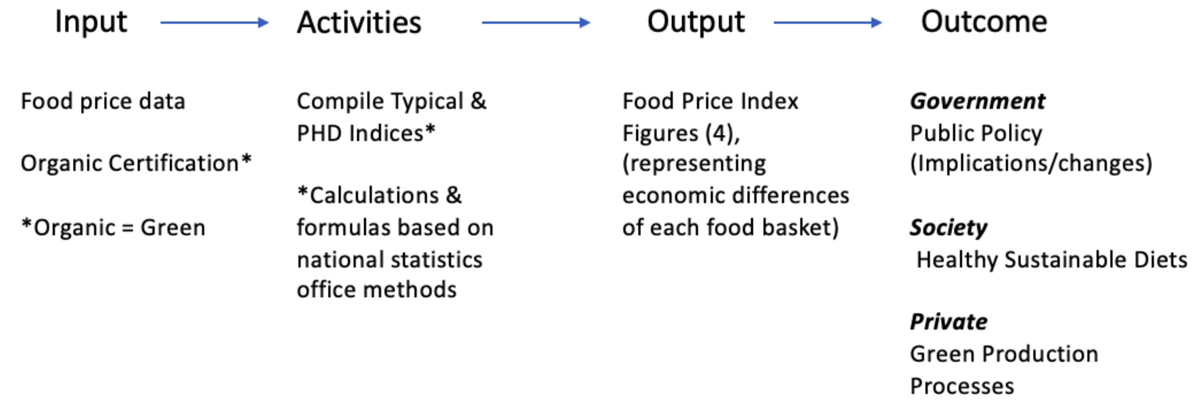

Figure 2: Conceptual Model

To further elaborate on the conceptual model above, *Table 1* (p. 20) further describes what the researcher is looking to discover in this study. The expected outcomes described in *Table 1* will be analysed in relation to what the results indicate what is currently happening, this will provide the basis of the discussion in section 5.

[6] Commercial Entity, see https://www.biogro.co.nz/organic-certification-programmes

[7] New Zealand Government Entity, see https://www.asurequality.com/services/certification/organic-certification/

Table 1. Study Expected Outcomes (Relative to conventional food basket/items)

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Price Level Difference (cost of green food items relative to conventional)</td></tr>
<tr><td>More</td><td>Less</td></tr>
<tr><td rowspan="2">Inflation (relative change of green food items to conventional)</td><td>Higher</td><td>For green food items the consumer has to spend more currently and will have to spend more in the future - depending on what to degree based on the rate that inflation increases. Making the divergence between green prices and conventional prices larger. Suggesting would not purchase green food items today, and moving forwards.

Commercial cost to produce green food items is more than conventional, will continue to increase in the future. Suggesting green production processes will be troublesome to adopt by more producers.

Government intervention important. Need to influence short and long term changes to reduce the extra price of green food items for consumers and larger costs for producers.

Would suggest New Zealand is not making progress towards a more sustainable food system and GE. Price more expensive and trend suggests becoming even more expensive in the future.</td><td>For green food items the consumer has to spend less currently, this will increase in the future to become closer to the conventional cost - depending on what to degree based on the rate that inflation increases. Suggesting consumers would purchase green food items today, but to a lesser degree moving forward, as the price of green food items relative to conventional food items is made more expensive by inflation.

Commercial cost to produce green food items is less than conventional, will rise in the future. Suggesting producers would adopt green production standards today, but to a lesser degree moving forward as the price of green food items relative to conventional food items is made more expensive by inflation

Government, could intervene with longer term measures to try and reduce the greater inflation experienced by green food items. Although has to be careful not to influence the positive fact that green food item prices are currently lower than conventional food item prices.

Would suggest New Zealand is somewhat making progress towards a more sustainable food system and GE. Trend not promising as inflation will increase the price of green items relative to conventional.</td></tr>
<tr><td>Lower</td><td>For green food items the consumer has to spend more currently, this will reduce in the future to become closer to the conventional cost - depending on what to degree based on the rate that inflation reduces. Suggesting consumers would not purchase green food items today, but more so in the future when the price of green food items green food items at a smaller divergence in price than current day prices.

Commercial cost to produce green food items is more than conventional, will decrease in the future. Suggesting producers would not adopt green production standards today, but would be more open to this moving forward when the divergence in prices is made smaller by inflation.

Government, could intervene with short term measures, although has to be careful not to influence the positive long term trend of lower green food price inflation relative to conventional food items.

Would suggest New Zealand is somewhat making progress towards a more sustainable food system and GE . Trend promising as inflation will decrease the price of green items relative to conventional.</td><td>For green food items the consumer has to spend less currently, this will continue to reduce in the future making the prices of green food items even cheaper when compared to conventional food items - depending on what to degree based on the rate that inflation reduces. Suggesting consumers would purchase green food items today, and moving forwards.

Commercial: certified green production standards produce green food items cheaper than conventional, will continue to decrease in the future. Suggesting producers would adopt green production standards today, and moving forward.

Government, minimal intervention necessary.

Would suggest New Zealand has made the transition towards a more sustainable food system and GE.</td></tr>
</table>

3. Methodology

The following section outlines the main methodological frameworks and assumptions present in this research. The chapter begins by justifying the research strategy and research design. Next, the data collection and sampling are outlined, including an explanation of the two different food baskets utilised in this study. Following this, the formulas which the food price index creation and calculation are based on will be explained. Finally, the assumptions present throughout this study are listed.

3.1 Research Strategy

As this study attempts to create a (green) food price index and then assess its usefulness as an economic metric towards New Zealand's transition towards a green economy, a mixed methods approach (quantitative & qualitative) is best suited for this. A *quantitative* approach was taken involving the collection of numerical data (Bell, Bryman & Harley, 2018), by sourcing historic and current price data of the food items investigated in this study. Secondary price data was collected from Statistics New Zealand Food Price Index monthly publications. Where-as primary data was collected by the researcher directly from New Zealand certified organic retailers. This provided the basis for the indexes to be compiled and analysed. A *qualitative* approach was implemented through the form of semi-structured interviews from those who are already involved with certification programs in New Zealand. This was done in order to assess the validity of findings, as well as to gather insights about the potential actionable outcomes of the gFPI created.

It has to be remembered that the measurement of the green economy (sectors) is a relatively novel research area, this was highlighted in the literature review section of this study, which reviewed the current methods of measurement (see section 2.2, 2.2.1, 2.2.2, 2.2.3). Furthermore, there was no literature on a green FPI, and for the PHD diet there is no literature in relation to price indexes. Thus, these both are novel research fields this study brings to the academic forefront, and hopefully will spur other scholars interests into further developing the methods used, and researching in these fields. Similarly, there is a considerable limitation in the number of scholarly articles published on the green measurement technique this study proposes[8]. Therefore, the argument can be made that an inductive process would be advisable for investigating the research question proposed. Induction involves drawing generalisable inferences out of observations highlighting the qualitative aspects of this study (Bell et al. 2018). For this study it would mean utilising insights found from the compiled green food price index figures, and related interviews into the areas where the gFPI could prove actionable in New Zealand's transition towards a more green economy (the GE as defined by the author of this study, see section 2.1). Moreover, the accuracy of basing the measurement of a green economy through the utilisation of certification should provide an interesting observation of this study, as the link between green certification and official statistics has not been considered in the past.

This research could be thought of as practice oriented in nature, as the developed economic metric has the potential to influence, and could be utilised by, a variety of actors, such as national statistic offices, (social) enterprises, government bodies and regional councils amongst

[8] To read publications surrounding the green CPI concept/measurement see the following document: Webb (2016) Green + Monitoring the preconditions for sustainable development: https://web.archive.org/web/20190606084126/http://challenge.institute/wp-content/uploads/2016/05/Green-For-Review.pdf

others. However, the research may also provide theoretical contributions in the GE field through the generation of a novel measurement method in the green economy field.

3.2 Research Design

The research for this study has been designed in the form of a case study. The case study design is common practice in business research and has been widely used by scholars to provide valuable findings in business and management research (Eisenhard & Graebner, 2007). This type of study is generally interested in the particular nature and complexities of the case in question (Stake, 1995). The case in question could be described as an instrumental case, as the traditional ways of understanding the broader issue of measurement of/towards a nation's green economy are challenged (Bell et al. 2018). The focus here will be on New Zealand and the measurement of its food sector, through the form of conventional and green food item prices in relation to its level of transition towards a sustainable food system/green economy.

Furthermore, this particular case could also be characterised as being longitudinal because the investigation seeks to understand how a phenomenon - the price of conventional and sustainable food items - has changed over time, generating insights into the level of transition towards a greener economy (Bell et al. 2019).

3.3 Data Collection

Data was obtained through three methods in order to answer the research question. Firstly, primary price data of certified organic food items was sourced directly for certified organic New Zealand retailers. Secondly, secondary price data was sourced based upon a food basket approach. Finally, interviews with industry professionals allowed for the validity of the methods proposed to be examined, and other insights surrounding the actions and areas a gFPI could stimulate change to emerge.

3.3.1 Food Basket Approach

A food basket is made up of variety of food items which, when added together constitute a complete basket. The food basket method is one of the more commonly used and recognised methods for assessing and monitoring food availability and cost internationally. It has been utilised in studies for measuring the healthiness of a diet to the cost of various food scenarios differing per socioeconomic region (Burns et al. 2010). Furthermore, (a degree of) sustainability has been incorporated in the food basket approach in previous studies. For instance in Australia, where researchers created a reference food basket based on foods with lower environmental impacts (Friel et al, 2014). The PHD has also been analysed through a food basket approach to find out how much it costs per continent (Hirvonen et al. 2020). This study looks to build on this body of literature through the creation of two food baskets; a typical New Zealand basket and a PHD basket. There are some notable commonalities and differences between these baskets which are important to bear in mind and will be outlined below.

Both the typical and the PHD basket will have a conventional and green version. The conventional basket contains uncertified foods, whereas the green basket is composed only of certified organic food items. Thus, each food basket will generate two indexes, amounting to four indexes in total (see *Table 1*, p. 23).

Table 2: Food Price Index Matrix
(showing baskets created in this study and the type of food products for which data was collected).

	Typical New Zealand Basket	*Planetary Health Diet Basket*
Conventional Uncertified food products (Data source: Statistics New Zealand)	**Index 1.** Official Food Price Index	**Index 3.** Planetary Health Diet Basket weighted according to what is good for people and the planet but filled with uncertified food products
"**Green**" certified organic food products (Data source: NZ Organic food retailers)	**Index 2.** "Green" Food Price Index i.e. Statistics New Zealand basket filled with certified organic products	**Index 4.** Certified food products filling the "green" Planetary Health Diet Basket

(Certified organic foods serving as a proxy for being "green" products)

3.3.2 Typical New Zealand Basket Composition

New Zealand household's habitual food consumption patterns were identified using the most recent national nutritional survey data, in combination with Household Economic Survey data (2018/19). Based on these findings, Statistics New Zealand publishes a Food Price Index Review - the most recent of these being from 2020 - which indicates the average food purchase and consumption habits of New Zealand citizens. This review provides expenditure weights, which indicate the relative importance of the food item(s) in the (FPI) food basket (Statistics New Zealand, 2020). *Table 3* (p. 24) outlines the aforementioned subgroups and classes, coupled with the expenditure weight. This shows how much the average New Zealander spends on each food class per $100nzd spent. These items and figures are applied to the Typical basket created in this study. As Statistics New Zealand does not provide information regarding the contribution at the individual food item level, the researcher assumed that each food item per class contributes equally.

Of the two food baskets investigated in this study, the *Typical* basket is composed of a wider variety and contains substantially more food items. The list of food items constituting this food basket represent the food items used by Statistics New Zealand in publishing their monthly food price index publications[9] (Statistics New Zealand, 2021). This indicates the average New Zealand food consumption habits and is an accurate representation of a business-as-usual scenario within New Zealand's food system. The food items making up the typical basket can be analysed on various levels, going from broad to specific, i.e., subgroup, class, individual food item. Statistics New Zealand distinguishes five subgroups; fruit & vegetables, grocery food, meat/poultry & fish, non-alcoholic beverages and restaurant meals/ready-to-eat food. These subgroups contain in total 14 classes; fruit, vegetables, meat/poultry, fish/other seafood, bread/cereals, milk/cheese/eggs, oils/fats, food additives/condiments, confectionary/nuts/snacks, other grocery food, coffee/tea/other hot drinks, soft drinks/waters/juices, restaurant meals, ready-to-eat food. In total, the food basket consists of 165 individual food items (for a complete food item list used in this study see *Appendix 3*).

[9] See https://www.stats.govt.nz/publications?filters=Food%20price%20index%2CInformation%20releases

Table 3: Statistics New Zealand FPI Spending per Class (per $100nzd)

Food price index expenditure weights by class, June 2020

Class	Fruit and vegetables	Meat, poultry, and fish	Grocery food	Non-alcoholic beverages	Restaurant meals and ready-to-eat food
Fruit	4.82				
Vegetables	8.21				
Meat and poultry		12.49			
Fish and other seafood		2.57			
Bread and cereals			9.53		
Milk, cheese, and eggs			9.4		
Oils and fats			1.64		
Food additives and condiments			2.56		
Confectionery, nuts, and snacks			8.51		
Other grocery food			2.8		
Coffee, tea, and other hot drinks				2.15	
Soft drinks, waters, and juices				8.1	
Restaurant meals					9.43
Ready-to-eat food					17.8

Source: Statistics New Zealand[10]

3.3.3 PHD Basket Composition

The PHD food basket items coincide directly with the food items which make up the PHD, as proposed by Willet et al, (2019). *Table 4* (p. 25) outlines the scope of food classes in the PHD (for a complete food item list used in this study see *Appendix 4*). The PHD consists of whole grains, vegetables, fruits, legumes, nuts and unsaturated oils (Willet et al, 2019). For the most part, protein is recommended to be sourced from plants, although low to moderate amounts of seafood and poultry are accepted. A very low (and sometimes null) amount of red meat, processed meat, added sugars and refined grains should be consumed. Dairy consumption is optional, but when consumed, only moderate levels of around 250 g/day are recommended (Willet et al, 2019**)**.

Although at face value both the typical and PHD food baskets look somewhat similar, the PHD food basket consists of far fewer food items, 26 in total. The expenditure weight per food item in the PHD basket is associated with the average micronutrient intake of grams per day. For this the average figure was taken, for example in the Whole grains class, each rice, wheat and corn each contributed 77.33 grams (232g / 3food items). Hereafter, the price per gram of each particular food item was multiplied by the number of grams of that food item in the food basket (see section 3.7.3). In order to ensure reliable historic data were obtained, particular food classes such as fruit and vegetable were simplified to a few core items. Apples and oranges represent the fruit section of the basket, whereas broccoli, carrot and kumara are representative of the vegetable section of the basket. Food items were compared against those listed in the typical basket whenever possible, however, due to limited data availability there are at times disparities between conventional and green food items (see sections 3.8.5 & 3.8.6)

[10] https://www.stats.govt.nz/methods/food-price-index-review-2020

Table 4: Planetary Health Diet Food Basket Item List, Caloric & Gram Totals

	Macronutrient intake (possible range), g/day	Caloric intake, kcal/day
Whole grains*		
Rice, wheat, corn, and other†	232 (total gains 0–60% of energy)	811
Tubers or starchy vegetables		
Potatoes and cassava	50 (0–100)	39
Vegetables		
All vegetables	300 (200–600)	..
Dark green vegetables	100	23
Red and orange vegetables	100	30
Other vegetables	100	25
Fruits		
All fruit	200 (100–300)	126
Dairy foods		
Whole milk or derivative equivalents (eg, cheese)	250 (0–500)	153
Protein sources‡		
Beef and lamb	7 (0–14)	15
Pork	7 (0–14)	15
Chicken and other poultry	29 (0–58)	62
Eggs	13 (0–25)	19
Fish§	28 (0–100)	40
Legumes		
Dry beans, lentils, and peas*	50 (0–100)	172
Soy foods	25 (0–50)	112
Peanuts	25 (0–75)	142
Tree nuts	25	149
Added fats		
Palm oil	6·8 (0–6·8)	60
Unsaturated oils¶	40 (20–80)	354
Dairy fats (included in milk)	0	0
Lard or tallow‖	5 (0–5)	36
Added sugars		
All sweeteners	31 (0–31)	120

Source: Willet et al, 2019

3.3.4 Quantitative Primary Price Data, Green Food Items

The sampling frame used in this study remained relevant for the research question (Bell, Bryman & Harley, 2019), as only certified organic retailers were included in the primary data collection of green food item prices. This means that the selection criteria fit within the population investigated in this study. From here a probability sample was taken, as the price for each food item investigated in this study was checked from the certified organic retailers who were able and willing to provide data. The methods of collecting prices of green food items utilised by the researcher followed those used by Statistics New Zealand (see section 3.3.5), comprising of both manual (in-store) and point-of-sale strategies.

Prices were collected from six retail outlets in four pricing centres. These pricing centres were; Auckland, Christchurch, Dunedin & Wellington. Of the retailers, four were organic supermarkets, one was an organic butchery and one was an organic café/restaurant. Data collection proved to be a more difficult task than expected. All New Zealand certified organic retailers were contacted by the researcher, with the hopes of obtaining historical and current prices for each of the over the food items covered in this study. The objective of collecting historical price data was to be able to represent a time series of the FPI index figures, allowing for trends to be discovered in relation to the research question this study addresses. However, the vast majority of organic retailers that had been contacted by the researcher had not collected and or stored historic price data. With the limited few which had historic price records on hand, and were willing to share their records with the researcher, generally the data obtained dated back at most 1 - 4 years. It must be noted, then, that without all items in a basket having available data for an extended time period, the researcher was limited to creating indexes representative of the last three years only for the PHD basket (2018 - 2021).

As there was a the wide variety of food items in the *Typical* basket, this made data collection a problematic task. Hence the majority of the *Typical* basket was taken from current prices (October .2021), and could be tracked in the future if the method, and subsequent metric provide value and are used moving forward. As the scope of items in the *PHD* basket is considerably more limited, it proved a manageable task obtaining historic price data (up to 2018) for the majority of food items. This is conceptualised in the results section where the *PHD* index figures date back three years, whereas the *Typical* index figures are from 2021 onwards.

3.3.5 Quantitative Secondary Price Data, Conventional Food Items

The methods used for the secondary price data collection were replicated from best practice and largely follow the procedures used by the National Statistics Office. In New Zealand, this means using the methods Statistics New Zealand utilises when developing monthly food price index figures. The conventional food item prices in this study were sourced directly from Statistics New Zealand FPI monthly publications[11]. This means the data is highly reliable as it is sourced and compiled from robust methods corresponding to be practice. Furthermore, the FPI publications are analysed by statisticians, economists and other institutional actors regarding the macro-economic outlook of the New Zealand food sector. Thus, it is of importance that the data be reliable and robust to ensure accurate decision making by these institutional actors. The methods used by Statistics New Zealand are outlined below.

The approach Statistics New Zealand takes aligns with a census-style data collection approach, as "the reference population of the FPI covers approximately 98 percent of the usually-resident New Zealand population living in permanent dwellings" (Statistics New Zealand, 2020, p. 9). A snapshot of economic habits surrounding food purchasing of New Zealand's population is identified, implying that the nature of this sample should be relatively representative of average New Zealand consumer (Bell, Bryman & Harley, 2019). Around 19,000 prices from 560 retail outlets are collected in the 12 pricing centres across New Zealand, these being; Whangarei, Auckland, Hamilton, Tauranga, Napier-Hastings, New Plymouth, Palmerston North, Wellington, Nelson, Christchurch, Dunedin, and Invercargill. Of the retailers; 56 are

[11] See http://infoshare.stats.govt.nz/?_ga=2.149774452.312834562.1635887581-1188728348.1635887581
Economic Indicators → Consumer Price Index → Food Price Index Level Selected Monthly Weighted Average Prices for New Zealand Monthly
FPI monthly publications see https://www.stats.govt.nz/topics/food-price-index

supermarkets, 32 are greengrocers, 53 are fish shops and butchers, 68 are convenience stores (e.g. dairies and service stations), and 350 are restaurants (with and without bars) and takeaway outlets (Statistics New Zealand, 2020). The method of collecting prices of food items used by Statistics New Zealand is a combination of manual (in-store) and point-of-sale (checkout scanner provided by some supermarkets, used from 04.2020 onwards).

3.3.7 Qualitative Interview Data

For the qualitative interviews the researcher applied purposive sampling, more specifically theoretical sampling, as those interviewed were selected because of their close relevance to the research question (Bell, Bryman & Harley, 2019). The selection of those who were interviewed occurred as an iterative process as the research project developed. Thus, a sequential sampling approach was applied, as those sampled were gradually added over time as the research project developed (Bell, Bryman & Harley, 2019). A flexible semi-structured format was applied. Although the specific issue of using certification as a measure of sustainability in the food sector of an economy was investigated, interviewees were encouraged to go off on tangents in order to express what they viewed as important and relevant for the scope of this research. In total two interviews were conducted. The first interview was conducted an employee from certification body AsureQuality, the interviewee is the lead-assurance member of environmental and sustainability services. The second interview was conducted with a senior analyst of the environmental accounting team from Statistics New Zealand. The intention of these interviews was twofold. First, to discuss the validity of methods used in creating and calculating the gFPI used in this study. This was to ensure the GE metric developed in this research could be seen as providing accurate figures and findings. Secondly, to understand from an institutional actor's perspective where the gFPI has relevance in a practical application sense.

3.4 Data analyses

Both the quantitative and qualitative methods in this research will be analysed by the researcher, as outlined below.

3.4.1 Quantitative Index figures

The creation of quantitative data into index figures will be completed with Microsoft Office Excel. After this, various graph diagrams will be created with the index figures, allowing the reader to easily interpret and understand the results (Bell, Bryman & Harley, 2019). The graphs depict the results of the cost of each index at present-day costs for the year 2021, and show historical comparisons between different food baskets/food item subgroups investigated in this research. These figures highlight the economic trends surrounding the price activity of conventional versus green food baskets/items.

3.4.2 Qualitative Interview insights

The qualitative interview insights will be analysed in respect to the research question this study aims to address. More specifically, by providing further insight into the reliability of the methods used in this study to create the gFPI, and the areas as to where the gFPI could create change/influence in an actionable sense.

3.5 Calculation Assumptions

This section introduces the calculations and formulas used in this study. Initially, the price per gram calculation for both conventional and green food items is outlined. Following this, the methods used for assessing the average weight of a particular food item is described. Lastly, the food items for which sourcing the price data was not possible are listed, as well as the imputation of these figures.

3.5.1 Conventional Prices

Conventional prices were sourced directly from Statistic New Zealand monthly food price index publications. For current prices, the most recent FPI publication from Statistics New Zealand at time of writing (October 2021) was utilised for these figures. Furthermore, in order to calculate the average price of a food item for one year - for time series purposes - the following calculation was used.

The example given represents the average price per gram for conventional (uncertified) Apples, for the year 2021.

2021.01 - 4.62$NZD, 2021.02 - 3.41$NZD, 2021.03 - 2.87$NZD, 2021.04 - 2.86$NZD, 2021.05 - 2.88$NZD, 2021.06 - 2.83$NZD, 2021.07 - 2.63$NZD, 2021.08 - 3.01$NZD, 2021.09 - 3.22$NZD, 2021.10 - 3.24$NZD

Calculations were conducted on Microsoft Excel. The formula used was the AVERAGE function. The average of the 10 prices listed for 2021 = 3.157$NZD (KG). In order to calculate the price per gram, the figure of 3.157$NZD needs to be divided by 1000. Thus, the price per gram for Apples in 2021 = **0.003157**$NZD (3.157$NZD/1000).

3.5.2 Green Prices

As Green prices were sourced directly from certified organic retailers in New Zealand, the formatting of the sourced data had to be calculated to match a monthly, and subsequently yearly, figure. For instance, some data obtained represented prices from various days of the month until the next price change. This change was at arbitrary (at the retailer’s discretion) and could span days, months or even years. Thus, in order to represent accurate and comparable figures, the following calculation was applied.

3.5.3 Average price per gram per year

The example used is for calculating the price per gram of wheat (white roller flour) for the PHD Green Index, for the year 2021. The same formula and calculation process was applied to all green food prices, which were sourced from New Zealand organic retailers.

January, February, March (until the 24th) = 83 days or 22.74% (83/365).
Average price per gram = 0.0042$NZD

March (from the 25th), April, May, June, July, August, September, October, November, December = 282 days or 77.26% (282/365).
Price per gram = 0.00495$NZD

Average price per gram 2021 = **0.004779**$NZD
(0.0042$NZD * 22.74% + 0.00495$NZD * 77.26%)

3.6 Average Volume of Food Items

3.6.1 Conventional Typical Basket

For some food items measured, Statistic New Zealand uses an item range, for instance Chocolate Blocks are measured from 100g to 250g. In such circumstances the average weight was used in calculations. The food items this applied to are listed were the following: *Chilled Fruit Juice/Smoothie*: 1000ml - 1500ml, 1250ml was used. *Chocolate Block (convenience store):* 100 - 250g, 175g was used. *Dried Mixed Herbs:* 10 - 15g, 12.5g was used.

When Statistics New Zealand left the weight of the food item unspecified, there were three methods applied. First, when the green version of the identical item had a stated weight of the item, this was also applied to the conventional item. This was done in order for the calculations, and subsequently the results, to be directly comparable and remain reliable. When there was no green food item weight, the average weight was taken from the New Zealand and Australia food standards food measures database[12]. The weight of the food item from the database was applied to both the conventional and green options when used. If the particular food item was not listed in the database, average item weights published online by one of New Zealand's largest supermarkets – Countdown[13] - were used. The weight of the food item from Countdown was applied to both the conventional and green food item when used. The food items are listed below in *Table 5* (p. 30/31), with the number indicating which calculation method was used: 1 (green method), 2 (database method) and 3 (Countdown method).

Table 5: Conventional Typical Basket Average Weight of Food Items

Method	Food Item	Average Weight
1	*Bread rolls Hamburger Bun*	*(6pack)* 70g each, 420g total.
3[14]	*Chewing Gum*	56g per packet.
3[15]	*Eggs*	*(Dozen)* 55grams per egg, 660 total. (For free range and standard, the same weight is assumed)
3[16]	*Flatbread*	*(10pack)* 43g each, 430g total.
1[17]	*Ice Block*	*(6pack)* 62ml each, 372ml total.
1[18]	*Ice Cream Novelty*	120ml.
3[19]	*Instant Noodles (5pack)*:	80g each, 400g total.
3[20]	*Meat Pie (6pack)*	160g each, 1020g total.
3[21]	*Pizza*	500g.
3[22]	*Powdered Drink Flavour (3pack)*	80g each, 240g total.

12 https://www.foodstandards.govt.nz/science/monitoringnutrients/ausnut/foodmeasures/Pages/default.aspx
13 https://shop.countdown.co.nz
14 https://shop.countdown.co.nz/shop/productdetails?stockcode=135903&name=wrigleys-extra-chewing-gum-white-sugar-free
15 https://shop.countdown.co.nz/shop/productdetails?stockcode=411926&name=otaika-valley-eggs-dozen-free-range-size-7
16 https://shop.countdown.co.nz/shop/productdetails?stockcode=636826&name=countdown-pita-bread-garlic
17 https://commonsenseorganics.co.nz/shop-online/frozen/frozen-desserts/tropical-nice-blocks/
18 https://naturallyorganic.co.nz/product/oob-organic-vanilla-ice-cream-120ml-tub/
19 https://shop.countdown.co.nz/shop/productdetails?stockcode=305529&name=indomie-instant-noodles-multi-pack-mi-goreng-satay
20 https://shop.countdown.co.nz/shop/productdetails?stockcode=279224&name=irvines-chilled-pie-6pk-mince-cheese
21 https://shop.countdown.co.nz/shop/productdetails?stockcode=81770&name=mccain-meatlovers-pizza
22 https://shop.countdown.co.nz/shop/productdetails?stockcode=264552&name=raro-sachet-drink-mix-bahama-breeze-240g

-	*Soft Drink (poured)*	500ml assumed.
3[23]	*Tea Bag (100 pack)*	2g each, 200g total.

3.6.2 Green Typical Basket

For the green typical basket the methods used for calculating the average volume of a particular food item were matched to the methods used in the conventional Typical basket calculations, as outlined above. This was done in order to ensure reliable figures and viable direct comparisons among indexes.

3.6.3 Conventional PHD Basket

There are slight differences between this study and the original paper by Willet et al (2019), as this study specifies the food item per category. For instance, the authors suggest 200grams (126 calories) across the Fruit's class of the PHD basket. Rather than specifying exactly which fruit items make up this total, they allow for context-specific decisions at the discretion of the individual based upon their living context, seasonality and economic affordability (Willet et al, 2019). In contrast, this study proposes that *Apples and Oranges* are representative of the Fruit's class in the New Zealand context. An example of the difference in the number of grams in the PHD basket in this study compared to the original publication is outlined below. Formulas 6 & 7 below outline how the grams of a particular food item in the PHD basket were calculated.

3.6.4 Green PHD Basket

For the green PHD basket the methods used for calculating the average volume of a particular food item were matched to the methods used in the conventional PHD basket This was done in order to ensure reliable figures and viable direct comparisons among indexes.

3.7 Basket Calculations

This section aims to make clear how the index figures were calculated. There are some differences between the Typical and PHD food baskets which are clarified below. First, the Typical basket will be explained, followed by the PHD basket.

3.7.1 Conventional Typical Basket

On average, the weekly cost for a one-person (adult) household in New Zealand equals $645. Of this, 16.8% is spent on food, equating to 645$NZD * 16.8% = 108.36$NZD [24]. By dividing this by the number of days in a week (7), we get a daily spend on food of 15.48$NZD (108.36$NZD / 7), which amounts to the total cost of the conventional typical basket.

The formulas outlined in the next section show how the calculation of each food item's weight (in grams) was formulated.
The example in formula 1 comes from the *Fruit* sub-class, formulas 2 and 3 used *Orange* as the food item to provide an example of how the calculations occurred.

Formula 1*:* Food Weight per Item
= Expenditure weight (in %, per Statistics New Zealand) multiplied by the Average Daily Spend on Food for One Adult ($NZD).

[23] https://shop.countdown.co.nz/shop/productdetails?stockcode=267315&name=dilmah-tea-bags-tagless
[24] https://www.stats.govt.nz/information-releases/household-expenditure-statistics-year-ended-june-2019

Fruit sub-class = 4.82% (Expenditure Weight) * 15.48$NZD = 0.746136$NZD spend on fruit category per day.

0.746136$NZD / 16 (number of fruit items in typical basket) = **0.0466**$NZD (per fruit)

Formula 2 outlines how the average price per gram of a food item was calculated. Considering that the Typical basket was tracked moving forward (rather than using historic data), the most recent price was taken for a food item. This was then divided by the food item's weight as highlighted below.

Formula 2: Individual food item Price Per Gram *(Orange)*
= 3.93$NZD / 1000 = 0.00393$NZD ppg

Formula 3 calculates the individual food item's weight (in grams) within the food basket.

Formula 3: Individual Food Item Weight in Food Basket
= Food Weight per Item (Answer to Formula 1) divided by the price per gram of food item (Answer to Formula 2).

Orange = 0.0466$NZD / 0.00393$NZD = **11.87 grams** of Oranges weight in typical basket.

Formulas 2 and 3 are important for two reasons. They not only ensure that the initial calculation of each food item's contribution to the index figure was accurate, but also play a vital role in the calculation of the *Green Typical Basket.*

The food price index contribution from the food item Orange for the conventional typical basket amounts to **0.0466**$NZD (11.87 grams in basket * 0.00393$NZD).

3.7.2 Green Typical Basket

The certified organic food basket, uses the same Formulas 1,2 & 3 as the *Conventional Typical Basket*. However, an extra calculation is necessary to account for the green nature of the certified basket. This calculation involves multiplying the price per gram of the certified organic food item to the total grams of each particular food item. This is outlined below in Formula 4.

Formula 4 represents the individual contribution of each food item in the FPI figure.

Formula 4: FPI contribution figure of individual food item
Total Grams in Food Basket (answer of Formula 3) multiplied by Green Price per Gram

Green Orange FPI contribution= 11.86 grams * 0.006$NZD = **0.1466**$NZD

Formula 5 indicates how the complete index figure was calculated.

Formula 5: FPI Complete Index Figure
= All individual food item FPI contribution figures added together (answer to Formula 5 all added together)

E.g. 2020 Green PHD Index = 14.69$NZD (see *Appendix 8*).

3.7.3 PHD Basket

The Eat-Lancet paper by Willet et al (2019) states that the PHD originates from indicates the caloric value of each particular food group, and, at times, food item. Although the number of grams is also listed, this value needs to be tested against the New Zealand Food Composition Database figure. This is to ensure that both the Typical and PHD index calculations will be based on the same reliable figure. Furthermore, when developing the PHD the authors account for context-specific foods, this is represented by the food groups Vegetables and Fruits not having specific food items listed. For other food groups, such as Whole Grains, there are multiple food items listed (Rice, Wheat, Corn) with only the total caloric intake given (811 kcal/day). Thus, the aforementioned assumption, that each food item per class contributes equally was applied, which means that each Rice, Wheat and Corn component contributed 270.33 calories each (811/3).

Considering that the caloric value of each food item constituting the PHD as calculated by Willet et al (2019), this exact figure was utilised in the calculations for the PHD basket index figures relevant to this study. Below is an example for the Typical food item Whole Milk (**153 kcal/day**) to illustrate this.

Formula 6 refers back to the New Zealand Food Composition Database and the publication *Understanding Nutrition* (Whitney & Rolfes, 2005, p. 8). The example below indicates how the calories per gram of Whole Milk were calculated.

Formula 6: Energy (KJ) conversion to Calories, then converted to Calories per Gram
= Energy (KJ per 100g) /4.2 (KJ to Calorie conversion) / 100 (per 100g conversion to 1g)

Whole Milk = 248KJ / 4.2 = 59.05 calories per 100gram
59.05cal/ 100gram = ***0.5905Cal per gram***

Formula 7 outlines the total amount of grams per each food item in the food basket. Whole Milk is used as an example again.

Formula 7: Total Grams of food item in Food Basket
= Calories of food item in food basket / calories per gram
(As calculated per Willet et al, 2019) (answer of Formula 6)

Whole Milk = 153 calories / 0.5905 calories per gram = **259.32 grams** of Whole Milk in food basket. Thus, 259.32 grams of Whole Milk is the equivalent of 153 calories.

Formula 8 indicates how the average price per gram of each food item was calculated. The example used is for the year 2020 for the conventional food item Whole Milk, which is measured per 2000ml. However, when calculating other historic indexes - 2019, 2018 - the matching year's data was used.

Formula 8: Price per Gram of Food Item
= average (Microsoft Excel AVERAGE function) of all prices registered from
01.01.2020 - 31.12.2020 / unit measured (generally taken as price per kilogram = /1000)

2020.01 - 3.63$NZD, 2020.02 - 3.64$NZD, 2020.03 - 3.63$NZD, 2020.04 - 3.58$NZD, 2020.05 - 3.62$NZD, 2020.06 - 3.64$NZD, 2020.07 - 3.51$NZD, 2020.08 - 3.50$NZD, 2020.09 - 3.52$NZD, 2020.10 - 3.56$NZD, 2020.11 - 3.58$NZD, 2020.12 - 3.54$NZD

Calculations were conducted on Microsoft Excel. The formula used was the AVERAGE function. The average of the 12 prices listed for 2020 = 3.58$NZD (2000ml). In order to calculate the price per gram, the figure of 3.58$NZD needs to be divided by 2000. Thus, the price per gram for Whole Milk for 2020 = **0.0018**$NZD (3.58/2000).

Formula 9 represents the individual contribution of each food item to the FPI figure.

Formula 9: FPI contribution figure of individual food item
= Total Grams in Food Basket * Price per Gram
(answer of Formula 7) * (answer of Formula 8)

E.g. Whole Milk = 259.32 grams * 0.0018$NZD = 0.464$NZD

Formula 10 indicates how the complete index figure was calculated.

Formula 10: FPI Complete Index Figure
= All individual food item FPI contribution figures added together
(answer to Formula 9)

E.g. 2020 Conventional PHD Index = 10.89$NZD (see *Appendix 7)*

3.8 Imputation

As outlined earlier in the research methods section, there were some food items for which historic price collection proved a difficult task. At times there was no certified organic version of conventional food items, while in other instances sourcing the data from organic retailers was unsuccessful. For such items where no/limited price data were available, imputation was used in an attempt to accurately represent the historic cost of these food items. The figures imputed were based on a categorisation of 1 - 3. 1 means there was a relatively similar food item which to base the imputation on in order to detect a relatively reliable historic trend for the food item. 3 indicates there was no appropriate substitute food item to base imputation on. Thus, the average figure of: (average price per gram of green certified food items - average price per gram of conventional food items) + equivalent conventional food item was applied as explained below (see section 3.9.1). Examples are given below for each rating of the scale.

1: Starting data point available of food item (but no historic price data available), and substitute historical price data of similar item available. For example, Berries used for Strawberries

2: Starting data point available of food item (but no historic price data available), and substitute historical price data of questionable item available. For example, Beef mince used for Beef corned silverside.

3: No starting data point available of food item (and no historic price data available). For example, for the Fish category of the basket, there is no certified organic fish for sale in New Zealand. Thus, the conventional price of the food item (fish) was taken, and multiplied by average figure of the price difference (across the whole basket) between green and conventional items (see section 3.9.2).

3.8.1 Imputation with a Current Food Item Price

For some food items, sourcing the historic price data was a problematic task. This is outlined below with the example of Palm Oil, where today's price was sourced online and imputation was used to calculate the annual historic cost dating back to 2018.

The fact that Statistics New Zealand did not collect price data on Palm Oil, and none of the retailers who provided data for this study sold Palm Oil, created difficulties in representing the historic price of certified organic Palm Oil. Thus, the price for both conventional and green Palm Oil was sourced online, and the following formula was used for imputing a representative historical price of the product. As Palm Oil is listed in the Fats section of the PHD, the most similar food item (SFI) used in the calculations was Olive Oil.

Formula 11 provides the example for conventional Palm Oil's average price for 2021.
SFI = Olive Oil.

Formula 11: ((SFI 2021 average Price per gram - SFI today's Price per gram) / SFI today's Price per gram) * today's price of Palm Oil + today's price of Palm Oil = Imputed figure

((0.011019 - 0.1086) / 0/01806) * 0.011 + 0.011 = **0.011161**$NZD

3.8.2 Imputation Without a Current Food Item Price

For some items there was no certified organic product on the New Zealand market for sale. The reason for some food items is unclear. For example, many vegetables are certified organic, however, for Tomatoes there was no available certified organic version. The closest certification for Tomatoes was spray-free. If this item were to be used to represent the cost of Tomatoes, it would create an inconsistency with the data analysis in this study. Therefore, for food items that were missing, such as tomatoes among others (see sections 3.8.3, 3.8.4, 3.8.5, 3.8.6). Price imputation was utilised and based on the average figure of which certified organic foods differed from conventional food items. It is important to note that this figure has been calculated strictly on the food items for which both conventional and green prices were available. So, the aim was to create a figure which was as accurate as possible, although it should be noted that this is a considerable limitation of this study. The calculation of the figure used in this study is outlined below.

Formula 12: Figure = (price per gram of all organic food items / price per gram of all conventional food items) / Number of items
= 1.299$NZD / 109 = **0.0119**$NZD

Green Food Item price = Figure (from formula 12) + Price Per Gram of Conventional food item (equivalent of green item). See Pear example below (see section 3.8.4).

3.8.3 Conventional Typical Food Items Imputed

There was no need for imputation of the Conventional Typical food items as all prices were collected directly by Statistics New Zealand. For two food items (Nectarines & Strawberries) no prices were listed, so these were collected online from Countdown supermarket data (see links below).

Nectarine. Countdown. (n.d.). Nectarine. Retrieved November 12, 2021, from https://shop.countdown.co.nz/shop/productdetails?stockcode=567612&name=fresh-produce-the-odd-bunch-nectarines

Strawberry. Countdown. (n.d.). Strawberry. Retrieved November 12, 2021, from https://shop.countdown.co.nz/shop/productdetails?stockcode=702150&name=fresh-produce-the-odd-bunch-strawberries

As this study looks at the average food intake for an adult, *Infant Formula* was removed from the food item list and its expenditure weight of (0.044892$NZD) redistributed and added to the nearest alternative (*Fresh Milk*). The expenditure weight was evenly distributed across the two food items in this category, *Milk Enriched & Milk Standard.* This meant that the expenditure weights of each of these products increased from 0.27864$NZD to 0.301086 $NZD, which was calculated as follows: Original milk expenditure weight of 0.27684$NZD + Infant formula expenditure weight of 0.022446$NZD divided by 2).

3.8.4 Green Typical Food Items Imputed

For all of the food items listed below in *Table 6*, no certified organic alternatives could be found. This means there was no beginning price point to measure/impute from and, therefore, the figure from formula 12 (see section 3.9.2) was added to the conventional food item. This was done for all of the items listen in *Table* 6 and the example of certified organic Pears below should clarify this for the reader.

Conventional Pear price per gram 0.00504$NZD + 0.0119$NZD = **0.01695**$NZD (Green Pear price per gram).

Table 6: Green Typical Food Items Missing/Imputed

Pears	Tuna (canned)	Powdered Drink, Fruit Flavoured
Grapes	Mussels (marinated)	
Pineapples	Bread, White	
Peaches	Breakfast Biscuits	
Tomatoes	Pasta, Filled (fresh)	
Parsnips	Meat Pies (chilled)	
Mixed Vegetables (frozen)	Pizza (frozen)	
Beef, Corned Silverside	Pastry (frozen)	
Pork, Loin Chops	Cheese, Slices (processed)	
Pork, Leg	Eggs, Standard	
Chicken Nuggets	Margarine	
Salami	Chewing Gum	
Ham (sliced/shaved)	Hummus Dip	
Fresh Fish Fillets	Pasta & Sauce (dry mix)	
Mussels (live)	Spaghetti (canned)	

3.8.5 Conventional PHD Food Items Missing/Imputed

For the food items listed in *Table* 7 the researcher was unable to source historic price data directly from Statistics New Zealand FPI publications. In order to overcome the difficulties this causes for calculating time series indices, a similar substitute food item was used in the imputation methods stated above. The reasoning and scale rating (see section 3.8), are also outlined below.

Table 7: Conventional PHD Food Items Missing/Imputed

Scale Rating	Food Item Missing	Substitute Food Item & Reasoning
2	Polenta	Rice, closest alternative from the carbohydrate category.
2	Lentils	Peas, closest alternative from the legumes category.
2	Soy (Tofu)	Peas, closest alternative from the legumes category.
1	Tree-nuts (Almonds)	Peanuts, closest alternative from the legumes/nuts category .
2	Palm Oil	Unsaturated Oil (Olive), closest alternative from the fats category.
2	Lard	Unsaturated Oil (Olive), closest alternative from the fats category.

3.8.6 Green PHD Food Items Missing/Imputed

For the food items listed in *Table* 8 the researcher was unable to source historic price data directly from certified organic New Zealand retailers. In order to overcome the difficulties this causes for calculating time series indices, a similar substitute food item was used in the imputation methods stated above. The reasoning and scale rating (see section 3.8), are also outlined below.

Table 8: Green PHD Food Items Missing/Imputed

Scale Rating	Food Item Missing	Substitute Food Item & Reasoning
2	Milk	Beef, closest alternative as milk is produced by cows.
2	Chicken (breast)	Eggs, closest alternative as chickens produce eggs.
3	Fish	No substitute food item available. Average ratio was applied to conventional price per gram of fresh fish prices (per Statistics New Zealand).
2	Peas	Lentils, closest alternative from legumes category.
2	Soy (Tofu)	Lentils, closest alternative from legumes category.
2	Palm Oil	Unsaturated Oil (Olive), closest alternative from the fats category.

4. Results[25]

The results of this study will be presented in two parts. First, the food price index figures will be visualised with the aid of various graphs, and the main findings briefly described. This will help the reader understand the price differences between green and conventional items, as well as across the typical and PHD food baskets. Following this, the interview insights will be analysed in relation to the methods used in creating the novel gFPI, and the actionable outcomes of such a metric. When figures are representative of 2021 current prices. This means from the time of writing using the data which was the most recently up to date, for conventional food items this is price data from October 2021, where-as for green food items this is price data from November 2021.

4.1 FPI Figures

The total cost (in NZD$) of each food basket is shown in *Figure 3*. For a consumer in New Zealand the Typical green basket was considerably the most expensive option, amounting to $37.10 for one day's worth of food. Whereas the most cost-effective option was the PHD conventional basket, totalling 11.54$NZD for daily food expenditure. The green alternative for both the Typical and PHD baskets were more expensive than their conventional counterpart. For the Typical basket, the extra expenditure needed to purchase the green basket was 21.62$NZD, or an increase of 144.72%. In comparison, the green PHD basket amounted to 3.62$NZD more than its conventional counterpart, otherwise stated as a percentage increase of 31.37%.The cost of both the conventional and green PHD baskets was cheaper than the Typical basket alternatives. For example, a consumer would save 3.90$NZD (-25.45%) if they were to purchase the conventional PHD basket in comparison with the conventional Typical basket. The difference between green versions was noticeably larger, however, amounting to a reduction of 21.94$NZD (-59.18%) if the PHD option were purchased rather than the Typical green basket.

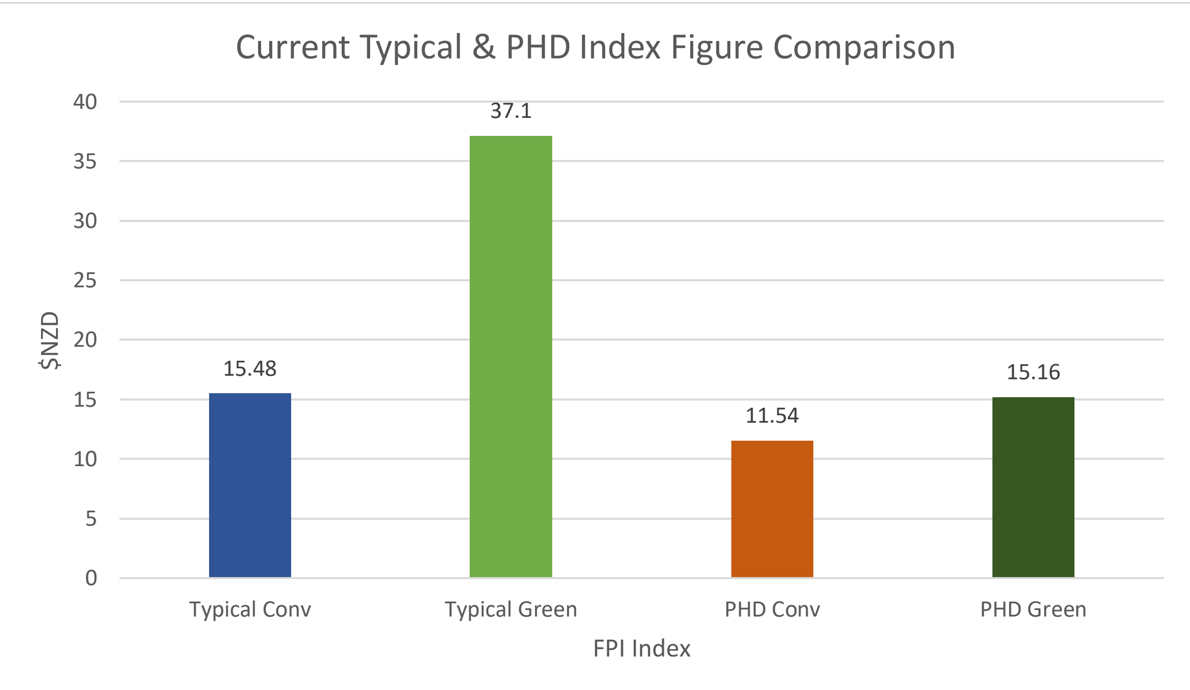

Figure 3: Comparison of Typical & PHD Index Figures

[25] Conventional current price as at 10.2021, Green current price as at 11.2021

Now it is time to analyse each food basket more in-depth. First, the PHD basket results are discussed. This entails a representation of the historic price differences between conventional and green baskets, followed by a break-down of the contribution of each sub-class to the total basket cost. Second, the Typical basket results are highlighted based on the contribution of each sub-class. Unfortunately, a time series was unable to be conducted for the Typical basket, due to the aforementioned limitations (see section 3.4.3).

4.1.1 PHD Basket

As the one of the intentions of this study is to understand whether New Zealand is progressing towards a more green economy through the transition towards a more sustainable food system, an understanding of the historic trend of green versus conventional food prices is an important consideration. The historic cost of the PHD food basket from 2018 to the current point of data collection (November, 2021) for both conventional and green food items is shown in *Figure 4* (p. 38). For each year, the green basket is more expensive than the equivalent conventional basket. The smallest divergence in total cost between baskets occurs in 2021, with the green basket costing 3.51$NZD more (31.42%). On the other hand, the largest divergence takes place in 2019, as the green basket amounts to 4.21$NZD (40.64%) increased expenditure in relation to the conventional equivalent.

The trend representing the difference between green and conventional remains relatively stable for the period 2018 - 2021, as the difference between baskets remained within 0.70$NZD (3.51$NZD to 4.21$NZD, 31.42% to 40.64%). The cost of both conventional and green baskets slowly increased over time, with the conventional basket (0.1775$NZD) increasing on average year after year slightly more than the green equivalent (0.0375$NZD). More specifically, the conventional basket had its largest increase between 2019 - 2020 with prices rising by a total of 0.54$NZD (5.21%). The green basket experienced the largest cost increase between the average 2021 prices and current price (11.2021), amounting to 0.51$NZD (3.48%).

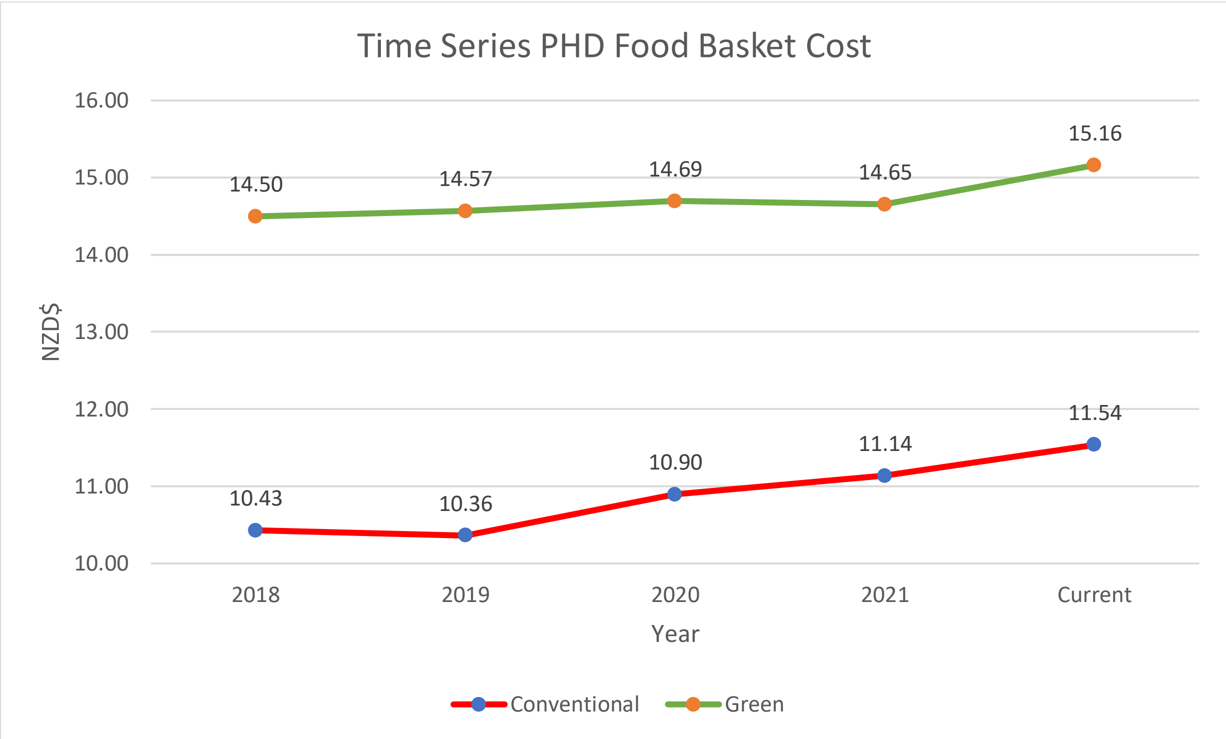

Figure 4: Time Series of PHD Total Food Basket Cost (both conventional & green)

Although the total cost portrayed in *Figure 4* (p. 38)is an interesting insight, it is important to show the relative change (de/inflation) between conventional and green indices, and sub-classes, as this allows the reader to understand how much food prices have changed since a base year (2018). *Figure 5* (p. 39) represents the inflation rates (base year 2018) of both the conventional and green PHD indices. The largest level of inflation experienced throughout the time-series analysis occurred in 2019, for the green index, amounting to a 7.60% increase in prices. The smallest level of inflation (deflation) also was experienced by the green index, at -5.80% in 2020. This change between 2019 to 2020 for the green index represented the biggest year on year change in inflation present in the time series, a considerable -13.40% decrease in prices. Although not quite as volatile, the conventional index alike experienced changes in prices. The largest change experienced for the conventional index occurred from 2019 to 2020, an increase of 5.82%. For the years 2020 (10.96%), 2021 (2.50%) and current (0.11%) the conventional PHD index experiences a higher level of inflation, relative to the green PHD index, although this difference is becoming smaller throughout the years to present day. The closest convergence between conventional and green indices appears in the current period, where the conventional index (3.59%) experiences 0.11% greater inflation than the green index (3.48%). Where-as the largest divergence between indices takes place in 2020, with the conventional index (5.16%) amounting to 10.96% larger inflation than the green index (-5.80).

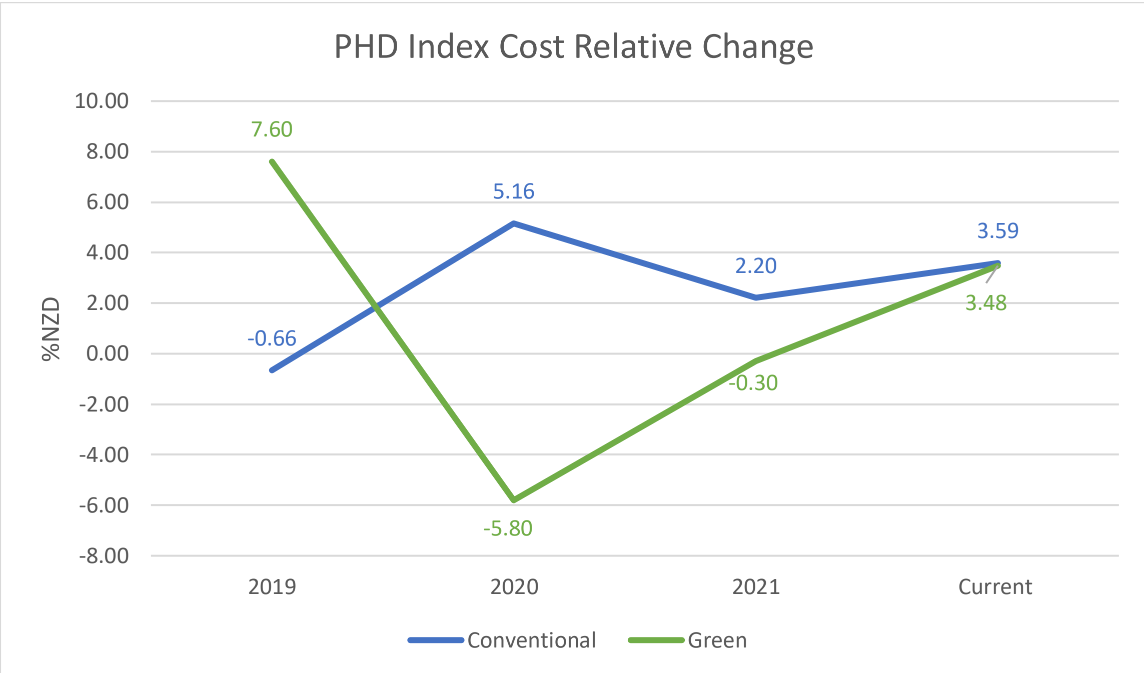

Figure 5: PHD Relative Cost Change (base year 2018)

Figure 6 (p. 40) provides a simple overview of the relative (%) and absolute ($) differences across the PHD food basket. The green basket is consistently higher across both categorisations. The largest difference in absolute terms occurred in 2019, where the green PHD food items cost 5.25$NZD more than the conventional PHD food items. In relative terms the largest divergence also occurred in 2019, with the green PHD basket costing the average New Zealand consumer 51% more in expenditure, when compared to the conventional PHD basket. Generally throughout the years investigated, the differences in both absolute and relatively terms remains relatively stable. With the absolute differences between baskets remaining within 0.70$NZD (3.51$NZD to 4.21$NZD, 31.42% to 40.64%). Where-as the relative difference between the baskets remained between 31% (November 2021) & 51% (2019).

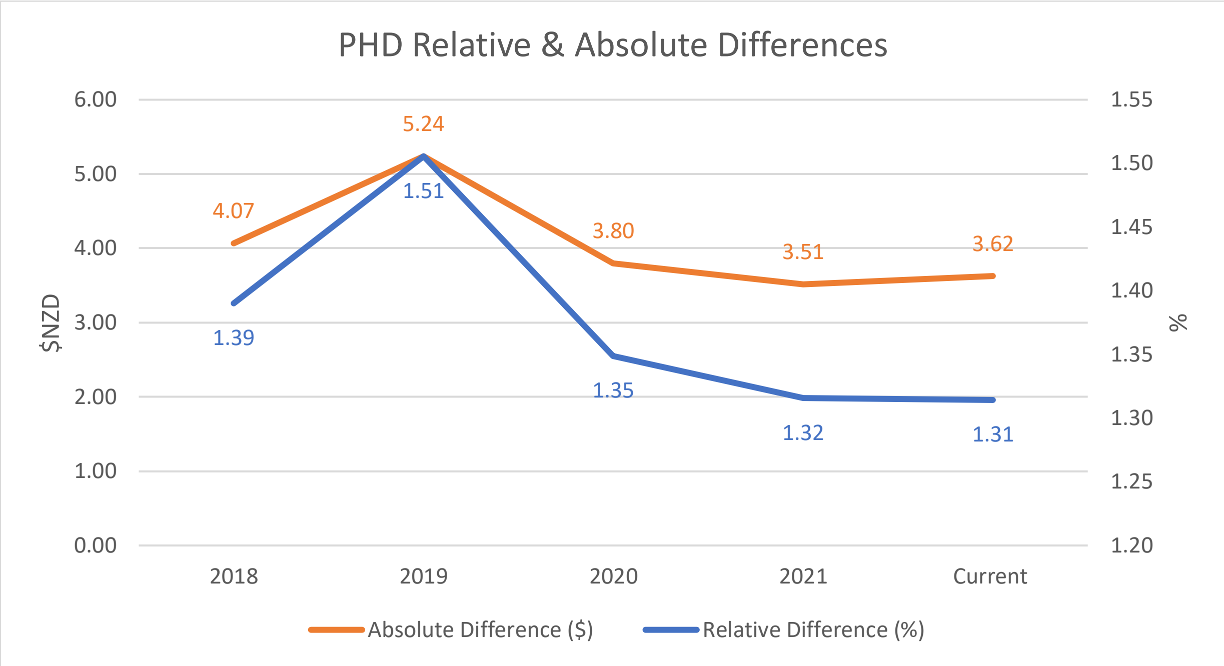

Figure 6. PHD Relative & Absolute Differences (base year 2018, figure representative of Green compared to Conventional)

Figure 7 (p. 41) represents the inflation rates of both the conventional and green PHD sub-classes (base year 2018). This visualises to the reader the changes in prices per sub-class food items over time relative to 2018. For all sub-classes the lines representing the relative change for conventional and green sub-classes intersect, this means that neither conventional or green sub-classes experience a consistently higher/lower level of inflation throughout the years 2019 to the current period. When looking more specifically at each sub-class the range of inflation is highlighted for both conventional and green sub-classes, and other interesting findings are mentioned.

The conventional carbohydrate sub-class experienced a smaller range of inflation throughout the years analysed of 4.15% (0.43% to 4.58%), compared to the green carbohydrate sub-class, which has a substantially larger range of 23.27% (-1.20% to 22.07%). The largest year over year increase in prices occurred in the green sub-class between 2021 and the current period, where prices increased by 18.75% (3.32% to 22.07%) .

The green vegetable sub-class is the only sub-class in *Figure 7* (p. 41) which experiences a constant increase in inflation of prices throughout the years analysed from -8.15% to 5.48%, amounting to a range of 13.63%. The conventional vegetable sub-class prices experienced a larger overall range of inflation totalling 26.2% (-11.59% to 14.61%). The greatest levels of both deflation (-11.59%) and inflation (14.615) on price changes in the vegetable sub-class occurred in the conventional version. The largest overall increase in prices between one year of all sub-classes in *Figure 7* took place between 2019 and 2020 for the conventional vegetable sub-class, increasing by 26.2%.

The range of inflation for the prices of conventional fruit amounted to 13.68% (-4.14% to 9.54%). Where-as the green fruit sub-class had a slightly greater range of price inflation of 14.83% (-4.79 to 10.04%). The fruit sub-class is the only sub-class to have both the conventional and green line intersect as each time period changes.

The conventional dairy sub-class had the smallest range of inflation of all sub-classes in *Figure 7*, coming to 3.81% (-0.38 to 3.43%). Where-as the green dairy sub-class price changes range was slightly more at 5.10% (0.00 to 5.10%).

The range of inflation for the prices of conventional protein was 4.74% (0.11% to 4.85%). In contrast the prices of green protein provided a considerably larger range, amounting to 22.45% (-10.81% to 11.64%). Of all green sub-classes, the green protein sub-class recorded the largest level of deflation between any given time period, this was between 2019 and 2020 where prices decreased by 22.45%.

The green fat sub-class is the only sub-class which experiences a constant decrease in inflation of prices throughout the years analysed from 14.46% to -6.25%, providing a range of price deflation of 20.71%. The conventional fat sub-class experienced a smaller overall variation in inflation range of 4.41% (-1.44% to -5.85%). For the conventional fat sub-class, this was the only sub-class in *Figure 7* (p. 41) to have each year's prices be cheaper than in 2018 (base year), as represented by all figures being less than zero.

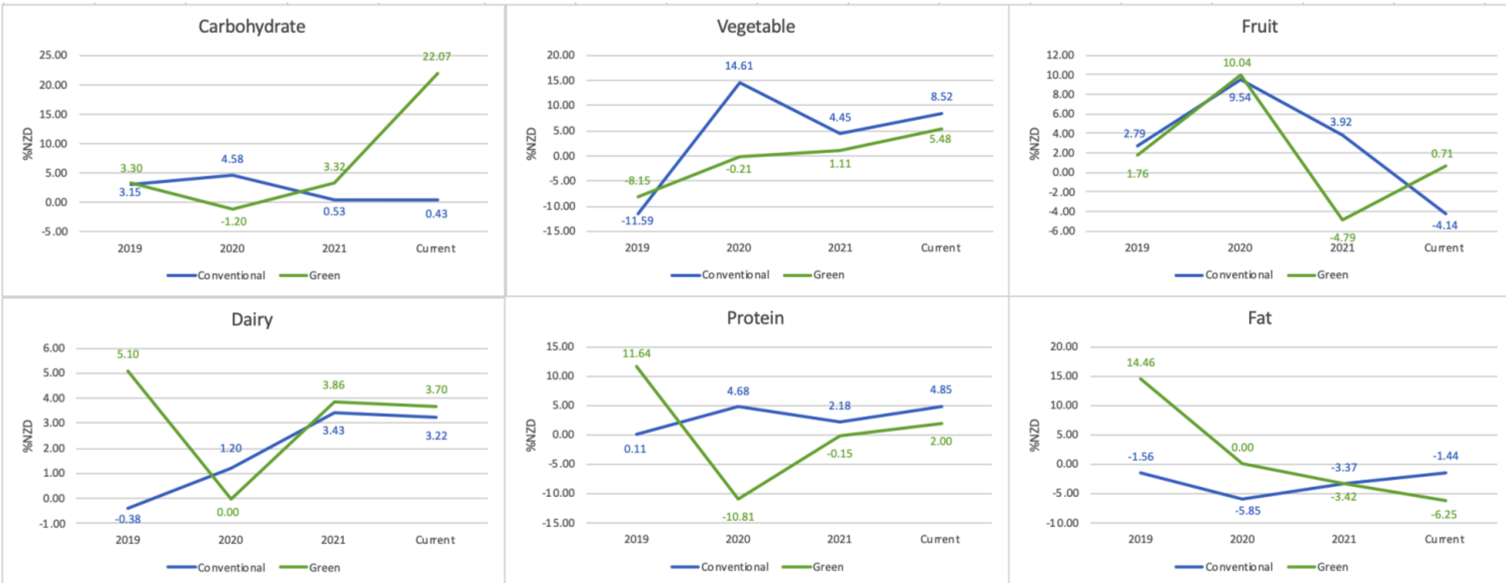

Figure 7. Relative Change PHD Sub-Classes (base year 2018)

The contribution of each sub-class to the total PHD food basket cost for both conventional and green is represented in *Figure 8* (p. 42). Each sub-class of the green basket amounts to more expenditure when compared to the equivalent sub-class of the conventional basket. The examples that follow provide an in-depth description of the current time period (October, November 2021). Thus, the current total cost of the green basket (15.16$NZD) is larger than that of the current conventional basket (11.54$NZD). The largest contributor for both conventional and green baskets was from the Protein sub-class. For the conventional basket this amounted to 7.59$NZD, or 66% of the total cost of the food basket. In the green basket, Protein cost 8.74$NZD, equating to 58% of the total cost. The sub-class which provided the least cost in the green basket was that of Dairy, totalling 0.75$NZD (5%). Also, the smallest contributor within the conventional basket is the sub-class Dairy 0.49$NZD (4%). It is interesting to note that the conventional basket has two more sub-classes which cost less than the cheapest sub-class of the green basket. These are: Fat 0.57$NZD (5%) and Carbohydrates 0.69$NZD (6%). The differences among conventional and green sub-classes remains relatively stable, with the largest divergence amounting from Protein (1.15$NZD), whilst the smallest was Dairy (0.26$NZD). Such an analysis and understanding as to where the costs from the food basket came from could also be completed for the years (2018 - 2021) data was collected for prior to the current period.

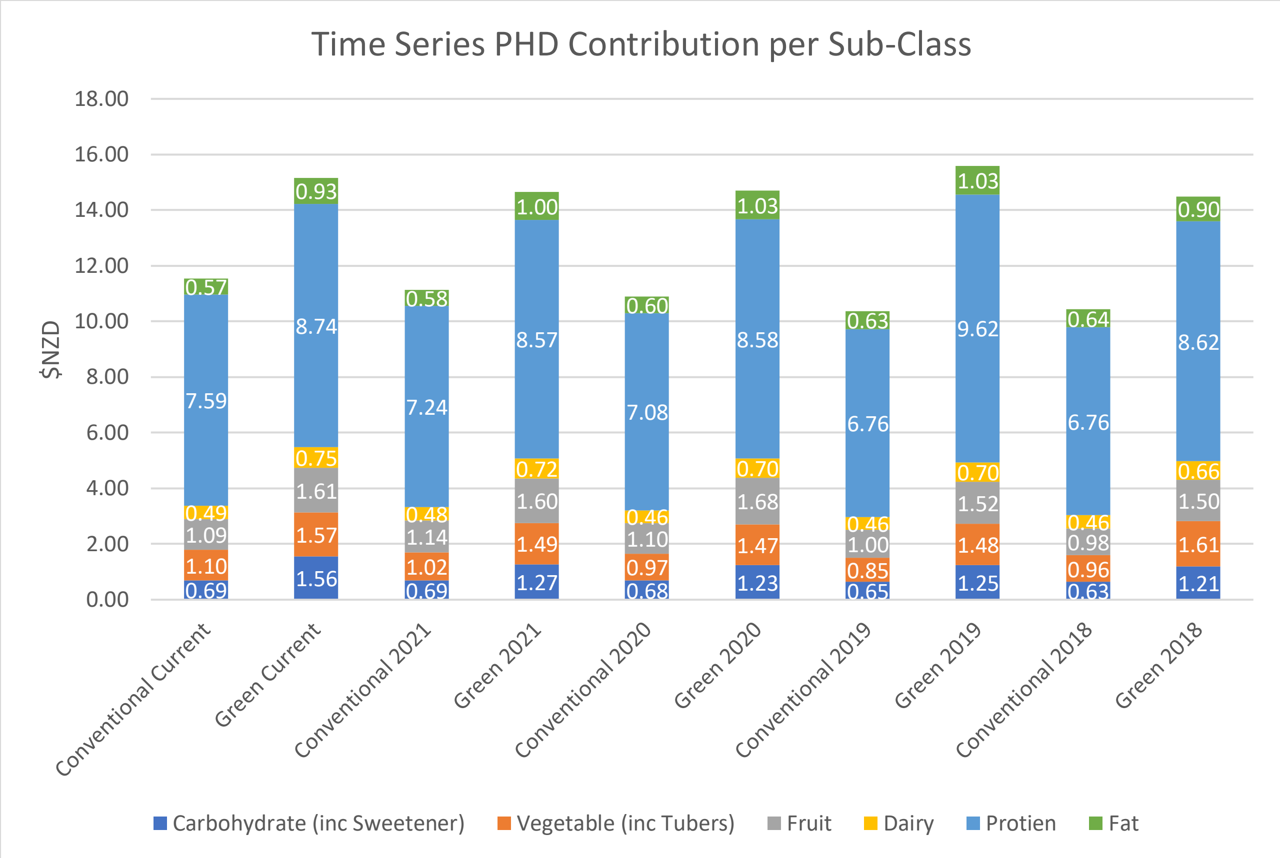

Figure 8. Price Contribution/Comparison per Sub-Class of PHD Basket (both conventional & green)

4.1.2 Typical Basket

In order to The contribution of each sub-class to the total Typical food basket cost for both conventional and green is represented in *Figure 9* (p. 43). Similar to the PHD basket, each green sub-class costs more than its conventional equivalent. Unsurprisingly, the green typical basket (37.10$NZD) costs the New Zealand consumer significantly more - 21.62$NZD - than the conventional version (15.48$NZD). The sub-class which amounted to the largest expenditure on food items was the same for both conventional and green baskets, namely the grocery sub-class. In the conventional basket grocery amounted to 5.33$NZD (34%), whereas for the green basket grocery totalled 13.24$NZD (36%). The smallest contributing sub-class for both baskets was from Fruit, conventional basket 0.75$NZD (5%) and green basket 1.91$NZD (5%). The differences among conventional and green sub-classes were considerably larger than for the PHD food basket, ranging anywhere from 1.16$NZD (Fruit) to 7.91$NZD (Grocery).

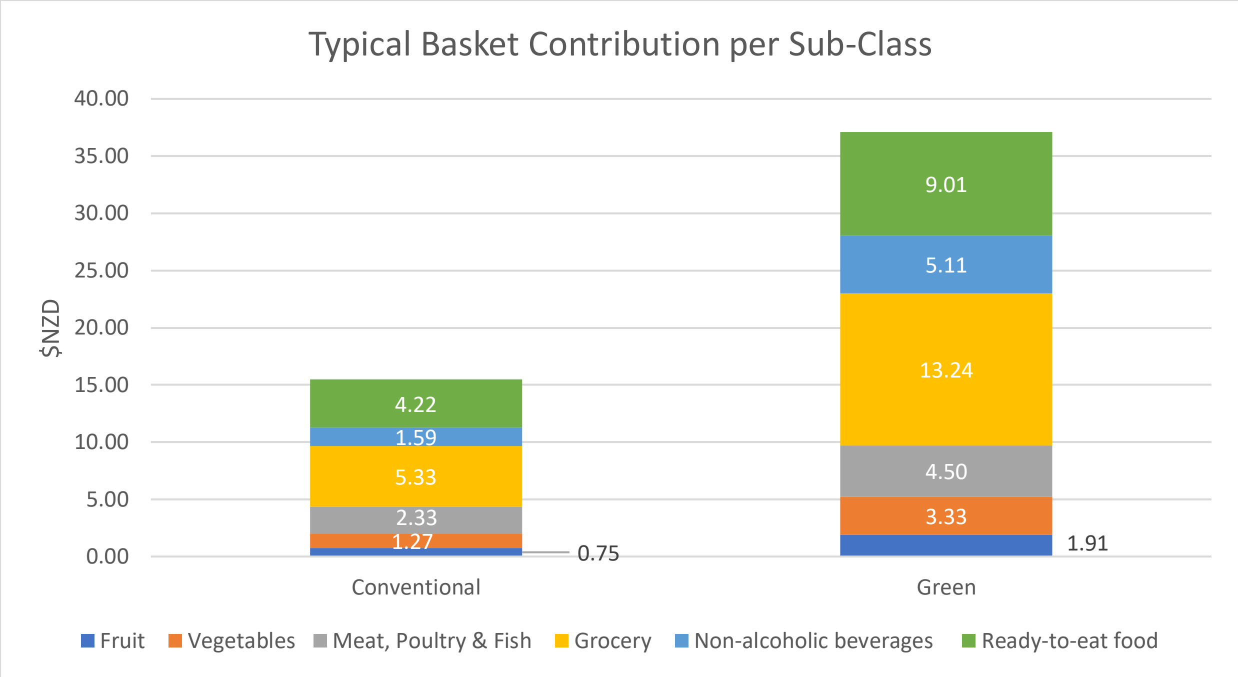

Figure 9: Price Contribution/Comparison per Sub-Class of Typical Basket (both conventional & green)

4.2 Interview Insights

There were two interviews conducted. The first was with a lead employee of certification body AsureQuality. The second involved a senior member of Statistics New Zealand. As the interviewees preferred to remain anonymous, the AsureQuality respondent shall be referred to as Respondent X and the Statistics New Zealand respondent shall be referred to as Respondent Y. It should be noted that the researcher did not use a systematic method of analysing the interviews, rather, the interview transcripts were analysed and quotes/insights which were related to the research question were utilised in the following results sections. Two main insights emerged throughout the semi-structured interview analysis. The first relates to the validity of methods used in creating the gFPI and the second relates to the practical application of a gFPI. Both are discussed below.

4.2.1 Accuracy of Methods Used in Creating the gFPI

As the measurement of a sector of a (green) economy based on the utilisation of certification is an underexplored area in the literature. The methods used in creating the gFPI - which aims to serve this purpose for the food sector of the New Zealand economy - warranted an evaluation from those interviewed. As the member of the National Statistics Office who was interviewed is knowledgeable in the field of economic measurement techniques, the aim was to understand whether or not the methods in creating the gFPI in this study, and subsequent results would be valid and insightful, whilst allowing for conclusions and further recommendations to be drawn. For this the responses to question 4 (a, b & c) are indicated (see Interview Guide in *Appendix 9*).

Concerning the construction of the gFPI, Respondent Y indicated that the index figures methods are in-line with how general price indexes are created, "Those are two basic components. As long as you got to a standardized weighting scheme and price relative to that basis. You've got the basics of a price index" (personal communication, December 9, 2021). Furthermore, the measurement in the form of grams was seen as appropriate, "I think cause you've expressed in grams, price breakdowns and it would work for, within comparability of the food price index" (personal communication, December 9, 2021).

Both interviewees indicated that there is a place for certification (of production standards & products) when it comes to measuring a nation's green economy. Respondent X commented, provided there are certifications that are widespread (i.e. cover each sector of the economy adequately), such a method of measurement could work for each sector which, when combined, amount to a nation's economy. Whereas Respondent Y stated "it seems like there's some potential use, but it's not quite sure how" (personal communication, December 9, 2021). The reservations expressed surrounding certification in the measurement of a (green) economy stems from the Statistics community and their idea of an environmental good. As expressed by Respondent Y, "Because the definition of an environmental good can change overtime, you [get] kind of shifting baselines and I don't know certification necessarily resolves the[m]" (personal communication, December 9, 2021).

Although the above paragraphs indicate that the gFPI created in this study should provide reasonably accurate and reliable results, the interviewees did mention some areas which could be improved upon to create a more robust gFPI. Respondent X indicated that certification lacks the ability to certify those who are ahead of the game. Meaning, certification has the ability to crowd out producers who are applying improved practices but are unable to be certified as certification is yet to exist (personal communication, December 7, 2021). Furthermore, Respondent X suggested using more than one certification scheme, or the combination of various certification schemes to increase the accuracy (see paragraph below) exist (personal communication, December 7, 2021).

A potential way of overcoming some of the difficulties with certification was proposed by Respondent Y. "Cause it's like certified, yes or no. If you're gonna have problems, but you may want to kind of break it down by those different types of certification levels. That may be that may be a way around it." (personal communication, December 9, 2021). This is a valid and insightful proposition, suggesting that a tier of certifications such as; minimal (do no harm), good, and gold standard (best certification in class), might help overcome some of the limitations of certification. This is further elaborated on in the future research section of this paper, as it would be beneficial to implement such an approach in future studies.

4.2.2 gFPI Areas for Implementation - Actionable

When interviewees were asked where they could see the gFPI being used/creating action, both referred to its relevance for public policy. More specifically, the possibility of using the gFPI for stimulating public policy decisions related to the New Zealand food ecosystem. Respondent X indicated that if the New Zealand government wants to encourage sustainable production, then it is of importance to understand the results and costs of this, and how to drive the cost of sustainable production down over time, so that more producers can implement sustainable practices (personal communication, December 7, 2021).

Respondent Y provided a more pragmatic response when asked how the gFPI could be used, stating "Policy relevance, so it's probably something which you know if it [were] very clear [meaning the gFPI index figure], [there is] policy application" (personal communication, December 9, 2021). Although both interviewees indicated possible action in the public policy space due to the gFPI, more specific details outside of those stated above were difficult to discover. This is not overly surprising as the methods used and the gFPI metric are a novel development, with little literature surrounding the topic. Thus, those interviewed, although experts in their field, may have found it difficult to envision the precise areas of public policy impacted by the gFPI.

Other areas of implementation were also mentioned. Respondent X highlighted the gFPI in relation to a political opportunity, implying the possibility to influence regulations, subsidises and grants in the New Zealand food system (personal communication, December 7, 2021). Moreover, from a communication (marketing) perspective, Respondent X indicated the PHD results and insights as a point of interest (personal communication, December 7, 2021), this is further elaborated on below, relating to individual food consumption habits. The gFPI and its possible applications in relation to public policy, demand and supply-sided strategies are further elaborated on and discussed in the following section.

5. Discussion

The previous chapter provided the results of the gFPI index figures and various interesting insights from the interviews conducted. However, in order to answer the research question "*Can the creation of a novel green food price index act as an accurate and actionable economic metric for the transition towards a green economy, for New Zealand's food system?"* the interpretation and implications of these results are needed. In section 2, several challenges and current shortcomings of measuring a nation's green economy were discussed. Although the methods used in this study are by no means a perfect solution, they generated many interesting and valuable contributions and helped to create a gFPI. Links between the proposed measurement method and a green economy were made in order to build on existing theory, whilst practical applications of a gFPI are highlighted. This chapter discusses the possible actionable outcomes of the gFPI. Initially, the main uses and areas of practical implementation for the gFPI are outlined. Next, the actions regarding the gFPI and of the supply-side (green production processes) of the New Zealand food ecosystem are elaborated on. Lastly, the gFPI and its potential impacts on the demand-side (consumption habits) are identified.

It is important to remember that the measurement of a green economy is a relatively new field and, hence, there are limited methodologies and publications available (see section 2.2). Furthermore, the agreement on how to measure a green economy, and the sectors which constitute it, still lacks unanimous agreement in academic circles, and lacks presence in institutional discussions. Therefore, this study proposes a fundamentally new approach to measuring the greenness of a given sector of the economy, and could thus only draw on Webb's (2016) source, representing the initial conceptualisation of green statistics and metrics.

5.1 Main Uses of a gFPI Practical Implementation

One of the central aims of creating the gFPI was that it assists in measuring what the level of sustainability in the NZ food system is by understanding the current and historic prices of green (sustainable foods) compared to conventional food items. The analysis of the price differences and rates of inflation (see *Figures 4 - 7, p. 38 - 41.)* suggest that the green food baskets cost more than the conventional food baskets (in current day prices), and that the historical data shows that the green PHD food basket remains consistently more expensive in comparison to the PHD conventional food basket (31% to 51% from 2018 to November 2021). When comparing the findings of this data to the expected outcomes of the study (see table 1, p. 20), it suggests that based on the cost of green food items being more expensive, and the green PHD basket prices increasing consistently more than the conventional PHD basket, that little progress has been made towards achieving a more sustainable food system, and therefore a greener NZ economy. In other words, the expected outcomes which would suggest New Zealand is transitioning towards a more sustainable food system and GE are not being met. A conclusion which can be drawn from this lack of progress to date is that more action is needed to stimulate the transition to a greener economy. Some possible areas in which the gFPI could be utilised as indicated by those interviewed are outlined below.

When addressing the relevance of a gFPI in an actionable sense, the area of public policy primarily emerges. As stated earlier in the results section, both interviewees saw the initial actions surrounding the gFPI in the realm of public policy. For example, Respondent Y indicated that the gFPI, when understood clearly, would have direct policy relevance and application. Where-as respondent X suggested that if the New Zealand government wants to encourage sustainable production, then it is of importance to understand the results and costs of this, and how to drive the cost of sustainable production down over time, so that more producers can implement sustainable practices (personal communication, December 7, 2021). As the gFPI is based on certified green production processes (see section 2.2.3), the cost of these is measured in what the consumer pays for these foods. By providing data which represents the cost of this, it can be seen that the cost of sustainable production in the scope of this study has not reduced over time. This is indicated in *Figure 6 (p. 40)* which shows that the green PHD index remains between 3.51$NZD - 5.24$NZD (31% - 51%) more expensive throughout the years investigated: 2018 to 2021 (October, November). Furthermore, the gFPI provides the rates of change across the index as a whole. *Figure 5* (p. 39) highlights this and shows the rates of change each year from 2019 to 2021 experienced by both conventional (2019: -0.66%, 2020: 5.16%, 2021: 2.20%) and green (2019: 7.60%, 2020: -5.80%, 2021: -.30%) PHD indices. Because of this data availability and understanding strategic responses/actions can begin to be put in place. This influence on actors in institutional settings in the public policy sphere could act as a positive nudge for demand and supply-side changes (as elaborated on in the following sections), which could possibly help the New Zealand food system to have increased levels of sustainability. Although it must be noted that this analysis is based off a relatively small historic dataset, ranging from January 2018 to November 2021. This limited data was a limitation of the study, as it is likely that more/clearer trends would have emerged surrounding green versus conventional prices if this data would have been obtained over a longer period of time, for example, over the last decade.

Through the process of collecting price information based on certified production processes it becomes possible to create ‘green’ statistics (Webb, 2016). Furthermore, “from these statistics it is possible to select and calculate indicators for example changes in green prices for broad categories of goods and services, or national totals, proportions or rates of change in green and other categories of production” (Webb, 2016, p. 59). As the gFPI aligns with the process stated above surrounding ‘green’ statistics and green metrics, this provides it with the premise to potentially act as a future economic indicator within the scope of the New Zealand food system. This could occur as economists and government officials are already comfortable with such data the gFPI utilises/produces given its similarities with the CPI, this simplifies the analysis of gFPI insights (Webb, 2016). In other words, the potential application of the gFPI overcomes many of the difficulties/shortcomings highlighted in the green measurement section (see section 2.2), and future changes, by those in institutional settings, could be applied efficiently and effectively. Meaning, the possible adoption by governments of an economic indicator, based on green statistics, to create green metrics such as a gFPI would require minimal changes in the way data is analysed and utilised in decision making purposes.

Another factor which could contribute to the gFPI having possible influence within public policy is through the timely and accurate information the metric provides. The timely and accurate information the gFPI provides is an important contribution, as scholars have indicated the struggles surrounding the sourcing of timely data in relation to environmental sustainability (Webb, 2016). As the figures measured in the gFPI are based on certified production standards - where data is readily available, this ensures the data and subsequent index figures can be compiled in a timely manner. Such timely data is important as it provides those who can influence public policy - national statistic offices, regional city councils and the New Zealand Government - with the most up-to-date and accurate figures. Furthermore, the methods used in the creation of the gFPI align with the methods Statistics New Zealand uses in creating their monthly FPI publications. This means that the possible adoption of the gFPI by organisation such as Statistics New Zealand would be possible, as the concepts and procedures are already well understood.

From a more commercial perspective the data collected per sub-class as represented in *Figure 7 (p. 41)* indicates another potential application of the gFPI which could be insightful for commercial enterprises to consider the future adoption of GPP. The historical data from 2018 to 2021 (October/November) represents the rate of change a particular sub-class of PHD food items price has changed over time. If this were to be combined with the future development of data streams to include the producer price index (PPI). This could potentially allow producers who have already adopted GPP to potentially adjust future agreed upon price contracts based on these food input price changes, minimising the risk associated with food items produced in a manner aligned with GPP (BLS, 1997). For example, the green carbohydrate sub-class experienced a significant price increase of 18.75% between 2021 (3.32%) to the current period (November, 2021) (22.07%).

5.2 gFPI & Green Production Processes (Supply-Side)

Although the insights that emerged were interesting and warrant further discussion, it is of importance to reinforce that due to the limited timeframe associated with the historic data (2018 to 2021), and the limited range of items covered in a historical sense (PHD) that possibly some longer-term trends were not discovered in this research. A longer timeframe of historical prices over a broader scope of food items could describe a more accurate longer term picture, possibly unearthing more in-depth findings surrounding the greenness of a food system, and it's impacts on the GE.

A point of significant interest within this study was attempting to understand the long-term trend showing the differences between the cost of certified green production processes (*certified organic*) and conventional practices. By understanding this price trend, the cost difference of green production standards in the New Zealand food system should become clear. If there was little difference between prices, this would suggest that green production standards are not overly costly to adopt and produce with (Webb, 2016). An example of this historic cost difference between green and conventional PHD is made clear in *Figure 4* (p. 38). For the period 2018 - 2021 the extra cost of the green basket remained constant, between 3.51$NZD to 4.21$NZD (31.42% to 40.64%). Although it is not overly encouraging that the difference between green and conventional food items is not becoming smaller over time - as was hoped to be seen in the expected outcomes (see *Table 1, p. 20*) - this reinforces the importance of measuring the difference between conventional and green economy sectors. This could help actors better understand and explain to those who have the capabilities of making changes (public policy etc) to act, and hopefully allow this gap to become smaller in the future. In addition, this finding would suggest that producers in the NZ food ecosystem likely would not be encouraged to uptake GPP in the short term until these changes have become more widespread.

Also, another possible outcome of the gFPI as indicated through *Figure 7 (p. 41)* could be that it shows actors in the New Zealand food ecosystem who have not already adopted GPP, which sub-class of green food item prices have been changing at a lower rate compared to their conventional equivalents. This possibly could encourage producers to adopt GPP for food items whose prices are experiencing a smaller/slower rate of change. For example, the green fat sub-class data shows that each year the price was decreasing, from 14.46% in 2018 to -6.25% for the current time (November, 2021). Moreover, it also shows that the green fat sub-class experiences a lower rate of current change compared to the conventional fat sub-class (-1.44%). These insights could encourage producers to adopt GPP in sub-classes which are trending towards smaller price divergences. Through greater adoption of GPP by commercial actors in the food sector, it could be expected that there could be smaller net environmental impacts (see section 2.4.1**)**. This aligns well with the calls from scholars on 'bringing socio-economic patterns in line with planetary boundaries' (Merino-Saum et al. 2020, p. 14).

As Webb (2016, p. 63) indicates regarding certified green production practices, "With time, such interventions can be checked against environmental observations to check if the mandatory application of the standard had the intended effects". For the scope of this paper this implies conducting a robust environmental evaluation of the impacts of certified organic production standards in the coming years, although this may not be a straightforward task to conduct such an analysis, if done, direct comparisons could be made with conventional production practices from which overall environmental benefits/impacts could be derived. Based on the organic section above (see section 2.4.1) **,** it is likely that such an environmental analysis could emphasise the positive outcomes and externalities of certified green production processes (certified organic). In other words, the circular nature of certified organic production standards helps those commercial actors who have adopted such standards to operate with sustainability in their day to day operations, and could be used for commercial purposes such as in marketing materials - as highlighted by Respondent X - or more generally, for consumer education concerning New Zealand's transition towards a more sustainable food system.

5.3 gFPI & Consumption Habits (Demand-Side)

An interesting finding that warrants further discussion is what is depicted in *Figure 3 (p. 37)*, where the total cost for one day's worth of food based on each food basket (conventional & green) is shown by the total index figure. The index figures produced in the gFPI indicate that both the conventional and green PHD diets are cheaper than the Typical conventional and green diets. For example, a consumer would save 3.90$NZD (-25.45%) if they were to purchase the conventional PHD basket in comparison with the conventional Typical basket. The difference between green versions was noticeably larger, however, amounting to a reduction of 21.94$NZD (-59.18%) if the PHD option were purchased rather than the Typical green basket.

As Willet et al (2019) indicate, the foods which make up the PHD total have a smaller environmental impact than most conventional diets, i.e. *Typical* New Zealand diet. This implies that the economic insights provided by the gFPI could have the potential to help shift the transition in the average New Zealander's food consumption from current habits, which are rather emissions-intensive (Typical), to more environmentally-friendly ones that remain within planetary boundaries (*PHD*). This change could be achieved as the gFPI clearly shows the consumer how much a particular diet (food basket) costs. Moreover, the cost of each sub-class and each individual food item, which, when added together, constitute the food basket, can be easily determined, see *Figures 5 & 6 (p. 39-40)*. In other words, through the use of the gFPI in this study, an individual is able to understand how much of their income they spend on a particular (green) food item, and how much this sub-class is changing over time. For example, in *Figure 7 (*p. 41) it is made clear to the consumer that the green fat sub-class price is reducing year after year, from 2018 (14.46%) to 2021 (-6.25%). Thus, suggesting this would be a sub-class of foods that a consumer would have to spend a smaller percentage of their income on. Although this is an interesting finding it is important that other actors (governments, businesses etc.) communicate the index figures (and also inflation rates of sub-classes) to the consumer so they can become aware of such tools as a gFPI. This could occur through simple and straightforward awareness/marketing campaigns that show the consumer the possible (short-term) economic benefits. This entails that in the future cross sector partnerships - between various (social) enterprises, government bodies & civil society groups - could be established to align the findings and messages that the gFPI provides to consumers (van Tulder, 2018). Through this knowledge and comparison with other food item costs, an individual could possible change their food purchasing habits to items which are better for people and planet, whilst helping to ensure economic security.

Scholars have emphasised the importance and impacts of food choices and consumption on individuals, families and the nation as a whole (Jones, Wham, & Burlingame, 2019). Furthermore, the environmental impacts of the food system - soil degradation, loss of biodiversity, damaged ecosystems, diminishing fish stocks, with greater changes to come - were also of importance (Hollis, 2014 & Rockström, Stordalen & Horton, 2016). If understood and utilised correctly, the gFPI could act as a positive lever to transition demand-end approaches towards a more sustainable New Zealand food system. This would be achieved by consumers reducing their consumption of greenhouse gas intensive food items (de Coninck & Revi, 2018 & Hollis, 2014).

To date, there are limited studies into consumers adoption of a PHD. This is due to the fact that the PHD was first published in 2019, providing a relatively short timeframe for academic studies to be conducted since then. However, there are promising indications of consumers' receptiveness to the PHD. A study in America, conducted by Semba et al. (2020) provided meals which were aligned with the PHD guidelines to residents in Baltimore city, as part of Covid-19 relief aid. When surveyed about the food "participants showed a high level of satisfaction with the taste, appearance, and healthfulness of the meal" (Semba et al. 2020, p. 206). Although there are certain contextual differences between America and New Zealand, the findings that participants had a minimal trade-off between the taste of their current diet and the PHD shows that there is the possibility for its rapid adoption. Other research has also shown price is noticeably the largest hinderance in consumers switching to more sustainable products, Gleim et al. (2013) found that 43% of respondents highlighted this as the main barrier to buying green, followed by quality (14%).

However, it is unrealistic to expect all individuals to transition immediately from a *typical* diet to a PHD diet, at least making some food purchasing and consumption changes, which are more in-line with the PHD approach, could help in contributing to a more environmentally friendly food ecosystem in New Zealand. Whilst simultaneously causing improved health outcomes for individuals and society. This is largely dependent on the degree of change and commitment to transition from the individual. The stronger this change, the closer the alignment with the proposed definition of a GE in the scope of this research, and the better the outcomes for people, New Zealand and our shared planet. This reinforces the importance of first understanding the issue - in this case food choices and their impacts on people & planet - and then being able to educate society as to how to potentially make changes to mitigate the negatives, and transition to more positive outcomes and externalities.

6. Conclusion

This research aimed to understand *"Can the creation of a novel green food price index act as an accurate and actionable economic metric for the transition towards a green economy, for New Zealand's food system?".* Based on a quantitative and qualitative analysis of a conventional and green (certified organic) typical New Zealand diet, and a PHD diet, it can be concluded that the gFPI could potentially provide various actionable outcomes, that could help transition New Zealand towards a more green economy. The results of this study propose various actions which possibly would help the New Zealand food system become more sustainable, and consequentially a greener economy. Although to what degree is difficult to know given the data available, limited number of interviewees, early stage of development and without these actions being put into practice. The gFPI has the potential to act as a green indicator - based on statistical methods well understood by those in institutional settings - to clearly measure and represent the historic and current level of sustainability in the New Zealand's food sector. Through this timely measurement institutional actors could enact changes to make the price divergence of green food items in comparison to the equivalent conventional food item smaller. Hereby, having positive flow-on effects for producers (supply side) and consumers (demand side) as explained below.

Further implications of the gFPI arose through the possible outcomes on supply sided strategies. This relates to the gFPI indicating the current level of adoption of certified green production processes - which do no/less harm to people and planet compared to conventional processes - and act as a form of education through understanding the current and historical price of their green food products. Through this analysis and understanding it could be expected to see a possible increase in uptake of these environmentally friendlier production standards within producers. Thereby allowing the circular nature and positive externalities of certified organic food production processes to be felt on a larger scale in New Zealand. Also implications of the gFPI arose through the potential realisable outcomes on demand side patterns. The gFPI could have the power to further educate consumers surrounding food choices and could shift consumption patterns, towards more environmentally friendly choices. This is a real possibility as the gFPI indicates to consumers the price comparison of green food items to their conventional equivalent, enabling consumers to purchase green food items which have minimal price divergences (in comparison to conventional equivalent) and are produced in a do no harm manner. Thus, helping the consumer to remain within the realms of economic security whilst not contributing to the overstepping of the planetary boundaries.

In summary, the gFPI metric has the potential to be applied in a variety of different settings, and from various actors, likely helping contribute to New Zealand's food system becoming more sustainable, and subsequently aiding in New Zealand's transition towards a more GE. The gFPI and the methodology used to develop such a green metric are a beginning to the answering of calls from Georgeson, Maslin & Poessinouw, for alternative/better measurement of green economy transformations through new data sources (2017, p. 16). There is plenty of scope to further develop this initial proof of concept, but the initial results and potential actionable outcomes of the green metric look promising.

6.1 Practical Recommendations

Based on the conclusions above, practitioners should consider the future use of the gFPI as a (headline) green economy metric for the food sector. This means, the continued tracking of individual food item prices (which Statistics New Zealand currently does), and the tracking of green (certified organic) food item prices (which a data agency could do), and compiling these individual food items to the aggregate level in creating the index figures. At this point, practitioners are able to measure how the food sector of the economy is developing in terms of its level of greenness, and could be able to nudge institutional changes/actions that would likely increase the food systems level of sustainability, as mentioned in the discussion section of this paper (see sections 5.1, 5.2 & 5.3). Through this experimental application of the gFPI and methods used to construct the green metric, government, business and other interest groups can see first-hand the validity and reliability of the metric, and from here determine which further developments/refinements should be made before it could potentially be utilised as a headline indicator. Therefore it would be important to start building partnerships around the gFPI metric. This could emerge through cross sector partnerships between civil society groups and (social) enterprises, or between policy agencies and data agencies for example. Through the development of these partnerships the gFPI could possibly begin to gain institutional legitimacy , and could possibly create a strong external voice of support by those who are associated/aware of the green economy metric. Furthermore, from a more commercial perspective, if businesses begin to utilise the data the gFPI provides in decision making processes this could emerge as a powerful method of recognition and future development. These are important propositions given that the member of Statistics New Zealand indicated that tangible evidence and strong vocal support of the gFPI metric would be needed before agencies would consider its wider adoption.

With the utilisation of the methods provided in this research, practitioners could help increase the interest in the field of measuring a green economy. Consequentially, providing researchers or institutional bodies (E.g. Statistics New Zealand) who are interested and see value in the continued development of green metrics the motivation to test (& further develop) these methods in other sectors of the economy, as recommended in the future research section of this paper (see 6.3.2). Recognition & possible adoption within practitioner ecosystems could increase the likelihood a GE metric such as a gFPI becoming mainstream. As those who are measuring the economy could utilise the figures and insights provided by the gFPI to enact changes in public policy and other areas, positively impacting both people and planet.

6.2 Theoretical Recommendations

This research adds to the existing body of literature on the measurement of a GE, through clearly illustrating the value of novel measurements techniques and potential actions surrounding the development of green metrics and their possible impacts on a GE. More specifically, this research was tailored towards the food sector of the economy. Interesting findings emerged in relation to how green metrics - such as a gFPI - could potentially help enterprises operating in the New Zealand food sector adopt more sustainable practices (GPP). This could be tested in the future through the analysis of the number of organisations that are certified organic and the value they produce compared to uncertified actors. If the number and value of certified organic enterprises is growing and expanding over time, and the benefits of this are understood from an economic, environmental and social perspective this could further strengthen the future development of green production processes. Thus, it would be recommended that other scholars continue building on this proof of concept, by attempting to apply the methodology used in this research to other sectors of an economy, the energy sector, for example. Of course, researchers should be aware of the measurement limitations (see section 6.3.1), and should carefully consider which certification, or tiered certification, that would most appropriate and representative of sustainability in the energy sector. In theory through the further development and application of methods used in this study, this could allow for all of the sectors of an economy to be measured, and therefore a complete green consumer price index (gCPI) could be created. A green metric such as a gCPI could possibly act as a headline indicator, and when directly compared to a conventional CPI clear distinctions between sustainability levels throughout the sectors of a nation's economy could be understood, and acted upon by institutional actors. Furthermore, scholars should attempt to further develop the methodology used in this study, this would ensure that most of the limitations (stated in the following section) are overcome, and to provide results with an increased level of validity, ensuring that the insights and conclusions drawn to be with even greater accuracy. This is an important proposition given the many potential positive impacts that a green metric such as a gFPI could bring to life.

6.3 Limitations & Future Research

As this research was based on a novel methodology and situated in a relatively underdeveloped area in the literature, it is confronted with various limitations. These limitations are outlined below, as well as future research suggestions, which at times could potentially overcome the stated limitation. First the more practical limitations are stated, these relate to the calculations and figures. After this more general limitations are stated in combination with future research ideas/areas which could potentially overcome these limitations.

6.3.1 Practical Limitations

Practical limitations of this study relate to the creation and calculation of the gFPI, this entails reasoning for how particular calculations were done, which particular food were selected, and the disparity between green and conventional prices across particular food items.

6.3.1.1 Typical basket NZ spending based on a one-person household.

Typical basket NZ spending ($NZD) was based on a 1-person household. Assuming this is an adult and in-line with the average expenditure on food (16.8% of total expenditures). There is a limitation of using this figure because general CPI calculations are based on the prices for a household. Reasoning for using the figures of a 1-person household was from a practical perspective, as the FPI figure created in this study aims to represent one day's cost of food purchasing and consumption for a single adult in New Zealand. Furthermore, the PHD food basket is based on a 2500 calorie figure, which aims to represent the daily caloric intake for one adult (Willet et al. 2019). Thus, by using the methods outlined above allows for the typical basket to be compared to the PHD basket, as both represent the equivalent of one day's worth of food (in calories and expenditure).

On average in NZ, the weekly cost for a one-person household (assumed adult) equals 645$NZD[26]. Of this, 16.8% is spent on food. Thus, 645$NZD x 16.8% = 108.36$NZD weekly spend on food. By dividing this by the number of days in a week (7), a daily spend on food of **15.48**$NZD emerges ($108.36 / 7).

[26] See: https://www.stats.govt.nz/information-releases/household-expenditure-statistics-year-ended-june-2019

6.3.1.2 Restaurant Meals and Ready-to-eat food

For the typical and green typical baskets, the expenditure weights for the two classes of *restaurant meals* and *ready-to-eat food* have been added together. The reasons for this are twofold. Firstly, Statistics New Zealand does not collect restaurant meals at the individual food item level. This means that it is not possible to calculate the price per gram - as per other conventional items - and thus problematic. Secondly, it was difficult to track down restaurants which were certified organic. It is more common - at least in New Zealand - for café's to be certified organic. Generally, cafés tend to serve more ready-to-eat food rather than restaurant meals. Thus, because of these reasons the expenditure weight of restaurant meals (9.43% or 1.47$NZD) was added to the ready to-eat-food class. This means that the expenditure weight of the ready-to-eat food class increased from 17.80% (2.75$NZD) to 27.23% (4.215$NZD) for the Typical basket.

As the restaurant & ready-to-eat meals sub-group has a considerable weight in the Typical basket, it was with the researchers best intentions to represent this part of the basket as accurately and representatively as possible, while remaining concise enough to directly compare the conventional items against the matching green version. There are sixteen items Statistics New Zealand collects prices for in the ready-to-eat class, with many of these items not having a green (certified organic) equivalent, for instance: fish and chips and meat pies, among others. Thus, four commonly consumed food items were selected that have an identical green version to represent the 27.23% (4.215$NZD) of the Typical basket, these being: *Salad (vegetable), Sandwich, Pizza and Coffee*. These same four food items were also used in the green typical basket to ensure direct comparability among index figures. Keeping in line with the other expenditure weightings, it is assumed that each item has an equal expenditure weight which results in each item contributing **1.05**$NZD (4.215$NZD / 4).

6.3.1.3 Green Prices being cheaper than Conventional

There are a few food items investigated in this study for which the certified organic (green) version turns out to be cheaper (in price per gram (ppg)) in comparison to the matching conventional item. This is largely due to the limited nature of certified organic products for sale in New Zealand, and at times a food item which had a larger overall volume was used in the price calculations. This generally means when a given food item is larger in total volume (1kg vs 100g), the price per gram tends to be cheaper. Outlined below are the food items which highlight this limitation.

Herbs dried: firstly, Statistics New Zealand does not state which herbs are measured. For the certified organic alternative Rosemary was selected, as this is a commonly grown and consumed herb in New Zealand cuisine. This creates an initial inconsistency as Rosemary could be cheaper than the herb(s) measured by Statistics New Zealand. Furthermore, the measurement weight of the typical food item Herbs was in 12.5g, whereas the green food item Herbs was 25g. Because of the two reasons above, the green Herbs price per gram (0.098$NZD) was cheaper than the conventional Herbs price per gram (0.184$NZD).
Huckleberry. (n.d.). Rosemary. Retrieved November 10, 2021,
from https://www.huckleberry.co.nz/products/down-to-earth-organic-rosemary.

Herbs fresh: for the most recent prices (01.10.2021) Statistics New Zealand did not record/publish the price for fresh Herbs. Thus, the price data for dried herbs - measured in 12.5g - was applied to the fresh herbs category, as this is the closest alternative in the typical food basket. Furthermore, the only certified organic fresh Herb which price data could be found was measured in 70g, this being Parsley. Due to the aforementioned reasons, the green fresh

Herbs price per gram (0.056$NZD) was considerably cheaper than the conventional fresh Herbs price per gram (0.184$NZD).
Huckleberry. (n.d.). Parsley. Retrieved November 10, 2021,
from https://www.huckleberry.co.nz/products/organic-curly-parsley

Milk Enriched: there were no certified organic milk enriched food items. Thus, the price of the closest certified organic food item was used, namely, Milk standard homogenised. Because of this inconsistency with matching of the items, the green (0.002895$NZD) food item in terms of price per gram comes out slightly cheaper than the conventional one (0.002945$NZD).

Water: the only certified organic water item was measured in 10L (10.80$NZD), in comparison to the conventional water item which was measured in 750ml (2$NZD). Thus, the price per gram for green water (0.00108$NZD) works out to be cheaper than for conventional water (0.0026$NZD).
Naturally Organic. (n.d.) Organic Water. Retrieved November 10, 2021,
from https://naturallyorganic.co.nz/product/new-zealand-organic-water-10-litre-in-a-box/

The price per gram of Broccoli, Pumpkin and Peanuts (salted) turn out to be slightly cheaper for the green in comparison to the conventional option. As these items were recorded in the same measurement weight from the same period, there appears to be no obvious reason for this disparity. It is important to mention that prices for green food items were sourced from significantly fewer retailers (see section 3.3.6) than the typical item prices (as per Statistics New Zealand methods). For this reason and data collection limitation, it is likely that Broccoli, Pumpkin and Peanuts (salted) were cheaper per gram.

Broccoli: conventional (0.01001$NZD), green (0.008$NZD).
Difference in price per gram (0.00201$NZD)

Pumpkin: conventional (0.00321$NZD), green (0.0028$NZD).
Difference in price per gram (0.00041$NZD)

Peanuts: conventional (0.01392$NZD), green (0.01252$NZD).
Difference in price per gram (0.0014$NZD)

It is also important to note that the price data for certified organic beans is based on dried Adzuki beans (as this was the only option that historic prices were able to be sourced for). Fresh beans were representative for conventional prices, as Statistics New Zealand collects the prices of fresh beans, rather than dried ones. Hence, the prices (in the PHD indices) for green certified beans (dried) may at times be represented as a smaller (cheaper) figure in comparison to conventional beans (fresh).

6.3.2 General Limitations & Future Research Suggestions

This research and the green measurement technique proposed utilise certification. There are some inherent limitations to certification as mentioned in the literature review and interview results (see sections . One of the more pressing limitations surrounding certification is to what degree the given certification represents a certain level of sustainability, as was mentioned in the interview results. This study used a practical approach deeming certified organic to be sustainable for the food items investigated in this study. However, to better understand the implications of these results, future studies could address this limitation by applying tiers of certification, to account for level of sustainability, rather than just yes/no categorisation as current method suggests. Although it should be noted that, it is likely to be a difficult and complex task as to who determines which certification is appropriate for a particular level of sustainability. Scholars interested in this area could potentially apply Webb's classification of sustainability relating to products/services, according to the traffic light system (see Webb, 2016, pg. 54).

Another limitation present in this study was that the Typical New Zealand index figures were only presented with current data (October 2021). In other words, the historical data needed to provide a time-series representation was unable to be sourced by the researcher, and there for missing in the results section. The reason as to why historical data was unable to be sourced was largely due to the wide scope of items constituting the Typical basket, made more problematic by the fact that various food items in the Typical basket had no certified organic equivalent. Another factor limiting the data collection was the relatively short-timeframe available for the masters research project . Only the PHD basket was represented with historic data, this means the findings and discussion in this study are based on a more limited set of food items than what would have been the case if the Typical basket also had a historical representation and analysis. Therefor it would be recommended that future studies look at expanding the scope of food items/diets investigated and represented in a historical/time-series sense. Such as, building on the Typical basket in this research and providing a historical representation of the index figures. This would allow for meaningful comparisons to be made between different diets, with differing levels of sustainability associated with each, possibly allowing for interesting long-term trends to be discovered. These trends could show insights into how much the prices of more sustainable food items/diets has changed relative to less sustainable options, from here impacts could be analysed from a consumer and environmental perspective. Thus, this could further uncover findings and potential motivators for producers to produce and consumers to purchase foods that are better for both people and planet.

A limitation this study suffers from is the lack of the generalisability to other nations, meaning those other than New Zealand. More research is needed to test whether the gFPI developed in this study has the same or different actionable findings in other geographic contexts and cultures. For instance, if studies were to be conducted in nations with different levels of development there may turn out be different outcomes related to the nation investigated, and it's transition towards a more green economy through their food system. It could be assumed that the lesser developed a nation the more possibilities for action, and positive change emerge from a green metric such as a gFPI. This in turn could help the sustainable development of these nation's and their transition towards a more sustainable food system. Therefore, it is suggested that future research should apply the methodology in this research (& further develop it where necessary) to create and analyse their nation's gFPI, and subsequently level of sustainability (greenness) in their food sector. This would allow for interesting comparisons to be made between nations food systems, whilst potentially acting as a positive nudge for nations to improve their level of greenness relative to other nations.

Another limitation of this study is that it solely focuses on the food sector of the economy. Therefore limiting the generalisability for the whole of the New Zealand economy, but rather providing relatively detailed insights into the food sector of the economy. This was done for pragmatic reasons, as the measurement of each sector of New Zealand's economy (amounting to a gCPI) was not possible given the limited timeframe and resource constraints of the masters research project. In order to understand the level of sustainability for the whole of the New Zealand economy, future research should continue building on this proof of concept, by applying the measurement methodology in this study to other sectors of the New Zealand (or a different nation's) economy. For example, the energy sector could be an interesting field of research given the developments surrounding renewables, and it's relevance within the SDG's. The methodology used for studies looking into other sectors of the economy should remain relatively similar to that used in this study, an important area for the researcher's to consider is the careful selection of which certification to utilise in the measurement technique, and if a tiered or single certification is applied. The results of studies looking into other sectors of the economy should provide interesting findings into the greenness of the particular sector studied, and actionable insights into how the sector could transition towards more sustainable practices. For example, in the energy sector consumers could understand the price divergences of electricity from renewable sources/companies costs in comparison to conventional counterparts. By understanding the long term trend of this price difference, consumers could potentially become more motivated to adopt energy from more sustainable sources. Through these understandings, and actionable insights, this should ultimately contribute to a nation transitioning towards a more green economy.

To conclude the author hopes the findings of this research will help organisations, political actors and individual members of society to further continue their efforts of aligning with the transition towards a more green economy.

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8. Appendix

Appendix 1. Typology of Green Economy Discourses

	Weak green economy	Transformational green economy	Strong green economy
Macroeconomic trajectory	Green growth	Selective growth/ A-growth	Limits to growth/ post growth
Economic, social & environmental indicators	Unmodified GDP	Modified GDP	Encompassing measures of welfare
Western levels of consumption sustainable or unsustainable	Western consumption sustainable/green consumerism	Green consumerism/ institutional changes needed	Western consumption unsustainable/ more systemic institutional changes needed
Focus of security discourse	State security	Limited economic and environmental security	Extensive economic and environmental security
Key institutional literature	World Bank 2012, Lagarde 2012, WTO 2012, OECD 2011, US Department of Defense 2010, Tamiotti et al. 2009, CNA 2007	United Nations Statistical Division 2012, Patil 2012, UNEP 2011 European Commission 2009, Stiglitz et al. 2009	Academic literature only e.g. Jackson and Victor 2011, Cato 2009

Source: Ferguson, 2014

Appendix 2. Food Impacts Organic vs Conventional

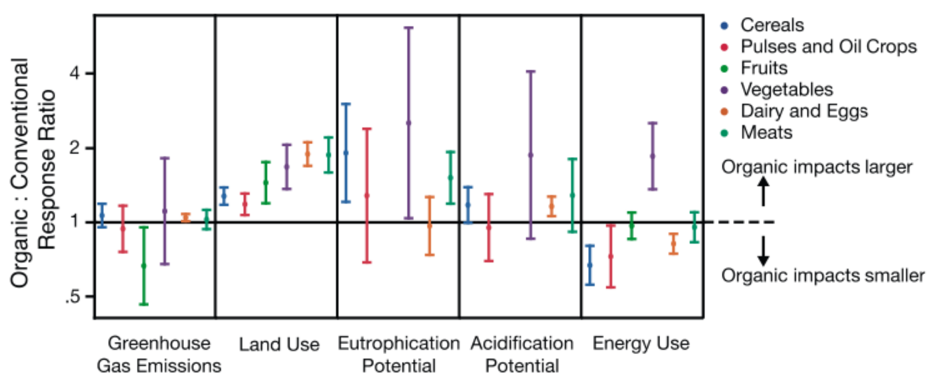

Figure 1. Response ratio of the environmental impacts of organic and conventional food production systems. Comparisons were made within publication to control for agronomic and environmental differences between publications. Plotted on a log base 2 scale, where a ratio greater than one indicates organic systems have higher impacts; a ratio less than one indicates organic systems have lower impacts. Bars are means and standard errors.

Source: OurWorldinData, retrieved from:
https://ourworldindata.org/is-organic-agriculture-better-for-the-environment

Appendix 3 . Typical Basket Complete Food Item List

Fruit and vegetables

Fruit

- Oranges, fresh
- Mandarins, fresh
- Bananas, fresh
- Apples, fresh
- Pears, fresh
- Avocados, fresh
- Nectarines, fresh
- Strawberries, fresh
- Kiwifruit, fresh
- Grapes, fresh
- Pineapples, fresh
- Apricots, dried
- Sultanas, dried
- Berries, frozen
- Peaches, canned
- Pineapple, canned

Vegetables

- Celery, fresh
- Lettuce, fresh
- Salad leaf, packaged
- Broccoli, fresh
- Cabbage, fresh
- Cauliflower, fresh
- Beans, fresh
- Cucumber, fresh
- Pumpkin, fresh
- Capsicums, fresh
- Tomatoes, fresh
- Courgettes, fresh
- Carrots, fresh
- Parsnips, fresh
- Onions, fresh
- Mushrooms, fresh
- Kumara, fresh
- Potatoes, fresh
- Fresh Herbs, packaged
- Mixed vegetables, frozen
- Peas, fozen
- Potato fries, frozen
- Olives, jar
- Tomatoes, canned

Meat, poultry, and fish

Meat and poultry

Beef and veal

- Beef, corned silverside
- Beef steak, blade
- Beef steak, porterhouse/sirloin
- Beef, mince, steak/topside

Pork

- Pork, loin chops
- Pork, leg

Mutton, lamb and hogget

- Lamb/hogget, forequarter chops
- Lamb/hogget, leg

Poultry

- Chicken pieces, fresh, excluding breast
- Chicken breast, fresh
- Chicken, whole, frozen

Preserved, prepared and processed meat

- Bacon, middle rashers
- Chicken nuggets, frozen

- Salami
- Sausages
- Chicken, cooked, hot, whole
- Ham, sliced or shaved

Fish and other seafood

- Fresh fish, fillets
- Mussels, live
- Fish fillets, frozen, multipack
- Prawns, frozen, uncoated
- Salmon, canned
- Tuna, canned
- Mussels, marinated

Grocery food

Bread and cereals

Bread

- Bread, white
- Bread, wheat meal
- Bread, wholegrain
- Bread rolls
- Flatbread

Cakes and biscuits

- Biscuits, plain
- Biscuits, chocolate
- Biscuits, crackers
- Cake slice, packaged
- Cake, iced

Breakfast cereals

- Breakfast cereals, corn based
- Muesli
- Breakfast biscuits

Pasta products

- Pasta, fresh, filled
- Pasta, dried

Pastry-cook products

- Meat pies, chilled
- Pizzas, chilled or frozen

Other cereal products

- Flour, white, standard
- Rice, long grain, white
- Pastry, frozen

Milk, cheese and eggs

Fresh milk

- Milk, enriched
- Milk, standard, homogenised

Yoghurt

- Yoghurt, flavoured, 150g pottle

Cheese

- Cheese, mild cheddar
- Cheese, Camembert
- Cheese, processed slices

Other milk products

- Cream
- Soya milk, shelf stable

Eggs

- Eggs, standard
- Eggs, free range

Oils and fats

- Butter
- Margarine
- Olive oil

Food additives and condiments

- Sugar, white

		Pasta sauce
		Mayonnaise
		Tomato sauce
		Soy sauce
		Herbs, dried
		Vinegar
	Confectionery, nuts and snacks	
		Chocolate, boxed
		Chocolate, blocks (supermarkets)
		Chocolate, blocks (convenience stores)
		Chocolate, novelty bars
		Chewing gum
		Sweets, family pack
		Ice blocks
		Ice cream, bulk pack
		Ice cream, novelties
		Salted peanuts
		Muesli and cereal bars
		Potato crisps
	Other grocery food	
		Hummus dip
		Honey
		Jam
		Peanut butter
		Soup, canned
		Instant noodles, multipack
		Pasta and sauce, dry mix
		Prepared meals, frozen
		Spaghetti, canned
		Desserts, frozen
Non-alcoholic beverages		
	Coffee, tea and other hot drinks	
		Coffee, ground
		Coffee, instant
		Tea, bags, plain
		Tea, bags, flavoured or herbal
		Drinking chocolate
	Soft drinks, waters and juices	
		Soft drinks, large bottle
		Soft drinks, small bottle
		Soft drinks, poured
		Water, bottled
		Fruit juice, apple based
		Fruit juice, orange
		Fruit juice or smoothies, chilled
		Drink, powdered, fruit flavoured
		Energy drinks (supermarkets)
		Energy drinks (convenience stores)
		Breakfast drink
Restaurant meals and ready-to-eat food		
		Pizza
		Sandwiches, fresh/toasted
		Salad
		Coffee

Source: Statistics New Zealand

Appendix 4. PHD Basket Complete Food Item List

CARBOHYDRATES	
RICE	White Long-Grain
CORN/MAIZE	Polenta
WHEAT	White Flour
TUBERS	
POTATOES	
VEGETABLES	
DARK GREEN	Broccoli
RED & ORANGE	Carrot
OTHER	Kumara
FRUIT	
	Apples
	Oranges
DAIRY	
MILK	
PROTIEN	
CHICKEN	Breast
FISH	
EGGS	
PORK	Loin Chop
BEEF	Mince
LAMB	Leg
Beans	
Peas	
Lentils	
Soy	Tofu
Peanuts	
Treenuts	Almonds
FATS	
PALM OIL	
UNSATURATED OIL	Olive
LARD	Beef
SWEETENERS (sugar)	

Source: Adapted from Willet et al. 2019.

Appendix 5. Typical Conventional Basket Calculations

Food Item & Expenditure Weight	**Formula 1**	**Formula 2** 2021M10 PPG	**Formula 3**
Fruit 4.82	***0.74614***		
Orange	0.04663	0.00393	11.86603
Mandarin	0.04663	0.00512	9.10811
Banana	0.04663	0.00296	15.75456
Apple	0.04663	0.00324	14.39306
Pears, fresh	0.04663	0.00504	9.25268
Avocados, fresh	0.04663	0.00633	7.36706
Nectarines, fresh	**0.04663**	0.00660	7.06568
Strawberries, fresh	**0.04663**	0.00840	5.55161
Kiwifruit, fresh	0.04663	0.00390	11.95731
Grapes, fresh	0.04663	0.01123	4.15258
Pineapples, fresh	0.04663	0.00373	12.50228
Apricots, dried	0.04663	0.02160	2.15896
Sultanas, dried	0.04663	0.00685	6.80450
Berries, frozen	0.04663	0.01252	3.72472
Peaches, canned	0.04663	0.00361	12.91874
Pineapple, canned	0.04663	0.00482	9.66792
Vegetables 8.21	***1.27091***		
Celery, fresh	0.05295	0.00436	12.14553
Lettuce, fresh	0.05295	0.00539	9.82458
Salad leaf, packaged	0.05295	0.03353	1.57916
Broccoli, fresh	0.05295	0.01001	5.29016
Cabbage, fresh	0.05295	0.00341	15.52918
Cauliflower, fresh	0.05295	0.00402	13.17276
Beans, fresh	0.05295	0.01617	3.27486
Cucumber, fresh	0.05295	0.00844	6.27423
Pumpkin, fresh	0.05295	0.00321	16.49673
Capsicums, fresh	0.05295	0.01238	4.27742
Tomatoes, fresh	0.05295	0.01204	4.39821
Courgettes, fresh	0.05295	0.01197	4.42393
Carrots, fresh	0.05295	0.00234	22.63013
Parsnips, fresh	0.05295	0.00630	8.40548
Onions, fresh	0.05295	0.00202	26.21510
Mushrooms, fresh	0.05295	0.01324	3.99958
Kumara, fresh	0.05295	0.00313	16.91837
Potatoes, fresh	0.05295	0.00220	24.07023
Fresh Herbs, Parsley	0.05295	0.18400	0.28780

Mixed vegetables, frozen	0.05295	0.00359	14.75056
Peas, fozen	0.05295	0.00268	19.75914
Potato fries, frozen	0.05295	0.00350	15.12986
Olives, jar	0.05295	0.01050	5.04329
Tomatoes, canned	0.05295	0.00350	15.12986
Meat, poultry & fish 15.06	***2.33129***		
Meat and poultry ***12.49***	**1.93345**		
Beef and veal ***3.2***	**0.49536**		
Beef, corned silverside	0.12384	0.01358	9.11929
Beef steak, blade	0.12384	0.02028	6.10651
Beef steak, porterhouse/sirloin	0.12384	0.03192	3.87970
Beef, mince, steak/topside	0.12384	0.01657	7.47375
Pork ***0.97***	**0.15016**		
Pork, loin chops	0.07508	0.01563	4.80345
Pork, leg	0.07508	0.01097	6.84394
Mutton, lamb, and hogget ***1.12***	**0.17338**		
Lamb/hogget, forequarter chops	0.08669	0.01922	4.51030
Lamb/hogget, leg	0.08669	0.01763	4.91707
Polutry ***3.01***	**0.46595**		
Chicken pieces, fresh, excluding breast	0.15532	0.00798	19.46316
Chicken breast, fresh	0.15532	0.01312	11.83811
Chicken, whole, frozen	0.15532	0.00527	29.45310
Preserved, prepared, and processed meat ***4.2***	**0.65016**		
Bacon, middle rashers	0.10836	0.01924	5.63118
Chicken nuggets, frozen	0.10836	0.01149	9.43081
Salami	0.10836	0.03150	3.44000
Sausages	0.10836	0.01107	9.78862
Chicken, cooked, hot, whole	0.10836	0.00788	13.75127
Ham, sliced or shaved	0.10836	0.01419	7.63636
Fish and other seafood ***2.57***	**0.39784**		
Fresh fish, fillets	0.05683	0.03760	1.51153
Mussels, live	0.05683	0.00467	12.16996
Fish fillets, frozen, multipack	0.05683	0.01500	3.78891
Prawns, frozen, uncoated	0.05683	0.02384	2.38368

Salmon, canned	0.05683	0.02243	2.53399
Tuna, canned	0.05683	0.01568	3.62560
Mussels, marinated	0.05683	0.01944	2.92354
Total			
Grocery 34.43	***5.32976***		
Bread and cereals ***9.53***	**1.47524**		
Bread ***3.09***	0.47833		
Bread, white	0.09567	0.00238	40.13975
Bread, wheatmeal	0.09567	0.00420	22.77771
Bread, wholegrain	0.09567	0.00511	18.70572
Breadrolls	0.09567	0.00767	12.47823
Flatbread	0.09567	0.01035	9.24417
Cakes and biscuits ***3.24***	**0.50155**		
Biscuits, plain	0.10031	0.00984	10.19415
Biscuits, chocolate	0.10031	0.01390	7.21658
Biscuits, crackers	0.10031	0.00577	17.38482
Cake slice, packaged	0.10031	0.01260	7.96114
Cake, iced	0.10031	0.01260	7.96114
Breakfast cereals ***1.02***	**0.15790**		
Breakfast cereals, corn based	0.05263	0.00786	6.69618
Muesli	0.05263	0.00703	7.49032
Breakfast biscuits (weet-bix)	0.05263	0.00577	9.12166
Pasta products ***0.34***	**0.05263**		
Pasta, fresh, filled	0.02632	0.01670	1.57581
Pasta, dried	0.02632	0.00412	6.38738
Pastry-cook products ***0.65***	**0.10062**		
Meat pies, chilled	0.05031	0.00614	8.19748
Pizzas, chilled or frozen	0.05031	0.01084	4.64114
Other cereal products ***1.19***	**0.18421**		
Flour, white, standard	0.06140	0.00131	46.99286
Rice, long grain, white	0.06140	0.00273	22.49231
Pastry, frozen	0.06140	0.00654	9.39258
Milk, cheese, and eggs ***9.4***	**1.45512**		

*Fresh milk **3.6** + **0.29** Preserved milk (infant formula)*	0.55728			
		#		102.2363
Milk, enriched (same as standard)	0.27864	#	0.00295	3
		#		157.6366
Milk, standard, homogenised	0.27864	#	0.00191	5
*Preserved milk **0.29***	0.04489			
Infant formula	0.02245			
*Yoghurt **1.13***	**0.17492**			
Yoghurt, flavoured, 150g pottle	0.17492		0.00600	29.15400
*Cheese **2.5***	**0.38700**			
Cheese, mild cheddar	0.12900		0.01102	11.70599
Cheese, Camembert	0.12900		0.03992	3.23146
Cheese, processed slices	0.12900		0.01444	8.93352
*Other milk products **0.62***	**0.09598**			
Cream	0.04799		0.00943	5.08707
Soya milk, shelf stable	0.04799		0.00356	13.47978
*Eggs **1.26***	**0.19505**			
Eggs, standard	0.09752		0.00755	12.92487
Eggs, free range	0.09752		0.01545	6.31038
*Oils and fats**1.64***	**0.25387**			
Butter	0.08462		0.01052	8.04411
Margarine	0.08462		0.00460	18.39652
Olive oil	0.08462		0.01086	7.79227
*Food additives and condiments **2.56***	**0.39629**			
Sugar, white	0.05661		0.00180	31.45143
Pasta sauce	0.05661		0.00652	8.68291
Mayonnaise	0.05661		0.00839	6.74382
Tomato sauce	0.05661		0.00529	10.71049
Soy sauce (tamari)	0.05661		0.00890	6.36096
Herbs, dried	0.05661		0.18400	0.30768
Vinegar	0.05661		0.00329	17.19005
*Confectionery, nuts, and snacks **8.51***	**1.31735**			
Chocolate, boxed	0.10978		0.03292	3.33472
Chocolate, blocks (supermarkets)	0.10978		0.01740	6.30914
Chocolate, blocks (convenience stores)	0.10978		0.02874	3.81935

Chocolate, novelty bars	0.10978	0.03020	3.63507
Chewing gum	0.10978	0.05554	1.97673
Sweets, family pack	0.10978	0.01560	7.03712
Ice blocks	0.10978	0.03507	3.13058
Ice cream, bulk pack	0.10978	0.00317	34.68531
Ice cream, novelties	0.10978	0.03430	3.20064
Salted peanuts	0.10978	0.01392	7.88642
Muesli and cereal bars	0.10978	0.01405	7.81345
Potato crisps	0.10978	0.01247	8.80580
*Other grocery food **2.8***	**0.43344**		
Hummus dip	0.03940	0.01975	1.99512
Honey	0.03940	0.01476	2.66962
Jam	0.03940	0.00739	5.33443
Peanut butter	0.03940	0.00725	5.43249
Soup, canned	0.03940	0.00716	5.50330
Instant noodles, multipack	0.03940	0.00628	6.27946
Pasta and sauce, dry mix	0.03940	0.01662	2.37152
Prepared meals, frozen	0.03940	0.01726	2.28232
Spaghetti, canned	0.03940	0.00417	9.45687
Desserts, frozen	0.03940	0.01482	2.65881
Baby food	0.03940	0.01045	3.76904
Total			
Non-alcoholic beverages 10.24	***1.58515***		
*Coffee, tea, and other hot drinks **2.15***	**0.33282**		
Coffee, ground	0.06656	0.02850	2.33558
Coffee, instant	0.06656	0.05520	1.20587
Tea, bags, plain	0.06656	0.02540	2.62063
Tea, bags, flavoured or herbal	*0.06656*	0.05620	1.18441
Drinking chocolate	0.06656	0.01310	5.08122
*Soft drinks, waters, and juices **8.1***	**1.25388**		
Soft drinks, large bottle (same as small)	0.11399	0.00183	62.17587
Soft drinks, small bottle	0.11399	0.00615	18.53481
Soft drinks, poured	0.11399	0.00690	16.52016
Water, bottled	0.11399	0.00267	42.74591
Fruit juice, apple based	0.11399	0.00150	75.82423
Fruit juice, orange	0.11399	0.00240	47.49545
Fruit juice or smoothies, chilled	0.11399	0.00391	29.13832
Drink, powdered, fruit flavoured	0.11399	0.00550	20.72529
Energy drinks (supermarkets)	0.11399	0.00980	11.63154

Energy drinks (convenience stores)	0.11399	0.00728	15.65784
Breakfast drink (coconut milk)	0.11399	0.00525	21.72600
Restaurant meals and ready-to-eat food 27.23	***4.21520***		
1kg Salad vege	1.05380	0.01218	86.51897
252g Sandwich	1.05380	0.02040	51.66495
500g Pizza	1.05380	0.03086	34.14780
395g Coffee	1.05380	0.01041	101.2777 1
	15.47845		

Appendix 6. Typical Green Basket Calculations

	Formula 1	Formula 2	Formula 3	**Formula 2** *(Green Food Item)*	Formula 4
Fruit	***0.74614***				
Orange	0.04663	0.00393	11.86603	0.00600	0.07120
Mandarin	0.04663	0.00512	9.10811	0.00950	0.08653
Banana	0.04663	0.00296	15.75456	0.00498	0.07846
Apple	0.04663	0.00324	14.39306	0.00450	0.06477
Pears, fresh	0.04663	**0.00504**	9.25268	0.01696	0.15691
Avocados, fresh	0.04663	0.00633	7.36706	0.00943	0.06946
Nectarines, fresh	0.04663	0.00660	7.06568	0.01500	0.10599
Strawberries, fresh	0.04663	0.00840	5.55161	0.05584	0.31000
Kiwifruit, fresh	0.04663	0.00390	11.95731	0.00598	0.07150
Grapes, fresh	0.04663	**0.01123**	4.15258	0.02315	0.09612

Pineapples, fresh	0.04663	**0.00373**	12.50228	0.01565	0.19564
Apricots, dried	0.04663	0.02160	2.15896	0.03496	0.07548
Sultanas, dried	0.04663	0.00685	6.80450	0.01898	0.12915
Berries, frozen	0.04663	0.01252	3.72472	0.02196	0.08179
Peaches, canned	0.04663	**0.00361**	12.91874	0.01553	0.20060
Pineapple, canned	0.04663	0.00482	9.66792	0.01238	0.11964
Vegetables	***1.27091***				
Celery, fresh	0.05295	0.00436	12.14553	0.02327	0.28259
Lettuce, fresh	0.05295	0.00539	9.82458	0.00836	0.08217
Salad leaf, packaged	0.05295	0.03353	1.57916	0.05817	0.09185
Broccoli, fresh	0.05295	0.01001	5.29016	0.00800	0.04232
Cabbage, fresh	0.05295	0.00341	15.52918	0.01109	0.17220
Cauliflower, fresh	0.05295	0.00402	13.17276	0.00666	0.08767
Beans, fresh	0.05295	**0.01617**	3.27486	0.01992	0.06524

Cucumber, fresh	0.05295	0.00844	6.27423	0.01145	0.07184
Pumpkin, fresh	0.05295	0.00321	16.49673	0.00280	0.04619
Capsicums, fresh	0.05295	**0.01238**	4.27742	0.02000	0.08555
Tomatoes, fresh	0.05295	**0.01204**	4.39821	0.02396	0.10537
Courgettes, fresh	0.05295	0.01197	4.42393	0.02698	0.11936
Carrots, fresh	0.05295	0.00234	22.63013	0.00680	0.15388
Parsnips, fresh	0.05295	**0.00630**	8.40548	0.06487	0.54529
Onions, fresh	0.05295	0.00202	26.21510	0.00698	0.18298
Mushrooms, fresh	0.05295	0.01324	3.99958	0.02000	0.07999
Kumara, fresh	0.05295	0.00313	16.91837	0.00850	0.14381
Potatoes, fresh	0.05295	0.00220	24.07023	0.00340	0.08174
Fresh Herbs, Parsley	0.05295	0.18400	0.28780	0.05600	0.01612
Mixed vegetables, frozen	0.05295	**0.00359**	14.75056	0.01551	0.22875
Peas, fozen	0.05295	0.00268	19.75914	0.01248	0.24650
Potato fries, frozen	0.05295	0.00350	15.12986	0.01248	0.18874

Olives, jar	0.05295	0.01050	5.04329	0.02427	0.12240
Tomatoes, canned	0.05295	0.00350	15.12986	0.00550	0.08321
Meat, poultry & fish	***2.33129***				
Meat and poultry	**1.93345**				
Beef and veal	**0.49536**				
Beef, corned silverside	0.12384	**0.01358**	9.11929	0.02550	0.23253
Beef steak, blade	0.12384	**0.02028**	6.10651	0.02625	0.16030
Beef steak, porterhouse/sirloin	0.12384	0.03192	3.87970	0.04286	0.16627
Beef, mince, steak/topside	0.12384	0.01657	7.47375	0.02300	0.17190
Pork	**0.15016**				
Pork, loin chops	0.07508	**0.01563**	4.80345	0.02755	0.13233

Pork, leg	0.07508	**0.01097**	6.84394	0.02289	0.15665
Mutton, lamb, and hogget	**0.17338**				
Lamb/hogget, forequarter chops	0.08669	0.01922	4.51030	0.03000	0.13531
Lamb/hogget, leg	0.08669	0.01763	4.91707	0.02600	0.12784
Poultry	**0.46595**				
Chicken pieces, fresh, excluding breast	0.15532	0.00798	19.46316	0.01777	0.34580
Chicken breast, fresh	0.15532	0.01312	11.83811	0.02899	0.34319
Chicken, whole, frozen	0.15532	0.00527	29.45310	0.01571	0.46262
Preserved, prepared, and processed meat	**0.65016**				

Bacon, middle rashers	0.10836	0.01924	5.63118	0.05000	0.28156
Chicken nuggets, frozen	0.10836	0.01149	9.43081	0.02341	0.22076
Salami	0.10836	0.03150	3.44000	0.04342	0.14936
Sausages	0.10836	0.01107	9.78862	0.02625	0.25695
Chicken, cooked, hot, whole	0.10836	0.00788	13.75127	0.01571	0.21599
Ham, sliced or shaved	0.10836	0.01419	7.63636	0.02611	0.19937
Fish and other seafood	**0.39784**				
Fresh fish, fillets	0.05683	0.03760	1.51153	0.04952	0.07485
Mussels, live	0.05683	0.00467	12.16996	0.01659	0.20188
Fish fillets, frozen, multipack	0.05683	0.01500	3.78891	0.02692	0.10199
Prawns, frozen, uncoated	0.05683	0.02384	2.38368	0.03576	0.08524
Salmon, canned	0.05683	0.02243	2.53399	0.03435	0.08703

Tuna, canned	0.05683	0.01568	3.62560	0.02759	0.10004
Mussels, marinated	0.05683	0.01944	2.92354	0.03136	0.09168
Grocery	**5.32976**				
Bread and cereals	**1.47524**				
Bread	**0.47833**				
Bread, white	0.09567	**0.00238**	40.13975	0.01430	0.57406
Bread, wheatmeal	0.09567	0.00420	22.77771	0.01332	0.30332
Bread, wholegrain	0.09567	0.00511	18.70572	0.01332	0.24910
Breadrolls	0.09567	0.00767	12.47823	0.02488	0.31047
Flatbread	0.09567	0.01035	9.24417	0.02209	0.20423
Cakes and biscuits	**0.50155**				
Biscuits, plain	0.10031	0.00984	10.19415	0.03583	0.36529

Biscuits, chocolate	0.10031	0.01390	7.21658	0.03583	0.25859
Biscuits, crackers	0.10031	0.00577	17.38482	0.03348	0.58201
Cake slice, packaged	0.10031	0.01260	7.96114	0.02000	0.15922
Cake, iced	0.10031	0.01260	7.96114	0.02000	0.15922
Breakfast cereals	**0.15790**				
Breakfast cereals, corn based	0.05263	0.00786	6.69618	0.02330	0.15602
Muesli	0.05263	0.00703	7.49032	0.01999	0.14970
Breakfast biscuits (weet-bix)	0.05263	**0.00577**	9.12166	0.01769	0.16135
Pasta products	**0.05263**				
Pasta, fresh, filled	0.02632	**0.01670**	1.57581	0.02862	0.04510
Pasta, dried	0.02632	0.00412	6.38738	0.01056	0.06745

Pastry-cook products	**0.10062**				
Meat pies, chilled	0.05031	**0.00614**	8.19748	0.01806	0.14801
Pizzas, chilled or frozen	0.05031	**0.01084**	4.64114	0.02276	0.10562
Other cereal products	**0.18421**				
Flour, white, standard	0.06140	0.00131	46.99286	0.00532	0.25000
Rice, long grain, white	0.06140	0.00273	22.49231	0.00712	0.16015
Pastry, frozen	0.06140	**0.00654**	9.39258	0.01846	0.17335
Milk, cheese, and eggs	**1.45512**				
Fresh milk	**0.55728**				
Milk, enriched (same as standard)	0.27864	0.00295	94.61460	0.00290	0.27391
Milk, standard, homogenised	0.27864	0.00191	145.88482	0.00290	0.42234

Preserved milk	**0.04489**				
Infant formula	0.04489			0.07221	0.00000
Yoghurt	**0.17492**				
Yoghurt, flavoured, 150g pottle	0.17492	0.00600	29.15400	0.00740	0.21574
Cheese	**0.38700**				
Cheese, mild cheddar	0.12900	0.01102	11.70599	0.02780	0.32543
Cheese, Camembert	0.12900	0.03992	3.23146	0.07136	0.23059
Cheese, processed slices	0.12900	**0.01444**	8.93352	0.02636	0.23547
Other milk products	**0.09598**				
Cream	0.04799	0.00943	5.08707	0.01773	0.09021

Soya milk, shelf stable	0.04799	0.00356	13.47978	0.00439	0.05918
Eggs	**0.19505**				
Eggs, standard	0.09752	**0.00755**	12.92487	0.01946	0.25157
Eggs, free range	0.09752	0.01545	6.31038	0.01817	0.11464
Oils and fats	**0.25387**				
Butter	0.08462	0.01052	8.04411	0.03396	0.27318
Margarine	0.08462	**0.00460**	18.39652	0.01652	0.30388
Olive oil	0.08462	0.01086	7.79227	0.01870	0.14572
Food additives and condiments	**0.39629**				
Sugar, white	0.05661	0.00180	31.45143	0.00400	0.12581
Pasta sauce	0.05661	0.00652	8.68291	0.01174	0.10190
Mayonnaise	0.05661	0.00839	6.74382	0.03613	0.24364

Tomato sauce	0.05661	0.00529	10.71049	0.01248	0.13366
Soy sauce (tamari)	0.05661	0.00890	6.36096	0.02792	0.17760
Herbs, dried	0.05661	0.18400	0.30768	0.09800	0.03015
Vinegar	0.05661	0.00329	17.19005	0.01190	0.20456
Confectionery, nuts, and snacks	**1.31735**				
Chocolate, boxed	0.10978	0.03292	3.33472	0.03495	0.11655
Chocolate, blocks (supermarkets)	0.10978	0.01740	6.30914	0.03495	0.22050
Chocolate, blocks (convenience stores)	0.10978	0.02874	3.81935	0.03495	0.13349
Chocolate, novelty bars	0.10978	0.03020	3.63507	0.05980	0.21738
Chewing gum	0.10978	**0.05554**	1.97673	0.06745	0.13334
Sweets, family pack	0.10978	0.01560	7.03712	0.06980	0.49119
Ice blocks	0.10978	0.03507	3.13058	0.01586	0.04965

Ice cream, bulk pack	0.10978	0.00317	34.68531	0.02398	0.83175
Ice cream, novelties	0.10978	0.03430	3.20064	0.03317	0.10615
Salted peanuts	0.10978	0.01392	7.88642	0.01252	0.09874
Muesli and cereal bars	0.10978	0.01405	7.81345	0.11000	0.85948
Potato crisps	0.10978	0.01247	8.80580	0.03290	0.28971
Other grocery food	**0.43344**				
Hummus dip	0.03940	**0.01975**	1.99512	0.03167	0.06318
Honey	0.03940	0.01476	2.66962	0.03700	0.09878
Jam	0.03940	0.00739	5.33443	0.02909	0.15518
Peanut butter	0.03940	0.00725	5.43249	0.02114	0.11486
Soup, canned	0.03940	0.00716	5.50330	0.01597	0.08787
Instant noodles, multipack	0.03940	0.00628	6.27946	0.02150	0.13501
Pasta and sauce, dry mix	0.03940	**0.01662**	2.37152	0.02853	0.06767

Prepared meals, frozen	0.03940	0.01726	2.28232	0.02918	0.06660
Spaghetti, canned	0.03940	**0.00417**	9.45687	0.01608	0.15211
Desserts, frozen	0.03940	0.01482	2.65881	0.02674	0.07109
Baby food	0.03940	0.01045	3.76904	0.03750	0.14134
Non-alcoholic beverages	***1.58515***				
Coffee, tea, and other hot drinks	**0.33282**				
Coffee, ground	0.06656	0.02850	2.33558	0.05275	0.12320
Coffee, instant	0.06656	0.05520	1.20587	0.14590	0.17594
Tea, bags, plain	0.06656	0.02540	2.62063	0.06392	0.16751
Tea, bags, flavoured or herbal	0.06656	0.05620	1.18441	0.21625	0.25613
Drinking chocolate	0.06656	0.01310	5.08122	0.02563	0.13025
Soft drinks, waters, and juices	**1.25388**				

Soft drinks, large bottle (same as small)	0.11399	0.00183	62.17587	0.01183	0.73575
Soft drinks, small bottle	0.11399	0.00615	18.53481	0.01183	0.21933
Soft drinks, poured	0.11399	**0.00690**	16.52016	0.01882	0.31088
Water, bottled	0.11399	0.00267	42.74591	0.00108	0.04617
Fruit juice, apple based	0.11399	0.00150	75.82423	0.01418	1.07533
Fruit juice, orange	0.11399	0.00240	47.49545	0.01327	0.63011
Fruit juice or smoothies, chilled	0.11399	0.00391	29.13832	0.01327	0.38657
Drink, powdered, fruit flavoured	0.11399	**0.00550**	20.72529	0.01742	0.36100
Energy drinks (supermarkets)	0.11399	0.00980	11.63154	0.01206	0.14028
Energy drinks (convenience stores)	0.11399	0.00728	15.65784	0.01206	0.18884
Breakfast drink (coconut milk)	0.11399	0.00525	21.72600	0.00760	0.16512

Restaurant meals and ready-to-eat food	**4.21520**				
1kg Salad vege	1.05380	0.01218	86.51897	0.03833	3.31656
252g Sandwich	1.05380	0.02040	51.66495	0.05119	2.64475
500g Pizza	1.05380	0.03086	34.14780	0.05160	1.76203
395g Coffee	1.05380	0.01041	101.27771	0.01266	1.28200
					37.10121

Appendix 7. PHD Conventional Basket Calculations

						Today's Price (10.2021)		2021 (1-10)		2020 (1 - 12)		2019 (1 - 12)		2018 (1 - 12)	
	PHD Item List		Calories in Basket	**Formula 6**	**Formula 7**	PPG	**Formula 9**	PPG	**Formula 9**	PPG	**Formula 9**	PPG	**Formula 9**	PPG	**Formula 9**
	Carbohydrates														
	RICE		270.33333	3.42857	**78.84722**	0.00273	0.21525	0.00273	0.21494	0.00269	0.21236	0.00255	0.20139	0.00250	0.19718
Imputed	CORN/MAIZ	Polenta	270.33333	3.38095	**79.95775**	**0.00400**	0.31983	0.00399	0.31936	0.00395	0.31554	0.00374	0.29923	0.00366	0.29298
	WHEAT		270.33333	3.45238	**78.30345**	0.00131	0.10232	0.00131	0.10253	0.00135	0.10584	0.00132	0.10340	0.00118	0.09244
	Tubers														
	POTATOES		39.00000	0.74524	**52.33227**	0.00220	0.11513	0.00223	0.11686	0.00223	0.11683	0.00183	0.09586	0.00192	0.10052
	Vegetable (300)														
		Broccoli	23.00000	0.33333	**69.00000**	0.01001	0.69069	0.00800	0.55186	0.00674	0.46512	0.00598	0.41256	0.00632	0.43602
		Carrot	30.00000	0.37143	**80.76923**	0.00234	0.18900	0.00236	0.19094	0.00239	0.19331	0.00208	0.16820	0.00223	0.18025
		Kumara	25.00000	0.72619	**34.42623**	0.00313	0.10775	0.00454	0.15636	0.00574	0.19752	0.00500	0.17219	0.00707	0.24325
	Fruit (200)														
		Apple	63.00000	0.44762	**140.74468**	0.00324	0.45601	0.00316	0.44433	0.00408	0.57482	0.00373	0.52463	0.00364	0.51172
		Orange	63.00000	0.38810	**162.33129**	0.00393	0.63796	0.00429	0.69689	0.00322	0.52338	0.00294	0.47793	0.00286	0.46359
	Dairy														
	MILK		153.00000	0.59048	**259.11290**	0.00191	0.49491	0.00185	0.47949	0.00179	0.46360	0.00177	0.45809	0.00177	0.45982
	Protien														
	CHICKEN (breast)		62.00000	1.34524	**46.08850**	0.01312	0.60468	0.01241	0.57196	0.01254	0.57814	0.01321	0.60868	0.01306	0.60169
	FISH (fresh)		40.00000	1.04524	**38.26879**	0.03760	1.43891	0.03639	1.39252	0.03560	1.36240	0.03460	1.32397	0.03278	1.25461
	EGGS (standard)		19.00000	1.32857	**14.30108**	0.00755	0.10791	0.00703	0.10054	0.00673	0.09621	0.00675	0.09648	0.00608	0.08700
	PORK (loin chop)		15.00000	2.23571	**6.70927**	0.01563	0.10487	0.01492	0.10008	0.01514	0.10161	0.01620	0.10872	0.01550	0.10398
	BEEF (mince)		15.00000	2.26429	**6.62461**	0.01657	0.10977	0.01617	0.10713	0.01658	0.10986	0.01558	0.10323	0.01417	0.09389
	LAMB (leg)		15.00000	2.11429	**7.09459**	0.01763	0.12508	0.01646	0.11676	0.01566	0.11111	0.01636	0.11603	0.01598	0.11334
Imputed	Lentils	Brown/Green	57.33333	3.38095	**16.95775**	**0.00630**	0.10683	0.00614	0.10408	0.00585	0.09916	0.00564	0.09571	0.00570	0.09664
	Beans (fresh)		57.33333	0.34048	**168.39161**	0.01617	2.72289	0.01487	2.50398	0.01468	2.47227	0.01302	2.19218	0.01343	2.26150
	Peas (frozen)		57.33333	0.79048	**72.53012**	0.00268	0.19438	0.00261	0.18938	0.00249	0.18042	0.00240	0.17413	0.00242	0.17583
Imputed	Soy	Tofu	112.00000	1.07143	**104.53333**	**0.01089**	1.13825	0.01061	1.10895	0.01011	1.05649	0.00975	1.01968	0.00985	1.02959
	Peanuts		142.00000	6.00000	**23.66667**	0.01392	0.32944	0.01403	0.33209	0.01363	0.32266	0.01382	0.32707	0.01402	0.33181
Imputed	Treenuts	Almond	149.00000	5.92857	**25.13253**	**0.02400**	0.60318	0.02419	0.60803	0.02351	0.59076	0.02383	0.59885	0.02417	0.60751
	Fats														
Imputed	PALM OIL		60.00000	8.69048	**6.90411**	**0.01100**	0.07595	0.01116	0.07706	0.01155	0.07974	0.01227	0.08470	0.01246	0.08604
	Unsaturated (	Olive (pure)	354.00000	8.78571	**40.29268**	0.01086	0.43758	0.01102	0.44399	0.01140	0.45947	0.01211	0.48801	0.01230	0.49577
Imputed	LARD		36.00000	8.71429	**4.13115**	**0.01300**	0.05369	0.01319	0.05447	0.01365	0.05637	0.01449	0.05987	0.01472	0.06083
	Sweeteners	Cane Sugar	120.00000	4.04762	**29.64706**	0.00180	0.05336	0.00172	0.05095	0.00170	0.05042	0.00169	0.05017	0.00174	0.05160
	Total				**1647.09885**		**11.53562**		**11.13553**		**10.89541**		**10.36096**		**10.42941**

Appendix 8. PHD Green Basket Calculations

						Today's Price (11.2021)		2021 (1 -11)		2020 (1 - 12)		2019 (1 - 12)		2018 (1 - 12)	
	PHD Item List		Calories in Basket	**Formula 6**	**Formula 7**	PPG	**Formula 9**	PPG	**Formula 9**	PPG	**Formula 9**	PPG	**Formula 9**	PPG	**Formula 9**
	CARBS														
	RICE		270.33333	3.42857	**78.84722**	**0.00712**	0.56139	0.00375	0.29568	0.00372	0.29333	0.00380	0.29925	0.00397	0.31325
	CORN/MAIZI	Polenta	270.33333	3.38095	**79.95775**	0.00610	0.48774	0.00610	0.48774	0.00610	0.48774	0.00640	0.51173	0.00623	0.49786
	WHEAT		270.33333	3.45238	**78.30345**	0.00495	0.38760	0.00478	0.37421	0.00432	0.33795	0.00412	0.32234	0.00362	0.28382
	TUBERS														
	POTATOES		39.00000	0.74524	**52.33227**	0.00340	0.17772	0.00368	0.19255	0.00353	0.18491	0.00336	0.17607	0.00348	0.18209
	VEGETABLES (300)														
		Broccoli	23.00000	0.33333	**69.00000**	0.00800	0.55200	0.00730	0.50391	0.00747	0.51570	0.00657	0.45321	0.00783	0.54051
		Carrot	30.00000	0.37143	**80.76923**	0.00680	0.54923	0.00557	0.44972	0.00589	0.47559	0.00678	0.54752	0.00700	0.56523
		Kumara	25.00000	0.72619	**34.42623**	0.00850	0.29262	0.00998	0.34373	0.00864	0.29733	0.00871	0.29987	0.00929	0.31990
	FRUIT (200)														
		Apple	63.00000	0.44762	**140.74468**	0.00450	0.63335	0.00463	0.65113	0.00495	0.69680	0.00437	0.61507	0.00456	0.64183
		Orange	63.00000	0.38810	**162.33129**	0.00600	0.97399	0.00582	0.94485	0.00603	0.97949	0.00560	0.90829	0.00527	0.85513
	DAIRY														
Imputed	MILK		153.00000	0.59048	**259.11290**	0.00290	0.75013	0.00279	0.72340	0.00269	0.69651	0.00269	0.69651	0.00256	0.66275
	PROTIEN														
Imputed	CHICKEN (breast)		62.00000	1.34524	**46.08850**	0.02899	1.33611	0.02788	1.28482	0.02676	1.23325	0.02676	1.23325	0.02665	1.22838
Imputed	FISH (fresh)		40.00000	1.04524	**38.26879**	0.04952	1.89500	0.04831	1.84862	0.04752	1.81850	0.04651	1.78007	0.04470	1.71071
	EGGS (standard)		19.00000	1.32857	**14.30108**	0.02120	0.30314	0.01061	0.15168	0.01061	0.15168	0.01036	0.14819	0.01000	0.14301
	PORK (loin chop)		15.00000	2.23571	**6.70927**	0.03248	0.21788	0.03123	0.20952	0.02998	0.20111	0.02998	0.20111	0.02986	0.20032
	BEEF (mince)		15.00000	2.26429	**6.62461**	0.02798	0.18536	0.02698	0.17875	0.02598	0.17211	0.02598	0.17211	0.02472	0.16376
	LAMB (leg)		15.00000	2.11429	**7.09459**	0.02600	0.18446	0.02695	0.19120	0.02695	0.19120	0.02695	0.19120	0.02719	0.19288
	Lentils	Brown/Green	57.33333	3.38095	**16.95775**	0.00720	0.12210	0.00757	0.12841	0.00811	0.13746	0.00830	0.14075	0.00849	0.14393
	Beans (dried)		57.33333	0.34048	**168.39161**	0.00670	1.12822	0.00697	1.17430	0.00667	1.12284	0.00656	1.10497	0.00671	1.12998
Imputed	Peas (frozen)		57.33333	0.79048	**72.53012**	0.01248	0.90481	0.01312	0.95160	0.01404	1.01867	0.01438	1.04305	0.01471	1.06663
Imputed	Soy	Tofu	112.00000	1.07143	**104.53333**	**0.01415**	1.47915	0.01488	1.55564	0.01593	1.66527	0.01631	1.70513	0.01668	1.74368
	Peanuts		142.00000	6.00000	**23.66667**	**0.01252**	0.29631	0.00878	0.20779	0.00831	0.19675	0.00825	0.19525	0.00847	0.20036
	Treenuts	Almond	149.00000	5.92857	**25.13253**	0.02740	0.68863	0.02734	0.68720	0.02680	0.67349	0.02684	0.67466	0.02768	0.69569
	FATS														
Imputed	PALM OIL		60.00000	8.69048	**6.90411**	**0.01450**	0.10011	0.01556	0.10742	0.01616	0.11157	0.01616	0.11157	0.01394	0.09627
	Unsaturated (	Olive (pure)	354.00000	8.78571	**40.29268**	0.01870	0.75347	0.02007	0.80852	0.02084	0.83970	0.02084	0.83970	0.01798	0.72454
	LARD		36.00000	8.71429	**4.13115**	0.01967	0.08125	0.01967	0.08125	0.01967	0.08125	0.01967	0.08125	0.01967	0.08125
	SWEETENERS	Cane Sugar	120.00000	4.04762	**29.64706**	0.00400	0.11859	0.00393	0.11644	0.00385	0.11414	0.00387	0.11478	0.00382	0.11326
	Total				**1647.0989**		**15.16036**		**14.65008**		**14.69433**		**14.56688**		**14.49701**

Appendix 9. Interview Guide

Introduction:

1. Explain process of interview

    1. (i.e. first some general question, then more specific questions)
    2. Data processing

2. Ask once again for explicit consent to record interview a. **Start recording**

3. If you wish to stop or not answer a question you can tell me so at any time.

4. Explain topic of my research

    a. *Research question* is: can the creation of a green food price index act as an accurate and actionable (macro) economic metric for the transition towards a green economy?

    A New Zealand case study, looking at the food system (sector) of the economy.

General questions

1. General questions about the person

    1. How long have you worked in the certification/organics field? What functions have you fulfilled?

    2. What is your personal interest in this line of work?

    3. What to you represents a sustainable future/green economy?(NZ)

Specific questions

4. Relating to *methods* used in this study

a. From your perspective, how reliable/valid are the methods used in this research? Strengths & weaknesses (is there a better way of measuring this in the food sector?)

b. Do you see certification playing a key role in attempting to measure a sustainable future/green economy?

   If so; How to minimise/overcome the barriers of certification allowing for wider applicability?

c. Could you see this method working in the future when applied to other sectors of an economy? Yes, why so? If no, what would you suggest that would fit this purpose?

5. Relating to *Results*

a. Green being more expensive.

b. PHD being cheaper.

c. Difference in cost between PHD and green PHD has remained relatively similar over time, what does this indicate to you?

6. Open ended question to finish

a. How could you imagine people using/developing this method/metric (in the future)?
   Commercial, societal, political?

   Follow up with; traps and risks? Knock on effects?

Closing

1. Thank you for your time, is there anything you want to ask me about myself or my research?
2. Is there anything else you want to share about this topic?
3. Providing information on next steps of the research: i.e. data analysis, confirming the findings once again with this respondent
4. Stop recording