Does Dynamic Pricing Vary According To The Business Cycle?

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Abstract

Predicting and controlling the business cycle is considered being an end phenomenon of macroeconomic analysis and up to this point, the fundamental principles of firm pricing have been almost completely overlooked. Recent macroeconomic analysis literature in macroeconomics indicated that firms do not often track macroeconomic information such as the inflation rate and other key information and similar work has only attempted work on links between inflation and pricing. Using firm-level survey data I conduct an exploration of any links between dynamic pricing and business cycles through the usage of descriptive statistics and linear regression techniques with a comparison towards the literature. Our results show that while firms do believe that the business cycle plays an important part in decision making, there is no clear link between the two in themselves with a P-value of 0.13. We conclude that rational inattention may play a large part in why this is the case and infer that a similar approach to how inflation expectations were tracked, may uncover the degree of rational inattention towards real GDP growth, further questioning the effectiveness of monetary policy enacted by the NZ Reserve Bank.

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Attestation of Authorship

I hereby declare that this dissertation is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (Except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Acknowledgments

Chapter 1 Introduction

'Dynamic pricing' and the 'business cycle' are two terms you would not normally see in an academic paper of this sort. Most would consider attempts to draw them together to be challenging, as one looks at firm pricing in microeconomics, and the other looks at the real GDP growth of a country's economy. These are traditionally treated as two completely different subjects.

What is important here is not what the direct causality is, but rather how firms perceive the business cycle. One might consider this a direct causality, for example, if a firm even thinks the economy will crash, then this may have a strong impact on how it changes its processes. Because of this issue, it is becoming important to understand how management reacts to macroeconomic conditions.

A further concern lies in the attentiveness of firms towards macroeconomic indicators relative to how they value a certain statistic. For instance, we would expect a firm that values real GDP growth to use such statistics to assist with decision-making and to know at least what the professional forecast is. It may not agree with the forecast, but there should be a relationship between those that value it, and those that don't, in relation to how close it is.

Other authors (Coibion, Gorodnichenko, & Kumar, How do firms form their expectations? New Survey Evidence, 2018) have completed a similar work with inattentiveness to inflation. They found, through a comprehensive survey, that many firms were inattentive to the current NZ inflation rate, even though many believed inflation was an important statistic. This usually resulted from a lag, where the firm had looked up the inflation rate a few months before the survey, and thus gave an answer that was out of date. In this paper, I will investigate this in relation to the business cycle, and specifically real GDP growth, to check for potential inattentiveness to this statistic.

The term dynamic pricing (henceforth DP) describes a pricing strategy played by a firm to maximise profitability by adjusting the prices of the goods sold over a single goods lifetime. This is not the same as a firm adjusting pricing over the long term, but rather for a single unit over time. In the field of perishable goods, the main aim of the firm is to ensure the product sells before it expires, in which it must be salvaged, usually producing no revenue or in some extreme cases producing an extra cost of salvaging the unit.

A firm will attempt to gauge consumer demand based on previous sales history with a plan of decreasing its price to increase the probability of a certain product selling. A firm that practices DP is expected to have higher profits than a firm that does not. This isn't always the case as demand is not always consistent in the short term.

In some cases, a firm may miss potential profits if they, for instance, lower the price and then sell the product for a lower price than someone else would have paid for it. In other cases, some customers acting as strategic consumers may wait for the price drop to occur before making a purchase if they predict it will happen. Understanding whether DP increases profitability is important, based on the average profit margin, which is another area I will investigate in this paper.

The business cycle on the other end of the spectrum describes the overview of the economy in relation to real GDP growth and encompasses a broad perspective and general performance measure of an economy. 'The business cycle' is referred to as a cycle, because of the random walk, which refers to economic expansions and contractions, or in extreme cases booms and recessions. Historians will long remember the famous Global Financial Crisis of 2008 being one example of such a recession, and the Great Depression of the 1930s, which was an extreme period of contraction.

Usually the media reports on recessions, but seldom reports on economic booms. A quick examination of a country's business cycle would show how well their businesses recover, over the long term. Nevertheless, it is a topic that has strong interest from the Government, as they would prefer to prevent such recessions from ever happening in the first place. The reason for this is because recessions can imply low consumer confidence and some serious problems for investors who did not expect a recession.

This creates an increased demand for investigation and comparison to expanding the analysis into the macroeconomy to include factors such as attentiveness by the individual firms and firm reaction to the different stages of the business cycle. This includes how firms react to the economy during a boom, and how companies and management react during a recession. Perhaps further investigation is necessary, into how a firm should handle the different stages of the cycle.

DP and the business cycle are two pieces of terminology you would seldom hear in the same sentence, or perhaps even in the same paper since both are historically unrelated. While macroeconomics delves into sticky prices over the long term such as how many

times a firm will change its prices during a given year or a longer period, macroeconomic theory elaborates very little about firms' DP behaviour over the business cycle itself.

There are no papers that have tried to explore the relationship between DP and the business cycle. This thesis hopes to fill that void with an analysis of a survey dataset taken in 2014, which is a snapshot of firms in New Zealand that market and sell goods that are perishable. Perishable goods are a classic product to analyse, as there is already an incentive by the firm to ensure a sale of the good. Because of this, I have analysed this dataset intending to investigate the key relationships in the dataset between DP, and the expectations the firms have of the business cycle. This paper will be one of the earliest papers to do so.

This paper will first investigate how firms adjust their pricing during the business cycle, such as, during periods of recession and booms. It is important to understand whether firms think there is a negative effect on their own pricing strategies. If they think there is, they can investigate whether there should be a negative effect, looking at other companies and what they are doing.

I will also investigate using regression analysis, any key relationships between DP micro-level factors and business cycle expectations. I will first form a base model with DP and then extend it to include business cycle expectations. With the results I will perform a check using the analysis and the literature review, to synthesise and analyse the content to determine any implications for the effectiveness of monetary policy enacted, with the purpose of stabilising the economy.

The Survey data I am using is based on a similar survey completed by another set of scholars looking at inflation and pricing methods (Kumar, Afrouzi, Coibion, & Gorodnichenko, 2015). The new survey dataset itself is being used in an upcoming paper coming out in later on. This looks at similar factors though attempts a different approach and is currently unpublished. The Survey looks at six hundred and nine firms that operate in the food industry, which have perishable foods ranging from meat and poultry retailing, to fruit and vegetables, and a few others. The Survey is attached in Appendix B and includes several questions on standard firm characteristics, pricing information, and has a final section on macroeconomic expectations.

In this paper I have pre-processed the data using Microsoft Excel, and have assigned dummy variables, using the survey responses. Once the data is cleaned, I inserted the data

into STATA and ran descriptive statistics to output the key numbers to explain the questions posed in this thesis.

Then I attempt regression analysis in which I first build the fixed effects regression for DP, using only firm characteristics such as the age of the firm, average profit margins of the firm and so on. Then I compare it to another model which includes both firm characteristics and business cycle expectations and see whether there is an improvement on the original model, through statistical analysis, and then through a critical review of the literature and the potential effectiveness of the monetary policy. I will analyse this to assess the potential implications of this paper.

This paper is focused on firms that operate in the food industry, that operate with perishable goods with regards to the survey dataset and is based on the survey questions at a fixed point in time and does not include menu costs. The literature review focuses on the core principals of DP with the DP theory being focused only on key strategies that firms with perishable goods would use while an attempt is made to investigate most of the empirical papers that focus on DP in that area.

The macroeconomic literature is limited to papers that either look at the business cycle or papers that have a link to some aspect of the pricing, though this may not be DP but includes sticky prices, sticky information, and rational inattentiveness which have impacts and links to firm pricing. The scope of the empirical is, the data analysis does not include data from outside the survey, except for a comparison to the professional forecast of real GDP growth when investigating rational inattentiveness. The data being of a fixed point means the regression is cross-sectional, and no time series analysis is presented.

The structure of this paper first begins with a critical review of the literature, intending to highlight what has been done on both ends of the spectrum. This includes the DP theory which encapsulates what firms are supposed to do, and sometimes theoretical predictions in relation to profitability.

I will also review the limited empirical papers surrounding the analysis of firms that practice DP, and look at the models they ran, to better calibrate what relationships I expected to find. I then move to the key aspects of the business cycle and related works on sticky prices and rational inattention with linked works. I follow by presenting the data analysis including information on the descriptive statistics and regression results presented and analysed. I finish with a critical synthesis of the literature with the analysis to answer the three main questions this paper poses, along with concluding remarks.

Chapter 2 Literature Review

2.1 Introduction

I will analyse the key components of the literature in both the relevant fields of DP theory and any empirical papers that are useful, as well as the strands of macroeconomic theory and analysis that are related to how firms forecast macroeconomic indicators for themselves, and how this affects how they conduct business. I will be dissecting each section on its own merits and look at interactions between the DP theory and the macroeconomic insights, which could potentially expand the understanding on essentially why and how firms practice DP.

The theory will enable me to understand what I should be expecting to see from my results, as well as potentially informing me on what variables I should start including in the empirical analysis first. For instance, the DP theory indicates that a firm with perishable goods should aggressively practice it to ensure their product sells, and thus, in my empirical I would attempt to include variables that give indications on how long a products life is on the shelf. Any empirical work done will also give me insights into how I should start my empirical analysis which will then, in turn, give me a platform to move from and expand the literature from my thesis work.

The main aim of the literature review is to investigate both what has been done in relation to each separate component of DP and the business cycle literature, and to then highlight the gaps in each section, and what each section can offer the other. The idea behind this is that when we are trying to find out the determinants of something, we should not isolate the analysis into just being a microeconomic or a macroeconomic.

When attempting empirical analysis, we should be trying to consider all of the possible factors we have at hand, against simply only considering micro factors. To this end, while I investigate thoroughly into the DP and the macroeconomic literature, there are no papers that attempt to forge a link between the two. DP theory sticks to variables such as competition, workers, labour, and material costs, etc., while macroeconomics focuses on the indicator expectations of the firm to determine the price stickiness of the products they sell. It also looks at inflation and GDP and how firm characteristics such as labour and competition affect their forecasts.

The price stickiness observed by macroeconomics is different from DP because the papers look more at permanent price changes as opposed to temporary sale pricing. Thus, the

main gap this thesis is filling is the analysis of whether macroeconomic forecasts of firms influence the way firms practice DP.

I take a look at DP by going over the theories behind how firms should practice it. In relation to this thesis, I also look at the optimal strategy for a firm with perishable goods, to assist in how I should interpret my results, as well as other potential variables to consider. I also include empirical papers to explore how DP is practised, although there are only a few in number, due to the difficulty in obtaining short-term pricing data.

I then move into the macroeconomic literature in which I first take a brief look at the business cycle itself and what has been done in regard to the overall predicting and forecasting of GDP. From there I go on to the specific components of the business cycle, such as the ideas of sticky pricing, sticky information and related theories pertaining to price setting inertia and delays.

Then I finish with concluding remarks regarding the literature as well as setting the platform to move forward with the empirical analysis. Throughout I also highlight in sections how insights from macroeconomics can assist in the microeconomic interpretation and vice-versa, highlighting how, theoretically there can be some benefit to include such insights to find the axioms of price setting.

2.2 Dynamic Pricing Literature

2.2.1 Dynamic Pricing Theory

The fundamental idea behind dynamic pricing is not too complex, at least before the complex and higher-order mathematics is brought into the analysis. In its simplest form, the idea that the firm will fluctuate its prices over time to achieve the greatest profit they can, given the information they have at the time. However, in the case of perishable goods, this is quite different, as there is now the consideration of a finite selling horizon for goods since the goods are now perishable. As an example, in the case of food, if it is not sold by the expiration date then it becomes waste or at the very most, salvaged in some form.

Since this is a macroeconomic based paper I will only review the most fundamental pieces of work and then those most relative to the perishable goods market, because that is the context we are working in, given the DP literature at the time of writing is very theoretical,

with only a few empirical papers specifically looking at the determinants of DP currently published.

A firm operating in the business of perishable goods have two fundamental situations they face along with a few variables in the mix. The first decision to make when it comes to preparing a strategy is the inventory ordering system itself. When looking at perishable inventory theory (Nahmias, Perishable Inventory Theory: A Review, 1982) it is the starting point when it comes to inventory analysis.

Nahmias composes and reviews a large portion of the early literature and sums up the two types. The first type is when the firm knows exactly when the goods will perish by or have a fixed horizon. For example, you can think of this as being the case of an exact 'use by date', either through the actual perishable date of the product itself or through a determined date by the firm in which goods are to be salvaged. This is done to prevent predicted drops in quality to the point where the customer will not benefit or gain in any way from the goods at all, like a meat product that can be too old and rotten, can potentially generate a net loss in utility if it is sold after significant degradation in quality. In cases like this Nahmias explains that inventory decisions can be made in two ways.

The first way is in the case of deterministic demand in which the firm knows what the demand is and has full information regarding how consumers will purchase and what their strategies are to the exact number. Veinott is drawn on here, in which it is explained that if demand is known, then optimal ordering and issuing policies can be given (Veinott, 1960) in such a way that it is ensured no units expire. It is important to note that DP is not directly referenced in this paper as this paper's purpose it not to maximise profit but to minimise unit expiry, which is a part of the DP model but not the whole story, which is developed later. This is, of course, a theoretical understanding as many papers later, especially in macroeconomics, will show that firms very rarely have full information on demand structures.

The second is random life probability or stochastic demand, which is explored in much more depth in the Nahmias paper. This is when the true demand by consumers is not known by the firms and thus the firms must 'solve an equation' to minimise the number of goods that expire, through trying different production and inventory models. This makes it harder for a firm to determine correct ordering and production and the true solution is often much more difficult to pinpoint, and it is argued, that if demand is

random then it is no longer possible to obtain a production policy, so there is no perishing (Nahmias, Perishable Inventory Theory: A Review, 1982).

Generally, the stochastic demand theories are much more complicated than deterministic and are investigated much more, as solving the mystery will lead to markets becoming perfect (and essentially deterministic). These range from many different systems such as Nahmias and Pierskalla (Nahmias & Pierskalla, A Two Product Perishable/Non-Perishable Inventory Problem, 1976) that look at two-period models. For instance, in one case, if a product has a lifetime of two weeks, then we can say that week one is period one, and week two is period two. The inventory is checked after one week and then depending on the amount of stock going into period two, it is remade. If the starting level of old stock increases by one unit, the optimal order quantity will decrease, but usually by less than one full unit. It is merely an attempt to control for different demand structures and ensures product loss is minimised. At the end of the day, this is the more realistic scenario in which firms make critical decisions to minimise wastage.

Given demand is more realistically stochastic it is usually the focus of much of the later DP theoretical literature. Sobel and Zhang (Sobel & Zhang, 2001) attempt a model which includes consumers that have both deterministic demand and stochastic demand, to show an optimal ordering system can be achieved if stochastic demand is simply back ordered, which assumes the firm knows at least some detail regarding what specific consumers are going to do. This somewhat lags the process as it attempts to pinpoint an expected demand function, for instance, if demand for a product is 100 units one month, they may focus on producing just over 100 units, as they have some understanding, of the necessity of back orders needing to be sent out if they run low on supplies.

Because of this, once firms make the inventory production decision, they have yet another option to maximise profit and that is where the idea of DP comes in. DP gives a firm another angle of strategy to alter the prices over the course of its lifetime, to incentivise consumers to purchase specifically from them, rather than having to plan inventory decisions from the get-go.

A lot of the literature draws reference from the Gallego and Van Ryzin paper that formulates an optimal DP method for products with finite horizons and assumes a stochastic demand in their modelling (Gallego & Ryzin, 1994). The paper suggests simple fixed-price policies which entail a few significant price changes to increase profit over multiple successions of small price changes appear to work, in most cases, a

reference that in most practical applications, constant price adjustments are not always a good idea in business. As an example, if prices fluctuate constantly then the consumer will sometimes either feel like they are being ripped off, or they simply begin to plan around the constant price changes, on top of the menu costs implied.

It is advised that since revenue maximisation is always a key area for business, that DP is researched further, and continued to be developed via formulating problems for the framework, though there is no indication by the author of including any aspects of the business cycle in how demand would change.

Several DP models have been developed to be used, but those that use perishable goods fall under the same basic idea, that as the product moves closer to its expiry, the price should be decreased as an incentive for consumers to purchase it at a discount. Zhao and Zheng prove the basic assumed method of DP for firms with perishable goods, in which the straight forward strategy is that the optimal price decreases over time, given any number of items, so if a number of perishable goods stay the same then the optimal price will also decrease over time (Zhao & Zheng, 2000).

Zhao and Zheng also infer, that for this to hold, the consumers' willingness to pay a premium remains constant, and does not increase over time. For instance, if a consumer's willingness to pay a premium is increased, then they would stick to paying for the new product and the firm would be unable to sell the old product. This is where the idea of stochastic demand plays into the struggle of DP as under the case of deterministic demand, the firm would be able to adjust prices per the exact maximum value the customer would be willing to pay. However, under stochastic demand, the firm hopes the consumers' willingness to pay the premium does not change over time. It is a simple model which proves the fundamental axiom which implies that as quality decreases the price should decrease to match the consumer's perception of price versus quality degradation.

Elmaghraby and Keskinocak conduct a thorough investigation (Elmaghraby & Keskinocak, 2003). They begin by explaining the idea behind dynamic posted prices where the seller dynamically changes prices over time based on factors such as the time of sale, information on demand for the product, and supply with an objective of obtaining a balance to maximise profit. They then suggest three main categories of types of DP. There are three main factors the literature considers.

The first suggested by Elmaghraby and Keskinocak is the idea of replenishment versus no replenishment of inventory. This brings forward the idea in which the firm must make production decisions before the selling season begins or during selling seasons. For instance, a firm with a long production cycle may have to make its decisions in advance, and if there is a demand shock of some sort then because production is "lagged" the owner may not be able to adjust its stock quickly. Therefore, the optimal policy the producer should take will, of course, depend on their production, and thus in my analysis, I look at how the firm produces their goods, especially given they operate using perishable goods and production decisions become much more important. No-replenishment or at least seasonal, implies more pressure to sell the product, given that firstly they cannot back-order immediately and secondly once it's gone it's gone.

Then there is the idea that a product can either be dependent or have an independent demand over time. This is when a product's sale today can have an impact on a sale in the future, for example, due to a consumer's increased knowledge about the product, or if the product is durable, and therefore the consumer has time to gather information about it and make better-informed decisions versus a product that is bought once and that's it. To put it simply, a product like milk or bread will have repeat purchases, making the product dependent over time. As time goes on, the consumer becomes more informed about the product, and this is very important if the knowledge of the product is useful to decision making. This plays into a macroeconomic concept called sticky information in which information slowly disseminates across the population, and thus there is one link that could potentially be explored if an academic wanted to.

Thirdly there is the idea of myopic and strategic customers. A customer is myopic if they simply go into shops and make purchases if the current valuation is below his valuation of the given product at that given time. A strategic customer goes into a shop and makes purchases based on the future valuations and paths of prices when making his purchasing decisions.

DP is much simpler in the context of myopic customers since they only worry about the current situation, however in a situation with strategic customers, you now have an issue where the customer will take into consideration the fact that you are using a DP strategy and adjust accordingly. This can have an impact on the optimal pricing strategy, especially if using a DP strategy means the customer will know it too. This has evolved to the point where game theory models are now being developed to manage demand-side management (Srinivasan, Rajgarhia, Radhakrishnan, Sharma, & Khincha, 2017) to

maximise profit. Of course, with the inclusion of strategic customers, you are essentially bringing the concepts of game theory into play, which further complicates the optimal strategy. Realistically it will often be a mix of the two, and it may be income dependent, depending on each consumer's willingness to plan to get the best deal versus simply going in and buying a product they want.

A later paper by Herbon and Khmelnitsky (Herbon & Khmelnitsky, 2017) attempts to evolve the DP further, and specifically looks at the optimal policies regarding perishable goods. The policy recommended by this paper is similar to Zhao and Zheng, but insists the optimal policy is highly dependent on the form of demand incorporated in the model, whether it is strategic or myopic. Therefore, it is like playing a game where you do not know your opponent's preferences, and it continues the idea that the optimal strategy is almost unknown. Many consumer preferences change over time and even if you pick up the correct strategy, it will be at least slightly wrong in the future.

That is what the literature is heading towards. Many are trying to build the optimal DP policy based on estimating the consumer's demand, preferences, and expectations. However, there are no links to any macroeconomic indicators, be it the business cycle itself, or the ideas of sticky prices and sticky information, which could affect the optimal policy since it is heavily related to consumer confidence.

The theory is very comprehensive and gives a good understanding of how a firm should operate and continue to grow and develop. However, as imagined, there have been no attempts to include any insights of macroeconomics into any derivations of the optimal strategy. It is not questioned whether the stage of the business cycle would influence how to potentially predict demand, but we know that during a recession public spending goes down due to low consumer confidence and morale, and therefore there is potential to delve into whether the optimal DP strategy would strictly change during the different stages of the business cycle.

There is also an opportunity to understand how high inflation and exchange rates can influence certain strategies as well. Ultimately it may benefit the microeconomic theory to include aspects of macroeconomic theory rather than simply isolating the two.

2.2.2 Dynamic Pricing Empirical Literature

The empirical studies on DP take place during the 2000s in which many online firms began selling. This has made data collection much easier since we can simply go to each website and record the price the firm is selling their product at over a period, and then be able to model estimations on how firms price, simply from there. Rather than going to a store each day and asking firms to record any price changes on a large scale possibly invoking high research costs, pricing data can simply be taken off websites.

Even then, however, it is still relatively limited in terms of measuring DP behaviours. It started with testing on airline markets in which McAfee and Velde made attempts to test the theory using airline ticket pricing data, by collecting data on fares from 1260 flights from American Airlines, Orbitz, and Travelocity (McAfee & Velde, 2006). In this case, it was not collected from an index or an online website. The information was collected 'day by day', initially eight times a day. Surprisingly, the Airlines did not like this high amount of tracking, and so it was ultimately tracked only once per day per flight, in the end. In some cases, you do actually need permission to have a high frequency of price tracking.

The paper considered several DP theories and had a goal of trying to prove these theories. They noted how difficult the data collection was with the airline's reluctance to allow them to do this. This can explain partly why empirical work in this setting with data collection is quite tough. The only instance where it would be easier is if you were to look at an online price setting in which you could potentially design a data scraping program to track these prices over a long period of time. Alternatively, there may be a database to scrape from rather than each individual website.

Only one paper looks at the direct relationship between DP and specifically the field of perishable goods, and that is one in which the perishable goods is not actually food. In fact, it was a study on the Major League Baseball market (MLB) in relation to ticket sales, which by technicality is deemed perishable goods (Sweeting, 2013). Sweeting used data for single-game tickets from MLB games in 2007, from two online secondary markets, which come from both fans and professional resellers (such as eBay and StubHub) that have gotten tickets from the teams themselves. The model used here to estimate is a fixed-effects panel regression model with the model specification of:

$$p_{it} = D_t \beta_t^D + F_{it} \beta^F + C_{it} \beta^C + Q_i \beta^Q + FE_i + \varepsilon_{it}$$

Where $"p_{it}"$ is the price of the seat of listing on the date relative to the face value. 'F' value is for the performance of each team. 'C' value is for the term including variables to control for the actual number of competing listings on two main platforms – eBay and StubHub. Q value includes 23 separate variables to measure several characteristics of the listing traits, including minor things ranging from things such as seller feedback, and the type of listing in question. In this case, the D term is a separate dummy for each day leading up to the game itself, and what the ticket price is.

The actual results of the Sweeting paper are consistent with DP theory in which the price paths are negative trending, as reported by the author, 89% of price changes on StubHub and 80% price changes on eBay are in fact reductions. This means that as it gets closer to the day of sale, the price decreases as pressure increases on the seller to make the given sale before the expiry/salvage date. It is consistent with Zhao and Zheng (Zhao & Zheng, 2000) because as the tickets reach the salvage date the strategy of lowering the price to try to sell it is used, and this is the most effective strategy if the consumer's perception of the value of the ticket is consistent.

However, the gap of not having the business cycle present adds missing flavour to the game since the analysis is purely microeconomic based on the Sweeting paper. For instance, in the Sweeting model, the current state of the U.S economy is not considered. This analysis was run using 2007 data and was literally done right before the 2008 Global Financial Crisis which caused a significant recession to occur. Perhaps if 2008 or even 2009 ticket sales data was taken, a different set of DP behaviours would have been determined due to the consumers' confidence and sentient in terms of how they value goods such (Lozza, Bonanomi, Castiglioni, & Bosio, 2016). It could be expected that a different DP strategy could be used to ensure sales of tickets to the MLB games at this stage of the business cycle.

The Sweeting paper is the only empirical paper that attempts to directly link perishable goods and the theory of DP. And is the main gap this thesis is going to fill since there are absolutely no papers that even touch on the idea of both DP and aspects of the business cycle.

Therefore, in this thesis, I will largely be going for a more intuitive approach in which I regress key firm characteristics to determine what causes firms to practice DP, whether they use macroeconomic indicators or not. And hopefully being initially able to prove

most of the theory moving into including macroeconomic insights to further extend the analysis.

2.3 Macroeconomics

2.3.1 The Business Cycle

The starting point for this section of the literature review is to look at the foundations of the business cycle. The business cycles are recurring expansions and contractions in the level of aggregate economic activity, and these fluctuations are based on potential Gross Domestic Product (GDP) growth. There are periods of expansion which have increased economic activity, and contractions which have caused decreases in economic activity.

Economists primarily use the business cycle to predict the future of a country's economy. Being able to do that, will allow the policy to drive and avoid recessionary periods as much as possible since it is recessionary periods that cause the issues, such as, losses in consumer confidence and increases in unemployment. For instance, in the United States attempts have been made to identify turning-point dates in the U.S post-war business cycle (Birchenhall, Jessen, Osborn, & Simpson, 1999). This has also been done in New Zealand in which quarterly GDP data was used to generate a post-war business cycle, and once again identify turning points in New Zealand's economy (McDermott & Hall, 2009). This is one of the main goals of predicting the business cycle, as being able to do this, may enable us to prevent market crashes from occurring.

What makes the business cycle intriguing is the idea of consumer confidence. Simply put, this is an economic indicator that measures the degree of optimism consumers have about the overall state of the economy in relation to their financial situation. This is important because while it does come from the consumer side, all business owners are themselves consumers, and thus their own consumer confidence will reflect in their own businesses.

In New Zealand, we have many indexes such as the ANZ-Roy Morgan Consumer Confidence index and the Westpac-McDermott Miller consumer confidence index. It's important to note that this is reflective of the confidence in the entire economy as well as their own financial position regarding it. If consumer confidence is low then it generally means demand for certain luxuries will decrease, which in the field of DP may affect the optimal pricing strategy, another reason to potentially include this in theoretical analysis.

For instance, it was found that during the recession of 2007-2009 in the U.S., the negative sentiment towards the economy had a significant effect on all areas of aggregate consumption (Lahiri, Monokroussos, & Zhao, 2016). They do, however, comment that there was a lack of information which the models are based on, making them unlikely to be a true representation – though it certainly does provide an insight into this field.

Conversely, it is shown in another paper that consumer confidence shocks, during expansions likely reflect the media's portrayal of current events while on the other hand, during economic contractions these shocks are caused by something called "animal spirits" (Ahmed & Cassou, 2016). Thus, it has implications on whether raising inflation expectations on certain items would lead to a faster recovery if it is reflected in the media. "Animal spirits" is a term first used by Keynes which describes the psychological and emotional factors in each situation, and in this context, it is implied that fear of the economy breaking is what drives shocks during economic contractions. From here it was concluded that improving consumer confidence can lead to faster recoveries from serious recessions on the level of the Global Financial Crisis of 2008. Consumer confidence is very important to this thesis as well as the optimal pricing strategy, given we are looking at the firms' expectations of the current economy, and this will be reflected in how they would practice DP at different points in the business cycle.

Ultimately what will matter is the specific components of the business cycle, in which we turn to what is most important to this thesis, that is, the idea of sticky prices which has important relevance to the analysis of the business cycle (Bils & Klenow, 2004) and sticky information. Both are related to aggregate demand shifts, which impact the business cycle and can have impacts on what the firms expect of the business cycle.

2.3.2   Rational Inattention

I am going to include an analysis of the rational inattention literature in this section, as much of it relates to the understanding and updating of information concerning the business cycle. Rational inattention theory describes firms' limited ability to process information, not by irrational decision making but by decision making in which the firm either makes headway to track certain information or focuses on another part of the business (Sims, 2003).

Generally, this is determined by the value the firm puts on certain information compared to other tasks needed to be done in the organisation. This is slightly different from sticky

information – investigated later – as with sticky information we believe firms looking for information will not find it straight away, but it will take time to disseminate. Here we are talking about a firm making a distinctive choice whether to actively track certain information or not. While this does work both ways from the consumer side (Caplin, 2014) and from the firm side, in this section I will be focusing on the firm side. I will mainly focus on inattention to the business cycle, but in theory, it is related to everything the firm needs to track. For instance, showing firms' pricing with rational inattention to quality (Martin, 2017), further resulting in less informative prices and pressing the idea that a firm needs to allocate attention to many information sources.

Rational inattention is one of the key reasons why there can be a lag in how firms react to business cycle shocks, aside from price stickiness in response to the information. This has been confirmed for instance in the U.S where a rational inattention model of price setting has found slow responses, even with low friction in their respective industries (Mackowiak & Wiederhold, Business Cycle Dynamics under Rational Inattention, 2015).

The non-neutrality of money seems to dissipate when firms sell a higher number of goods (Pasten & Schoenle, 2016). They cite three reasons for this. The main reason is they believe multiproduct firms have more incentive to pay attention to monetary shocks, believing that understanding it will allow a firm to use it to help price all goods. As an example, take a firm that sells one product versus a warehouse or a supermarket that sells many products. It is unlikely the one product will be impacted by inflation, but this may be different for a firm that sells multiple products.

How much a firm is inattentive, in some cases, is dependent on how uncertain the firm is, and one paper using a Factor-Augmented Vector Autoregression Model proves this point showing that as uncertainty rises, the amount of information they chose to track rises (Zhang, 2017).

This implies that a firm facing uncertainty will place more value on the data and tracking it. For instance, this argues that a firm that is uncertain about GDP forecasts would consider tracking it more, which may imply a relationship between GDP forecast errors and usefulness of the business cycle indicators. This is consistent with survey data on firms' expectations which provide a direct line of understanding between the researcher and the firm. It showed the degree of attention to the aggregate economy fell during the Great Moderation which was a period of reduced volatility in the business cycle, meaning of course that firms were more confident of the economic forecasts (Coibion &

Gorodnichenko, 2012). Therefore there is a clear link between uncertainty and attention towards the business cycle at least in terms of the empirical data available.

More recently a Dynamic Stochastic General Equilibrium Model was compared to conventional models, and found that whilst firms have limited attention, profit and utility value losses are very small, however these losses are still significant, which is derived from the fact that a decision maker loses small amounts of utility every time they make a decision to track a new piece of information (Mackowiak & Wiederhold, Optimal sticky prices under rational inattention, 2009).

Despite this, they are adamant that rational inattention is the sole source of slow adjustment to monetary shocks, to the point of abandoning certain classical Calvo pricing principles (Calvo, 1983). The cost shown for finding data is presented as a simple opportunity cost, choosing to find information about doing another action instead of the classical assumption of 'costless' information.

Due to this theory, it is worth investigating in this thesis whether the value of information plays a part in how accurate the firm is with GDP estimates. From the literature, we would not immediately assume that a firm that thinks GDP is important to get it correct, as it would come down to the firm's uncertainty of the business cycle on whether they would be tracking it or not. One could believe that GDP was important, thinking they are certain of what the business cycle is going to do, and then get the estimate completely wrong anyway! And thus, the level of uncertainty could potentially be proxied. As always it is something to consider.

2.3.3 Sticky Prices

The basic idea of sticky prices is that they do not change immediately in the short term to reflect the market value of the item. In an efficient market, we assume that when a demand or supply shock occurs, the price will change to reflect the true market value of the product, so the firm can continue to maximise the profitability of its goods and services. However, there are many factors that can influence the degree to which the price level does not change instantly, and the idea of prices being sticky is that it is lagged to some effect.

Traditionally it is assumed in macroeconomics that firms are rational and have either full or partial information, while in microeconomics it is usually assumed everyone has full information but are sometimes irrational in their decision making.

The work on sticky prices is quite extensive and many papers exist on the subject. An early example of this is the Calvo model in which the price level in an economy is adjusted by the probability of a firm adjusting its price at a given time (Calvo, 1983). There are two ways to observe this. The first is a percentage of firms given as p will update their prices based on current information while $(1-p)$ will not optimise its pricing. The second way is to look at it as a probability θ that the firm will change and optimise its price level and $(1-\theta)$ firms that will not. Regardless of which way you look at it, this is a simple idea firms may or may not update their optimal price levels which causes this stickiness to occur.

The Calvo model has been one of the most influential models on sticky prices. Eichenbaum and Fisher back the model presented by Calvo, compiling a statistical analysis and a full estimation to evaluate the full effectiveness of the model in terms of whether it can account for the statistical behaviour of post-war US inflation (Eichenbaum & Fisher, 2004). They determined that the Calvo model can account for it and suggest that degrees of inertia can be explained only if two assumptions are dropped.

The first is that the firm faces a constant elasticity of demand, and the second is that capital is not firm-specific. The model presented by Eichenbaum argues that by making the elasticity of demand variable – following the Kimball model (Kimball, 1995) and capital being firm-specific – following the Woodford model (Woodford M. , 2004) that it can account for some of the inertia in optimising price setting. Using these models, a firm can fully understand its elasticity, and it can account for one of the reasons as to why a firm may not change its prices, as a firm that faces uncertainty will be resistant to change.

The variant proposed by (Woodford M. , 2004) put forward a variant of the Calvo model in which capital is firm-specific. This means that intermediate good firms view marginal costs as something that can be controlled, somewhat, or at least the perception they do have some influence on marginal costs. As shown by Eichenbaum and Fisher it can account for why some firms have less inertia in their pricing plans. If a firm, in theory, can exert full control over their marginal costs of production then they can properly readjust their price levels.

However, if the shock that occurs impacts the component of marginal costs, (the example used is a rise in the real wage rate) and if the firm has control and knowledge of its marginal costs, they will be more inclined to make a confident pricing decision. If they do not, then they will be hesitant until they get more accurate reads on their production costs.

The second model that is widely referred to in the subject of sticky prices is the Taylor model (Taylor, 1980). The Taylor model is used for both sticky wages and sticky prices. This comes from the idea of sticky wages in which labour costs are fixed for a certain amount of time, for example in the presence of a fixed contract in which the worker enters into an agreement with an employer to work for a certain wage rate for a certain amount of time.

In contrast to the Calvo model, firms set prices for a fixed amount of time and are staggered to some extent, for instance, half of the firms at a certain time will revise their "Contract" and adjust the price level while the other half will not. The main difference between Taylor and Calvo is the price level in Taylor's comes indirectly from staggered wage contracts, which cause lags in the business cycle.

It is more important to understand why prices can be sticky and many theories have been coined. Following and using Taylor, prices can be fixed by contracts, but they could also be implicit contracts as suggested by Okun (Okun, 1981). This means that prices are fixed in fairness to customers, for example, consumers may get agitated if the price of a good constantly changes to reflect the market as they may have fixed the value of the good in their head with the first price point.

In some cases, certain prices only increase when production costs go up in order to maintain a profit margin. In the case of Hall, it is argued, that based on their observation most of the industries are non-competitive in the sense that firms operate at a point where marginal cost is far below the set price point, through varying their volumes of production rather than changing the price (Hall, Blanchard, & Hubbard, 1986). It works in the way that if demand changes then supply is artificially adjusted to keep the price level the same, thus the stickiness in prices can occur based on what they choose to adjust. This follows a theory in which firms can vary their inventory/production when demand or supply shocks occur (Blinder, Inventories and Sticky Prices: More on the Microfoundations of Macroeconomics, 1982). Blinder also puts forward, the idea that industries with

perishable output are more likely to be flexible with their prices than firms with an easily storable output.

Carlton (Carlton, 1986) put forward the theory that firms sometimes choose to use various other elements of the transaction such as the product quality and service rather than changing the price. This theory relates to the idea that firms are hesitant to change their prices and would rather adjust components such as shipping costs to keep the main base price the same. So, rather than a firm changing its price, they will try to change everything but the actual price. This is a strange tactic as a rational consumer would be able to interpret the change in the economic price of a good rather than simply the price of the product itself, nonetheless, it is used to avert the actual change in price and does make the nominal price level sticky.

Ellison and Snyder investigate the online market using data scraping to collect a year's worth of pricing data and through using a Joint Maximum Likelihood Model. They showed that while prices in this market were flexible there was evidence of managerial inattention as a cause of price inertia observed, in which there would be times when a manager would be inattentive to market conditions, and as a result, there would be price clusters.

Elision Snyder and Zhang (Ellison, Snyder, & Zhang, 2016) press further on this idea and using the same data set investigate the idea of managerial attention and the costs associated as a source of price stickiness. The contribution showed that with the assumption firms used various rules of thumb, price stickiness occurs in the sense that a firm will set a fixed price period such as "I will change the price no more than once a month as a rule".

This thesis is more about what firms do. The idea of surveying has been done before to great effect and one significant paper is one where the firms were asked (Blinder, On Sticky Prices: Academic Theories Meet the Real World, 1994). For instance, it was found that 65% of firms in the survey change their prices less than twice per year on average.

The firms in the sample gave many justifications on why their prices are sticky, such as waiting for costs to change before changing the prices, firms holding back and waiting for others to change first, and firms choosing to use various other elements of the "vector" such as delivery, service, or product quality.

This is the idea behind Blinder's paper, to make connections between theory and the reality of things, and this thesis follows the same spirit in which the goal is to explore the connections between what should be and what is, and to find evidence of the connections between DP and the business cycle.

In contrast to DP, there is a lot more empirical work that has been done. This is mainly due to the advent and prominence of firms selling online. With these firms selling online, many empirical studies have been able to take advantage of the data available to understand how firms adjust their prices, given that a consumer can browse through the many different platforms the firms use.

As an example, one paper uses data from the Bureau of Labour Statistics between 1995 and 1997, which collected prices for roughly 70,000 goods from around 22,000 different outlets (Bils & Klenow, 2004). The paper by Bil's utilised the entire data set to show how important the idea of price stickiness is to analysing the business cycle. One needed inference is the importance of temporary sale prices, since this is still relevant to price stickiness, with the extra note that it is more supportive of state-dependent pricing. This means the seller in question can be making decisions based not on time or the wider environment, but the actual situation the firm is in, which is related to DP though it is not referenced in this paper.

There were many papers that came about once databases were being easily stored online. Brynjolfsson for instance analysed books and CD's sold online using 15 months' worth of observations and found that while friction was lower than the traditional brick and mortar, branding awareness and consumer trust created a level of heterogeneity amongst retailers that sold online, resulting in significant levels of price dispersion (Brynjolfsson, 2000). This challenged the popular theory that the online market would come to be the "perfect market" with friction-free capitalism (The Economist, 1997). Ultimately in 2007, it was clear in the literature that even though consumers had much lower and near zero search costs price stickiness was still in existence (Baye, Gatti, Kattuman, & Morgan, 2007).

For the most part, work done to analyse price stickiness is quite extensive in contrast to DP literature. Lunnemann and Wintr, for example, conducted a critical analysis of brick-and-mortar as well as online pricing (Lunnemann & Wintr, 2011). Looking at cross-country data between France, Germany, Italy, UK, and the US, they made two key inferences. The first being, there may be differences in the structure of online sellers,

meaning whether they both only sold online. This was shown to have a shorter duration of price spells, as opposed to having both an online presence, as well as off-line establishments which had shown to have longer price spells. Secondly, the idea is presented that the occurrence of sales could affect the changes in price, however, it does not explain the relative inflexibility of internet prices for certain categories analysed. This simply reinforces the idea that firms often hesitate to permanently change their prices, and firms will look to the practice of DP to allow them to make important sale targets without the worry of committing to a different price point completely.

Even with fewer search costs and some firms having lower fixed costs, prices are clearly sticky (Ellison G. , 2005). Ellison shows that even with the information available and more easily accessible by consumers, both product and brand differentiation would cause firms to price imperfectly, resulting in both price dispersion and a level of price stickiness. They conclude, while the geographical dimension is less important in this market, other factors need to be considered such as the fact that search optimisation is not necessarily one-sided. This means, firms may take an active role in stopping perfect consumer learning, creating a situation in which they can adjust and optimise their prices to levels that are more profitable. It is more related to the dynamic pricing in this paper in which the firms can now try to block other firms out in a competitive way. Perhaps by insisting on being the first website to appear on Google, gives a certain search tag, and then they can afford to have price levels even slightly higher than someone else.

There is a reason to support the idea that online prices are more flexible. Gorodnichenko compared both the U.S. and U.K. online prices and showed that online prices tended to be more flexible than the brick-and-mortar fronts. However, they stated that the differences were more quantitative than qualitative, meaning that while the firms studied have price flexibility they were smaller frictions which again challenged the more recent theories of sticky prices and price setting in general.

They concluded that even if e-commerce continues to grow price stickiness likely will not disappear because it is not determined exclusively by the costs of searching or the physical costs of changing a price, but there is still evidence suggesting it has much less friction, and continued to state that more attention should be put to building theoretical models to generate price stickiness and other imperfections in the market. What this can imply is that firms can practice dynamic pricing online given the lack of menu costs associated with doing so, and through this, it is possible the bridge between a firm permanently changing its price and temporarily changing its price becomes very little.

It is also worth noting that the law of one price is affected by sticky prices. As shown by Boivin, Clark, and Vincent who investigated the validity of the law of one price by looking at online book sales between the US and Canada (Boivin, 2012). It was concluded that movements in the exchange rate did not directly lead the book retailers to adjust their local-currency prices. This provided the argument that the exchange rate does not affect whether a firm adjusts its prices. Consumers may either be unaware or unfamiliar with cross-border purchasing which can be cheaper but have uncertainty on what shipping costs etc are. They inferred that international competition is unlikely to be the major cause for deviations from the law of one price which exist in the markets of today. This has implications in the dynamic pricing literature since a consumer that understands the notion that the law of one price does not hold, can look cross-country for specific goods they wish to acquire. This is important given the progressive liberalisation of free trade agreements occurring which will create competition from firms across the world and not just domestically. Therefore, firms would need to practice their dynamic pricing, given the price levels of other countries of consumer behaviour changes to reflect that.

Sticky pricing in the literature has been largely based on the firm's base price level. dynamic pricing, on the other hand, is the firm changing the price as time goes on, to sell it. This thesis wants to make the links between these two, and essentially show its relationship with the business cycle through cold hard evidence from the survey data. This is especially important given it is being shown online pricing is becoming more flexible as time goes on, and thus the gap between dynamic pricing and a firm's base price level needs to be bridged. In this thesis, I will be transferring the analysis of sticky prices to the analysis of dynamic pricing. One key aspect is that firms may face similar challenges to changing prices, such as the inertia and fear of losing a sale either through a good perishing, or a good being sold too cheaply where it could have been sold to another for a greater price. Sticky pricing in a macro sense is long-term whereas dynamic pricing is the shorter term.

2.3.4 Sticky Information

It is also useful to review the literature on sticky information since this can have implications on how firms react to the business cycle. Typically, in macroeconomics the assumption that is made for an individual making decisions that are not optimal is not necessarily incorrectly interpreting data but rather not having the right data, to begin with.

This is something that can affect firms, in that, they perform rational decision-making processes, but with incomplete information since information is sticky. The base form explained by Blanchard and Johnson puts forward the Expectations-Augmented Philips curve in which the expected inflation and actual inflation is considered (Blanchard & Johnson, 2013). What this means is that the current expectations of firms that operate in relation to future economic conditions are considered when determining and predicting what the inflation rate will do, and how firms adjust their prices. Traditionally it has been believed firms have full information, however recent literature pushes evidence that information is indeed sticky. Information can be sticky for many reasons, as it is the basic form, it can take time for people to learn and gather information on specific products and services, and they are expected to make rational decisions given limited data.

If we hold the assumption that firms are rational, then what is left is whether firms have access to data. Mankiw and Reis suggest that information is sticky. This is when individuals make decisions based on past information and events, rather than current information, which implies there is a lagged effect (Mankiw & Reis, 2002). The key here is agents are still rational, but do not have current data so sticky information models assume information slowly disseminates throughout the population.

Mankiw argued that a new model should be proposed which considers that information on macroeconomic conditions diffuses at a slow rate through the general population, essentially augmenting the sticky-price model into a new sticky-information model and arguing that current expectations of firms are derived from past expectations of current economic conditions rather than current expectations of future economic conditions. If this is the case, then it means that firms may even be practising dynamic pricing given their past expectations of the economic climate which means their strategies may not be useful anymore.

It has been widely assumed in economics that firms make rational decisions using the information that is publicly available. On its own it makes intuitive sense, especially with the current era of information technology, which makes data collection much more efficient, for instance, data such as the inflation rate can be found simply on a search engine. This has been shown to not be the case, and even with low search costs firms do not efficiently track information. Coibion demonstrated that many firms do not track the status of the business cycle and furthermore some even neglect to track inflation (Coibion, Gorodnichenko, & Kumar, How do firms form their expectations? New Survey Evidence, 2018).

The general belief is that firms are supposed to focus on other firms they are competing with, and the general state of the economy – notably inflation – (Fuhrer & Moore, 1995) and in some cases the exchange rate. This resulted in significant dispersion in the beliefs of the firms in terms of future possible macroeconomic conditions and is brought on by a term known as "rational inattention motives". This can have significant implications in dynamic pricing literature. If firms are not tracking the business cycle and basing their beliefs on past information, then we can have situations where the firms' decisions are lagged. For instance, if the economy is in a boom and the firm believes the economy is in a recession, then their pricing strategies will reflect that stage of the business cycle, and thus if the firm does indeed play different strategies at each stage of the business cycle then, they will be playing their cards at the wrong time.

Thus, it is more important to understand what firms expect. If firms do not have full information then they may not make the right decisions, even if they run the correct process to come to their conclusions. Like a researcher using the correct estimations, if their data is not corrected whether by being obsolete or invalid, then they may reach the wrong conclusion. Therefore, this thesis is more interested in the current expectations of the firms in the survey compared to the reality of the economy. This will have important implications since the firms will have the expectations in their mind based on what they think is happening, and their dynamic pricing strategies will reflect what they think is going on versus what is actually going on.

This is paramount to the intuition behind the objectives of the thesis since sticky information implies that firms may not be fully informed on aspects of the economy. It is expected that firms will not be 100% accurate on all points, for example, GDP expectations may not be even close to that of a professional forecaster such as treasury forecasts. This means that even if a firm had the perfect algorithm to generate the perfect dynamic pricing strategy, it is possible with incorrect inputs and expectations they will have the wrong model, or they could even have the wrong strategy and with the wrong inputs generate the right strategy.

2.3.5 Noisy Information

Not only can information be sticky, but in a world filled with data, the way in which it is pushed can influence the analysis of such information, and therefore the way macroeconomic expectations are adjusted. Information can either be imperfect as in the

data is wrong, or it can be interpreted wrong, not because of irrational thinking but in terms of a limitation of understanding, since some information requires knowledge of the subject in question (Salop, 1977). As an example, many firm owners may not know how real GDP growth works or may have trouble understanding the business cycle in relation to the pricing.

In a few cases it is argued that some nominal aggregate demand shocks cannot be common knowledge, sometimes even in the long run (Woodford M. , 2003). This is to say that the average person may never truly understand why something has happened, either because they cannot understand it, or the information is not correct. And not being able to fully understand something means that sometimes consumers and producers will interpret a given statistic as is. With the further assumption that people will have different expectations of the market, and as well as an extended paper which simplifies the former assumption into a two-period model (Angeletos & La'O, 2009), it brings forth the idea that price models based on imperfect common knowledge can help explain and assist with predicting the dynamics of inflation and output.

Empirical work has tried to use this to understand how firm prices differ across locations. One paper builds a two-period model to investigate the validity of the law of one price and attempts to include the idea of noisy information to better understand just why prices are different across locations (Crucini, Shintani, & Tsuruga, 2015). Papers like this are necessary in times where a person can simply go and make purchases online, but even with this, firms generate their beliefs based on what they find, and a rational agent can only be as effective as the information it can successfully gather, whether the information they find is correct or incorrect.

What needs to be realised is there is a limited time and many different professionals at work. In relation to the thesis it is possible to detect noisy information if, for example, a person in the survey indicates they regard a statistic such as GDP very highly in decision making, and yet, give a prediction that is far different than professionals have forecasted. On the other hand, one that views GDP as not being as helpful and giving a wrong answer can indicate rational inattention due to them putting their time and effort into other areas they deem are more important.

2.4 Summary

In this chapter, I have reviewed the literature that is relevant to assisting me in going forward with the empirical analysis. The dynamic pricing literature has a very strong theoretical underpinning which both informs me of the current state of what academia believes firms should do and gives me points of comparison between what academia says and what I discover to be the actual thoughts of the owners in the survey. However as shown, the empirical work in this topic is limited, likely due to the difficulty in obtaining pricing data, for example, with the airline's difficulty of tracking data in their written paper, almost stopped them from completing it. Therefore, this thesis will help to further the empirical analysis of dynamic pricing strategies played by firms at the very least in the New Zealand market.

The macroeconomics literature, on the other hand, has both strong theoretical and empirical underpinnings that are helpful in informing the thesis on the way to begin and move forward. The theoretical implications of sticky prices and sticky information give me a basis to investigate how firms react to both their own expectations of the market as well as proposed scenarios they could face. Rational inattention is also impactful on how I go about including the later questions in the survey to do with how much the firm values a certain statistic.

Whilst the literature is useful in informing my interpretation of the results in terms of how firms act versus how they should act, the empirical models I am building are largely intuitive. Even with guidance from the Sweeting paper, I am using theoretical underpinnings to build the analysis beyond the determinants of dynamic pricing. By using the survey data, the main goal is to determine what relationships exist between the dynamic pricing strategies played by each firm, and the macroeconomic expectations of each firm, both backwards and forwards.

Those operating more in the dynamic pricing field will be interested in the contributions of the determinants of dynamic pricing this paper will have. However, those operating more on the business cycle side will be more interested in whether a firms DP strategy and behaviours have any impact on predicting macroeconomic indicators and forecasting errors. Therefore, this paper tries to appeal to both.

This culminates to what gap we are trying to fill with this thesis. The initial gap is the general lack of empirical analysis of dynamic pricing strategies in general, which will help to further the understanding of the determinants of dynamic pricing from firm

characteristics. The further gap is whether the firm's forecasting of the business cycle and GDP growth has firstly, any implication on how the firm practices DP and secondly, whether the firm's DP strategy and frequency are helpful in forecasting real GDP.

The value of this thesis will be understanding both furthering the understanding of the determinants of dynamic pricing, both from a firm characteristic point on its own and again with business cycle expectations and an attempt made to make GDP error predictions based on dynamic pricing behaviours from the firm.

Chapter 3 Data Analysis

3.1 Introduction

In this chapter, I will be conducting and reporting on the analysis of the survey and the relationships it presents, as well as a critical discussion as to the implications the results have on both the literature and key questions posed in the introduction to this thesis. To recap, we are interested in the base relationship between dynamic pricing behaviours and variables against macroeconomic expectations and values of macroeconomic variables. This is important because we want to understand whether there is a way to predict how a firm will react to a certain stage of the business cycle. This is a critical step as this would give us an indication as to the business confidence these firms may have, and from an empirical perspective it would provide a further insight into DP itself given the sparse DP empirical literature. This would provide an opportunity to delve into an area previously unchecked by anyone.

We also hope to be able to provide insight on monetary policy efficiency in terms of the objectives of monetary policy from Reserve Banks, in this case, of course, the Reserve Bank of New Zealand.

The dataset I am using is from firms in New Zealand that operate in the food industry in New Zealand. The data is a survey of 609 firms based on (Kumar, Afrouzi, Coibion, & Gorodnichenko, 2015), and it is actual data being used in a forthcoming paper coming in late 2019. It is based on a range of classifications from fruit and vegetable retailing, all the way to meat and poultry retailing, and subsequently other food retailers that do not fall into any of the categories. All the firms work with perishable foods.

This is important because many DP strategies are used for perishable foods, so it provides a good opportunity and dataset to use. The survey includes simple firm and product characteristics such as the age of the firm and number of workers and includes data on the main product the firm sells and is what is investigated. However, the most important pieces of information we are concerned with are the questions on dynamic pricing and macroeconomic conditions in which questions are asked of the firm's manager regarding the valuation of certain macroeconomic indicators of real GDP growth, inflation, unemployment, and the exchange Rate.

These are important because these are the main variables we want to test, specifically, the base model is run with DP factors, and an extension of the model includes macroeconomic conditions. The different responses to the mock-up scenarios are where the survey asks

the firm manager how they would practice dynamic pricing given different levels of real GDP growth. In this instance, we are not specifying boom or recession, but we are giving them the business cycle values that would indicate such conditions, giving us a prediction on what the Firms think they would do in these situations.

The dataset is well suited to understanding what firms think they will do, which will give us great insights into what happens as opposed to the theory and statistics of it all. More information on the specific survey questions can be found in Appendix B with regards to the specific questions.

The key findings of the chapter include a near consensus that the firms believe that real GDP growth is key to their decision making and tend to alter DP behaviours during the different stages of the business cycle with management intending to increase the frequency of price changes under negative GDP growth (Recession), almost grinding to a halt during periods of a boom. The base model regression is quite strong and the improved model with business cycle indicators is better, although not necessarily with the direct expectations of real GDP growth, the value each firm places on real GDP has shown to correlate with DP behaviours.

This chapter is structured with a presentation of the results and highlights the key findings from the analysis. The results write up will not include any checks with the research questions but rather it will be a cut and dry results presentation. The discussion section that follows will be applying the results and outcomes to literature implications and public policy implications, highlighting key critical pieces of information to help guide future policy in relation to economic stability and the effectiveness of such policy.

I begin with an analysis of the summary statistics, already highlighting some very key pieces of information that help to inform the outcomes and answer critical questions to fulfil the purpose of this paper. I then move on to the regression analysis of the survey which attempts to find key relationships between the variables and to identify the determinants of dynamic pricing behaviours, with microeconomics on its own which attempts to form a baseline model to work with and prove basic relationships argued in the DP literature.

Then the macroeconomic analysis further explores the determinants of DP by including the macroeconomic expectations of the firms as well as the valuation of each macroeconomic indicator in terms of helping and informing their pricing decisions. Once

the results write up is presented I move on to a critical discussion which compares the results and outcomes to the presented literature and how it builds on it.

I will finish up with implications of the results on public policy, such as the implications on monetary policy and ensuring economic stability in a New Zealand context, given the dataset is based on New Zealand firms.

3.2 Summary Statistics

The summary statistics were computed of the firm characteristics, product and pricing characteristics and the macroeconomic conditions. Reported are the mean and standard deviation for each key statistic, as well as the extremes of the minimum and the maximum values to show the extremes. As I will demonstrate, the summary statistics provide critical insights to key questions about what firms expect to do in some cases, while the later regression analysis aims to test the likelihood of real GDP growth having an impact on their pricing behaviours.

The characteristics are the main features of the firm, such as the firm age in years, the number of workers both full and part-time, the share of trade which is how much is sold locally compared with internationally, the number of similar competitors the firm faces, the costs of the IRM compared with its revenue, labour and materials are gauged separately and the average profit margins in the last 12 months of the survey taking place.

The product and pricing characteristics are the specific variables related to the products and DP strategies practised. The expected time of sale purports to how close to perishing do the goods expect to sell in terms of days, for example, a firm may expect to sell a product a week before it goes out or in some cases a day before its expiry and this gives insight into how precise the firm's pricing strategy must be. The frequency of price changes, of course, is the main dependent variable and pertains to how often a firm will change its price before the good perishes. A firm, for example, may change its price just once to try and sell it before it goes bad, or it may do it multiple times to pinpoint and optimise its sale chances at various stage depending on the data the manager has.

Table 1 represents the summary statistics for all firms with the purpose of showing key information that can already inform the discussion against the current literature. The mean and standard deviation, as well as the maximum and minimum, are reported, and

all of the main variables relevant have been selected. The table gives a snapshot of the key variables we want to understand.

The total size is also reported as well as the inventory replenishment cycle which pertains to how long it takes for a firm to replenish a cycle of its inventory. A firm that takes many days to replenish will be under more pressure to ensure a good sale as well as much less freedom in terms of varying its production in the short-run.

The firm characteristics as shown are standard in terms of what we expect. Many of the firms are small businesses with few workers and many of them primarily sell in New Zealand as opposed to exporting. In the survey, the labour and material costs are reported as percentages of the firm's total revenue as opposed to the firm's total cost in this context. And most firms sell locally with a high share of trade mean, again this is expected given that most firms operate with perishable goods.

The first part of the last section reports key business cycle variables such as how each firm values each macroeconomic statistic out of 100. CPI inflation, unemployment, real GDP growth and the exchange rate are looked at, to gauge how they feel about each one in relation to pricing decisions. We would expect a firm that values real GDP growth to track it and have an accurate understanding of it, otherwise, it would validate the idea of rational inattention if a firm felt absolutely sure real GDP growth was useful, and yet did not have similar forecasts to professionals' forecasts.

The second part reports the different DP strategies under different real GDP conditions. In this part, we are directly asking the firm how they would react under the different stages of the business cycle. This is directly related to the main purpose of this paper with regards to whether it would change during the different stages of the cycle. However, we cannot simply accept this as the reality, but rather as what firms think they would do as otherwise the thesis would simply end after this table. In the regression, this is tested to see if there are any links both against this factor and also against the real GDP expectations of the firm in percent.

Table 1: Summary Statistics for All Firms

Variables	Mean	Std. Dev.	Min	Max
Firm Characteristics				
Firm Age	17.087	12.770	1.000	108.000
Number of Workers	6.780	1.962	4.000	18.000
Share of Trade	97.307	8.479	25.000	100.000
Number of Competitors	11.581	4.918	1.000	25.000
Labour Share of Revenue	32.420	9.702	10.000	50.000
Material and Other Costs Share of Revenue	48.184	9.940	20.000	70.000
Average Profit Margin	18.690	12.294	2.000	50.000
Product & Pricing Characteristics				
Expected time of sale before perishing	20.652	31.925	1.000	210.000
Frequency of Price Changes	1.448	1.260	0.000	6.000
Total Size of Price Changes	-36.018	29.548	-98.000	5.000
Inventory Replenishment (in days)	18.606	30.082	1.000	205.000
Dynamic Pricing and Macroeconomic Conditions				
Firms Usefulness of CPI Inflation Rate	39.159	27.202	0.000	100.000
*Unemployment Rate	23.998	14.670	0.000	50.000
*Real GDP Growth	75.859	14.000	50.000	100.000
*Exchange Rate	24.814	14.776	0.000	50.000
DP under High GDP Growth	0.813	0.676	0.000	2.000
DP under Negative GDP Growth	4.250	1.344	1.000	7.000
GDP Expectations	2.548	0.733	1.000	4.000

The product and pricing characteristics are where key information related to each important component of DP is reported. Reported is the expected time of sale before perishing. This is defined in the survey as 'how close to perishing do you expect the good to sell'. This means that if a firm expected to sell their good two days before perishing, then they would report the answer to that question as two days. Whilst the mean is relatively standard, the minimum and the maximum are very far apart, showing that some firms expect to sell literally the day before the good 'perishes', and in other cases, it may be long before perishability.

This is important as one key aspect of this paper, is one relationship we would expect to see in the regression analysis, is that firms would be under more pressure to sell goods

that are close to perishing, as opposed to firms that can afford to play the long game and wait it out.

Inventory replenishment is also reported in this table as this heavily relates to the secondary decision making made by firms alongside DP in terms of being able to control its production in the long run. Again, from looking at the table we see that while the lowest amount of days taken is just one day to replace their inventory if they were to practice and lower the price, and they sold out of their inventory, they could simply produce more to replace it.

However, both the mean and the maximum are quite high, implying that inventory decisions are needed to be made well in advance for a significant portion of the firms. This can further create pressures on the firm to make good pricing decisions. For example, if a firm decided to practice DP and lower the price too far and sell out, the firm may end up losing potential profits from a shortage due to the time it takes to replenish its inventory. This could create a situation in which the firm now has to make inventory decisions in advance, given the goods need to be sold and not perish in the practice of it.

Finally, as the dependent variable, the frequency of price changes is reported to show the current levels of practice. In this, we define the frequency of price changes as 'The number of times the price of the good changes before the good perishes'. The idea is that we are looking to assert what variables and characteristics influence the outcome of this number.

As a general baseline firms in the current state as a whole do not practice the art of DP often. A mean of 1.448 and standard deviation of 1.260 indicates that prices are rather fixed in general over the whole. This in itself is a conclusion that informs how the rest of the analysis will play out but on its own, it does not explain very much.

Table 2: Summary Statistics for Subsectors

Variables	Fruit and Vege	Meat and Poultry	Other
Firm Characteristics			
Firm Age	19.502	18.500	9.777
Number of Workers	6.330	6.927	7.092
Share of Trade	97.179	95.777	100.000
Number of Competitors	13.630	10.612	8.815
Labour Share of Revenue	33.868	33.835	27.138
Material and Other costs share of revenue	53.099	45.029	42.862
Average Profit Margin	15.223	21.534	21.462
Product & Pricing Characteristics			
Expected time of sale before perishing	13.088	32.039	18.492
Frequency of Price Changes	2.084	0.840	1.077
Total Size of Price Changes	-55.755	-16.723	-25.146
Inventory Replenishment (in days)	11.575	28.830	17.169
Dynamic Pricing and Macroeconomic Conditions			
Firms Usefulness of CPI Inflation Rate	42.073	28.422	50.054
Unemployment Rate	24.916	23.408	23.008
Real GDP Growth	77.341	73.966	75.746
Exchange Rate	24.828	24.451	25.362
DP under High GDP Growth	1.000	0.534	0.862
DP under Negative GDP Growth	4.396	4.165	4.077
GDP Expectations	2.648	2.456	2.485
Number of Observations	273	206	130

The analysis of the DP variable is extended to subsectors from Table 2 which report the means of each specific subsector of the frequency. We see that the mean is much higher for fruit and vegetable retailers, against other meat and poultry, and other firms. This indication is self-explanatory and shows the potential usage for fixed effects in the model.

However, further in Table 1 is the comparison to predicted DP behaviours under different levels of high GDP growth and low GDP growth. Ideally, we would at least expect no significant relationship in rational theory, although perhaps we would see a slight change in the practice as more pressure from drops in consumer confidence would impact the profitability of firms selling luxury goods. The change is quite drastic. Under high GDP growth, most firms predicted they would practice a low level of DP with a maximum of

two times, suggesting that firms would operate with the understanding that everything is looking up and the business cycle is doing well. Because of this, firms would be confident they would be able to sell goods comfortability without stress. However, under negative GDP growth (-1%), we can already see that firms would be willing to up the ante on their DP, with a new mean of 4.250 which is far above the reported mean of 1.448.

What this tells us is that many firms in the sample believe in the idea that real GDP growth has an impact on consumer confidence, as likely they would expect consumers to spend less on products overall. The theory of the business cycle stipulates that in times of hardship, consumers would spend more on inferior goods as opposed to normal or luxury goods. So, in that case, it would be rational for a firm operating with luxuries to practice DP more, however it may not necessarily entail increases for inferior goods.

Given that we are investigating firms operating with the basic need of food, many would still be operating with 'inferior' foods which may imply a level of misunderstanding when it comes to the impacts of recessionary periods. This is undeterminable at this stage as this thesis is looking specifically at DP, but it is a suggestion for further research in the future.

Looking at the rest of the macroeconomic factors we can draw some very important inferences in terms of the usefulness of such indicators. In this table, the macro values are compared among each subsector as the means in a similar fashion to Table 1.

The firms perceived the usefulness of key macroeconomic indicators are reported, which show what each firm believes is useful in price setting and adjustment. This tells the behaviours each firm has in relation to each statistic. We would expect for instance that firms would find the inflation rate useful for any sort of pricing decisions, given that increases in the inflation rate may impact the pricing expectations of other firms. It makes economic sense to track it and respond to it. For instance, high inflation indicates that a firm should increase its prices due to the real value of money and, in essence, their product, falling overtime, whilst low or even negative inflation may give cause to reduce the nominal price of their goods.

This is similar to the unemployment rate, with which high unemployment can indicate an opportunity to decrease wages which would have interactions with prices through the Phillips curve (Phillips, 1958), and the exchange rate which would be useful to firms looking to import/export their goods at better prices against the local currency.

Statistics show many firms put a high value on real GDP growth as a strong tool in pricing decisions across the board. The unemployment rate and exchange rate both have similar perceptions in which the mean indicates that firms only find them slightly useful in price settings. Given the share of trade is very high in New Zealand, the perception of the exchange rate was expected as some firms sell locally and do not import, so likely have no use for the exchange rate outside of banking and savings.

This may be true for the unemployment rate also, given that most firms only hold a few employees with an average of 7 workers so outside of monitoring the Philips curve there may be little use for it in price setting. On the one hand, we first have the CPI inflation indicator only being slightly more relevant than the former two, showing that firms do not find inflation to be that helpful in price setting.

This is somewhat unexpected as we would expect CPI to be the most important indicator to track, and at least, more than any other statistic since it directly relates to price changes in the market. Even going to the subsectors in Table 2 this reports that firms overall did not place that much attention on the CPI inflation rate, especially with the case of meat retailers. Thus, it tells us that at least on this statistic, getting incorrect CPI inflation rates may be understandable given they do not feel it be that useful.

And of all the indicators the firms feel most valuable, real GDP growth was felt to be the most important in determining their price setting behaviours. Compared to the other indicators this is not an expected result necessarily. The first important factor is that the overall rating given in Table 1 shows that the consensus in the survey was a usefulness of 75.859% in terms of how real GDP growth is useful for price setting with a standard deviation the same level as the exchange rate and the unemployment rate, indicating that for most firms it is perceived as being useful.

The second important factor is the minimum and the maximum, for some firm's CPI, unemployment and the exchange rate were not important at all with a score of 0 being the minimum usefulness. However, with real GDP growth, its minimum score is 50%, meaning that no firm in the sample felt it was less than 50% useful, which is higher than even the means of the other three indicators.

So, the question becomes "why is this?"

Firstly, in a similar fashion to the frequency of price changes under different levels of growth, many firms could believe that tracking the business cycle is necessary to know whether the economy is fast approaching a recession and thus act quickly to prepare for it.

Secondly, the push of consumer confidence in terms of the general opinion of the economy may cause firms to track real GDP growth more, as to react to it better. For example, if firms, from experience, know that spending drops during recessions, then it may cause firms to track the business cycle more, so as to ensure they know when it happens, and then subsequently know how to change their DP and dynamic inventory strategies as evidenced by the predicted price changes under different levels.

The last important component from the first two tables is GDP expectations itself and is one of the more important attributes of this thesis as one of the key outcomes is whether the GDP expectations of the firm plays a role in current DP practices.

Of course, while we can clearly see that firms believe it is useful, this does not imply in itself that it determines a definitive relationship between the two, which in this paper is what we are trying to find out. From this section, we can conclude that firms themselves believe that real GDP growth should impact it, but in this paper, we need to investigate and find out whether the current perceptions the firm has of GDP growth, actually have a consensus effect on these behaviours.

Table three screens important Yes/No questions of the survey showing each sub-sector response, and the number of responses to whether the main product was seasonal, was the same product throughout the year, and whether they import the main product. These results are very important as each subsector reveals vastly different characteristics. For example, while fresh meat, fish, and poultry retailing yielded almost no firms aside from four having the main product which is seasonal, and in the case of fruit and vegetable retailing, that again, almost all firms aside from four are seasonal.

This already is a very important characteristic, given that in the empirical we are aiming to use a fixed effects model for analysis, controlling the regression with the seasonal variable in and of itself provides an important fixed effect to maintain.

Table 3: Statistics for Yes/No Questions

ANZIC Classification	Seasonal	Same main product	Import the main product?
Fresh meat, fish, and poultry retailing			
no	202	137	192
yes	4	69	14
Fresh meat, fish, and poultry retailing Total	**206**	**206**	**206**
Fruit and vegetable retailing			
no	4	236	213
yes	269	37	60
Fruit and vegetable retailing Total	**273**	**273**	**273**
Other food retailers			
no	130	3	**130**
yes	0	127	**0**
Other food retailers Total	**130**	**130**	**130**
Grand Total	**609**	**609**	**609**

Few firms in the sample import their goods which is what we would expect. A few meat, fish and poultry retail firms import goods from overseas while just under a quarter of fruit and vegetable firms import there produce. This is likely from firms importing overseas specialities, produced in other countries and not in New Zealand. Other food retailers reported no further imports. Note that this indicates few firms import while the previous tables indicate that few firms export.

The figures I have presented show the different behaviours between the different subsectors in relation to both the current situation and the different scenarios presented with the purpose of drawing a comparison between how the different subsectors react to real GDP growth scenarios in terms of their DP behaviours. In relation to the changes in behaviour, it is roughly across the board with many firms increasing the level of DP to guard against low consumer confidence.

The perishability figures also highlight how close to perishing many firms expect to sell their goods, indicating a wide variety of times with most being around a week for both meat and vegetables. For other food retailers, many are expected to sell a day before they expire, indicating a need to be able to sell goods quickly or risk having to salvage their goods, perhaps even at a cost.

The summary statistics and data analytics already offer a strong indication of an expected relationship between GDP growth expectations and DP behaviours through the simple fact that many firms internally, would expect to increase their DP frequency under negative GDP growth, and in times of boom, where they would relax their pricing strategies. This does not definitively prove there is a relationship, simply because firms say there is. What we need is to analyse whether the firms current GDP expectations have a determining effect on the current level of DP they are practising to gain insight on whether a firm's expectations of the economy really have a firm-wide significant impact on DP.

3.3 Regression Analysis

3.3.1 Dynamic Pricing Analysis

For the first half of the regression analysis, the first output was one that only looks at the firms' characteristics, product, and pricing characteristics. The microeconomic level analysis will serve to help those in the field of DP with conclusions that inform how firms practice the art of DP given the already very limited empirical work currently done in that field. For example, it will build on and test the literature regarding how a firm should price its goods, as well as validate some of the theories postulated by scholars in microeconomics. This component will also provide a baseline to work with so that when macroeconomic variables and expectations are included, we can begin expanding the model and showing how macroeconomic insights can inform both current and future work about finding the determinants of DP.

The first model done was a very straight ford fixed-effects cross-sectional analysis with the level of DP as the dependent variable, and several firm characteristics such as age, a log of employment, competitors the firm faces, labour and material costs and profit margins. DP is measured as how many times the firm expects to change its price before it perishes for a single products cycle from when it first goes on sale all the way to when it perishes. We include age, labour and costs as general indicators of firm performance and we include competitors, as there could be a relationship, as competition in theory applies more pressure for firms to make competitive pricing decisions. Also included are the specific product and pricing characteristics which may have an impact on the decisions made by firms.

In Table 4 the first set of regressions are presented alongside robust standard errors. The first iteration is a base model with only firm characteristics presented, which serves to set the bar for this thesis. In this iteration variables such as the log of employment, material costs and average profit margin are significant, while competition is barely significant at 10%.

This gives a fairly low R-squared of 0.1956 which shows the model has low explanatory power. Firm age is not significant, which can be expected given that the age of the firm may inform us of their experience. Within the firm, the DP strategy may not be widely perfected on those terms given they may have prejudice and resistance to change.

While labour costs are not significant the material costs are significant at 5%, indicating that firms facing high material costs may be more incentivised to practice DP. Average profit margin in the last 12 months is significant at 1% which in this case is expected. But also, in this case, there is an anomaly in which firms with a higher profit margin will practice DP less than other firms. This goes against some of the literature in theory as the theory indicates increases in DP will lead to more optimal outcomes. However, what we are seeing here is that a firm that practices DP more will lead to a lower profit margin in the base model.

The next model tested starts to include product and pricing characteristics called 'Base + Product' and includes the perishability of the main product investigated, the new price setting relative to competitors, and the time it takes to replenish and replace goods after they have sold or perished, all of which were significant at 1%.

The Beta coefficients indicated that if a firm has a main product that is expected to perish soon, then it would practice DP more than a firm that is expected to sell a product way before it expires. This indicates what we expected from the literature, that firms which have highly perishable goods will tend to be under more pressure to sell goods that are close to perishing and proves the basic relationship when it comes to the theory of DP and perishable goods.

The relationship, however, is the opposite with the time it takes to replenish goods which affect the firm's capacity to alter its production in the short term. The more time it takes a firm to replenish its goods the more intense their DP will be. While it is the opposite, it still falls in line with the literature somewhat, as we would expect a firm with a long production horizon to be under more pressure to sell their goods before it perishes. For instance, a firm that takes a month to replace its products and must make inventory

decisions months in advance will be under more pressure to ensure products sell or otherwise face devastating consequences if their dynamic inventory strategy is not good. Essentially a longer production horizon leads to less of a capacity to practice DI, which places more weighting on DP.

Table 4: Determinants of Dynamic Pricing Fixed Effects

Variables	Base	Base + Product	Base + P + other factors
Firm Characteristics			
Firm Age	0.003	0.004	0
	(0.004)	(0.004)	(0.003)
Log of Employment	-0.686**	-0.256	-0.346
	(0.316)	(0.335)	(0.314)
Number of Competitors	0.025*	0.023*	-0.006
	(0.014)	(0.014)	(0.013)
Labour Cost Share of Revenue	0.038	0.41	-0.544
	(0.514)	(0.510)	(0.490)
Material and other Costs Share of Revenue	1.209**	1.367***	-0.868*
	(0.515)	(0.512)	(0.510)
Average Profit Margin in the last 12 months	-2.534***	-1.863***	-1.847***
	(0.438)	(0.402)	(0.388)
Product and Pricing Characteristics			
Number of days before a good perishes is it expected to sell		-0.058***	-0.055***
		(0.016)	(0.014)
Price Relative to Competitors		-5.214***	-6.487***
		(1.355)	(1.268)
Time it takes to Replenish goods		0.055***	0.054***
		(0.017)	(0.015)

Is the Main Product Imported?			0.199
			(0.151)
Is the Main Product Seasonal?			1.064***
			(0.110)
Constant	2.283***	1.418*	2.837***
	(0.613)	(0.738)	(0.728)
Observations	609	609	609
R-Squared	0.1956	0.2599	0.3855

The log of employment becomes insignificant in determining the frequency of DP in this model, showing that the number of employees a firm has, does not impact DP decision making. While the average profit margin is still significant at 1% the magnitude is much less than the base model going from -2.534 to -1.863, indicating it may not be as big an effect as shown. Overall in this model with it being a linear OLS estimation we can use the R-Squared to indicate the effectiveness of the model, and with it going from 0.1956 to 0.2599, this indicates a positive effect of including these variables in the model.

The factor of whether the main product is seasonal is also considered as an extension to the dynamic inventory variable, where the main product is only able to be produced at certain points of the year. For the most part, this is to present a further argument that firms operating on a seasonal basis have further pressures to ensure products do not perish. Given some foods will not be available for quite some time it is economically sensible to discern that a firm would practice DP more. By the model's standards, a firm is expected to increase its frequency by a full 1 unit if its main product is seasonal. This also raises the R2 significantly in this model up to 0.3855, while leaving most other variables; the values are the same as the model without this factor.

Many of the numbers in the model are expected. For example, a firm that expects to sell its product long before it perishes is expected to ease up on DP in this model, which is something we expect closer to expiry, adding more pressure, the firm would therefore likely be under to sell on time. This is also consistent with the time it takes to replenish goods in which the firm is expected to practice DP more if firms take a while to replenish goods.

While at first, it may seem strange that a firm that practices DP less is expected to make gains on the average margins, it is important to consider that while a firm may practice DP more, it does not mean a direct link to higher profitability. For example, the firm may not understand what it is doing; rather, they are erratically trying to optimise their pricing which may be causing them to lose money in the long run. The DP theory states optimal strategies for DP but does not explicitly link more DP into more profits. To further investigate this, it would be better to look at a group of firms in a similar industry with similar products and compare profit margins with the frequencies and perhaps even experiment with firms and ask them to practice DP at different given frequencies. Then you could compare that with the literature.

This model provides a basis for beginning to include macroeconomic factors in the model. The main objective is to see whether including such indicators improves the validity of the model and helps determine the behaviour of the firm in question. This model can inform the analysis of DP in the work already completed, as it adds to a limited empirical body of literature and contributes to proving the rudimentary idea that firms that have products closer to perishing will practice DP more.

Table 5 includes a supplementary analysis of the later model in terms of what determining factors cause a firm to practice DP in the first place by running maximum likelihoods for the model using both probit and logit formulas and comparing it to a linear probability model. The results are fairly like the fixed-effects model in which similar conclusions from Table 4, influence the probability of a firm practising DP versus a firm not changing its price at all.

It is, however, slightly stronger in terms of being able to explain whether a firm may enter into a DP strategy for their main product, for instance, the product being seasonal almost being certain of doing so. Once again on the contrary to the literature, a firm with a higher profit margin is expected to have a lower chance of practising it.

**Table 5: Determinants of Dynamic Pricing -
Maximum likelihood**

Firm Characteristics	LPM	Logit	Probit
Firm Age	0.000	-0.001	0.000
	(0.001)	(0.011)	(0.006)
Log of Employment	-0.121	-1.195	-0.720*
	(0.080)	(0.823)	(0.428)
Number of Competitors	-0.002	-0.032	-0.021
	(0.004)	(0.041)	(0.022)
Labour Share of Revenue	-0.228	-2.527*	-1.036
	(0.158)	(1.467)	(0.799)
Material and other Costs Share of Revenue	0.055	-0.124	0.234
	(0.185)	(1.603)	(0.912)
Average Profit Margin	-0.318**	-2.771**	-1.385**
	(0.151)	(1.219)	(0.686)
Product and Pricing Characteristics			
Number of days before a good perishes is it expected to sell	-0.028***	-0.299***	-0.158***
	(0.005)	(0.059)	(0.031)
Price Relative to Competitors	-0.414	-6.312*	-3.497*
	(0.359)	(3.563)	(1.944)
Time it takes to Replenish goods	0.025***	0.290***	0.153***
	(0.006)	(0.062)	(0.032)

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Is the Main Product Imported?	-0.067*	-0.731	-0.305
	(0.035)	(0.446)	(0.239)
Is the Main Product Seasonal?	0.197***	2.139***	1.015***
	(0.032)	(0.436)	(0.207)
Constant	1.198***	6.179	3.320***
	(0.200)	(2.175)	(1.151)
Observations	609	609	609
R-Squared	0.2843	0.3098	0.3012

3.3.2 Business Cycle Extension

In this section, we now move to include the characteristics of the firm which are macroeconomic based. Firstly, the GDP expectations are included to see if what a firm thinks and expects of the economy will affect the way it practices DP. Secondly, I include other key variables which can help better inform the analysis and the models explaining power, to determine whether including a macroeconomic component can help in any way shape or form.

The real GDP growth expectations are measured as what the firm thinks they will be in the next 12 months, which is essentially its forecast of real GDP growth based on the information they currently have. In the presented model it is directly tested against DP as the dependent variable, and at first, put on by itself and then tried with some supporting variables. "Base Model" is the original equation from Table 4, "With GDP" includes the GDP expectations of the firm manager in the model and "With Other Factors" includes variables that are significant to help to determine the relationship that business cycle expectations can help to explain.

In the first iteration, we include the microeconomic baseline as a means of comparison to show improvements in the models explaining power. The GDP expectations of each firm only, are included. In this case, there is an effect different from zero, so we can see the P-Value is just over the line, showing this variable is not significant in this model, albeit only barely.

What this means at least initially, is the GDP expectations of the firm given in the base model, developed in the microeconomic section, are not improving the explanatory power of the model, meaning that GDP expectations are not significant in determining the frequency of DP practised. However, it may be significant when other variables are not able to be attained in practice. For instance, without the average margin of the firm or even without seasonal data it may be closer to significant.

This has a strong impact on understanding that the business cycle has an impact on the DP practices of the firm. It is understood clearly that firms intend to practice pricing differently during different stages of the business cycle. However, GDP expectations are not significant to show that all the firms in question have different ideas on what the business cycle is doing right now. It, therefore, means that overall, we cannot forecast DP behaviours using this dataset using GDP expectations even though firms believe they

will alter their pricing. We cannot use the GDP expectations of the firm to determine DP behaviours.

Running a regression by adding the predicted DP behaviours under high GDP growth has shown to help explain current practices. This is the more conservative approach in which we would expect a higher current level right now if the firm intended to change its position under high GDP growth. This does not hold true for DP behaviour under a low GDP growth scenario. What this implies is that the high GDP growth scenario is more reasonable and predictable in terms of consistent behaviour, i.e. the position towards high GDP growth is quite stable, meaning the behaviour of firms they expect to exhibit is predictable and consistent in comparison to how they are acting now.

Under a negative GDP growth scenario, the predicted change in behaviour is quite unpredictable and random and insignificant in determining current practices. This implies that the firms' attention and understanding towards recession and depressions in economic terms is quite chaotic, and thus being able to predict how firms will react to a financial crisis is difficult.

While it is clear from the data that business managers, overall, will make their prices more flexible and responsive to change we cannot predict how it will change for each specific firm overall, with the data we have available. Therefore, there are strong implications for monetary policy which will be discussed in the discussion section.

The regression has strong impacts on the literature and asks the question as to whether real GDP growth plays a part in decision making in terms of the number of times a firm will practice DP. It is made clear that a firm who believes real GDP growth is relevant will practice it slightly less, compared with those that don't care for it for pricing decisions.

Whilst we know firms think it does, and they actively use it, that it is not significant in determining the number of times they will use it. At this stage, we cannot conclude any significant effects although we can conclude to some extent there is a follow on between the consistency of the strategy they would practice and the chaos that would arise under the recessionary stage of the business cycle.

This follows intuition quite strongly as during a period of boom there is less uncertainty, and less of that means firms are quite predictable and relaxed, and we can somewhat predict and quantify a relationship between what they are doing now, and what they would

do. It implies that it may be able to discern what firms as a whole, currently think of the business cycle based on the predictability of DP, compared with what it actually is. This should be repeated to further test this relationship.

Table 6: Dynamic Pricing Fixed Effects with Business Cycle Variables

Firm Characteristics	Base Model	With GDP	With other Factors
Firm Age	0	0	0
	(0.003)	(0.004)	(0.003)
Log of Employment	-0.346	-0.337	-0.079
	(0.314)	(0.315)	(0.289)
Number of Competitors	-0.006	-0.005	0.000
	(0.013)	(0.013)	(0.012)
Labour Share of Revenue	-0.544	-0.598	-0.171
	(0.490)	(0.491)	(0.469)
Material and other Costs Share of Revenue	-0.868*	-0.8343733	-0.779*
	(0.510)	(0.509)	(0.484)
Average Profit Margin	-1.847***	-1.831***	-0.997***
	(0.388)	(0.388)	(0.362)

Product and Pricing Characteristics

	Base Model	With GDP	With other Factors
Number of days before a good perishes is it expected to sell	-0.055***	-0.0547***	-0.036***
	(0.014)	(0.014)	(0.013)
Price Relative to Competitors	-6.487***	-6.496***	-5.179***
	(1.268)	(1.273)	(1.150)
Time it takes to Replenish goods	0.054***	0.0543***	0.0372***

	(1)	(2)		(3)	
	(0.015)	(0.015)		(0.014)	
Is the Main Product Imported?	0.199	0.192***		0.233	
	(0.151)	(0.150)		(0.144)	
Is the Main Product Seasonal?	1.064***	1.076***		0.926***	
	(0.110)	(0.109)		(0.104)	

Macroeconomic and Business Cycle Expectations			P-Value		
Real GDP Growth expectations within the next 12 months		-0.090	0.137	-0.067	0.256
		(0.061)		(0.059)	
Is GDP very Relevant in determining Price Setting?				-0.228*	
				(0.131)	
Predicted Dynamic Pricing Behaviour with High GDP Growth				0.550***	
				(0.077)	
Predicted Dynamic Pricing Behaviour with Low GDP Growth				0.0342	
				(0.030)	
Constant	2.837	3.03***		1.474**	
	(0.728)	(0.753)		(0.758)	
Observations	609				
R-Squared	0.3855	0.3881		0.4499	

The next part of the analysis was to determine whether firms had been attentive towards the key macroeconomic indicator of real GDP growth. The way I analysed this was straight forward and began with correlation analysis. Under full information and no inattention, we would expect to see firms who believe it is important to have expectations closely matching those of professional forecasters. For example, a firm that believed GDP growth was an important statistic for product pricing would be expected to at least look at the Treasury forecasts and align their expectations with the Treasury. We would expect a firm that does this to place value on it, or they may have a random guess at what the statistic is instead.

The attempt I made started with a correlation analysis in which I investigated the correlations between the GDP expectations and whether the firm felt GDP was helpful, however, this was found to be insignificant and not correlated to either.

While initially showing significant levels of rational inattention within the data, I ran a regression that indicated to 99% confidence that a firm which felt GDP growth was very relevant to price setting, would have expectations closer to that of professional forecasters, indicating that there is some level of attentiveness there. However so far this has only been proven for firms that believe it is very relevant. Firms that only believe it is fairly relevant on their ranking sheet are not more accurate to professional forecasting. This relationship does not hold with investment or real exchange rate, however.

This indicates that firms that believe it is very relevant will track the GDP forecasts to help with their price setting. Extending this to the original model made no extra contributions given the foundation data in the model. It seems that from the results, the microeconomic level data is very strong and helps explain many of the behaviours set forth. As a result, the macroeconomic level data does not help it too much with the exception of the predicted reaction to the different phases of the business cycle, which in itself can help inform a lot of policy decision making and correlations in terms of the attention put towards the cycle.

In Appendix A, I have included outputs related to the comparison of the forecast compared with professional forecasts by the NZ Treasury in 2015. Firstly, including a variant of that in the regression did not produce any significant improvements on the model and secondly, it puts forward the question that given many firms believe real GDP growth is important then surely, we would expect the vast majority of firms to give the correct forecast. However, many did not, and many underestimated the forecast by the

Treasury. To investigate this, it may be useful in a further survey to ask the firm for its own forecasts and then ask a follow-up question of what they think the 'professional forecast' is. At this stage, rational inattention is the likely theory to apply in this situation, in which firms simply do not have time to keep up with this statistic, or a similar conclusion can be drawn.

3.4 Discussion of Results

In this section, I will go about using the results and the literature to answer the questions posed in the introduction to understand and comprehend the scope of this paper. Beyond the basic idea of price adjustment, we seek the answers and understanding to help our policy development and our literature analysis. In the subsequent sections, I will show how the results have done this.

3.4 1 Implications of Results

A lot of the fundamental principles of the literature have been proven in the results. For instance, the idea that firms that sell perishable goods will tend to decrease their price to improve the chances of a sale is present and consistent with this theory, shown by the fact that most firms in the sample will decrease their prices with each iteration.

This indicates that at the very least firms are doing what they should be doing and have a grasp of the basic theory which is quite innate among firms as many themselves would pay less for goods as they get closer to perishing, and in some cases become obsolete, how often is of course still up for debate.

On the other hand, there is one key inference with this dataset in that firms that have practised more DP have reported lower average profit margins set wide, at least in the last 12 months of operation. This goes against some of the theory, which suggests, firms who practice DP would see at least incremental increases in profitability as many of the papers state, after all, it is the goal of the literature to discover and explore methods of profit maximisation in this particular field. It is important to note a few things about this specific finding.

Firstly, we do not have data on the average profit margins of each industry in general. In this data set to give us a baseline for profit margins, for instance, we do not know the average profit margin in vegetable and fruit retailing compared to other industries, and

even then, we would need to expand the analysis to past benchmarks given past pricing practices to fully understand the effectiveness of DP. Secondly and more importantly, a firm that practices DP may not necessarily, in theory, generate more revenue. Given that a firm is constantly attempting to gauge the more realistic strategic and stochastic demand curves of their consumers, it is not difficult to imagine a situation in which management makes pricing decisions, that are not correct given the demand for their perishable goods and ends up losing potential profits instead of retaining them.

It, therefore, should not be assumed in practice, that firms have the models and understanding of higher order game theory which bombards the user with complex mathematics and modelling to solve something that is essentially unsolvable without surveys, and simply ask the customer, who would then likely have different demands over time themselves.

This will inevitably create strong implications on the DP literature as the entire purpose of the DP literature is to increase the profitability of the firm through its equilibrium. This paper should motivate to some degree, the explicit investigation and validation of whether firms understand how to practice DP, and also actually understand what they are doing. I believe the microeconomic literature will tend towards profitability and whether different techniques practised by different firms will result in more favourable average margins.

Of course, this paper in itself paves the way for more empirical work to be conducted on DP and profitability, given that Sweeting is the only one so far to truly delve into the field of perishable goods looking at baseball tickets. There is, of course, one key difference between my work and his, which is that Sweeting found that DP was valuable and raised the expected payoffs roughly 16% overall. This could be attributed to the fact that baseball tickets are an all or nothing affair, meaning that a consumer has a choice to either see the game or not and cannot come to reconsider their decision, while in the field of food and produce it is repeatable, a consumer may choose to hold off purchasing for another time.

It can be quite difficult to compare the macroeconomics side of the analysis with the DP theory given there are no papers currently published that include or even mention any macroeconomic indication.

One key inference which could impact the DP literature is the time and stage of the business cycle the pricing data is taken from. For instance, the Sweeting paper (Sweeting, 2013) analysed pricing data that was taken in 2009, back when the U.S. economy was

coming out of a recession and back into a boom time. Given that firms in this sample expected to drastically alter their pricing techniques at different points on the business cycle it would be wise as a takeaway for someone analysing the microeconomic side, to take pricing data from a long time period, and perhaps even test to see whether a dummy variable is appropriate for considering the different stages of the business cycle.

On the other hand, it is quite clear that a certain level of "animal spirits" (Ahmed & Cassou, 2016) may be at work in this dataset. If we are being direct, it is difficult to determine the direct effect of a recession, as an example, a recession is technically caused by declines in real GDP growth, and is described as an inevitability of the economy as the workings of economic growth if it is above the line, and positive GDP growth is being postulated it should, in theory, be "fine". However, the firms in the sample perceive it much differently, believing a recessionary period is something to almost panic about.

It is quite possible that rational inattention is why there was no correlation between businesses that believe real GDP growth is useful for pricing decisions, and how close the prediction of the firm was to professional forecasting. This is because with full information we, of course, would expect a company who believes that real GDP growth is useful for pricing decisions, would have their expectations aligned with the forecasters. Therefore, it is likely the situation presented by Sims (Sims, 2003) in which firms just do not have time to keep track of forecasts.

Of course, we cannot forget about the classic macroeconomic theory of sticky pricing in this section. Under the idea of sticky pricing, we would believe a business may experience pricing inertia in terms of changing its price for many reasons. Let's imagine what the results would be if there was no sticky pricing. If prices were completely flexible, then firms would change their prices as they felt they needed to. What the survey implies is at different stages of the business cycle, the level of price stickiness may be much different.

I believe that research when investigating sticky prices should look further towards DP rather than the long-term base prices. Understanding DP would be much more useful in understanding whether prices are fixed over a products lifetime, compared to the business attempting demand targeting.

I would push to question how the firm should react to the different stages in the business cycle. For example, should it increase its DP during a recession just because of the decrease in consumer confidence, or should it always be practising DP on a regular basis?

We associate changes in the business cycle with consumer confidence, but that is because negative GDP growth is linked to stock market crashes and the like. When we think of a recession we usually recall the 2008 GFC and the crash of 1987 as recessions. Not necessarily brief periods of negative GDP growth, so it is possible the perceptions of the firm are inaccurate in this sense.

This paper is unique in that it is dealing with an area of economics that is rarely visited. One that attempts to bridge the understandings of microeconomics and macroeconomics is to build on something that can have a strong impact on each separate study. After all, reality does not occur in isolation of each other. Thus, in this section, we hope to lay a foundation which can be used for further research and know what questions need to be answered.

Using the dataset provided I have shown multiple times that there is an intention for companies to change their DP strategy during the different stages of the business cycle. This can be translated to the intention of the firm to change its strategy, and as I have mentioned previously it shows that the firm thinks it is important and shows there may be at least a link to the business cycle, however, this may not be what should happen. We know firms are under more pressure to sell their products, but perhaps more aggressive DP is not the correct answer. Perhaps dynamic inventory strategy is more appropriate during a recession.

It ultimately must be established whether the optimal DP strategy can work with the business cycle. The vast majority of DP papers up to now have essentially discounted the business cycle completely, and have instead taken, at best, to responding to the demand of strategic consumers. Given the literature on DP, this cannot be the case as consumer confidence can hit rock bottom during a recession and as the literature states, luxury goods will decrease in demand and inferior goods will increase due to changes in income from forecasted income losses and increased unemployment.

The big question is whether this can change the optimal strategy for businesses and should the optimal strategy change during the different stages of the cycle. Is the increase in DP necessary during a recession or should the firm always adopt a high and sharp strategy? That is a question for DP mathematicians to analyse and I think it would be a smart way forward with this sort of literature, especially in terms of making connections with real-world DP application in which demand is ever-changing, and the business cycle provides the "meta" for the expected situation.

3.4.2 Policy Implications

I will finish this section with implications for public policy and potential uses for this paper as I believe it necessary to always show a demonstrable purpose for the work I conduct.

To review, the results show that during periods of recession and booms the firm, at the very least, intends to change its DP strategy methods. The intent is very powerful in terms of how much they believe to change the frequency. For instance, in times of boom, most firms believe they would decrease the frequency of their pricing adjustments while in times of recession they would dramatically increase it.

While not indicated this may be because of the optimism of the economy at this point and thus, they feel under less pressure to have to adjust prices to ensure sales. This can have a strong implication on how a government unit can forecast business confidence based on the relative price stickiness that firms are experiencing. For instance, if a firm is not too confident in the economy it is said they will practice it more, and so it is seen as low confidence in the economy. This will be much clearer if a follow-up survey is conducted during a recessionary period on the business cycle to see if they acted on their intentions.

This makes a lot of economic sense as it builds around the objectives of the business cycle policy goals, which are to minimise the longevity and impact of recessionary periods and maximise the benefits of boom periods. It may be possible to build and maintain a model which observes the DP frequency to determine business confidence i.e. the more a firm practices DP more than they normally would, the less confidence they have in the general economy. However, to fully test this we would need to conduct a panel data research project and attempt to track DP data back at least 20 or so years, so the data covers at least a few business cycle fluctuations. With that, it may be possible to assess the theory that the stage of the business cycle will affect the level of DP practised, as well as the reverse idea.

This culminates in the key understanding that more DP can mean less confidence in the economy. However, this could be considered an aberration as all it is, is more fine optimisations to the price of a good in the hopes their good can sell in times of recession. It depends on whether the good they are selling is considered a luxury good or an inferior good, the former product sales decreasing during a recession while the later product potentially being higher in demand. This would depend on the type of perishable food

product being sold. However, in the sample, we saw all firms wanting to increase the level of DP regardless of the classification of the product they were selling.

We can move forward with a check on the implications of what this study can potentially have on the notion of monetary policy in terms of the effect on pricing strategies. The ideal scenario is one where the monetary policy that is used is useful and can make a difference.

The survey suggests that the GDP expectations of the business are not that significant in the pricing strategies of the firms although it did come close. It is important in this instance to understand the objectives of monetary policy which is to assist with monetary stability, which in turn maintains economic stability. The question is whether high DP can give an indication of economic stability in New Zealand and again, that can only be answered if we go back to the firms later on, during a recession, and check their methodologies. This would also give us data on any lags they may have in relation to rational inattention as well.

The difference between what a firm thinks the level of real GDP growth is, and the value it believes it can benefit from knowing, is also quite different. As shown in the results write up, businesses that believe knowing real GDP growth is helpful to their pricing decisions did not necessarily correlate with producing the predicted result the professionals provided. For example, the NZ Treasury predicted in that year a 3% real GDP growth.

Many firms that believed GDP growth was helpful for pricing decisions did not align with the professionals. This could imply that firms may not be interested in real GDP growth forecasting, but rather they could be focused on what GDP is right now and was in the last 12 months as opposed to the next 12 months. This could indicate a lag in policy implementation that would be targeted at GDP growth since it would imply the firms are backward, looking at their expectations somewhat. On the other hand, it may be that company managers have seen the forecasts but are simply under or over-optimistic about the future of the economy. Firms are under no obligation to simply report professional forecasting as their answer and beliefs about the economy, and if they do not believe in forecasting, perhaps based on the history of forecasting effectiveness, they may simply go out on their own and do their own analysis.

It could be an idea to perhaps ask the firm what they think real GDP growth is in the next 12 months, then question whether they have been following professional forecasting and

if so, what they have indicated to check this out. Of course, rational inattentiveness is likely to be at work here, especially if a firm believes real GDP growth is very useful and has simply not gotten around to researching it and has been focused on other things.

It is hard to track gains in policy analysis based on this survey data given. It is cross-sectional and based in this one moment. Of course, one clear inference we can gather is, firms have a strong connection to the business cycle in terms of how they price their goods, therefore while it has not been proven there is a definite theoretical link, we can examine an empirical link of expectations, thus building on the theory of how it comes together can help as to whether we should go about informing firms and consumers about how the business cycle can help pricing decisions in terms of DP.

3.5 Results Summary

From the analysis of the results, I could demonstrate and present the findings related to the exploration of the relationships between DP, and aspects and components of the business cycle. Specifically, there is a definite belief of the firm managers that they believe the stage of the business cycle based on GDP levels, has a significant effect on DP strategies going forward. I have also presented insights into how each component of the analysis informs the literature on each front.

The results build on the limited DP literature that aims to prove and test the different theories that have been postulated, the results prove that firms at least follow the basic strategy of decreasing their prices as the product moves closer to perishing although it is not necessarily caused by more aggressive DP strategies, suggesting the optimal strategy to increase profitability is not necessarily more DP, but could be in fact, less in some cases and more precise targeting. The inclusion of the business cycle adds a further layer to this game and the results postulate that it may be wise to test DP theories empirically at different stages of the business cycle to take the expectations of the cycle into account. This may be true for the Sweeting paper for instance and retesting that analysis at a different stage may yield different results.

This also impacts the macroeconomic literature as this paper looks at sticky pricing during the individual product lifetime, as opposed to the duration of the product during its tenure. To simplify, the vast majority of the macroeconomic literature tracks sticky pricing over years investigating the base prices of the product as opposed to discounting which has been done here. This paper shows that during recessions the prices become relatively

flexible during a recession and fixed during a boom. This goes against the literature which suggests base prices are fixed during the recession and flexible during the boom. However, this is easily explained in that firms may be more interested in discounting during recessions.

Policy implications are limited at this stage as we only have an indication of how businesses may react to volatile changes in the business cycle. The reality may be much different when the time comes however, at least it shows that firms do have a strong belief that the business cycle affects their business, even more so than inflation. Given that rational inattention may be quite strong, firms will not update themselves with GDP levels immediately unless a recession does occur in which "animal spirits" will come out and create growing levels of anticipation.

I believe that going back to the same firms and asking them the level of DP they are practising during a recession may give insight as to how they are going to react, as things can be different in the real world as opposed to scenario mock-ups. This would give us a much stronger insight into policy development as it would give a correlation between DP behaviours and GDP expectations and subsequently economic confidence.

There are still a lot of gaps this paper has not been able to fill, many things need to happen to complete the literature on this topic.

- A follow-up survey should be conducted to track current DP behaviours across the years if possible, culminating in behaviours practised during a recession to check if the firms did act on what they said they would do. However, we will have to wait for the recession to occur first, something that we should not want to happen in the first place.

- To confirm rational inattention, it should be asked of the firm to tell us their GDP expectations, update them with professional forecasting then get a new answer. If their answer changes then it shows rational inattention, especially if they record that they believe GDP is useful in pricing decisions.

- It needs to be determined whether there is a rational reason to consider the business cycle in DP decision making, currently, we know firms believe there is one, but there is no stable datum which suggests more aggressive pricing is useful during recessions. This then leads to the question as to "why should a firm not practice aggressive pricing during a boom?" It is a matter of why not in this instance in which prices are expected from this model to become relatively

flexible during recessions and relatively fixed during booms. So why should they be fixed at all after a recession?

Chapter 4   Conclusion

The purpose of this thesis was to investigate and explore the links between the DP and the business cycle. First by clearing a model with solely firm-level characteristics and behaviours, and then attempting to extend the model by including macroeconomic level indicators such as the real GDP expectations and the firms' opinions of the usefulness of certain indicators on decision making. The results are largely mixed, but I believe are useful with the DP model being potent for further isolated empirical analysis in an otherwise limited body of literature and the macroeconomic extension being useful for further exploration into the vast and open scape of relating the expectations of the bigger picture into decision making at the firm level.

In the literature review, I showed what was already done regarding the individual categories of the microeconomic literature concerning the theory and any empirical work completed on dynamic pricing. For the most part, it was made clear that the theory is incredibly strong and boasts several high-level models which attempt to adjust and boost the potential profitability of firms using several sophisticated modelling techniques. I covered the key literature required to inform this paper, but ultimately an entire review could be dedicated to reviewing the wider range of theories, and somehow relate them to business intelligence in terms of any real usage and benefit to firms in practice. However, there have been few attempts to push for any empirical work at least specifically in the field of DP, much less attempt to relate any sort of macroeconomic indicators to business level decision making, with a sense of perishable lifetimes. The closest being a paper investigating baseball ticket pricing under DP and the working paper my thesis takes its data from along with a few fringe papers on the edge from the literature review.

The macroeconomic literature is much more developed on the business cycle side, the work on sticky prices and related texts are quite strong in comparison to the microeconomic side. Primarily the work on sticky prices focused on long term price stickiness over long periods and has few attempts on short-term discounts. The business cycle literature was also strong and most of the understanding comes from the need.

The empirical work I have completed attempts to do two things. Firstly, it computes the basic DP model which attempts to explain the determinants of DP on its own. My analysis showed that many of the conventional theories held in which, as the product nears the end of its lifetime, a firm will lower its prices so as to increase the probability of a sale. It is a standard theorem that holds true in this case. On the other hand, the model I constructed

shows a reflection that more aggressive DP did not increase the average margin over the last 12 months as of the survey date. This is not necessarily a bad indication as it could simply mean that DP strategies were too aggressive and only challenges the assumption that more DP equals more profit. Firms need to ensure they understand that consumers are typically strategic and thus they may take advantage of aggressive and perhaps predictable DP strategies.

Secondly, attempts to include macroeconomic indicators have shown mixed results so far. In the model directly including real GDP growth has been unsuccessful while almost very close. Significant at 85%, if you must, 85% is essentially insignificant in traditional statistics and I will not push the bar that low. This contrasts an otherwise clear difference in the descriptive statistics which stated that at different levels of GDP most firms would change strategies. This paper suggests a few theories to explain this such as rational inattention in which firm managers are simply not keeping up with, at the very least, the professional forecasting which, while not 100% correct in themselves, presents a problem in the sense that attempting to include macroeconomic variables made the model much better and more workable. However, this did not come from the real GDP expectations itself as a reported P-value of 0.13 was not enough to be considered a significant variable in determining the level of DP. This indicates that there is some very close relationship but not yet definite.

Many firms in the sample responded that real GDP growth is significant for their pricing algorithms, almost double that of inflation and other key statistics. However, it was not a significant factor in determining pricing decision making. This means that there may be a misunderstanding of the true value in terms of what firms think is good in terms of the economy and thus all have different ideas regarding how to respond to real GDP growth. This is not reflected in the responses. Because of this, it is quite clear that firms plan to adjust their pricing during the different stages of the business cycle, but the analysis has shown at the current stage, the expectations of the firm do not match up with simply what they said they would do.

Future studies should attempt to replicate the methodology shown in this thesis. Other countries and/or industries may have more attentiveness and therefore it would be reflected in the regression. The present model showed an intention to strategise differently in reaction to different levels of real GDP growth, however it could not prove it here. Other industries may be more attentive and thus, more surveys in other industries could be good.

The way forward would be to repeat the survey during a recession to recheck the responses and match them against what they thought they would do. Though, of course, we should not tempt a recession, it would rather be a convenience for one to occur, and then a batch of surveys should go out. It's important to know how firms would react when faced with the imminent threat rather than asking firms to imagine a scenario as the full impact may not have taken hold simply by asking. That would allow the field to fully explore and understand the reality of predicting the macroeconomy.

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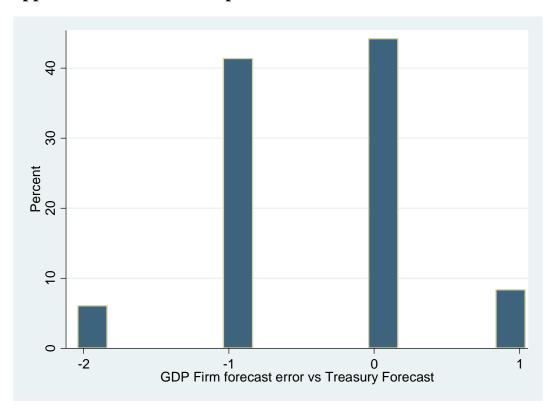
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Appendix

Appendix A: Research Outputs

The above figure is a comparison of GDP firm forecast errors between the individual firm and Treasury forecasts for 2015 based on the real GDP forecasts given within the next twelve months.

Appendix B: Survey Questionnaire

PERISHABLE GOODS MARKET FIRMS IN NEW ZEALAND
2014-2015 SURVEY

<div align="center"><u>**MAIN SURVEY**</u></div>

<u>**Firm Characteristics**</u>

1. **What is the main product of this firm?**
   "Main product": The product or product group from which this firm gets its largest share of revenue.

Main product or service: …………………………

   Is the main product seasonal?

Yes …….   No …….

   Is the main product the major revenue earner throughout the year?

Yes …….   No …….

   Does this firm import the main product?

Yes …….   No …….

2. **How many years old is the firm?**

Answer: ………………   year(s) old

3. **How many workers are employed in this firm?**

Full-time: …………………………
Part-time / Casual: …………………………

4. **Report the dollar value of the total amount produced by this firm over the last 3 months.**

Actual Production: ………………………… $

5. **What percentage of the firm's revenues in the last 12 months came from sales in New Zealand** (vs. other countries)**?**

Answer: ………………   % of sales originating in New Zealand

6. **How many direct competitors does this firm face in its main product line?**

Answer: ………………   firms.

7. **Out of the total revenues of the firm, what fraction is used for compensation of all employees and what fraction is used for the costs of materials and intermediate inputs (raw materials, energy inputs, etc…)?**

	Labor Costs	Costs of Materials and other Inputs
Share of total revenues:	………………. %	………………. %

<u>**Price Setting**</u>

8. **What is the average selling price of this firm's main product? Assume product, demand and supply conditions are normal.**

Average price = $ ……………… units of measurement ………………

9. **What was the average selling price of this firm's main product in previous periods?**

3 months ago = $ ………………
6 months ago = $ ………………
9 months ago = $ ………………
12 months ago = $ ………………

10. **For your main product line, how close to being obsolete/perished/out-of-season do you expect your goods to be when they are actually sold? Please provide your answer in number of days.**

Number of days: ………………

11. A. Considering your main product line, by approximately how many times (number of times) and by how much in total (in percentage terms) your firm changes the price of the product before the product becomes obsolete/perished/out-of-season? Please clearly indicate the approximate *'number of times'* and *'total size'* of the price changes. An example is done for you.

Time lengths	Size
e.g. ...3 times....	.... -10......%
....	................%

B. In the above (Q11A), what approach(s) do you use to implement price changes (e.g. automatic mark-down policy, demand supply approach, etc)?

Answer:	....

12. Considering your main product line, by what margin does your sales price exceed your operating costs (i.e., the cost material inputs plus wage costs but not overheads and depreciation)? Please report your current margin as well as historical or average margin for the firm.

	Current Margin	Average Margin
Answer:	.... %	.... %

13. Approximately after how many days your firm replenish its inventory for its main product line? Please provide an answer in number of days.

Number of days	....

14. How frequently will an individual customer of your main product line buy from you?

	(please tick one)
Every day:	....
Every week:	....
Every month:	....
Many only buy once:	....
Other (specify):	....

15. How often do you compare your prices with those of your closest competitors?

	(please tick one)
Every day:	....
Every week:	....
Every month:	....
Other (specify):	....

16. When setting a new price, do you typically aim to set a price that is lower, higher or equal to those of your closest competitors? By what percentage your new price differs from your competitors?

	(please tick one)	% price
Price lower:	....	....
Price higher:	....	....
Price equal to competitors:	....	

Menu Costs

17. Out of the total revenues of the firm, approximately what fraction is used for changing or updating prices each year? For example, costs of re-tagging items, printing new price lists, updating computer systems, paying workers involved in changing prices, etc.)

Answer:	.... %

Dynamic Pricing and Macroeconomic Conditions

18. **Which of the following macroeconomic indicators are useful for your pricing decisions?**
    Please provide a probability rank out of 100% for each indicator.
    i.   CPI Inflation Rate
    ii.   Unemployment Rate
    iii.   Real GDP Growth
    iv.   Exchange Rate

19. **If the real GDP grows at 5% to 6% per annum, by approximately how many times (number of times) and by how much in total (in percentage terms) your firm will change the price of the product before the product becomes obsolete/perished/out-of-season? Please clearly indicate the approximate *'number of times'* and *'total size'* of the price changes. An example is done for you.**

Time lengths	Size
e.g. ...3 times....	.... -10......%
....	..................%

20. **If the real GDP falls to -1%, by approximately how many times (number of times) and by how much in total (in percentage terms) your firm will change the price of the product before the product becomes obsolete/perished/out-of-season? Please clearly indicate the approximate *'number of times'* and *'total size'* of the price changes. An example is done for you.**

Time lengths	Size
e.g. ...3 times....	.... -10......%
....	..................%

21. **How much do you think real GDP will change in the economy over the next 12 months?**

22. **How informative is real GDP growth for your decisions related to price setting, investment and wages? Please rate your answer according to the indicated scale.**

	Irrelevant	Fairly relevant	Very relevant
a. Price setting	1	2	3
b. Investment	1	2	3
c. Wages	1	2	3

23. **Higher real GDP growth (e.g. 5%-6%) in the economy will affect your firms' profitability in what way:**
    a.   Increase in profits
    b.   Decrease in profits
    c.   No change in profits

This is the end of the survey. Thank you very much for your time.