Essays in the Economics of Regulation and Competition

Vicenç Esteve Guasch

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School of Economics and Centre for Competition Policy
University of East Anglia
United Kingdom

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Abstract

This thesis is divided into two parts, each of them covering a relevant topic in the economics of regulation and competition. Part I is devoted to the England and Wales water sector, and more concretely on the interaction between the regulatory regime and capital structure. Part II studies the competitive constraint from private label products on branded products in different categories of retail goods.

Since its privatization in 1989, England and Wales water firms have increased leverage levels dramatically, raising alarms among regulatory authorities, the general press, and academics. However, the relevant literature suggests that this is a welfare enhancing phenomenon in regulated sectors. Firms can strategically use debt to obtain higher prices, and this prevents the regulator to behave opportunistically, yielding higher investment and welfare. We test this theory in Chapter 1. We find that this is not the case and therefore our results pose serious questions on whether the main theoretical framework applies in our case study. In Chapter 2, we explore alternatives theories and find that firms have reacted to regulatory tightening by increasing leverage in order to maintain high returns, which works in the opposite direction of the theory.

The aim of Part II is to assess the competitive constraint from private label to branded products, which is central in competition analysis. We estimate a LA/AIDS demand system in five retail product categories, which allows us to recover elasticities and diversion ratios between brands, including the private label. Based on our findings, we conclude that (1) private label products should generally be considered in the same market as the branded products, (2) high market shares for private label products imply a tight competitive constraint on branded products, (3) lower private label shares impose a less severe constraint, but still significant.

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Part I

Capital Structure and Regulation: The England and Wales Water Sector

Abstract for Part I

We investigate the capital structure decisions by regulated firms in the context of the England and Wales Water Sector. Since its privatization in 1989, water firms have increased leverage levels dramatically, raising alarms among regulatory authorities, the general press, and academics. Some firms have attained gearing ratios above 90%, well above international standards for the water industry. Because firms in the sector are free to make their own financing choices and regulated prices are set individually for each firm, our case study offers excellent testing grown for theories of capital structure and, more specifically, for theories of capital structure under regulation. The most prominent theory of the latter suggests that regulated firms can issue debt to influence regulatory outcomes. More concretely, the regulated firm can strategically increase leverage anticipating that the regulator will set higher prices due to a higher financial distress probability.

In Chapter 1 we empirically test this hypothesis in a panel of 18 England and Wales water companies for the period 1992 to 2018. Previous literature has used Granger causality tests in panels of regulated firms and has identified positive effects from leverage on regulated prices. We argue that this methodology has certain caveats and instead model the regulatory pricing decision. Throughout our sample, both regulated prices and leverage increase significantly. However, our econometric analysis shows that the regulator has not set higher regulated prices for firms with higher leverage. We show that regulatory prices, even if set differently for each firm, are determined to a large degree within a common regulatory climate. That is, in each review, prices are allowed to increase or decrease by the same factor for all the companies in a highly similar manner. This is to be expected in any regulatory setting as it reflects common macroeconomic conditions as well as a given regulatory climate. The factors that explain most of the cross-sectional differences between firms are profitability (-) and investment (+). Firms that obtained higher rates of profitability in previous reviews are corrected downwards, presumably passing through efficiency gains to consumers, and firms with higher investment are allowed to raise prices by a higher factor.

The observed levels of leverage at the time of the review do not appear to have any effect on regulated prices neither for the sector as a whole nor for the cross-sectional firm variation. Thus our results from Chapter 1 indicate that the use of debt as a strategic device to obtain higher regulated prices is probably not the best explanation of why the England and Wales water companies have increased leverage levels in such a substantial manner. The fundamental question arising is therefore whether the incentives created by the regulatory regime matter at all and, complementary, which factors are important in determining capital structure decisions in the sector. We address these questions in Chapter 2 by empirically modelling firms' leverage decisions as a function of well-known capital structure determinants as well as regulatory variables. Interestingly, our results indicate a significant negative effect from regulatory tightening on leverage ratios, establishing causality operating in the opposite direction that the theory suggests.

Introduction

Since the 1980s, many countries have embarked on the privatization of their public utilities. Where competition was hard to introduce, price regulation was put in place as the alternative. In Britain, price cap regulation was designed to create efficiency incentives. Building on the then buoyant economics of regulation literature, incentive regulation would be superior to the traditional US-style rate of return. The Water sector, a natural monopoly, was one clear candidate for the experiment. It was one of the latest sectors to be privatized during Thatcher's government, with quite a lot of public opposition (Bakker, 2003). The ten big Water and Sewerage Companies (WaSC), regional monopolies in state ownership, were publicly offered on the stock exchange in 1989. Several Water only Companies (WoC) were also floated and granted licenses to operate in the new regulatory regime. A national independent regulator, Ofwat, would set price caps for each regional monopoly every five years. The companies would be able to keep any gains from cost reductions until the subsequent regulatory period.

As of today, more than thirty years later, the experience is still being highly scrutinised. The international tendency towards water privatization has been somewhat reversed, with an important wave of re-municipalizations taking place worldwide, from Berlin to Jakarta (Lobina, 2017). In Britain, the Labour party has proposed the re-nationalization of the sector since the 2015 general election, and a survey from 2017 reports that 59% of Britons would be in favour of it[1] (although according to the water firms association this number has declined to 42%, with over 90% of Britons trusting their water company).[2] The debate is not less intense in academia: a google scholar search of "water privatization" leads to more than 2,000 results, and "water privatization" "England and Wales" to 280, both queries made in May 2021 and only including articles published from 2017.

Since the main promise of privatization was to deliver productive efficiency, most of the literature on the sector has focused on measuring it (e.g. Saal and Parker 2001;

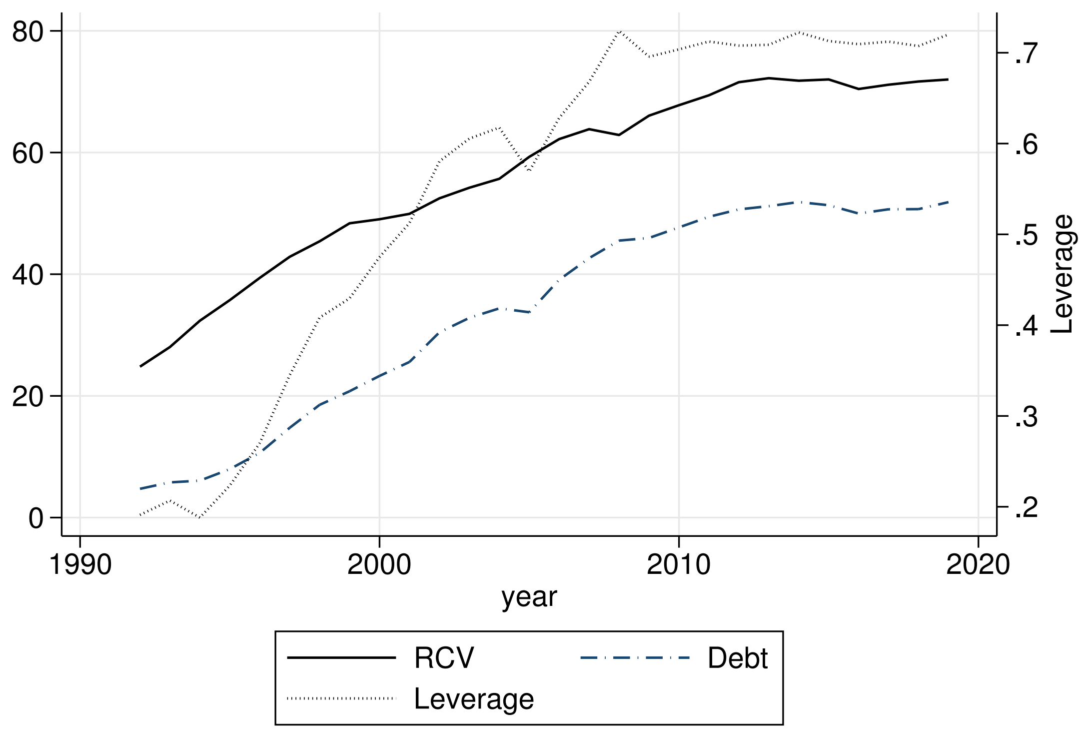
[1]https://yougov.co.uk/topics/politics/articles-reports/2017/05/19/nationalisation-vs-privatisation-public-view

[2]https://www.water.org.uk/news-item/new-survey-reveals-a-big-fall-in-support-for-water-nationalisation-and-shows-high-levels-of-trust-in-water-companies/

Saal et al. 2007). The sector has increased total factor productivity at an annual 1% average (2.1% if adjusted by quality) since privatization, 100% of Britons have access to drinking water and receive sewerage treatment, and quality indicators are in line with European standards (Frontier Economics, 2017). Yet most of the criticism of the sector has not focused on productive efficiency but instead in its financial dimension. Before the Initial Public Offering that finalised the privatisation process, the British government underwrote the entire debt of the national water companies. The newly private companies started trading at zero levels of gearing. Since then, leverage levels have been progressively increasing. Almost the totality of the new assets added to the sector's capital base has been financed by debt (see Figure 1). The current gearing ratios are above 70% for the industry, with some companies' ratios above 90%. These ratios are high compared to international standards for water companies or other utilities (Oxera, 2002), and the increase in leverage has been accompanied by more than a 30% price increase in real prices throughout the period (Figure 2).

These high levels of gearing have raised alarm. The sector was described as an organised rip-off in The Financial Times (Ford, 2017) and The Spectator (Cohen, 2017), where water companies were accused of borrowing to distribute dividends instead of financing investment. The UK Department of Trade and Industry, together with

Figure 1: Sector's evolution of RCV and debt.

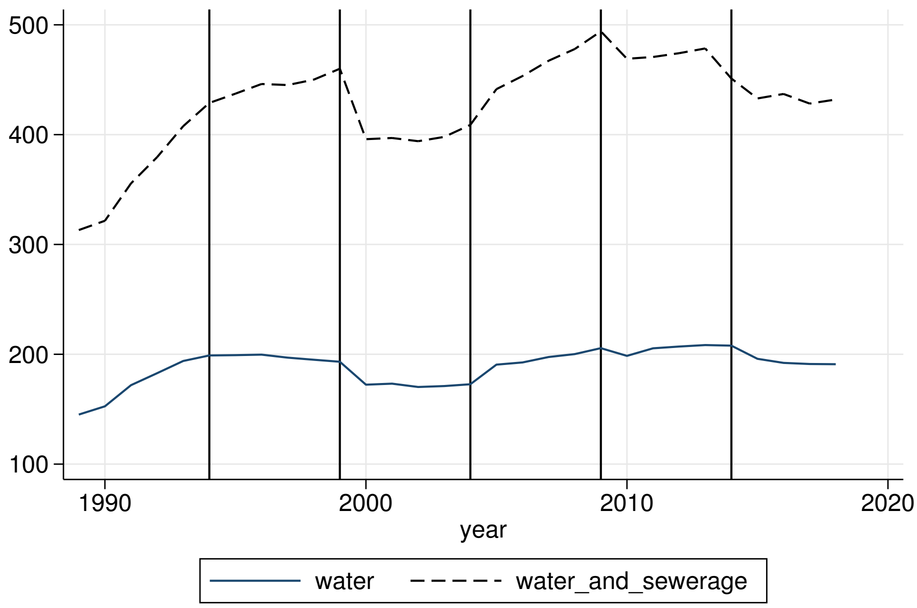


RCV: Regulatory Capital Value.
RCV and Debt in £M. Sector's leverage ratio is wegihted by RCV

HM Treasury, issued a joint report expressing concerns over a "dash-for-debt" in public utilities and argued that the high levels of gearing could be transferring risks to consumers and threaten future financeability requirements (DTI-HMT, 2004). The same water regulator, Ofwat, commissioned a joint consultation with Ofgem (the energy regulator) on similar grounds (Ofwat and Ofgem, 2006). On the academic side, Helm and Tindall (2009) have argued that the regulatory regime creates incentives for firms to increase leverage until balance sheet exhaustion, with the result of transferring risk to consumers. A report commissioned by Ofwat, confidential at the time, presented survey evidence claiming that water companies were betting on an eventual government bailout in case of financial distress (Ofwat, 2009).

Capital structure is often neglected in the economics of regulation literature. On the other hand, the finance literature on capital structure determinants has traditionally put aside regulated firms (Fama and French, 2001; Frank and Goyal, 2009). And yet this is striking if we consider how important is the issue, in magnitude. The water industry, as well as every other utility, is highly capital intensive. It periodically requires large investments to maintain and modernise the network, and near-future challenges of population growth and climate change will most likely increase funding needs. The ability to finance is a necessary condition of a successful regulatory regime, and one of the main reasons for privatization in the first place. When regulators set prices, they consciously take into account, and make assumptions about, companies' cost of capital, which is determined by their capital structure. Firms' cost of capital in turn, as well as capital structure, is affected by regulatory deci-

Figure 2: Average household bill



Average water / water and sewerage annual household bill in \pounds2019
Vertical lines correspond to review years

sions. The regulator needs to make sure that companies will provide the necessary investment for future regulatory periods and guarantee that the existing investors earn a “fair rate of return”, which is nothing else than the estimated firm’s cost of capital. To put this into perspective, consider the England and Wales water sector asset base, which by 2019 amounted to £68 billion. Water bills need to cover the rate applied to the base. That is, a 1% difference in the cost of capital adds up to £680 million, equivalent to a 15% reduction in the total operational costs of the sector, which were £4 billion in that same year. In the last 2019 price review, Ofwat set the lowest cost of capital for the industry since privatization: 2.9%, which triggered the immediate appeal to the Competition and Markets Authority (CMA) of several water firms.[3]

Given the magnitude of firms’ capital structure decisions and the concerns highlighted above, we believe that it is important to study the mechanisms and incentives that determine firms’ capital structure decisions and their pricing consequences. The discussion surrounding the sector has been so far qualitative.[4] The aim of Part I of this thesis is to provide an empirical analysis of capital structure in the England and Wales water sector.

In Chapter 1, we build on the theoretical framework by Spiegel and Spulber (1994) to test whether leverage has resulted in a positive effect on regulated prices. This is the main theoretical framework regarding capital structure decisions under regulation, in which firms can strategically use debt to obtain higher prices Our results are negative: we do not observe any effect from leverage on prices. Therefore, the use of debt as a strategic device to obtain higher regulated prices is probably not the best explanation of why the England and Wales water companies have increased leverage levels in such a substantial manner. To address this, we review the alternative literature in Chapter 2. We then estimate an empirical model of leverage determinants. Our results indicate a significant negative effect from regulated prices on leverage ratios, establishing a casual link that operates in the opposite direction of the theory. Instead of companies strategically using debt to obtain higher prices, we observe companies reacting to regulatory tightening. Section 2.4 concludes Chapter 1 and Chapter 2 jointly.

[3]The CMA finally ruled in favour of the water companies that appealed for a higher WACC than originally suggested by Ofwat (CMA, 2017)

[4]The only exception, to our knowledge, is Bertoméu-Sánchez (2019). However, he focuses on the effect of financialization.

Chapter 1

The Strategic Role of Debt

1.1 Introduction

The aim of this Chapter is to test whether higher leverage has resulted in higher regulated prices in the England and Wales water sector. This hypothesis is derived from the main theoretical literature in regards to regulated firms' capital structure, which builds on the theoretical model by Spiegel and Spulber (1994). As we have seen in the introduction of Part I of this thesis, many have raised alarm about "above-normal" levels of leverage in the sector, but the academic discussion has been only qualitative. We instead test the theory empirically.

The strategic use of debt highlighted in Spiegel and Spulber (from now on, the S&S effect) and others has been tested empirically, but never, to the best of our knowledge, in a single sector setting. The approach taken has been to identify the effects of leverage on regulated prices using Granger-causality tests in panels of regulated firms. However, we argue that this methodological approach has some caveats. Given that in our case we have a concrete and detailed understanding of the price setting process, we model the regulator's decision directly. In the England and Wales water sector, the regulator sets price limits individually for each firm, and firms are free to make their own capital structure decisions. This allows us to identify any potential effect of leverage on prices once we control for the other variables that affect price caps.

Our dataset covers 18 England and Wales water companies for the period 1992 to 2019, which includes 5 regulatory reviews. In each of these, the regulator determines by how much prices are allowed to increase (decrease) in each of the following 5 years. We will see that price caps are set in a highly similar manner for all firms in each review, and that an important part of the variation between firms is explained

[0] An earlier version of this paper was awarded *Best Paper in Water* at the 8th Florence School of Regulation Annual Conference in Florence, Italy, 2019.

by investment, which is bargained at the review time, and past levels of profitability. This is to be expected in a well-functioning price cap regulatory regime: efficiency gains are transferred to consumers in the following reviews. In other words, firms that obtained higher rates of profitability in a given regulatory period are subsequently tightened further. Concerning leverage, our econometric results show that the regulator has not set higher prices for firms with higher levels of leverage. For robustness, we also replicate the methodological approach from previous empirical studies in the appendix, obtaining similar results.

The chapter is organised as follows. In Section 1.2 we shortly present the theoretical framework from which we build our testable hypothesis. In Section 1.3, we give an overview of the England and Wales water sector. We then shortly describe the existing empirical approach of the previous literature in Section 1.4. In Section 1.5 we present our empirical strategy, section 1.6 describes the data, and section 1.7 discusses the results. Section 1.8 concludes the chapter.

1.2 Theoretical Framework

In this section, we shortly present the theoretical framework from which we take our testable hypothesis: higher gearing resulting in higher regulated prices.

The model developed by Spiegel and Spulber (1994) highlights the basic mechanism. The model consists of a profit-maximizing monopolist facing a price-setting welfare-maximizing regulator. The firm can finance welfare-enhancing investment by issuing a mix of debt and/or equity. The presence of a random cost parameter implies that any amount of debt generates a positive probability of financial distress for a certain price level range. Adding bankruptcy costs, the regulator sets a higher price in the presence of positive debt, and so the firm, anticipating this, strategically issues debt to increase the regulated price.

Several variations of this baseline model have been developed in the literature to include additional features. Spiegel and Spulber (1994) include a parameter capturing regulatory climate in the welfare function to obtain testable hypotheses regarding the regulatory regime. Cambini and Rondi (2011) introduce downstream competition, and Cambini and Spiegel (2016) model a partially state-owned firm. The mechanism by which prices are increasing in debt is common in all these models: i.e. the internalization of bankruptcy costs by the regulator.

But the effect of leverage on prices is only half of the story. In the baseline model by Spiegel and Spulber (1994) and the following ones, debt is used by the firm to extract higher regulated prices and, indirectly, equilibrium investment and welfare are also higher. The presence of debt prevents the regulator to behave opportunistically: once investment, which is modelled as sunk, has been undertaken by the firm, the regulator cannot lower prices *ex post*. High debt and therefore higher prices are thus welcomed: equilibrium investment and overall welfare are higher in the high-debt equilibrium.

The timing of the model is the following: in stage 1, the firm chooses how much to invest and the mix of debt and equity. In stage 2, the capital market competitively determines the value of the securities. In stage 3, the regulated price is set and the random cost parameter is realised (both in Spiegel and Spulber 1994 and Spiegel and Spulber 1997). However, it is possible to show that the positive effect of debt on prices is still present with exogenous investment. In a simplified version of the model by Moore et al. (2014) the regulator does not maximize a welfare function but instead announces a regulatory rule with a given level of cost pass-through: $p = a + (1 - b)C$, where p is a simple linear function of the firm's cost C with a given cost pass-through $(1 - b)$, b being the parameter that captures the power of incentives.[1] The firm maximizes revenue subject to meeting an exogenous investment requirement once the pricing rule has been announced. For a big enough level of cost pass-through, the positive effect of leverage on prices is still present with the same level of investment that would have resulted in the low cost pass-through - low price - low debt equilibrium. We reproduce this model in Appendix A.1.

In the next section, we describe the regulatory setting of the England and Wales water sector, and we will see that the way in which firms increase their capital stock is highly controlled by the regulator. This feature of the sector can have important implications for the application of the theoretical framework, i.e. if investment is given, the S&S could be present only for prices, but not act as a device that prevents regulatory opportunism.

1.3 The England and Wales Regulatory Regime

The England and Wales water sector is regulated by a price cap incentive regulation mechanism. Price cap regulation was widely introduced in the United Kingdom during the liberalization and privatization reforms of the 1980s. The aim was to move away from traditional rate of return regulation that was commonly used in the United States and introduce a framework that would create incentives to increase productive efficiency.

[1] This is common in the price regulation literature (see for example Cowan 2002).

Ofwat sets price caps for each of the individual water companies every five years. The first price cap was set directly by the government in 1989, and since then the regulator has gone through six reviews, PR94, PR99, PR04, PR09, PR14, and PR19. Price caps are set using an $RPI - X + Q$ formula, where $RPI - X$ is the traditional price cap formulation including the Retail Price Index and an efficiency factor X. This basic framework was corrected by adding a Q factor, which allows for price increases justified, for example, by new environmental requirements. Price caps should accommodate for each company's operational expenditure (with potential efficiency gains deducted), as well as for allowing the necessary investments to be undertaken by each individual firm. Moreover, the price cap needs to ensure that the shareholders of the company earn a fair rate of return on their assets. This fair return on investment is established by estimating the industry cost of capital and applying it to each company's regulatory capital value (RCV), their asset base. Firms are free to choose their capital structure and payout policy.

The review process consists of the following steps. When the price review is approaching, each company is asked to submit a business plan. This includes their expected operational (Opex) and capital (Capex) expenditures and proposed price increase for the next five years. Ofwat then adjusts the business plans to their own expectations.

The cost of capital is estimated by the regulator using a standard Capital Assets Pricing Model (CAPM). A pre-tax weighted average cost of capital (WACC) is computed using the following formula:

$$WACC = \frac{D}{RCV} r_D + \frac{E}{RCV} r_E = \frac{D}{RCV} r_D + \frac{E}{RCV} r_M \beta_E \tag{1.1}$$

Where $RCV = E + D = Equity + Debt$. The return on debt r_D is estimated given historical, actual, and forecasted debt interests. The return on equity, r_E, is not directly observable, and therefore is computed by multiplying the market return, r_M, by the industry estimated equity beta β_E. For the leverage ratio, Ofwat has applied a standardised assumption. Initially, in the early 1990s, the notional gearing assumption was set at 45%, well above the average industry actual ratios at the time (PWC, 2013). This notional gearing was increased gradually at each price review, reaching 60% in PR14, falling behind the actual gearing ratios of the industry since the year 2002. The notional gearing has been widely used in other regulated industries such as Transport, Energy, and Telecoms (PWC, 2013).

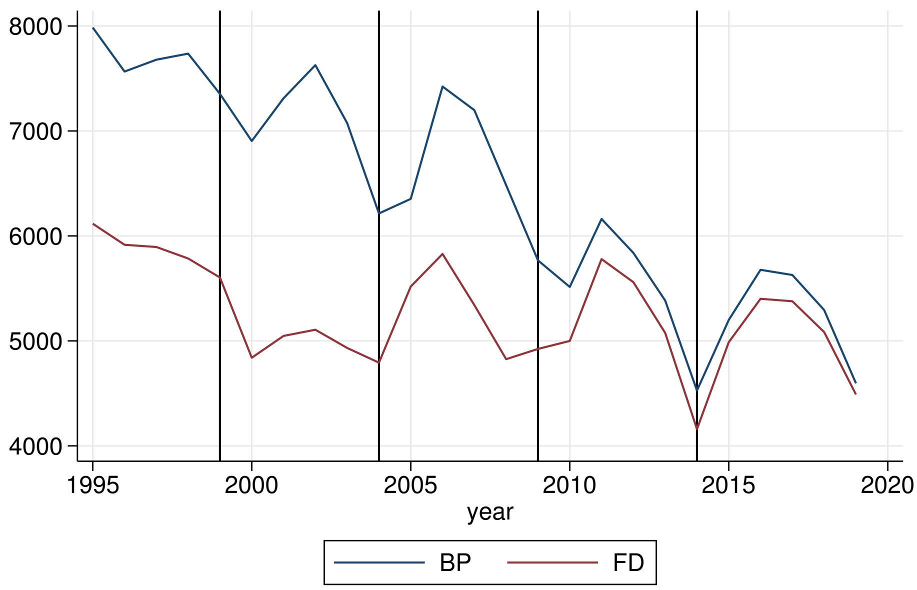
Therefore, leverage enters the regulatory pricing equation via WACC, not as actually observed, but through the notional gearing assumption. If a firm actual leverage ratio and/or cost of capital deviate from the assumptions made by the regulator, it is not by regulatory design that prices should react. If the regulator is reacting to an increased probability of bankruptcy by setting higher prices, as the theoretical model suggests, then this is not explicitly acknowledged by the regulatory setting rules.

A note on investment

In Section 1.2 we explained that the S&S effect on prices is only one side of the coin, the other side being higher investment and welfare equilibrium levels. But we also showed that the strategic effect from leverage to prices can be theoretically shown even when investment is exogenously set (see Appendix A.1). This is crucial because the main conclusion by Spiegel and Spulber (1994) or Bortolotti et al. (2011) is that the high-debt-high-price equilibrium is welcomed to guarantee high investment. However, investment in the England and Wales water sector needs to be scrutinised in more detail.

When companies submit business plans for the price review, they include investment as well as a proposed price increase. The regulator bases its final determinations on these. Since 1994, Ofwat has systematically allowed lower investment programs than the ones initially proposed –and therefore also lower price caps than the ones proposed by firms. Figure 1.1 presents the business plan proposed investment of the whole sector and the amount finally determined by Ofwat. It can be seen that the gap is considerable and that it has progressively narrowed.

Figure 1.1: Sector's total capital expenditure



BP: Proposed in Business Plan. FD: Ofwat Final Determinations.
Millions of £2019
Vertical lines represent review years.

Firms have the incentive to invest because Ofwat will remunerate them for it at a fair rate of return via WACC. The regulator has capped the proposed investment programs in what appears to be a systematic *gold-plating* strategy of the firms. This has important implications for the theoretical framework, i.e. it is hard to believe that companies would benefit from having their debt acting as a device that limits regulatory opportunism. Even if theoretically Ofwat could have behaved opportunistically have the companies not been highly geared up, the data seems to show the opposite. Ofwat has kept investment at lower levels than firms' proposals. Furthermore, investment has been declining over time while debt has been increasing.

1.4 Previous Empirical Literature

The empirical evidence on the relation between capital structure and regulation is not abundant, and it has mainly focused on the US.[2] More recently, two empirical papers have tested the effect of leverage on prices in a European context relying upon the theoretical framework explained in the previous section: Bortolotti et al. (2011) and Cambini and Rondi (2011). Both papers find a positive effect of leverage on regulated prices. The former uses a panel of traded European utilities covering the period 1994-2005, and the second a panel of European telecoms for the same period. The methodological approach is to use Granger-causality tests in order to identify the effect, a methodology that has been increasingly used in the economics of regulation (e.g. Alesina et al. 2005). The authors estimate the following model:

$$
\begin{aligned}
P_{i,t} &= \alpha_1 P_{i,t-1} + \alpha_2 P_{i,t-2} + \beta_1 L_{i,t-1} + \beta_2 L_{i,t-2} + \mu_i + \delta_t + \epsilon_{i,t} \\
L_{i,t} &= \theta_1 L_{i,t-1} + \theta_2 L_{i,t-2} + \gamma_1 P_{i,t-1} + \gamma_2 P_{i,t-2} + \mu_i + \delta_t + \nu_{i,t}
\end{aligned}
\tag{1.2}
$$

Where $P_{i,t}$ is the regulated price of firm i in year t and L the leverage ratio. For leverage to Granger-cause prices, it has to be the case that causality is only in one direction. If the β coefficients are significant and the γ coefficients are not, then we can say that leverage Granger-causes prices. If the relation is in both ways, we can only say that the variables are correlated. The model is estimated with Arellano and Bond Generalized Method of Moments (GMM) (Arellano and Bond, 1991; Blundell and Bond, 1998). Their results show that the β coefficients have a joint significant (and positive) effect on the regulated price, and that this relation is not significant in the other direction, prices to leverage. The interpretation of this result supports the hypothesis that higher leverage Granger-causes higher prices.

The problem with this methodology is that it does not take into account the regulatory length. That is, regulated prices are not set yearly. The model in 1.2 is capturing whether movements of leverage today are followed by movements of

[2] E.g. Taggart (1985) found that after the introduction of rate regulation in the US, firms increased leverage levels. See Bortolotti et al. (2011) for a more extensive review of the US evidence.

prices tomorrow, or vice-versa. With these variables being at the year level, the model is capturing movements from one variable to another year to year. In the England and Wales water sector, for example, some of which firms are included in the sample by Bortolotti et al. (2011), prices are only set by the regulator every 5 years. The variation that occurs within reviews is being captured by this model, but clearly cannot be attributed to a regulatory reaction to higher leverage, as the theory predicts. And this is not only the case in the water sector. Network price controls are now set for 8-year periods in the UK, and some UK companies in this regulatory regime are also included in the first study. The same is true, for example, in Telecoms, included in both studies.

In the next section, we propose an alternative methodological approach that takes the regulatory review period into account.

1.5 Empirical Strategy

In this section, we empirically test the hypothesis that higher leverage is used strategically to induce higher regulated prices their a sample of England and Wales water companies for the period 1992 to 2019. Because firms are free to choose its capital structure, and price caps are set differently for each specific firm by the regulator, we can potentially identify the effect of leverage on prices after controlling for the main determinants of price caps in the regulatory regime.

In the England and Wales water sector, price caps are set individually for each of the firms every five years. More concretely, the regulator establishes a factor by which prices are allowed to increase or decrease, on a yearly basis, with respect to the previous year. These are known, in the specific regulatory jargon, as K factors. At the same time, firms present significant heterogeneity in their mean leverage ratios as well as in the timing of leverage adjustments. We can thus identify the effect of leverage on K factors from the cross-sectional differences among firms. The case study therefore offers a perfect testing ground for the theory. Because we know which factors are explicitly taken into account by the regulator when setting price limits, we can control for confounding factors that change from regulatory review to regulatory review and have an influence on the decision on the regulatory price.

K factors are set following the following rule:

$$P_{i,t} = P_{i,t-1}(1 + RPI_t + K_{i,t}) \tag{1.3}$$

Where the K factor is composed of two elements: $K = -X + Q$. Recall that $RPI - X$ is the traditional price cap formulation including the Retail Price Index and an efficiency factor X and Q is an investment allowance. In terms of building a model of K factors we thus need to think in terms of X and Q.

For the Q element, investment data is available in our dataset as captured by the accumulated asset base or RCV. That is, the evolution of the asset base reflects the evolution of investment net of depreciation. Because K factors are meant to accommodate for the remuneration of the asset base as a whole, we expect the growth rate of RCV, i.e. net investment, to be an important explanatory variable of K factors.

The individual efficiency X factors can reflect a variety of issues. First of all, they might obey to a given regulatory climate of the correspondent review. E.g. the regulator might be pressured politically in a given review to be tougher on water bills. We will capture this effect which is common to all firms at a given regulatory period using dummies. Second, they can reflect heterogeneity on firms' past performance. If a firm performed relatively well in the previous regulatory period, this can be interpreted by the regulator as an increase in efficiency, which can therefore be passed to consumers by reducing K factors. Alternatively, it could also be interpreted as a regulatory misjudgement, in retrospective, of having established over- loose (tight) price caps in the past, needing downward (or upward) correction.

Our main proxy for X factors is therefore profitability, defined as operating profit divided by the asset base, RCV.[3] Observed profitability at a given review reflects whether the firm has outperformed the regulator's expectation. We therefore expect a negative effect from observed profitability into K factors.

Our baseline K factor model is:

$$K_{i,t} = \alpha + \beta_1 Profitab_{i,r-1} + \beta_2 RCV_{i,t} + \beta_3 Leverage_{i,r-1} + \sum_{r=2}^{5} \gamma_r PR_r + \phi_i + \epsilon_{i,t} \quad (1.4)$$

Where $K_{i,t}$ is the growth rate of the average bill of firm i in period t, in real terms (and therefore net of RPI). The timing of the variables is of great importance in our setting. K factors are set for each year t, but some variables are to be considered at the review level r. As our objective is to capture the effect of observed past performance at the time of the review, we need a variable that remains constant during the 5 years that K factors are set, which we compute as the 5-year average of the previous review period profitability ($Profitab$). RCV on the other hand, which is expressed in growth rates, appears in its actual value at year t. As investment is agreed at the time of the review, what is important in determining

[3] Ofwat definition, and widely accepted, measure of profitability.

K factors is not its observed value at the time of the review but its actual realization.

The potential effect of leverage must be captured in a similar way than profitability. It is the level of leverage observed on the previous review $r-1$ that will have an influence, constant through the next 5 years, on K factors. That is, the actual level of leverage is irrelevant for K factors, which have already been set. The effect that leverage might have on the regulatory decision must be, if present, the result of the observed levels. In this way, we solve the problem of Granger-causality, that potentially identifies movements within reviews that cannot be attributed to a regulatory reaction.

For profitability, it is reasonable to compute the five-year average, as what matters is the overall profitability of the last review. In the case of leverage on the other hand, we considered appropriate to include the observed leverage at the moment that the review is taking place. To illustrate this point, imagine that a given firm increases leverage substantially in year 1 of a given review and then reduces leverage by the same amount in year 2, and a firm that stays on the low leverage level from years 1 to 4 and gears up by the same amount as the first firm in year 5. Taking the average levels of leverage would imply that these two firms have the same value of observed leverage. However, if the regulator was reacting to leverage, the second firm would be treated as more leveraged than the first one. In other words, what matters is the last observed level of leverage. We therefore include the leverage level not as the last review average, as we do for profitability, but instead, as the last level observed at the time of the review.

PR_r are review period dummies, taking value of 1 for each of the 5 years of any given review and zero otherwise. As explained, these can capture the common political climate of a given review. Furthermore, these dummies also capture any macroeconomic conditions at the moment of the review that are taken into account to establish K factors, such as interest rates that enter the cost of capital estimation, which is common for all firms. Finally, we include firm fixed effects that can reflect a variety of idiosyncratic differences among our sample units.

1.6 The Data

Our dataset contains financial information on the England and Wales 10 Water and Sewerage Companies (WaSC) and 8 Water Only Companies (WoC). The panel is slightly unbalanced due to gaps in the data, and the unique source of the dataset is Ofwat. It covers the period 1992 to 2019, including 5 full reviews: PR94, PR99, PR04, PR09, and PR14. Table 1.1 contains the summary statistics of the variables needed for our analysis.

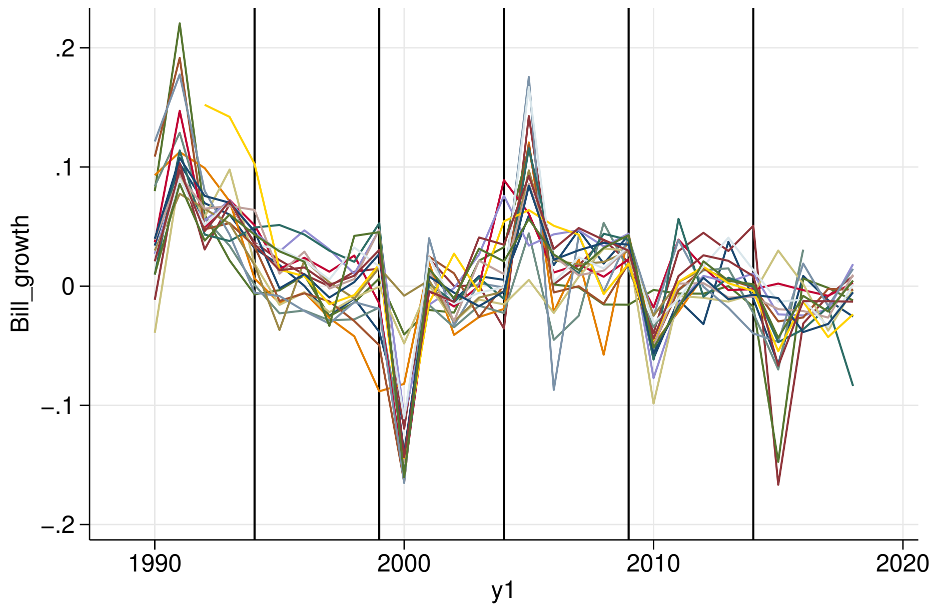
Table 1.1: Summary statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Bill (£)	523	322.43	141.87	107.34	664.32
Bill_growth (%)	504	0.010	0.051	-0.167	0.221
Revenue (£000s)	490	683.05	651.82	23.09	2,293.38
Revenue_growth (%)	472	0.009	0.046	-0.175	0.178
Profitability (ratio)	421	0.083	0.032	0.024	0.240
RCV (£000s)	532	3,089.41	3,342.75	39.92	14,729.30
RCV_growth (%)	513	0.043	0.059	-0.271	0.419
Leverage (ratio)	490	0.519	0.249	-0.407	0.948

The average water (or water and sewerage) bill average for the sample period is £322.43, at constant 2019 prices, and has experienced a growth rate of 1% per year. Revenue, which includes only regulated business revenue, has grown at almost identical rates. In PR09 Ofwat de facto switched from a price cap to a revenue cap mechanism, and in further sections, we will use K factors (growth rates) of both variables in our analyses, for the sake of robustness. K factors, whether in revenue or prices, vary substantially throughout the sample, ranging from -16% to +20%, with a standard deviation of 0.05 approximately.

Figure 1.2 overlays K factors for each of the firms in our sample through time. It can be seen that there is a clear common trend for all firms, with the largest movements occurring in the first year of review periods. This common trend is what we will capture by introducing price review dummies. Yet it can also be seen that there are

Figure 1.2: Sector's K factors



Graphs by firm.
Vertical lines represent review years

no minor differences between firms, variation that we expect to be attributed to our two main independent variables: RCV and profitability and, potentially, on leverage.

Notice that leverage has negative values. This is because it is defined as net debt divided by RCV, and at the beginning of the sample some firms had a positive net debt stock. Average profitability since 1992 has been above 8%. This ratio is defined as operating profit over RCV.

1.7 Results

Table 1.2 presents the results of our baseline model. We present the results with and without including leverage, and with and without firm fixed effects. The first thing to notice is that the variables we expected to predict K factors, as they are explicitly acknowledged by the regulator, are all statistically significant. Profitability, which as explained above has been defined as the average profitability rate of the previous review 5-year period, has a negative coefficient ranging from -0.646 to -1.073. This indicates that Ofwat reduces K factors by 0.65 to 1% as a result of an increase in profitability of 1%. Given that the range of profitability of our sample is 2.4 to 24%, and that the average K factor is 1%, differences in profitability levels between firms have had a large impact on determining the regulator's pricing decision.

The most straightforward explanation for this is to interpret Profitability as a proxy of X factors, as we explained above. Observing how well a firm did in a given regulatory period, the regulator can adjust prices accordingly, passing efficiency gains to consumers. Nevertheless, this is not the only explanation that can explain these highly significant coefficients. Another possibility is that the regulator is aiming at a target rate of return and that he is just adjusting its past mistakes. For example, if a firm was allowed excess profitability this is corrected in the next review period, independently of whether high profitability rates were a consequence of good performance. In both scenarios though, Ofwat is behaving as it is expected in the regulated context.

To make sure that we are not capturing a simple correlation between profitability and K factors, in Table 1.3 we switched the variable *Profitab*, which as explained in the previous review average, for the actual yearly profitability levels (*Actual_prof*). It can be seen that this variable has no significant effect on K factors. It is only the observed levels of profitability that matter, as we would expect from the regulatory setting.

The second variable that we expected to have a significant impact on K factors is the growth rate of the asset base, *RCV_growth*. The price setting rule allows explicitly

Table 1.2: K factor equation

	(1)	(2)	(3)	(4)
Profitab	-0.646***	-0.836***	-0.845***	-1.073***
	(0.105)	(0.129)	(0.112)	(0.137)
RCV_growth	0.201***	0.224***	0.114**	0.112**
	(0.0374)	(0.0404)	(0.0495)	(0.0509)
PR99	-0.0654***	-0.0700***	-0.0462***	-0.0507***
	(0.00674)	(0.00707)	(0.00708)	(0.00746)
PR04	-0.0169**	-0.0235***	0.00491	0.00300
	(0.00745)	(0.00796)	(0.00865)	(0.0101)
PR09	-0.0580***	-0.0652***	-0.0372***	-0.0387***
	(0.00813)	(0.00870)	(0.00971)	(0.0115)
PR14	-0.103***	-0.109***	-0.0816***	-0.0822***
	(0.0126)	(0.0130)	(0.0131)	(0.0145)
Leverage			-0.0191	-0.0386**
			(0.0137)	(0.0188)
_cons	0.0880***	0.107***	0.0937***	0.123***
	(0.0125)	(0.0145)	(0.0152)	(0.0178)
Obs.	437	437	352	352
R2_within	0.344	0.347	0.368	0.373
R2_between	0.506	0.450	0.429	0.348
Firm FE	No	Yes	No	Yes

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.010

Table 1.3: K factor equation with actual profitability

	(1)	(2)	(3)	(4)
Actual_prof	-0.134	-0.102	-0.113	-0.0135
	(0.0946)	(0.110)	(0.112)	(0.135)
RCV_growth	0.190***	0.181***	0.149***	0.116**
	(0.0391)	(0.0422)	(0.0548)	(0.0570)
Leverage			0.0113	-0.00112
			(0.0145)	(0.0207)
Obs.	420	420	336	336
R2_within	0.255	0.256	0.221	0.225
R2_between	0.647	0.646	0.518	0.320
Firm FE	No	Yes	No	Yes

Standard errors in parentheses

Review dummies and constant omitted

* p<0.10, ** p<0.05, *** p<0.010

for investment and it needs to make sure the asset base is remunerated. Our model is able to capture this regulatory feature, with coefficients for *RCV_growth* ranging 0.11-0.22. These coefficients imply that an increase of the asset base of 10% is translated into a 11-22% increase in prices, which is not only significant statistically but also in magnitude.

Turning into price review dummies, we can see that all of them have negative coefficients and almost all of them are statistically significant. This result can be attributed to several factors. First of all, as it can be seen in Figure 1.2, it is clear that the regulator sets K factors for all firms in a similar manner. The dummies in our model capture this common trend, with price review 1994, the first one by Ofwat, being the baseline. This common trend can be attributed to the regulatory (or political) climate. For example, a new chief of the regulator is appointed, or a new government, and they want to be perceived as making it tough for water companies to make profits, or to force prices downwards to obtain consumer sympathies. Even if the regulator is independent, which we do not contest, it seems clear that the data shows a very pronounced common trend. Another possibility is that the common trend obeys to macroeconomic factors, which are common for all firms. The clearest example of this is the WACC, which is computed using the same interest rate for all firms.

The negative coefficients imply that, everything else constant, the regulator has reduced K factors in each review with respect to the 1994 baseline. This is consistent with the fact that 1994 was seen as relatively lax by commentators in the past (e.g. Saal and Parker 2001; Saal et al. 2007). It is also important to notice that the constant of the model is positive and significant and ranges from 8 to 12%. Given that profitability and price review dummies all have negative coefficients, it could give the wrong impression that K factors are basically going down except for investment, but this is not the case. E.g. taking column 2, at base price review, with zero *RCV_growth*, and average profitability of 8%, our model predicts a K factor of -0.836*0.08+0.107=0.04012, which is a price increase of +4%. Taking the same values for profitability and RCV_growth, and moving to PR99, we obtain a -3%, +2% in PR04, etc. It can be seen that PR04 and PR14 were the two most lax reviews with respect to 1994, while PR99 and specially PR14 were the toughest.

Our model therefore is able to capture the nature of the regulatory regime. Given that we have included the two variables that are explicitly entered into the pricing rule, and also review-period dummies and firm fixed effects, we can now think of these as controls and test whether leverage has an impact on K factors. Columns 3 and 4 include Leverage (recall that this variable is defined as the last observe leverage ratio at the time of the review) on the main model, with and without firm fixed effects. In column 3, the coefficient in leverage has a coefficient not statistically different from zero. When introducing firm fixed effects in column 4, the coefficient appears significant at 5% confidence but has the opposite sign as we were expecting from the theory. The coefficient of -0.0386 implies that an increase in leverage of 0.10 (e.g. from 40% leverage ratio to 50%) would have a negative impact on the K factor of 0.3%. This amount is small but non-negligent, and the result is somewhat striking. In Table 1.4 we include the actual level of leverage, lagged one period, instead of the observed one, as a robustness check (recall that our variable is constant for every 5-year period). In this case, we obtain non-significant coefficients for leverage with or without firm fixed effects.

Table 1.4: K factor equation with actual leverage

	(1)	(2)
Profitab	-0.729***	-0.899***
	(0.120)	(0.143)
RCV_growth	0.199***	0.217***
	(0.0395)	(0.0429)
L.Actual_Lev	-0.0162	-0.0186
	(0.0135)	(0.0157)
Obs.	419	419
R2_within	0.346	0.348
R2_between	0.555	0.513
Firm FE	No	Yes

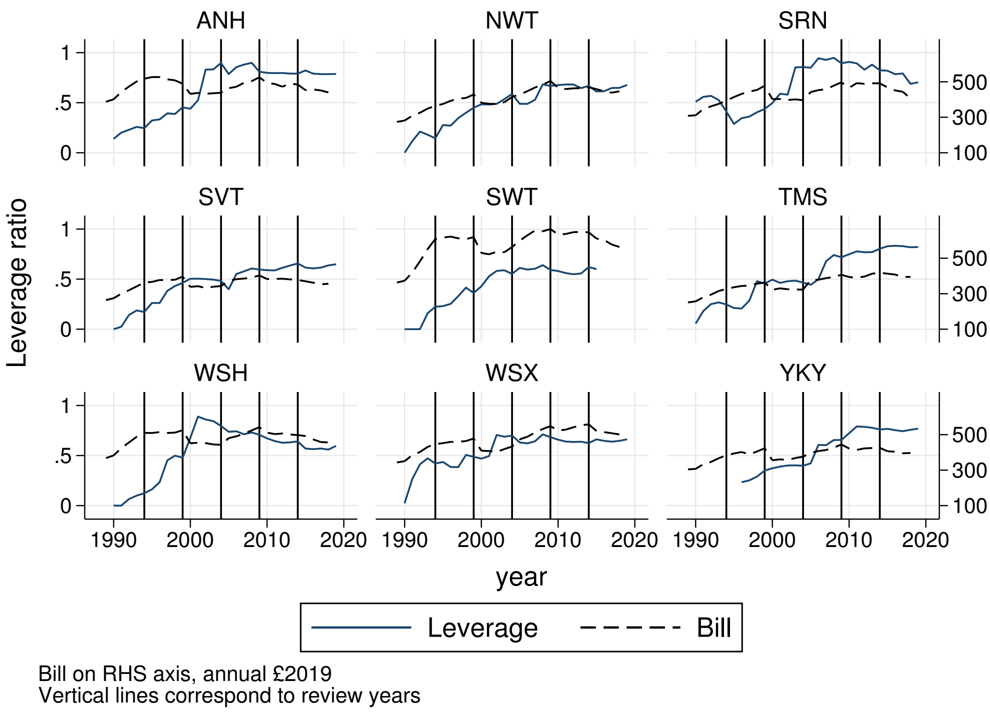
Standard errors in parentheses
Review dummies and constant omitted
* p<0.10, ** p<0.05, *** p<0.010

1.7.1 Overall Sector's Leverage

A potential caveat of this analysis is the fact that the regulator might have been reacting to the overall sector's leverage. That is, it could be argued that, after observing high levels of leverage in the sector, Ofwat decided to be more lenient overall. This effect could occur in several ways. For example, the regulator could set a higher-than-appropriate cost of capital, which is an important component of the K-factors setting process for the sector as a whole. Alternatively, the regulator could simply be more lenient, as per the regulatory climate, and this could be a consequence of the observed high levels of leverage. Econometrically, any of these options would imply that the negative adjustments that we observe with respect to PR94 in our review dummies would have actually been larger had the levels of leverage in the sector been lower.

Unfortunately, our dataset contains only 5 reviews, and introducing the sector's overall levels of leverage interacted with price review dummies leaves us without enough degrees of freedom to carry out a sensible estimation. However, we can consider this possibility by looking into the evolution of the sector's debt levels and K-factors graphically. Recall Figure 1 from Section 1.3, which presents the overall leverage ratio of the sector, weighted by the firms' assets. Figures 1.3 and 1.4 present the average bill and leverage ratio by company.

Figure 1.3: Leverage ratio and average bill, WaSCs*



The weighted average leverage ratio of the sector increased steadily from 1994 until 2003-2004, years in which it experienced a correction, and continued growing afterwards until reaching an almost constant 70% average. According to the results of our baseline model (Table 1.2), price review 1999 and price review 2014 were the toughest compared to the baseline of the 1994 review. This leaves us with price review 2004 and 2009 being relatively less tough. Given that for PR99 the average levels of leverage were just above 40% and that by PR14 these had stabilised, it seems reasonable to suspect that Ofwat could have tightened price caps by a lower factor in PR04 and PR09 as a consequence of the increases in debt that preceded those two intermediate reviews. That is, in 1999 overall levels were not seen as being

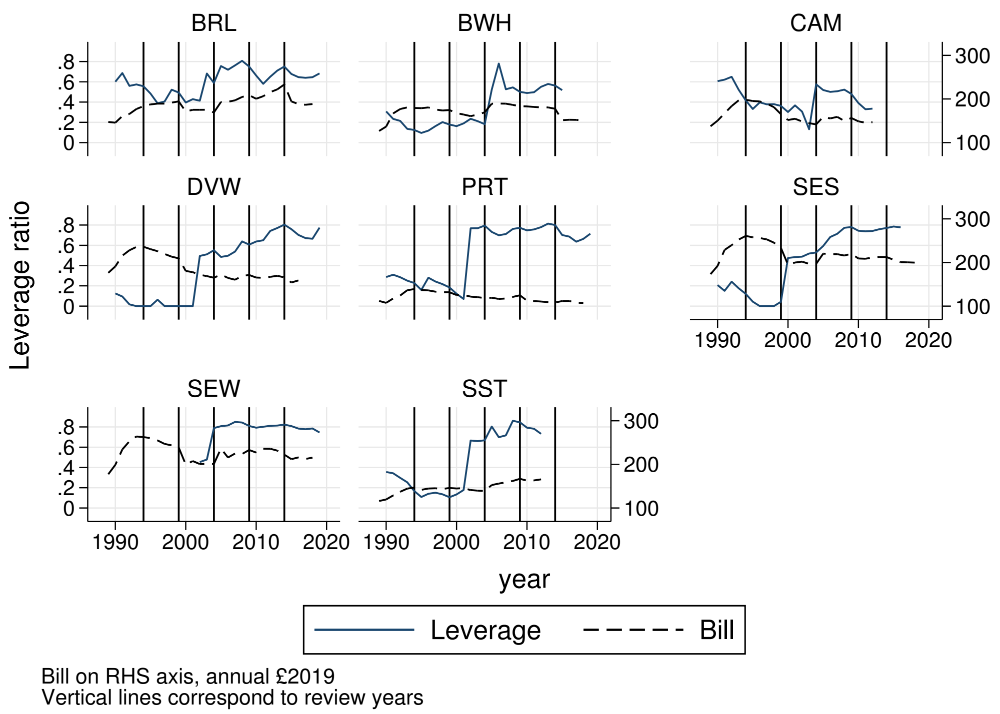
*ANH: Anglian Water, NWT, United Utilities (Northubmrian) SRN: Southern Water, SVT: Severn Trent, SWT: South West Water, TMS: Thames Water, WSH: Dwr Cymru Cyfyngedig (Welsh), WSX: Wessex Water, YKY: Yorkshire Water.

**BRL: Bristol Water, BWH: Bournemouth Water, CAM: Cambridge Water, DVW: Dee Valley Water, PRT: Portsmouth Water, SES: South &East Surrey Water, SEW: South East Water, SRN: South Staffordshire Water problematic, but were seen as a such in the next two reviews, as a consequence of which the regulator became more lenient for the sector as whole. Finally in PR14, because debt levels had reached a kind of steady state, the regulator was able to tighten further again.

The problem with this reasoning is that one would expect PR04 to have been a less tough review than PR09, and our estimates clearly show the opposite. By 2004, some firms had indeed reached levels of leverage of considerable magnitude, such as ANH and SRN (see Figure 1.3), but the overall sector's ratio was still below 70%. Yet many firms had their rapid leverage increases after PR04, like TMS, YKY, or NWT, and the sector's average had reached 80% by then. Considering this, one would think that it would be in 2009, and not in 2004, when the regulator would have been more lenient, but the coefficients in our model indicate the opposite.

In summary, one of the shortcomings of our econometric analysis is the possibility that the regulator has reacted to the average levels of leverage in the sector by applying less tightening overall. However, if this was indeed the case we would expect to see less tightening in 2009 than in 2004, and we observe the opposite.

Figure 1.4: Leverage ratio and average bill, WoC**



1.7.2 Robustness

Regulatory Learning

Another possible shortcoming of our analysis is that, because it covers a long period, it could be subject to regulatory learning. By this we mean that it could be possible that the regulator reacted eventually to high levels of leverage, but then stopped "falling into the trap". To explore this possibility, we interact each price review dummy with the observed level of leverage. By doing this, we would be able to identify any marginal effect of leverage on prices if it had been present solely in a given review. If this was the case, some of the interactions should be significant and positive. In Table 1.5 we report our model including these interactions. As it can be seen, none of them are statistically significant from zero, ruling out the possibility that we missed out on a regulatory learning effect.

Table 1.5: K factor equation with regulatory learning

	(1)	(2)
Profitab	-0.876***	-1.101***
	(0.177)	(0.252)
Leverage	-0.00329	-0.0454
	(0.0263)	(0.0324)
RCV_growth	0.117	0.112
	(0.0731)	(0.0756)
PR99xLev	-0.0455	-0.0269
	(0.0399)	(0.0405)
PR04xLev	0.00619	0.0470
	(0.0300)	(0.0393)
PR09xLev	-0.0455	-0.0115
	(0.0393)	(0.0549)
PR14xLev	0.0407	0.0726
	(0.134)	(0.131)
Obs.	352	352
R2_within	0.376	0.383
R2_between	0.402	0.299
Firm FE	No	Yes

Standard errors in parentheses
Review dummies ommitted
* p<0.10, ** p<0.05, *** p<0.010

Revenue Cap

In 2009, Ofwat de facto switched its regime from a price cap to a revenue cap (Ofwat, 2010). In Table 1.6 we report the results for Table 1.2 having switched the dependent variable from the bill growth rate (K factor) to the revenue growth rate (K (revenue) factor). It can be appreciated that the results are fairly similar. Coefficients for the variable *RCV_growth* have decreased, but not substantially, and the coefficients on Leverage, the main variable of interest, are virtually identical.

Table 1.6: K factor (revenue) equation

	(1)	(2)	(3)	(4)
Profitab	-0.666***	-0.844***	-0.818***	-1.080***
	(0.101)	(0.125)	(0.112)	(0.137)
RCV_growth	0.160***	0.179***	0.0875*	0.0931*
	(0.0371)	(0.0400)	(0.0495)	(0.0508)
PR99	-0.0552***	-0.0596***	-0.0395***	-0.0445***
	(0.00653)	(0.00683)	(0.00707)	(0.00744)
PR04	-0.0119*	-0.0184**	0.00515	0.00215
	(0.00721)	(0.00770)	(0.00864)	(0.0100)
PR09	-0.0529***	-0.0601***	-0.0367***	-0.0396***
	(0.00788)	(0.00842)	(0.00970)	(0.0114)
PR14	-0.0917***	-0.0989***	-0.0755***	-0.0776***
	(0.0120)	(0.0124)	(0.0131)	(0.0145)
Leverage			-0.0133	-0.0328*
			(0.0137)	(0.0188)
_cons	0.0875***	0.105***	0.0907***	0.123***
	(0.0121)	(0.0141)	(0.0152)	(0.0178)
Obs.	419	419	352	352
R2_within	0.312	0.315	0.341	0.348
R2_between	0.484	0.459	0.379	0.288
Firm FE	No	Yes	No	Yes

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.010

Granger Tests

As a last robustness test, we reproduce the methodological approach of Bortolotti et al. (2011) and Cambini and Rondi (2011) in the appendix, which consists in determining whether prices Granger-cause leverage or vice-versa. We do not find Granger-causality in neither direction.

1.8 Conclusion

In this Chapter, we have tested the hypothesis of whether higher leverage has resulted in higher regulated prices in the England and Wales water sector. In order to do so, we have departed from the previous literature methodological approach consisting of Granger-causality tests and instead have estimated a K factor equation that reflects the England and Wales regulatory setting pricing rule. Our model is able to capture the main explicit factors that enter the K factor setting process, and once we control for these, we find no evidence of any positive effect of leverage in prices.

The main caveat of our econometric analysis is that it does not allow us to estimate a potential industry-wide effect. As discussed previously, we are only able to identify the S&S effect if the regulator has reacted to leverage on an individual firm basis. However, the trends in the data do not support this possibility.

Our main result is therefore striking given how well established are the predictions of the S&S theoretical framework, which have been also supported empirically. In the Appendix, we have reproduced the Granger-tests methodological approach from the previous literature, obtaining similar results. We therefore conclude this chapter by stating that there is no evidence of an S&S effect on prices in the England and Wales water sector. The reasons behind the high levels of gearing in the sector should be found then in alternative explanations. We proceed to discuss these in the next chapter.

Chapter 2

Capital Structure Determinants

2.1 Introduction

We have concluded the first chapter of this thesis by pointing out that there is no evidence of a S&S effect in the England and Wales water sector: high leverage has not led to higher regulated prices. Thus the strategic use of debt in the S&S sense is probably not the best explanation of why the England and Wales water companies have increased leverage levels in such a substantial manner. The fundamental question arising is therefore whether the incentives created by the regulatory regime matter at all and, complementary, to determine which factors are important in determining capital structure decisions in the sector.

In this chapter, we address these questions by empirically modelling firms' leverage decisions as a function of well-known capital structure determinants as well as regulatory variables. Interestingly, our results indicate a significant negative effect from regulatory tightening on leverage ratios, establishing causality that operates in the opposite direction as the S&S theoretical framework suggests.

The chapter is organised as follows. We start by discussing the two alternative explanations that have been put forward regarding the high levels of leverage in the sector: the arbitrage hypothesis by Helm and Tindall (2009) and leverage as a reaction to regulatory tightening introduced by Mayer (2005). We also discuss classical theories of capital structure in the context of regulation. Based on the previous, we present our empirical model and results in Section 2.3. Section 2.4 concludes.

2.2 Literature Review

Before proceeding to the empirical part of the chapter, in this section we highlight the alternative hypotheses that have been put forward in the academic literature regarding the sector's high levels of leverage. These are two: Helm's WACC arbitrage hypothesis (Helm and Tindall, 2009) and Mayer's view of leverage as a reaction to regulatory tightening (Mayer, 2005). Both of these were written in the precise context of the England and Wales water sector. We discuss each of them in relation to general capital structure theory and S&S.

2.2.1 Helm's Arbitrage Hypothesis

Helm and Tindall (2009) argued that the England and Wales water sector regulatory regime creates an incentive for firms to increase leverage until balance sheets are exhausted.[1] This results from the way that the asset base is remunerated via WACC. In the author's words:

> "What made it particularly attractive to swap debt for equity was that the regulators calculated the allowed rates of return on the basis of a weighted average cost of capital (WACC) and on the assumption of low gearing. Since the marginal cost of debt was below the WACC (by definition) there was obviously an arbitrage to be made. In due course, it was achieved, either through acquirers, or by incumbents fighting off takeovers."(Helm and Tindall, 2009, p. 422)

To understand the fact that the marginal cost of debt is, by definition, lower than the WACC, let us reproduce its formula below:

$$WACC = \frac{D}{D+E}r_D + \frac{E}{D+E}r_E \tag{2.1}$$

If one assumes that the cost of debt, r_D, is smaller than the return on equity, r_E, then an increase in leverage (D/E, debt-equity) lowers the WACC, and therefore there is an incentive to increase leverage as soon as the estimated WACC is fixed by the regulator. The fact that $r_D < r_E$ is a usual assumption, as r_D would be the risk-free interest rate plus a risk premium (that could be zero in a non-risk firm hypothetical situation), while the return on equity will always bear the residual claimant's risk; i.e. debt holders get paid first. However, the seminal work by Modigliani and Miller (1958, 1963) showed that under certain conditions the WACC will be constant at any leverage level because equity holders will demand an increasing premium as a function of leverage. Therefore, even fixing r_D at the risk-free rate, the presence of leverage increases the volatility of equity holders' expected returns, which need to be compensated. The return on assets, which is equivalent to the WACC, and the value of the firm, are constant at any leverage ratio.

[1] See also Helm (2018) and Helm (2020).

For MM propositions to hold, one needs to assume perfect capital markets: no taxes or transaction costs, perfect certainty, and rational behaviour. If taxes are introduced, the MM model has the striking result of 100% leverage being the optimal capital structure due to the tax-shield effect of debt. Following this result, Myers and Majluf (1984) argued that with the introduction of financial distress costs, the WACC would result in a U-shape function with respect to leverage. This is commonly known as static trade-off theory.

Having this in mind, one can see Helm's point clearly: if current leverage is below optimal, then gearing up will reduce the actual cost of capital with respect to the regulator's estimated WACC. Yet notice that this is true only up to the optimal level and, more importantly, that the firm would have the incentive to reduce its cost of capital even in the absence of regulation. This is true unless the regulatory setting remunerated assets, for example, by indexing the WACC to actual levels. But this would remove the incentive of firms to achieve optimal financing costs, which is socially desirable. This is why Ofwat has repeatedly stressed that companies are free to choose their own capital structure (Ofwat , 2015).

The mechanism that Helm describes as an arbitrage is therefore nothing else than the movement of leverage ratios towards optimal. Whether firms move beyond the optimal point is a different issue, which we will discuss below. Yet the regulator seems to have given credit to this reasoning:

> "There is no doubt, with the benefit of hindsight, that it had been too easy for companies and their shareholders to make money by gearing up and outperforming the WACC, rather than by improving operating efficiency, innovating and delivering for customers"(Ross, 2017)

This is somewhat surprising, given that the alleged arbitrage has allowed firms to achieve very low financing costs that have resulted in a lower estimated WACC at each price review. This is exactly how one would expect price cap regulation to work regarding operating costs: after a standard has been set, firms are able to capture the efficiency gains until the next review, in which the regulator will be able to lower prices. This is indeed what has happened regarding the cost of capital: starting as all-equity, firms have progressively reduced the cost of capital through gearing, and the estimated WACC has been adjusted downwards, from 5.5% in PR94 to 3.6% in PR14. If the WACC had been indexed, the incentive to reduce the cost of capital might well have vanished. In PR19, Ofwat set the lowest WACC since privatization (2.96%), which resulted in some of the water companies making an official claim to the Competition and Markets Authority, which they won (CMA, 2017).

Recall that the WACC is a very important component of the average water bill, as it is the whole regulated asset base that will be remunerated. Even a half percentage point can make a significant difference. This was made obvious by the official claim to PR19, but the debate surrounding what constitutes an appropriate WACC has always accompanied the sector. It had been argued that Ofwat had been overestimating the WACC systematically. First by attributing a higher-than-actual cost of debt (Turner, 2013), and second by the assumption of equity betas that were unrealistically high for a low-risk sector as water (Tapia, 2012). Nevertheless, this has been "solved" in subsequent price reviews and does not deviate the firm from achieving the optimal capital structure.

We therefore argue that the arbitrage hypothesis is wrong: the incentive to increase leverage would exist even in the absence of regulation, and it is desirable from an efficiency perspective, until optimal. Whether debt levels in the sector are beyond optimal is out of the scope of this thesis. However, there is some evidence that points out in this direction. A report commissioned by Ofwat presented survey evidence that water companies, and their creditors, were taking into account the probability of being bailed out in case of financial distress (Oxera, 2002). In other words, creditors would have granted interest rates that were not fully internalising the cost of potential bankruptcy. This is of course a reason for concern. If this is the case, firms are gearing up beyond optimal, which could result in different scenarios, all of them negative. In the eventually of an actual episode of financial distress, a bailout would imply a higher bill for taxpayers, and if the company is allowed to fail, this could perfectly compromise the ability to raise finance in the future, which is one of the main objectives to be guaranteed by sound regulation. If the regulator translates the higher risk of bankruptcy into higher bills, we are basically observing the S&S effect. But Chapter 1 of this thesis has shown that the price effect is not observable in the data, and we have not seen either any event of financial distress.

Another important caveat of the arbitrage hypothesis is that it portrays a scenario in which the gearing assumption of the regulator is lower than the actual one. Yet this was not the case in earlier reviews, in which notional gearing assumptions were set at 40% when companies were way below these gearing ratios. Yet the incentive to gear up was still present, as we have argued, as it would have been in the absence of regulation.

Nevertheless, there is an important lesson to be learned from this discussion: finance matters. The discussion around privatization was focused mostly on productive efficiency, and the fact that a single percentage point of the cost of capital could offset any achievable efficiency gains was overlooked. Even if we assume that firms have moved to optimal gearing levels and not beyond, and therefore had the good incentives in place, one cannot but wonder whether the regulatory regime ignored that equity holders would earn higher returns by gearing up than by increasing actual productivity.

Ownership changes and financialization

Helm also explains how ownership changes have impacted capital structure decisions. In Helm and Tindall (2009), the authors track several acquisitions of water and other utility companies in the UK, as well as stock exchange de-listings that most of the companies have undergone (today only 3 of the 10 big water firms remain listed). These de-listings and acquisitions, which are often simultaneous, are also accompanied by large increases in leverage. These are often the result of a special dividend that is paid once to the new owners, and it is common not only in regulated sectors.

Allen and Pryke (2013) explain in more detail how the sector has become highly financialised by these new actors. They describe, using the example of Thames Water, a model of debt refinancing based on securitization that, according to them, resulted in highly opaque financial structures, with various subsidiaries in off-shore tax havens, engineered to transfer profits from consumers to investors. This financial engineering operations were also cited in the general press, with the Financial Times writing a series of pieces on it (see for example Ford 2017).

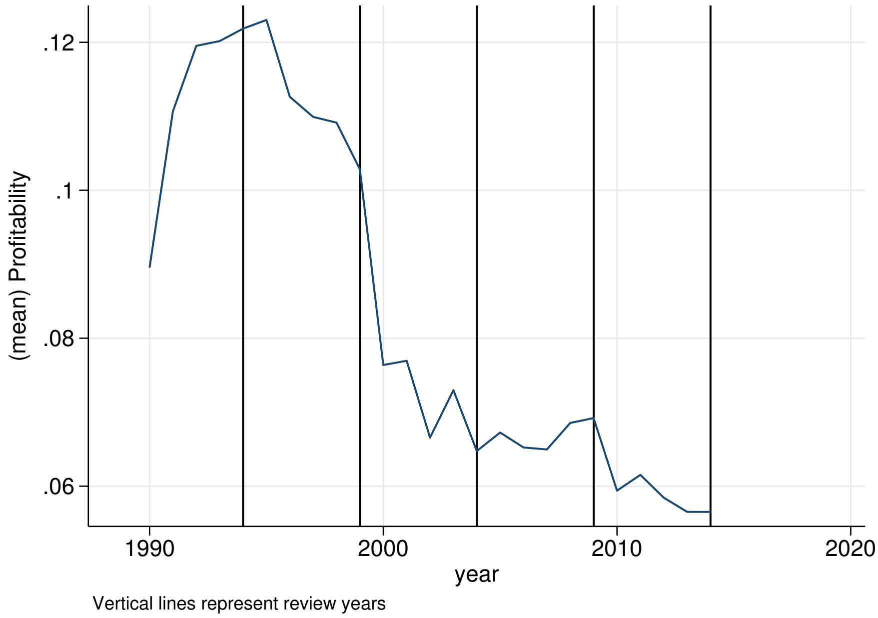
For our purpose here though, these operations, no matter how condemnable might be, are irrelevant so far as they are not related to the regulatory regime. Water companies have steady cash-flows, which is a pre-condition for the securitization described in Allen and Pryke (2013), but having steady cash-flows is not is not an exclusive feature of regulated companies. Leveraged buyouts and financial engineering, together with other strategies usually grouped under the umbrella of the term financialization, are not a feature of regulated sectors but a highly generalised one.

For empirical reasons, we will consider ownership changes as a potential explanatory variable for leverage levels, but we do not believe that these financial engineering operations are a result of the regulatory regime. If these issues are a reason for concern, as they might well be, they are beyond the scope of price cap regulation.

2.2.2 Leverage as a Reaction to Regulatory Tightening

In the last section, we have argued that the arbitrage hypothesis is somewhat misleading. Firms would have had the incentive to increase leverage even in the absence

Figure 2.1: Average profitability



of regulation unless the WACC had been indexed. Given this and our results of Chapter 1, we cannot but ask the question of whether regulation matters at all.

An alternative explanation to this puzzle was described by Mayer (2005). The author argued that the progressive tightening on price caps pushed firms into leverage as a strategy to maintain high returns for investors. The first review by Ofwat, in 1994, was considered to be relatively loose, and PR99 for the first time reduced water bills in real terms. Figure 2.1 reflects the decline of profitability over time.

Mayer's argument is that, being "short of cash", firms borrowed in order to maintain profits. In the empirical section of this chapter, we show that this is indeed the case: firms that were assigned lower price caps in PR99 geared up more.

This argument does not rule out the S&S effect. As Mayer already pointed out, the now highly indebted firms were sending a message to the regulator: a further tightening and the victim will be dead. This is precisely the consequence of leverage in the S&S framework. Yet, as argued throughout Chapter 1, we cannot see any evidence of this effect on prices.

If this argument is correct, then regulation decisions do have an impact on capital structure decisions. In the next section, we empirically test this hypothesis by estimating a leverage equation.

2.2.3 Dividends

It is impossible to completely disentangle the relation between payout and gearing policies. The MM propositions on capital structure are naturally followed by the dividend irrelevance theorem (Modigliani and Miller, 1963). However, there is a huge body of literature that explains why the dividend irrelevance theorem might be "irrelevant" (see for example DeAngelo and DeAngelo 2006). The aim of this chapter is not to focus on payout policy, but one of the reasons for gearing up that has been put forward in the literature relates directly to the payment of dividends.

Armitage (2012) uses the England and Wales water sector to discuss payout policy in the context of regulated firms, in a qualitative manner. He shows that dividend payments for the 10 big water companies have exceeded free cash-flows, and that traditional theories of payout policy are unable to explain this feature. He instead argues that there is a strong demand for dividends from investors, which cannot be the result of information asymmetries (because they are very low in the sector) nor an attempt to reduce agency costs.

One needs to take into account that dividends can be used to immediately gear up a company, or what it is the same, borrowing can be used to pay dividends. We do not aim in this chapter to model dividends as an explanatory variable for leverage, for this obvious reason, but it is important to bear in mind that increases in leverage might be explained by the demand for dividends from investors that Armitage (2012) describes. We have already mentioned that ownership changes are usually accompanied by large increases in leverage and are complementary to a large dividend payment. More interesting, there is a clear relation between Mayer's explanation of leverage as a response to regulatory tightening and the high demand for dividends. If lower cash-flows resulting from lower price caps are inducing firms to borrow more, this is a way to maintain high levels of dividends.

2.3 Empirical Strategy

The aim of this section is twofold: first, to test whether Mayer's hypothesis of leverage as a reaction to regulatory tightening holds, and second to explore which variables are important in determining firms' capital structure. In order to do this, we estimate a simple leverage equation that includes commonly known determinants from the finance literature as well as regulatory variables. This methodological approach is used in Bortolotti et al. (2011) and Cambini and Rondi (2011) to test whether private firms and/or firms under an independent regulatory agency present higher leverage levels in a sample of regulated firms. Leverage equations have also been widely used in the financed literature, usually excluding regulated firms (Frank and Goyal, 2003, 2009).

Capital Structure Determinants

Profitability

Profitability, defined in the last chapter as operating profits over RCV, tends to be an important predictor of leverage in the finance literature. However, the direction of its sign has been a highly debated topic (Frank and Goyal, 2003). On the one hand, trade-off theory suggests that more profitable firms would borrow more, as they have lower financing costs and a lower probability of bankruptcy. On the other hand, pecking order theory suggests that less profitable firms will borrow more (Myers and Majluf, 1984). The intuition behind the latter arises from the fact that managers prefer to raise financing first through internal funds, then through debt, and only raising equity as a last resort. This is due to the asymmetry of information between managers and investors. In the context of non-regulated firms, it has commonly been found, empirically, that profitability affects leverage negatively, supporting the pecking order theory argument (Frank and Goyal, 2009).

However, the two conflicting views on the effect of profitability have to be nuanced in the presence of regulation. The fact that the most profitable firms have lower financing costs, and therefore it is expected that this variable presents a positive effect on leverage, still holds. Yet we also know that the regulatory regime adjusts price caps as a reaction to past profitability, which could be anticipated by creditors, vanishing the effect. The reasoning behind pecking order theory becomes even more debatable. In its context, firms would recur to debt when lacking internal funds. But companies in the England and Wales water sector are known to extract any cash flows and distribute them (Armitage, 2012). After all, new investment would have to be financed by agreeing with the regulator, and therefore there is no need to maintain reserves for future investment opportunities. Furthermore, if Mayer (2005) argument is right, firms would be borrowing when obtaining lower profitability to maintain dividends. Or, in other words, firms would borrow when short of cash. If this is the case, we would expect the effect of profitability on leverage to be negative, but not for the reasons that pecking order theory suggests. It is also important to notice that the reason to prefer internal to external borrowing in this framework is due to asymmetric information, firms would have a hard time obtaining finance at the fair expected return. And external finance also involves transaction costs. Water companies though, because they are highly regulated, should have minimum problems of asymmetric information or transaction costs. Information about their accounts is readily available and scrutinised publicly. Pecking order theory is therefore not expected to apply in strong force in our scenario. A negative effect of profitability on leverage ratios might entail a largely different explanation.

Ownership

Ownership changes can introduce significant changes in companies gearing policy, as we saw in the previous section. To account for this, we introduce the variable *Priv_Eq*, for private equity, which is a dummy that takes value zero until the year a firm is acquired by a private equity fund. We expect this variable to have a positive effect on leverage.

Regulatory tightening

To test Mayer's hypothesis of leverage as a reaction to regulatory tightening, we need to introduce a variable that can capture "tightness". The first candidate appears to be no other than K factors themselves, or prices, as they represent the tightness-looseness of the regulatory decision. However, including K factors in a leverage equation would be misleading, because these are determined by review. A more accurate representation of how tight a price review has been for a given firm consists in interacting the K factor with the respective regulatory period dummy. These will capture the degree of regulatory tightening faced by each company at each review, which is precisely the variable that will capture the effect described by Mayer. We expect these interaction terms, or at least some of them, to have a negative effect on leverage: the looser the K factors in a given review the less a firm would need to leverage as a reaction to regulatory tightening.

Firm size

Firm size typically has a positive effect on leverage because larger firms tend to have lower financing costs and are less likely to experience financial distress. In the case of the England and Wales water sector, this variable might not be relevant as all the firms are subject to the same regulatory regime, which implies that both their financing costs and their probability of bankruptcy are similar. We proxy this variable with the log of RCV.

Other common determinants

Depreciation and fixed-to-total assets ratios are also commonly used in leverage equation empirical models. Depreciation because it creates a non-debt tax shield, and therefore is expected to have a positive effect on gearing, and fixed-to-total assets as it reflects tangibility: better collateral and therefore lower financing costs. Unfortunately, we have data on depreciation only for a few years of our sample, and no data for fixed-to-total assets ratios. However, we do not expect these variables to be relevant in our context. Depreciation rates in the sector are regulated and will be the same across firms. Differences in the magnitude of depreciated assets can be captured by firms' size. Regarding tangibility, we believe that firm fixed effects will suffice to capture any relevant differences between firms, as the asset structure of these companies is generally constant over time.

Macroeconomic factors

Finally, any leverage equation should include year dummies to account for interest rates or other economic factors. Because all our companies are in the same country, yearly dummies would suffice to take into account any relevant economic factor.

2.3.1 Estimation and Results

The leverage equation to be estimated is the following:

$$\begin{aligned} Lev_{i,t} &= \alpha + \beta_1 Profitability_{i,t} + \beta_2 Priv\_Eq_{i,t} \\ &+\beta_3 \ln RCV_{i,t} + \sum_{r=2}^{4} \gamma_r PR_r * K_{i,t} + \phi_i + \delta_t + \epsilon_{i,t} \end{aligned} \quad (2.2)$$

Where $Lev_{i,t}$ is the leverage ratio of firm i in year t, and the subscript r denotes the 5-year review period. Our γ coefficients capture the effect of regulatory tightening in a given review with respect to the 1994 baseline. We report the results of this estimation in Table 2.1. Column 1 presents the model without firm fixed effects, and column 2 with firm fixed effects included. The first result to be noticed is that the effect of Profitability is positive and significant. In terms of magnitude, our coefficient of 2.9-3% predicts that the leverage ratio would decrease by this amount in the event of a 1% increase in profitability. For example, a profitability decrease of 3% results in a 9% leverage increase. Having in mind the downward trend of profitability shown in Figure 2.1 and the upward trend in leverage shown in Figure 1, this result is consistent with two variables moving in opposite directions over time. More interestingly, given that our estimation includes year dummies that would capture the common trend in leverage, our result shows that differences in borrowing behaviour can be explained by differences in profitability between firms.

The negative effect of profitability on leverage is consistent with the fact that water firms borrow to maintain dividend payments. As discussed earlier, thinking about this result in terms of pecking order theory, which is the usual reasoning for non-regulated firms, could be misleading. If this was the case, this negative coefficient would imply that firms prefer to use internal funds before turning into debt. Yet we know that firms in the sector do not maintain cash reserves and that investment is pre-determined in each regulatory review. These negative coefficients therefore provide evidence that firms use borrowing to maintain dividend payments to equity holders, as suggested by Armitage (2012).

Table 2.1: Leverage Equation

	(1)	(2)
Profitability	-2.921***	-3.097***
	(0.662)	(0.567)
Priv_Eq	0.0944**	0.103**
	(0.0410)	(0.0409)
lnRCV	0.104	0.00952
	(0.198)	(0.00929)
K_x_PR99	-1.215***	-1.231***
	(0.374)	(0.368)
K_x_PR04	0.268	0.391
	(0.312)	(0.296)
K_x_PR09	-1.024	-0.782
	(0.925)	(0.790)
Obs.	420	420
R2_within	0.742	0.740
R2_between	0.318	0.627
Firm FE	No	Yes

Standard errors in parentheses
SEs clustered by firm
* p<0.10, ** p<0.05, *** p<0.010

The coefficients for our variable *Priv_Eq* are also significant and imply an increase in leverage of 9.4-10% if a water company is acquired by a private equity firm. The coefficient of private equity are to be expected given that these firms specialize in relatively short-term financial engineering that typically consists in the replacement of much of the equity with debt, with the intention of selling back the firm after a few years (Helm and Tindall, 2009). Firm size, proxied by *lnRCV*, does not appear to affect leverage, but this is not surprising given the institutional similarities between the firms.

The interaction terms between K factors and review dummies are our proxy for regulatory tightening. As we explained in the previous section, we were expecting to see some of these significant and negative if we were to support Mayer's hypothesis. This is indeed the case but only for one of the review periods, as compared to the baseline review 1994. The coefficient of 1.18-1.20 indicates that a percentage point increase in price caps during the review of 1999 would have resulted in an approximate 12% reduction in leverage. In other words, our model predicts that without PR99 tightening we would have not observed such increases in gearing. This reaction, which is not repeated in subsequent price reviews, provides evidence in support of Mayer's hypothesis. Firms that were assigned looser price caps did not increase leverage by that much during the next five years, as they were probably not in such need of cash to maintain dividends as their counterparts.

2.3.2 Revenue Cap

Because Ofwat moved into a revenue cap in 2009, we now report the results of Table 2.1 switching the K factor interactions for its revenue counterparts. We obtain very similar results.

Table 2.2: Leverage Equation with revenue K factors

	(1)	(2)
Profitability	-2.596***	-2.667***
	(0.634)	(0.570)
Priv_Eq	0.0925**	0.0997**
	(0.0399)	(0.0419)
lnRCV	0.0485	0.0123
	(0.209)	(0.0101)
Krev_x_PR99	-1.222**	-1.223**
	(0.501)	(0.488)
Krev_x_PR04	-0.110	-0.0548
	(0.297)	(0.284)
Krev_x_PR09	-0.327	-0.243
	(0.752)	(0.746)
Obs.	403	403
R2_within	0.738	0.737
R2_between	0.505	0.654
Firm FE	No	Yes

Standard errors in parentheses
SEs clustered by firm
* p<0.10, ** p<0.05, *** p<0.010

2.4 Conclusion

In this chapter, we have reviewed alternative explanations to the S&S framework regarding the high levels of leverage observed in the England and Wales water sector. Our econometric results show that leverage is importantly determined by profitability, which provides evidence of a significant demand for dividends. Ownership changes have impacted positively on leverage ratios, as it had already been highlighted in the literature. Finally, we observe that the degree of regulatory tightening did have an impact on gearing policy, but only following price review 1999, the one, and only, that reduced bills in real terms.

Conclusion Part I

In Part I of this thesis we have analysed the England and Wales water sector capital structure in relation to its regulatory regime. Before privatization, the British government wrote off the totality of debt of the sector. Since then, water companies have increased their leverage levels dramatically, with some companies reaching levels well above international standards for water utilities. These high levels of leverage in the sector raised alarms in government and the general press, also motivating a few academic articles of qualitative nature. This thesis has taken an empirical approach in interpreting what are the causes of these high levels of leverage and, more generally, in explaining what is the relation between the regulatory regime and the capital structure decisions of firms, prices, and investment.

In Chapter 1 we modelled the regulatory pricing decision to test the hypothesis that firms increase leverage to obtain higher regulated prices. This hypothesis is derived from the main theoretical framework regarding capital structure in regulated firms, the Spiegel and Spulber (S&S) model. The S&S model shows that the regulator will set a higher price in the presence of higher debt because the latter creates a positive probability of bankruptcy, which is costly. Anticipating this, firms strategically issue debt. However, our econometric analysis finds no evidence of a positive effect of leverage on regulated prices. We have tested this proposition modelling the regulatory pricing decision, finding no effect. We also reproduced the methodology already applied in the previous literature, confirming the same result.

Our result could be easily misinterpreted as good news: leverage is not translating into higher prices for consumers. However, the effect on prices is only one side of the coin in the S&S framework. In the theoretical equilibrium, higher debt also results in higher investment rates, with the overall effect on welfare being positive. But as we discuss in Chapter 1, investment in the sector seems to suffer from gold-plating. Furthermore, it can be shown theoretically that the positive effect of leverage on prices can exist when investment is exogenously determined. The fact that we do not find evidence supporting the S&S should therefore be interpreted cautiously.

Interestingly, our model of regulated prices or, more concretely, K factors, reveals a well-functioning price cap regulatory regime. The regulator has been tightening K factors in each regulatory review following the 1994 first price caps. This can be the result of political and regulatory climate factors as well as macroeconomic favourable conditions during the period, e.g. low interest rates. Complementary, our model also shows that K factors react negatively to observed profitability levels. That is, firms that obtain higher profitability rates in a given regulatory period are adjusted downwards in the following one. Given that price cap regulation is intended to pass through efficiency gains to consumers, this is what we would expect from a well-functioning regime. Leverage is not found to have an effect on K factors in any model specification.

An important limitation of our empirical strategy is that it can only capture the effect of leverage in prices if this is the result of the cross-sectional variation. We would be able to capture a positive effect from leverage to prices if the regulator is setting higher prices for firms that present higher levels of leverage, but not if the regulator is reacting for the sector as a whole. If the regulator is being loose in setting price caps as a result of the overall sector leverage, or because of certain firms' gearing level, but not applying these looser price caps to the corresponding firms but to the sector as a whole, we would not be able to capture this effect. However, we have argued that this possibility does not fit well with what we would expect to see in the data, i.e. Ofwat did not tighten price caps less strictly in the reviews following the largest increases in overall sector's leverage.

The results of Chapter 1 therefore suggest that the theoretical framework by S&S is not able to explain the high leverage levels of the England and Wales water sector. In Chapter 2, we have empirically analysed capital structure determinants to explore alternative explanatory variables. The aim is to identify which variables affect firms' decisions and, more importantly, to determine whether regulatory decisions have an effect on firms' behaviour at all. In order to do this, we estimate a leverage equation that includes well-known capital structure determinants as well as a self-constructed variable that reflects the regulatory strictness faced by each firm in each regulatory review. Our results show that the latter has a positive effect on leverage. That is, we observe that a firm that is assigned tighter price caps in a given regulatory period gear up more. This indicates that the regulator does indeed create an incentive to increase leverage, but in the opposite direction and sign that the S&S predicts. Instead of the regulator setting higher prices as a reaction to higher leverage, we observe a reaction of firms, from regulatory tightening to higher leverage. Our findings are consistent with the fact that firms needed to borrow to maintain high levels of dividends Armitage (2012).

We cannot but stress once more the importance of financing in the context of regulated firms. We have seen that gearing up has been beneficial to consumers in the form of lower cost of capital, but the question of whether firms have leveraged beyond optimal levels remains open and might pose important challenges for the sector in the future. The fact that the finance side of regulation was not a primary element of discussion during privatization, which focused almost exclusively on efficiency, entails a lesson for the future. If price cap regulation aims to reward firms for being more efficient in the production sense but not in the financial one, we cannot but see the story of capital structure in the England and Wales water sector as a regulatory failure.

Part II

Private vs branded label competition

Chapter 3

The Competitive Constraints from Private Label Offers on Branded Grocery Pricing

Joint work with Kai-Uwe Kühn [1]

3.1 Introduction

The aim of this chapter is to assess the competitive impact of private label offerings on branded goods sold in grocery retail. We present an analysis of substitution between branded and private label products based on a selected number of product groups and draw conclusions for competition analysis. We show that private label products should generally be considered in the same market as branded products in the same product group. For a first assessment, the competitive constraint from a private label product on branded products is well approximated by its market share in the product group. This means that private labels should always be included in the initial assessment of market definition in merger cases. More importantly, they should also be included by default when calculating market shares to determine critical market share thresholds when applying, for example, the Vertical Block Exemption Regulation.

The issue of whether private label and branded goods should be considered in the same market has been debated in competition cases for a long time. Traditionally,

[1]University of East Anglia and Centre for Competition Policy. This chapter was originally written as a report commissioned by Markenverband, The German Brands Association. Vicenç Esteve Guasch conducted the empirical analysis and Kai-Uwe Kühn wrote most of the report. The report was nominated to the 2022 Antitrust Awards and can be consulted online in https://awards.concurrences.com/en/awards/2022/academic-articles/the-competitive-constraints-from-private-label-offers-on-branded-grocery (last consulted 28/03/2022). We thank Markenverband for its financial support and comments, IRI for discussions about its data, Michael Kummer for his help and comments, and Scott Thompson for useful discussion.

competition authorities have considered large price difference between branded and private label products as evidence that branded and private label products are in separate markets.[2]

Today, it is well known that this type of reasoning is economically incorrect. As we know from the industrial organization literature, a product that is perceived to be "lower quality" and sells at a low price can impose very significant competitive constraints on a product that has perceived "higher quality" and higher price.[3] This price differentiation by perceived quality is known as "vertical product differentiation" in the academic literature.

Private label and branded products in supermarkets are a classic example for such vertical product differentiation. Differentiation occurs primarily because branded products are heavily advertised in public media and thus have developed a brand image (Sutton, 1991). Private label products typically are not advertised heavily and are sold mostly at a significantly lower price. Price differentials are maintained because consumers have different willingness to pay for products with a strong brand image.[4]

We also know that markets with vertical product differentiation naturally tend towards a concentrated market structure when significant "quality" differences are endogenously created by sunk investments like advertising or R& D (Sutton, 1991). To assess market power in such markets it is therefore particularly important to understand whether private label brands do constrain the pricing of branded products in practice.

Since theory suggests that there are no simple criteria to establish the closeness of competition of private label products to branded products, such an assessment must be based on empirical analysis (Doyle and Murgatroyd, 2011). We provide such an analysis in this chapter for five consumer product categories. We show that private label products do indeed impose very significant competitive constraints on branded products.

[2]See Schmitt and Smith (2021) for a detailed case history.

[3]See Sutton (1986) for an overview of the literature on product differentiation along a quality dimension (as well as references within). Quality in this literature means any characteristic (e.g. advertising) that makes consumers willing to pay more for the product. Product differentiation arises from different willingness of consumers to pay for quality improvements.

[4]This is not to say that there are no other quality differences between branded products and private label products. Conversely, some private labels have been advertised and tried to develop their own brand image. However, advertising generally is a dominating differentiating factor between brands and private label products. The exposition chosen here is only for illustrative purposes. Our empirical analysis does not rely on these concepts, and traces only the substitution patterns.

Central to an analysis of market definition is determining the degree of substitutability between products. Since products are differentiated, some competing products will be closer substitutes than others. "Closeness of substitution" is often argued very loosely in competition cases, but it can be rigorously defined in economics, allowing empirical verification.

The economic concept capturing the idea of "closeness of competition" is the "diversion ratio". The diversion ratio from product i to product j is defined as the share of customers that switch from buying product i to buying product j in response to a price increase of product i. "Closeness of competition" is measured by the difference between the diversion ratios of product i's competitors. If a product j has the highest diversion ratio for product i, then j is the closest competitor to i, because it is the greatest beneficiary of substitution from product i in response to a price increase.

A private label product can be viewed as a competitor of a branded product when its diversion ratios is significant relative to the diversion ratios of other competing branded products. When the diversion ratio is higher than those of other branded products, then the private label can even be a closest competitor to a branded product (Shapiro, 1995). Our detailed empirical analysis across several product groups suggests that it is not unusual that a private label product is the closest competitor to all the major brands in a product category. Our analysis shows this to be the case for product groups with large private label market share. These are typically product groups where the vertical dimension of differentiation dominates. When there is additionally horizontal product differentiation this will generally not be the case. However, for all product categories included in our analysis, private label products are close enough competitors to impose substantial competitive pressure.

These findings lead to two important conclusions:

1. Private label products should by default be considered in the same market as the branded products in a product category.
2. Market definition should only exclude private label from the market if there is other strong evidence that there is negligible competitive constraint from the private label product.

There are some further patterns that emerge from our analysis that are helpful for a first assessment of competition in a market with private label and branded products. First, when the price of a private label product is much lower than those of branded products while the measured market share of the private label product is very high, the competitive constraint from private label products is very strong. In fact, a very high market share of the private label product does not indicate a dominant position. On the contrary, it indicates a tight competitive constraint on the ability of brands to raise prices.

Second, even where the market share of a private label product is much smaller, including the private label product as part of the market is appropriate for an initial analysis. Although in all analysis of competition, market shares are typically not sufficient to ascertain the competitive constraint from a specific product, this would not justify excluding the private label product when calculating market share. Including all branded and private label products in a product category for a first cut analysis appears to be no worse than in other markets, where market shares are routinely used as a filter in competition assessments or for determining whether a product is covered by, for example, the Vertical Block Exemption Regulation.

Third, we also show that private label products can be the main competitive constraint on branded products that, at first glance, appear to belong to a different product category altogether. An example analysed in this chapter is diapers and training pants. These two product categories might be classified as belonging to different markets in a competition investigation that attempts to divine substitutability from introspection. However, our analysis shows that regular private label diapers may exert a considerable competitive constraint on training pants even though there are no private label training pants on offer. If one were to define a market for training pants it would be highly concentrated, but competitive constraints would be much more significant than such an incorrect market definition would suggest. I.e. the pattern we find suggests that there are separate markets for diapers sized for babies and diapers sized for toddlers, where regular diapers sized for toddlers and training pants are in the same market.

Our results indicate that, in concrete cases, it may be very important to conduct a detailed empirical analysis, similar to the one conducted in this chapter, to ascertain the actual competitive interaction in the specific market, because qualitative introspective analysis of closeness of competition will often lead to incorrect results – especially where the competitive role of private label products is concerned.

The result that a large market share of private label products typically implies a tight competitive constraint on branded products in the same products group is of considerable importance because of the importance private label products have on supermarket shelves today.

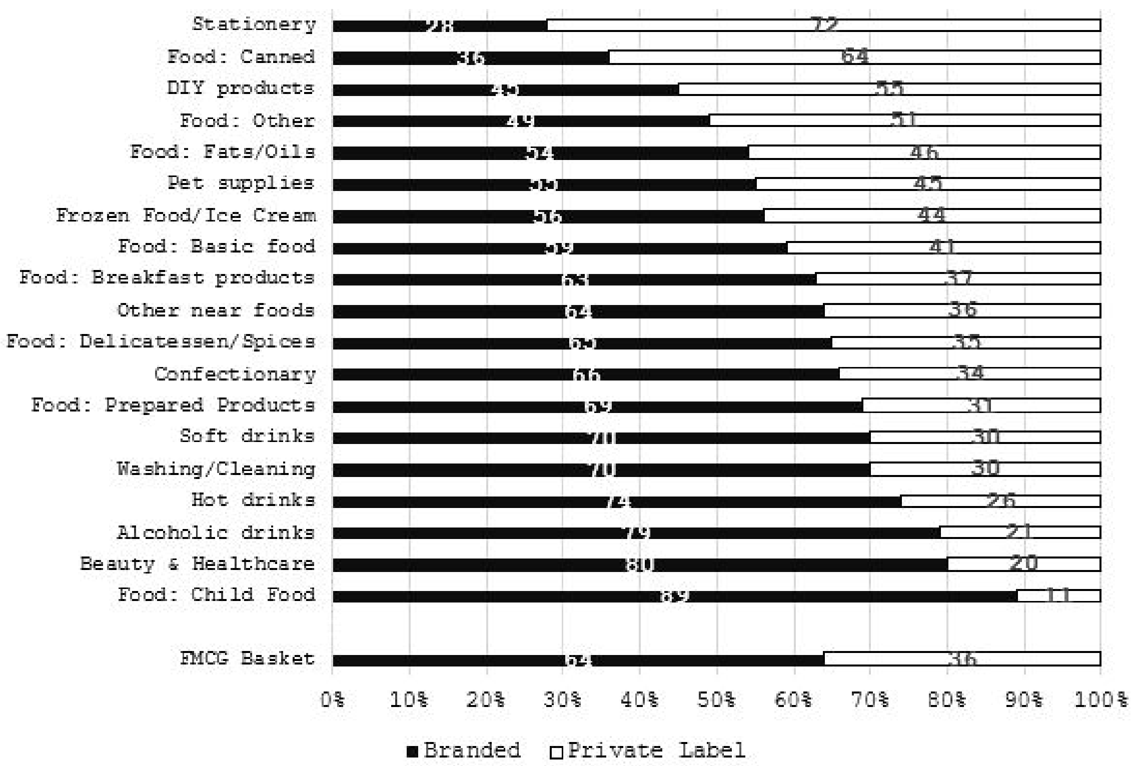
In Figure 3.1 we can see the presence of private label products in a variety of supermarket retailing product categories in Germany.

Figure 3.1 shows the revenue shares of private label and branded products at a considerably aggregated level of product groups in supermarkets and across a broad set of supermarkets. One notices immediately that there are broad categories of high-volume products in which private label products have a large market share of 30% and more. Our analysis suggests that one would expect a significant competitive constraint based on such market shares.

However, these numbers include Aldi, which until recently has only sold private label products. This inclusion may distort the market structure encountered by customers when shopping in a particular store within supermarket chains that carry branded products. Figure 3.2 shows that private label market shares remain very significant even when one separates out the Aldi shares:

While the set of product groups in which private label products would be expected to have 30% or more market share becomes smaller from excluding Aldi, it still includes all the products with the highest frequency of sales. The implications of our analysis for the assessment of competition between brands and private label products is therefore of considerable importance. For the 5 product groups analysed, private label products appear relatively close competitors to branded products. The

Figure 3.1: Private Label vs. Branded Products in % of Revenue



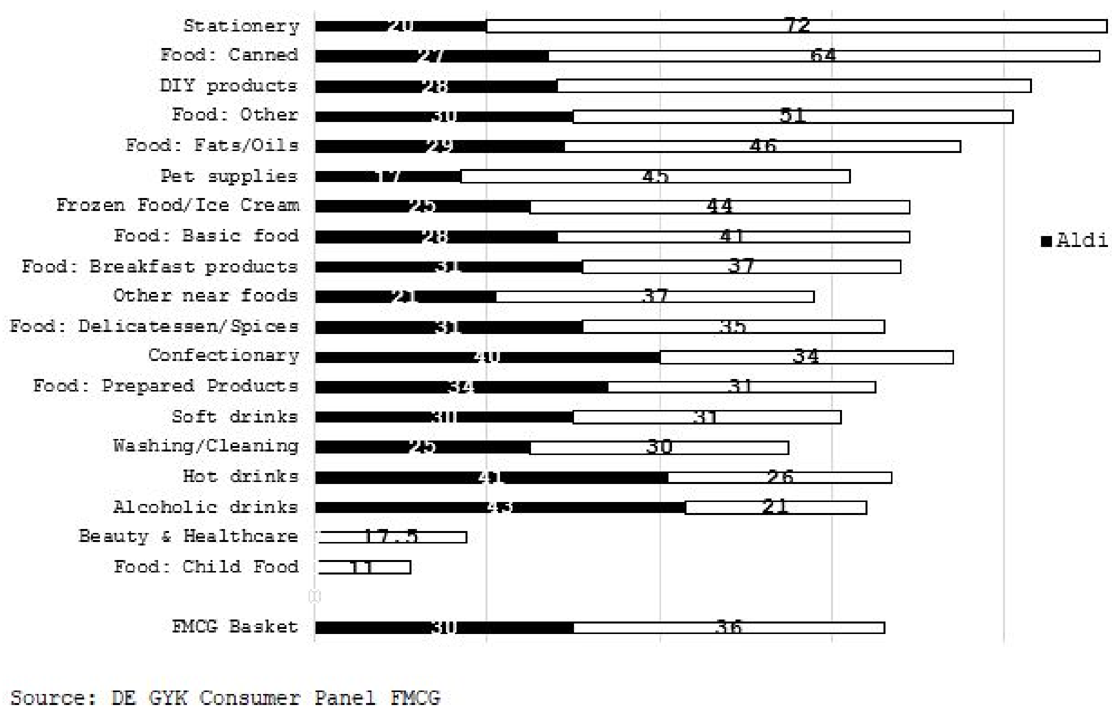
Source: DE GYK Consumer Panel FMCG

competitive constraint appears tightest, where the market share of the private label product is highest.

Our technical analysis in the remainder of the chapter proceeds in several steps. Because in grocery retail we cannot directly observe diversions from one product to another (unlike some contractual markets where the customer switches supplier), we estimate diversion ratios indirectly by using our data to estimate price elasticities. For that purpose, we estimate demand systems for each of the five product categories in our data set. This generates a set of own- and cross- price elasticities of demand that fully characterize the substitution pattern observed.

Own-price elasticities of demand measure the percentage quantity loss when the price of a good is increased and prices of all competitors are held constant. The cross-price elasticity measures the percentage quantity increase when the price of a competing product is increased. These elasticities thus give information both about the degree to which a product loses customers due to a price increase and the degree to which such customers substitute to a specific competitor product. It is shown that by combining the elasticity estimates with the market share of the competitor product one can derive an estimate for the diversion ratio. Our analysis shows that the proportion to which a branded product loses customers to a private label alternative is generally of the same order of magnitude as the relative market share of the private label product among all other products sold in that category at a retailer,

Figure 3.2: Aldi Share among Private Label Product Groups



making market share a good first guide for the competitive constraint imposed by private label products.

A central part of the formal analysis is the estimation of price elasticities, which can only be done through regression analysis for each of the relevant products in each product category. We estimate demand based on a very flexible, but tractable functional form, the LA/AIDS demand system (Deaton and Muellbauer, 1980; Alston et al., 1994; Eales and Unnevehr, 1988; Green and Alston, 1990; Green et al., 1991). The AIDS model is appropriate to our purpose for several reasons. First, because it does not impose consumer behaviour restrictions; if we were to estimate a logit demand system we would need to assume that consumers only purchase one good (discrete choice) and the resulting elasticities between products would be symmetric. The lack of symmetry is crucial in our case study as we believe it is extremely unrealistic for branded-private label products. Our results confirm this.

Estimating a nested logit or a random coefficients model would solve the symmetry problem but would still impose more structure than it is needed in AIDS. In a nested logit we would have to define the nested structure; in a random coefficients we would still assume discrete choice. The data requirements of a random coefficients model was also not feasible given our data limitations. The main problem with the AIDS system that these models tried to overcome is the fact that the parameters to be estimated grow exponentially to the number of products. However, this is not a problem in our case as we aggregate products at the brand level.

Note also that the LA/AIDS demand system has been regularly used in demand estimation for supermarket products including attempts to estimate substitution between branded and private label products (Cotterill et al., 2000; Hausman and Leonard, 2005; Huang et al., 2007). These efforts differ from ours because they are generally performed at a fairly high level of aggregation, either at the level of whole supermarket chains or the whole industry. Sometimes these regression analyses also distinguish by different locations.

Other research on private label products has focused in a wide variety of issues. These include the determinants that favour the introduction of private label products, the incentives of retailers to introduce them, and the choice of product quality (see Berges-Sennou et al. 2004 for a more detailed literature review).

While there is some evidence that competition between discounters that mostly sell private label products on one hand and full range supermarkets on the other already constrain branded products (Rickert et al., 2013), we are particularly interested in substitution by the individual end customer within a given store. This can be interpreted as measuring direct interbrand competition in the store, while abstracting from competition between different retailers and retail formats . We thus look at substitution at a much more disaggregated level and estimate a demand system for customer choice within a specific store separately for each German retail chain that we consider. Prices are observed as weekly averages over a time horizon of three years, separately for each store of the retailer.

In the remaining part of the chapter, we first describe the data in Section 2. In Section 3 we present the basic steps of the analysis based on one specific supermarket chain. For the remainder of the chapter, we present tables with the main results in the text. We describe the methodology and further details on the data in the Appendix.

3.2 The Data

We rely on a data set from IRI, which was made available by Markenverband for the purposes of this study. The data is limited to five food categories: milk, cat food, frozen pizza, dishwashing liquid, and diapers. It contains weekly observations of average quantities and prices at the level of individual stores for the years 2016-2018.

The data is limited to three German retailers that we refer to as retailers 1-3. The data set has been anonymized with respect to identifying information for the retailer to maintain confidentiality. The data set, nevertheless, allows stores to be linked to the corresponding retailer.[5] Observations from stores which cannot be mapped to a retailer have been removed from the sample.

Not all stores in the same chain offer the same product line. This can be a problem when estimating the AIDS demand model, because the model assumes that the set of products remains constant across observations. However, in our data set, product lines vary across stores of a specific retailer only with respect to products with extremely small market shares. Including these products would therefore not affect the estimates generally and may even reduce the precision of the estimates. We therefore drop those products from consideration. The only product group where this is different is milk. For fresh milk, local suppliers tend to have very significant market shares so the product offerings vary regionally across stores within a retailer.

[5]Retailers generally have multiple, differently branded chains. To preserve the number of observations we have performed estimations at the retailer level. We have checked whether results materially change when estimating at the at the chain level. While it is more difficult to obtain stable estimates, qualitative results do not appear to be affected.

To avoid estimation problems for milk, we focus the analysis on UHT-milk, for which the product line for each store within a retailer is the same.

We further reduce the number of products by aggregating across different European Article Numbers (EANs) that represent essentially the same products. For example, we aggregate across different "flavours", i.e. different versions of the product which are usually sold at the same price.[6] We also aggregate across different package sizes by estimating a price per given unit of volume or weight. Effectively, we aggregate up to level of brand (like Whiskas and Sheba) thus distinguishing different brands in different price categories for a given manufacturer. This reflects our focus on competition between private label and brands. We estimate the model separately for each product category and retailer.

3.3 Demand Estimation

We estimate the linear version of then Almost Ideal Demand System (AIDS) as first suggested by Deaton and Muellbauer (1980). This econometric model of demand allows us to compute own- and cross-price elasticities from the estimated parameters. The share of product i is modelled as a function of the prices of the other products and real expenditure. In our case, products are aggregated at the brand level, and so subscript i will be the brand. Total expenditure refers to the total expenditure on the product category, as we estimate each of them independently:

$$w_{i,m,t} = \alpha_i + \sum_j \gamma_{i,j} \log(p_{j,m,t}) + \beta_i \log(\frac{Y_{m,t}}{P_{m,t}}) \tag{3.1}$$

Where $w_{i,m,t}$ is the share of sales of brand i in store m in week t. Or:

$$w_{i,m,t} = \sum_{i,m} \frac{p_{i,m,t} * q_{i,m,t}}{Y_{m,t}} \tag{3.2}$$

p and q are price and quantity,[7] $Y_{m,t}$ is the total expenditure on the product category, and P is a price index. For simplicity, we use a linear Stone Price Index, resulting in the so-called LA/AIDS model. It has been showed that this linear approximation compares well with the translog version (Alston et al., 1994). However, one issue with the Stone Price index is that it results in the expenditure share appearing in both right- and left-hand side of the equation, generating simultaneity. To correct for it we use lag of the share, as suggested by Eales and Unnevehr (1988):

[6] For example, dishwashing liquids of the same brands with different fragrances. Note that this abstracts from certain promotion policies where a specific "flavour" is used for promotions, but the regular price is maintained for other flavours.

[7] See Appendix B.3 for the details of the aggregation

$$\log P_{m,t} = \sum_i w_{i,m,t-1} \ln p_{i,m,t} \tag{3.3}$$

Therefore, the share of each product i is a function of prices and real expenditure. By construction, shares add up to one in each store-week, yielding the following additivity properties:

$$\sum_{i=1}^{n} w_i = 1, \sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \beta_i = 0, \sum_{i=1}^{n} \gamma_i = 0 \tag{3.4}$$

Homogeneity $\sum_j \gamma_{i,j} = 0$ and symmetry $\gamma_{i,j} = \gamma_{i,j}$ can be imposed if desired to make the demand system consistent with economic theory. However, imposing these results in important flexibility constraints. The homogeneity condition, commonly known as no money illusion condition, has been systematically violated when tested empirically; this stylised fact can be attributed to a number of different causes (Deaton and Muellbauer, 1980; Ng, 1995). If imposed, one obtains a demand system consistent with consumer theory, but since we are not interested in carrying out welfare analysis, which would require these conditions to be met, we decide not to impose it. We are interested in the substitution patterns between private label and branded products and not in obtaining a theoretically consistent demand model.

Similarly, we choose not to impose symmetry for the same practical reasons. If we constrain the model to have symmetric cross price effects, cross-elasticities are then a by-product of market shares and β_i coefficients. We rather prefer that the cross effects captured by $\gamma_{i,j}$ are flexible to capture asymmetries between private label and branded products, which is the main aim of this chapter.

The system equations to be estimated are:

$$w_{i,m,t} = \alpha_i + \sum_j \gamma_{i,j} \log(p_{j,m,t}) + \beta_i \log(\frac{Y_{m,t}}{P_{m,t}}) + \varphi_m, + \delta_t + \epsilon_{i,m,t} \tag{3.5}$$

Once the system has been estimated we can recover uncompensated (Marshallian) cross and own price elasticities from the model parameters (Green and Alston, 1990; Green et al., 1991):

$$e_{i,j} = -\delta_{i,j} + \frac{\gamma_{i,j} - \beta_i \overline{w_j}}{\overline{w_t}} \tag{3.6}$$

Where $\delta_{i,j}$ is the Kronecker delta (1 if $i = j$, 0 otherwise), and $\overline{w_i}$ is the average share.

The estimation has been carried out using a system of seemingly unrelated regressions (SUR) in Stata. Right before estimation, we have discarded stores that are contained in our sample for less than 20 weeks. Recall that by the nature of the model, we can only use observations in which all the selected manufacturers have sales. E.g. if a store never sells sport/training diapers, it will not be considered in our estimation. The minimum of 20 weeks criteria ensures that we are not using stores in which some of our selected brands are only sold rarely.

3.4 Estimating Diversion Ratios from Store Level Data

Often competition authorities have decided that two products are in different markets when their prices are very different. Private label products often exhibit very different (lower) prices. They often are not very differentiated in terms of their physical characteristics but differ from branded products primarily by brand recognition and national advertising. However, very differently priced products could still be in the same market. In fact, it could be the case that the most immediate competitor of a branded product is not another high-price branded product but the low-price private label one. The tightest constraint of a specific branded product is determined by the product that gains the largest share of purchases that the branded product loses from raising the price. This idea is captured in competition economics by the diversion ratio, which is given by the following formula:

$$\begin{aligned} DR_{i,j} &= \text{Diversion Ratio from product } i \text{ to product } j \\ &= \frac{\text{quantity gained by product } j \text{ from price increase of product } i}{\text{quantity lost by product } i \text{ from price increase of product } i} \end{aligned} \tag{3.7}$$

In formal mathematical notation this is generally expressed as the ratio of the change in the quantity demanded for product j, ∂D_j, to the change in the quantity demand for product i,∂D_i, from a small change in the price of product i, ∂p_i, where D stands for quantity demanded and p for price. The symbol ∂ indicates a small change. With this notation we can rewrite the definition of the diversion ratio between i and j more formally as:

$$DR_{i,j} = \frac{\frac{\partial D_j}{\partial p_i}}{-\frac{\partial D_i}{\partial p_i}} = \frac{e_{j,i}}{e_{i,i}} \frac{s_j}{s_i} \tag{3.8}$$

The second term in this expression simply formalizes the verbal definition of the diversion ratio further above. The term $\frac{\partial D_j}{\partial p_i}$ indicates the sales gained by product j when the price of product i is slightly increased. The term $-\frac{\partial D_i}{\partial p_i}$ represents the quantity lost by product i when its price is increased. The ratio of the two is the share of customers that would be captured by product j of all those who would switch from buying product i after a price increase.

Diversion ratios are not directly observable in grocery retailing. For that reason, we transform the diversion ratio into terms that we can either estimate or observe directly from the data: price elasticities and market shares at a given store.

This transformation of the equation, shown after the second equality sign, achieves this goal. The term $e_{i,j}$ gives the percentage change in demand for product j when the price i is changed by one percent. This is called the "cross-price elasticity of demand" between products j and i. It is a standard measure for substitution between two products. The term $e_{i,i}$ is the percentage change in demand for product i when the price of product i (its "own price") is changed by 1%. This is the "own-price elasticity of demand" and measures the sensitivity of sales to a price increase of a product (keeping the prices of all competitor products constant). These elasticities can be estimated from the AIDS model through a regression analysis.

The competitive constraint a private label product imposes on a branded product is dependent on the cross-elasticity of demand of the private label product in response to a price increase of the branded product, relative to how price sensitive the brand product is to its own price increase. Note that the ratio of cross-price elasticity of demand for the private label product j to the own-price elasticity of demand for the branded product i can be low if the cross-price elasticity is low. We will, in fact, see that the cross-price elasticity of the private label product with respect to a given branded product is often lower than the cross-price elasticity of other branded products with that product in question. Such an observation does not show, however, that the private label product imposes less of a competitive constraint.

The reason is that elasticities only measure percentage demand reactions for a given percentage price increase. However, when a private label product has a large market share the total loss in sales to the private label product from the branded product in question can be much bigger than from any of the other branded products. In other words, when the market share of a private label product is high, it is likely to have a large constraining effect on branded products, even when the cross-elasticity of demand is smaller than those between the branded products.

Note that this analysis implies that the observation of much lower prices for private label products is not an indication that they are in a different market. On the contrary, the low price causes the large market share, which implies that the private label product imposes a strong competitive constraint. It is precisely the low price that wins over customers and limits the ability of branded products to set higher prices to exploit the willingness of customers to pay a premium on branded products.

3.5 Results Outline

In the next sections we present the results of our estimates by product category. We start with UHT-milk, a product which is mostly vertically differentiated, and then move into both horizontally and vertically differentiated products. UHT-milk is an example of high market share of private label that implies a tight competitive constraint on branded products. We continue with cat food, another example of large private label market shares. We then present the results for dishwashing liquid, which serves as an example of fragmented markets. The last two product categories that we report are highly concentrated and have lower private label shares. Frozen pizza is an example in which private label competes with two main players. Finally the diapers market has basically a single branded player.

For the sake of clarity, we do not include the coefficients of equation 3.3 in the main text but in the appendix. The elasticities matrices are only included when needed for argumentation, the totality of them can also be found in the appendix. The reader will notice that in most of the tables that we report private label appears only in rows but not columns. This is due to the fact that we encountered identification problems for private label price movements, which are mostly non-existent throughout our sample. We can therefore consistently identify the effect of a change in price in the branded products on private label quantities, but in many cases we cannot do the opposite because private label own-elasticities are not identified. If this is the case we abstain from reporting non-identified elasticities (or diversion ratios) in the main text, but all tables are included in Appendix B.5 and B.6. We discuss this identification problem in more detailed in Appendix B.4.

3.6 High Market Share of a Private Label Product Implies a Tight Constraint on Branded Products

3.6.1 Large Market Share of Private Label Implies a Strong Constraint on Brands: The Example of UHT Milk

For our example of a market in which there is a very high share of private label, we have selected UHT-milk. We have excluded fresh milk because branded fresh milk supplies are very localized. For this reason, the product line for fresh milk differs for different stores of the same retailer. This pattern would create considerable difficulties for the estimation approach adopted in this chapter. In contrast, UHT-milk supply is generally national. While the product line may differ between retailers they generally do not vary for different stores of the same retailer. We therefore estimate demand separately for each retailer and thus do not have to be concerned about varying product lines in our demand estimation for UHT-milk.

UHT-milk is an example for a market with very little horizontal product differentiation, so that products are primarily differentiated along a vertical dimension of perceived quality. The economic literature suggests that competition in such markets is quite fierce despite the fact that they also appear quite concentrated. We will show that the price constraining role of private label UHT-milk is therefore particularly important. This is precisely reflected in its high market share.

In addition to the private label product, each of our three retailers list three brands of UHT-milk. All of them carry the products of Milchwerke Berchtesgaden and Molkerei Weihenstephan. The third brand is either Schwarzwaldmilch or Hochwald. To allow for full anonymization of retailers we label both brands as "Waldmilch" in the tables below. Both "Waldmilch" brands tend to be at the higher price end for the corresponding retailer at which they are sold.

Table 3.1 below shows the average share of units sold and average retail price per litre of UHT-milk for each of the products with substantial sales for Retailer 2. We observe that the private label product has an average market share of more than 64%. Also note that these shares can vary considerably from store to store. The standard deviation, which measures the dispersion of market shares, is 16.13 percentage points, which here is relatively large. To obtain a sense for the degree of variation, assume for the sake of illustration that market shares across stores and time are distributed symmetrically around the mean (which they are not). Then there would be about 5% of stores/week observations for which the private label share is below 32% and about 5% of stores/week observations, where it would be above 96%.

A large dispersion relative to the mean market share is also observed for the branded products supplied by Waldmilch, Milchwerke Berchtesgaden, und Molkerei Weihenstephan. Note that the highest price brand is Waldmilch with €1.28 per litre followed by Molkerei Weihenstephan with €1.21, and Milchwerke Berchtesgaden with €1.06. The private label price is much lower and only 53% to 65% of the prices of the branded products.

Our empirical analysis shows that the large price differential between the private label and the branded products generates the very large market share we observe. As a result, the private label product imposes a very strong competitive constraints

Table 3.1: Descriptive statistics. UHT-Milk

	Retailer 2	
	Share*	Price**
Private Label	5.34	0.69
	(15.23)	(0.25)
Waldmilch	5.32	1.28
	(7.24)	(0.45)
MW Bercht.	7.24	1.06
	(11.45)	(0.10)
MK WS	12.10	1.21
	(9.12)	(0.16)

*Share of unit sales
**Price in euros for 100ml
MW Bercht.: Milchwerke Berchtesgaden.
WS: Molkerei Weihenstephan.

on the pricing of the branded products.

The first step in the analysis is to estimate demand for each branded product and the private label product separately using the AIDS model. From the estimated parameters of the regression equation, we calculate the implied own-price and cross-price elasticities for each of the products. These elasticities are presented in Table 3.2 below.

Table 3.2: Price Elasticities. UHT-Milk. Retailer 2

Q/P	Private	Waldmilch	MW Bercht.	MK WS
Private	-1.262***	0.116***	0.292***	0.442***
Waldmilch	0.013	-2.542***	0.043	0.345***
MW Bercht.	0.656***	-0.062***	-3.370***	0.625***
MK WS	0.513***	0.094***	0.312***	-2.920***

Elasticities represent the change in quantity in the product-manufacturer in rows due to a price change of the product-manufacturer in columns. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Standard errors of the elasticity estimates in parentheses .
MW Bercht: Milchwerke Berchtesgaden. MK WS: MK Weihenstephan.

Each entry in Table 3.2 shows the percentage quantity change of the product indicated in a row from a percentage price increase by the product indicated in a column. Stars behind the estimates indicate that the estimate is statistically distinguishable from zero. When this is not the case, we treat the coefficient as zero and ignore it in further calculations because we cannot reject the hypothesis that it is, in fact, zero.

The numbers on the diagonal correspond to the own-price elasticities of the products. Note that profit maximization implies that these coefficients must each be strictly smaller than -1, which is the case here. For branded products they are between -2.5 and -3.4, which is of the order of magnitude expected from other studies of groceries products (if a little less elastic). The own-price elasticity of the private label product is notably less elastic but still within a range that can be rationalized by theory.

Cross-price elasticities are almost all strictly positive and statistically significantly different from zero. There are two exceptions. First, Waldmilch's quantity does not appear to react to price increases of the lowest priced products, namely the private label product and the product of Milchwerke Berchtesgaden. This is not very surprising. Waldmilch is the most expensive brand and the private label product is far less expensive than any branded product. This holds to a slightly lesser degree for Milchwerke Berchtesgaden.

When the price of a low-priced product is raised, substitution will typically go with a larger proportion to another lower priced product or to the next higher priced product (unless consumption is reduced overall). Substitution from a low-priced product to the highest priced product will be much rarer – especially for products that are mainly differentiated by perceived quality. Our results are consistent with these predictions. Substitution for the private label product goes primarily to the two next highest priced products but not to Waldmilch. Substitution from MW Berchtesgaden goes either to the lower priced private label product or the next higher priced branded product, but not to Waldmilch. The estimate of the cross-elasticity for MW Berchtesgaden is slightly higher than that of the private label product, although both are statistically indistinguishable from zero.

However, the negative cross-price elasticity of Milchwerke Berchtesgaden with respect to the Waldmilch price is not consistent with theory. It is statistically significantly negative, indicating that the demand for the Milchwerke Berchtesgaden product falls when Hochland increases its price. This makes little sense. However, such unreasonable estimates sometimes arise in demand estimation. Since such a regression result is suspect, we eliminate these results for further analysis. This is particularly unproblematic in this case since Waldmilch has a very small share of the market in any case, which may be the reason that it is difficult to estimate reasonable cross-price elasticities for this brand.

Combining the information from demand elasticities and market shares we obtain estimates for diversion ratios between products, which can be interpreted as measures of closeness of competition for different brands. This is shown in Table 3.3.

Table 3.3: Unit Diversion Ratios. UHT-Milk. Retailer 2

	Private	Waldmilch	MW Bercht.	MK WS
Private		64.3***	91.0***	94.4***
Waldmilch	0.1		0.9	5.2***
MW Bercht.	5.0***	-3.3***		12.7***
MK WS	6.5***	8.4***	15.5***	

Diversion of quantities of the row product due to a price change by the column product. Stars indicate degree of significance. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The coefficients without stars cannot be distinguished from zero and therefore essentially have to be interpreted as zero.
MW Bercht: Milchwerke Berchtesgaden. MK WS: MK Weihenstephan.

We see from these diversion ratios that the large bulk of quantity shifts from an increase in the brand product prices arises from substitution to the private label product. When the private label product raises the price, there is some substitution to higher priced products, but not to the highest priced product.

The much lower diversions from the private label product to brands arises because an increase in the private label product price primarily leads to private label customers stopping their purchasing of UHT-milk. There is some evidence for this because the own-price elasticity of the private label product is very strongly affected by the income effect. This means that customers with a smaller budget will substitute out of UHT-milk consumption when the cheapest product gets more expensive in order to retain income for buying other products.

It is also possible that private label milk is not priced at the profit maximizing price for private label sales. This could be the case because the price of private label products is often priced to attract customers to visit the store. Store advertising (in contrast to national advertising by brands) often targets products like milk that are bought by many customers for regular use. The level of prices of frequently purchased branded products as well as private label offerings are often driven by competition between stores. Stores price a core set of products at low prices to attract business to the store and gain margins on other products that customers do not use for a price comparison between stores. The low price of the private label product is then driven less by competition between brands of the same product category, but the increase in the quantity of sales of other products that customers buy who were attracted to the store by the low price for the private label product. For that reason, estimates of demand for private label products can be distorted, because our regressions cannot include all of the factors that would capture competition between retailers through store specific advertised prices.

Consistent with this role of retail competition, we see a particularly high incidence of non-sensical own-price elasticity estimates and cross-price elasticities for changes in the private label price in our data set. On one hand, the price of the private label would be set lower than its own-price elasticity would suggest, because pricing takes into account the margin of other products that are bought. This would explain own-price elasticities below the ones implied by theory. At the same time, a price increase of the private label product does not increase the quantity of competitor branded products as much because a relatively larger part of substitution is absorbed by substitution to another retailer. As a result, the cross-elasticity can even become negative.

Since our interest in this chapter concerns the constraint that private label products impose on branded products, our analysis on diversion ratios will focus primarily on the impact of price increases of the branded products on the quantities sold of other products in the product group. This analysis uncovers the diversion ratios from branded to private label products, which gives us the relevant information on the pricing constraint that private label products impose on branded products.

There is one further issue that becomes apparent when considering Table 3. Note that diversion ratios generally should add up to something smaller than 1 because substitution in reaction to a price increase does not only go to competitor products but also to non-consumption. However, some of the diversion ratios above add up to more than 100%. There are two reasons for these estimation results. First, the diversion ratios depend on estimates of the underlying parameters that themselves are estimated with error. If the diversion ratios add up to more than 100% this will, at least partially, reflect estimation error.

Second, it appears to be difficult to identify the volume reduction from lower consumption of UHT-milk (or other products). This is determined primarily by the own-price elasticity. For this reason, the relative size of the diversion ratios from a brand to its competing product appear to be much more informative than the absolute value of diversion ratios. The explanation is that such relative measures do not depend on the own-price elasticity of demand, which determines the degree of substitution out of the product group.

We therefore calculate in Table 4 the share of each product of the total diversions that go to other products of the same product category in the same store, when the price of another products is increased. This measure only depends on the (market share weighted) cross-price elasticities of the competitors of a product that raises its price. In simple terms, this is the store market share a competitor gains among customers that switch from a product that raises its price.

An advantage of this measure is that it can easily be compared to the relative market shares of the competing products in the store. Suppose there are two competitors of the firm that raises the price. One has a market share of 40% and the other a market share of 20% in the store. This means their relative market shares are 66.6% and 33.3% respectively of the total joint market share of 60%. A rule of thumb often used for firms in the same market is that it is assumed that competitors would gain customers form another firm raising prices in the proportion of their relative market shares. When that is true, relative market shares can proxy for diversion ratios and thus also proxy for the relative constraints that companies impose on any specific competitor. In Table 3.4 we show that this correspondence between relative market shares and diversion ratios is approximately true for the private label product for UHT-milk at Retailer 2.

Table 3.4: Relative Diversion Ratios in Store (in %) vs. Relative Market Shares. UHT-Milk. Retailer2

	Private	MW Bercht.	MK WS
Private		**85**	**84.1**
		81.2	85.7
Waldmilch	**0.9**	**0.8**	**4.6**
	21,6	5.7	6.1
MW Bercht.	**43.1**		**11.3**
	29.4		8.2
MK WS	**56**	**14.4**	
	49.1	13.0	

Diversion of standardised quantity-units of the row product-manufacturer due to a price change on the column product-manufacturer. *** p<0.01, ** p<0.05, * p<0.1.
MW Bercht: Milchwerke Berchtesgaden. MK WS: MK Weihenstephan.

In Table 3.4 the bold numbers give the relative diversion ratios, i.e. the share of sales lost by the product in the vertical column to all competitors in the store that is captured by the product on the horizontal row. The smaller, unbolded numbers are the relative shares of the products in each row excluding the sales quantity of the product in the vertical column.

To understand the table, consider Milchwerke Berchtesgaden increasing the price. This puts us into the second column. The bold numbers in the table are the relative diversion ratios. The number 85 in the first row indicates that 85% of the sales that Milchwerke Berchtesgaden loses from a price increase to competitors in the same store (when all other products stick to the same price) are captured by the private label product. The second highest relative diversion goes to Molkerei Weihenstephan with 14.4%. The remaining business (0.8%) goes to Waldmilch. These numbers do not add up to 100% due to rounding error.

We see that the relative diversion to the private label product, which has the lowest price, is higher than its relative market share. This can be read off in the row for private label, where the relative diversion ratio of 85% is higher than the smaller number below, which indicates the relative market share of 81.2%. However, the estimation error on the relative diversion ratios means that these numbers are effectively not distinguishable. This means that the constraint imposed by the private label product on the price of Milchwerke Berchtesgaden and Molkerei Weihenstephan is a little larger than the relative market share suggests but qualitatively the two correspond almost exactly.

In contrast, the competitive constraint from the firm with the highest price, Waldmilch, is significantly lower than its relative market share of 5.7% would suggest. Also note that the relative diversion ratio of Waldmilch is only of significant impact for Molkerei Weihenstephan, the product with the highest price after Waldmilch. For price increases of the private label product, the relative diversions from Molkerei Weihenstephan is higher than that of Milchwerke Berchtesgaden despite the fact that Molkerei Weihenstephan has the higher price. However, this is a reflection of the higher popularity of the Molkerei Weihenstephan product. When compared to the relative market share, Milchwerke Berchtesgaden does impose a stronger constraint on the private label despite being a less popular product.

These patterns reflect the insights from our earlier discussion. Products are primarily vertically differentiated in the UHT-milk market, i.e. perceived “quality” differences based on brand reputation will determine relative prices. Substitution in response to a higher price will then go asymmetrically more to lower priced products than to higher priced products. This means that in such vertically differentiated markets the lowest price firm will impose a disproportionate competitive constraint on all other products and gain large market share. Hence, the private label product is the most important competitive constraint on all branded products. The high market share reflects that constraint.

We have shown these results first for just one retailer, which allowed us to illustrate some of the challenges with estimation and interpretation of the results. However, not all retailers are the same. They may cater to different types of customers with higher and lower incomes. Their private label products may have different reputation for quality. For this reason, we would expect the estimation results to somewhat differ from retailer to retailer. In the remainder of this section, we show that the qualitative results of our discussion on UHT-milk carry over to other retailers but that there are some differences due to different roles of products at different retailers.

Table 3.5 first shows the descriptive statistics for retailers 1 and 3 in our data set.

Table 3.5: UHT-milk. Sample descriptive statistics.

	Retailer 1			Retailer 3	
	Share (%)	Price(€)*		Share (%)	Price(€)*
Private Label	74.02	0.73	Private Label	67.77	0.72
	(13.61)	(0.10)		(16.00)	(0.09)
MW Bercht.	5.74	1.13	MW Bercht.	2.96	1.02
	(7.77)	(0.10)		(3.98)	(0.09)
MK WS	10.66	1.20	MK WS	13.54	1.19
	(7.11)	(0.17)		(13.28)	(0.15)
Waldmilch	9.58	1.49	Waldmilch	15.73	1.12
	(10.30)	(0.10)		(8.97)	(0.12)

* Average share of unit sales
**Average price per litre in €
MW Bercht: Milchwerke Berchtesgaden. MK WS: MK Weihenstephan. Schwarz: Schwarzwaldmilch

Note that for Retailer 1 and 3 the relative price positioning between Private Label, Milchwerke Berchtesgaden, and Molkerei Weihenstephan are almost identical with those for Retailer 2. However, for Retailer 1 Waldmilch, as the most expensive brand, is priced significantly higher than Waldmilch at Retailer 2. Nevertheless Waldmilch, has about twice the market share at Retailer 1 than it has at Retailer 2. In contrast, Waldmilch has a significantly lower price at Retailer 3 and at the same time very low market share.

These results indicate significant differences between the retailers in their ability to sell high priced brands in their stores. We would expect this to also have impact on the diversion ratios. For simplicity of exposition, we directly present the comparison between relative diversion ratios and relative market shares at the retailer to illustrate these differences.

Note that for retailer 1 the relative diversion ratio to the private label products is around 80%. This is again very close to the relative market share of the private label product. This is different for the second lowest priced product (Milchwerke Berchtesgaden), which receives a higher relative diversion of sales relative to its relative market shares. This reflects that substitution from higher priced products to lower priced products is stronger in vertically differentiated markets than substitution the other way around.

It is somewhat surprising that a price increase of Milchwerke Berchtesgaden has a disproportionate quantity effect on Waldmilch compared to its relative market share, while it has virtually no effect on Molkerei Weihenstephan. This may be related to difficulties of estimating quantity responses in Molkerei Weihenstephan. When Molkerei Weihenstephan, the second highest price product, raises the price the quantity share gained by Waldmilch is lower than its relative market share. In fact, we then have the same asymmetry of stronger substitution to lower priced products we saw for Retailer 1 and the private label product providing the critical constraint.

Retailer 3 provides a counterexample to this pattern in the reaction of consumers to a price increase at Waldmilch, which appears to be a high quality image product with low market share at Retailer 3. It appears that in this case substitution to a similarly positioned product, namely Molkerei Weihenstephan, dominates the relative diversions, which far exceed those of the relative market share of Weihenstephan. When other products increase their prices the by far dominant relative diversion is again to the private label product. However, this diversion is in this case somewhat lower than the relative market share. The reason appears to be the pricing behaviour of Waldmilch, which appears to be perceived as a higher quality product, but positioned at a significantly lower price than at Retailer 2. Hence, the price-quality combination appears particularly attractive generating relative diversions far above relative market share.

Generally, it appears that the basic patterns are stable across retailers. Market share including sales of the private label product is a reliable guide to closeness of competition (i.e. the source of relative price constraints of branded products). The private label product is the closest competitor of all other UHT-milk producers in the market. Where results vary somewhat this is usually caused by a producer with smaller market share or a product placed at the upper end of the pricing range, namely Waldmilch. But even these high-priced products appear strongly constrained by

Table 3.6: UHT-milk: Relative Diversion Ratios vs. Relative Market Shares

	Retailer 1		
	MW Bercht.	MK WS	Waldmilch
Private Label	**80.5**	**79.5**	**78.8**
	78.5	82.9	81.9
MW Bercht.		**13.5**	**21.2**
		6.4	6.3
MK WS	**0.0**		**0.0**
	11.3		11.8
Waldmilch	**19.5**	**6.9**	
	10.2	10.7	
	Retailer 3		
	Waldmilch	MW Bercht.	MK WS
Private Label	**37.7**	**64.7**	**63.6**
	69.8	78.4	80.4
Waldmilch		**15.0**	**12.8**
		3,4	3.5
MW Bercht.	**10.5**		**23.6**
	14.0		16.1
MK WS	**51.8**	**20.3**	
	16.2	18.2	

Relative Diversion ratio of standardised quantities to the row product due to a price change for the column product in larger **bold** numbers. Corresponding relative market shares in smaller unbolded numbers below the relative diversion ratio.
MW Bercht: Milchwerke Berchtesgaden. MK WS: Molkerei Weihenstephan.

private label competition in their ability to raise prices.

3.7 The Interplay of Vertical and Horizontal Product Differentiation

Our example of UHT-milk is a limit case where products are homogeneous except for a vertical dimension of perceived quality. This meant that substitution was particularly strong between products with a high and low perceived quality level. So far, we have looked at private label products with very high market shares. In this section we show that for private label products with lower market shares there is more variance in the relationship between market share and competitive impact than at high market shares. Nevertheless, the market share remains a good guide for a first assessment of the competitive impact of private label products on branded products.

Private label products tend to have lower market shares when the branded products are more strongly horizontally differentiated, so that quality differences between products do not dominate the degree of product differentiation for all products. Vertical product differentiation still has a similar role to play as in the previous section because the low perceived quality good will still impose a particularly strong constraint with respect to the branded product that is least differentiated on the horizontal dimension. But that also means that some branded products that are differentiated from the private label product may sometimes be priced more aggressively than the private label product of some retailer because they are closer on the horizontal dimension with another branded product.

Horizontal differentiation then means – as in all markets – that the mapping from market shares to competitive constraints becomes less reliable. This insight does not imply that private label products should not be considered in the same market as branded products. Instead it reflects the general observation that with horizontally differentiated products market shares do not fully reflect the relevant competitive constraints and thus a more careful analysis is generally necessary to fully understand competitive constraints.

In the remainder of this section, we look at four examples for product groups ranging from a very fragmented market like the market for dishwashing liquids to a very concentrated market like frozen pizza and baby diapers, where we show the different way how horizontal and vertical product differentiation interplay.

3.7.1 Cat Food: Large Market Share of Private Label still Captures the Competitive Constraints when Manufacturers offer different Quality Levels

Our second example with high private label market shares is cat food. Market shares do not quite reach the levels we observe in UHT-milk. This is unsurprising since UHT-milk would, most likely, be perceived as a less (horizontally) differentiated product. Brand image is then primarily a vertical attribute and the pricing constraint from the low brand image private label tends to be particularly strong.

Brands in cat food are also differentiated horizontally, i.e. customers differ at equal prices in their preferences over products. In addition, we also have branded producers put several brands on the market. Furthermore, brands differ to the extent to which they are important for wet or dry food. While it is possible to separate wet and dry food products, this leads to a very unwieldy set of results. Here we aggregate to the brand level since the qualitative results are unchanged when we focus simply on vertical and horizontal differentiation by brand.

An additional complication is introduced because that the main manufacturers of cat food offer both a basic and a higher quality brand to target different customer groups. Private label products are only active at the basic level and are priced in the lowest price bracket, although in cat food the private label products do not have the lowest price. Still, the question arises whether the private label product is a significant constraint only for the basic brands or also for the brands offered explicitly as higher quality products at higher prices. Table 3.7 shows the basic structure of this market for the three retailers in our sample.

Table 3.7: Cat Food: Average Shares and Average Prices

	Retailer 1		Retailer 2		Retailer 3	
	Share*	Price**	Share*	Price**	Share*	Price**
Felix (Nestle)	11.75	0.30	19.06	0.34	14.06	0.34
	(7.09)	(0.07)	(11.12)	(0.06)	(7.00)	(0.06)
Gourmet (Nestle)	3.71	0.60	8.68	0.61	6.74	0.61
	(4.55)	(0.14)	(7.32)	(0.11)	(5.80)	(0.10)
Private Label	53.92	0.23	31.04	0.22	44.37	0.25
	(15.65)	(0.07)	(24.92)	(0.05)	(13.38)	(0.04)
Kitekat (Mars)	11.65	0.19	13.93	0.20	10.16	0.20
	(7.85)	(0.02)	(9.31)	(0.04)	(5.89)	(0.03)
One (Nestle)	3.52	0.44	5.77	0.45	4.57	0.43
	(2.65)	(0.10)	(3.65)	(0.07)	(3.11)	(0.07)
Sheba (Mars)	6.64	0.62	9.14	0.65	9.17	0.65
	(6.38)	(0.11)	(6.27)	(0.11)	(6.84)	(0.12)
Whiskas (Mars)	8.80	0.34	12.37	0.33	10.93	0.35
	(5.22)	(0.06)	(7.31)	(0.07)	(5.33)	(0.05)

*Share in units (standardised at 100g)
**Price in €per 100gr

There are two brand manufacturers at all retailers, Mars and Nestle, which each producing a brand in a lower price segment (Whiskas and Felix respectively) and in a high-priced segment (Sheba and Gourmet). In addition Nestle produces an intermediate level brand (One) and Mars a very low price alternative (Kitekat). The higher-end brand for Mars is priced on average at 88% above the basic brand, Whiskas, while Nestle's high priced brand Gourmet is priced between 70% and 80% higher than Felix. The private label product is priced at a discount of 25% to 30% of the basic brands Whiskas and Felix. But Mars' Kitekat brand is consistently priced even below the private label product.

Interestingly the private label brand has by far the largest market share, ranging from 31% for retailer 2 to 54% of retailer 1. But the lowest price brand does not achieve much more than 10% market share. Clearly the quality perception of customers is higher for the private label products than for Kitekat, since they sell at a higher price and achieve larger market share. We now show that market share is not always a good guide for where customers substitute to because reactions to price increases may not be proportional to market shares when the trade-off between price and quality varies between customers.

Estimating an LA/AIDS demand system allows us to determine by estimation whether the basic brands and the high-priced brands both compete with the private label product. We show in Table 3.8 that this is generally the case.

There is considerable variation in substitution behavior to private label brands. Only for retailer 3 is the relative diversion ratio close to the relative market share of the private label product. For the other two retailers relative diversion ratios tend to be significantly below the relative market shares. But in those cases diversion ratios to the even lower priced Kitekat are significantly above the relative market share of Kitekat. The largest joint relative diversion ratios from Gourmet and Sheba is always to the low priced brands Kitekat and private label. For retailers 1 and 3 this exceeds 50%. This shows that low price brands including private label account for the strongest price constraint on the highest price products.

Generally substitution is broadly spread between all brands with private label always taking a very substantial proportion of the relative diversion. It is therefore again appropriate to include private label and brands in a single market. We also again have the phenomenon that very large market shares of private label indicate that prices are low and that the competitive constraint imposed on brands is large. The idea of a firm with market share having particular market power is therefore incorrect. Private label products have large market share precisely because they are constraining brands through low prices at acceptable quality levels.

This insight might seem surprising at first, but upon reflection it is quite intuitive. While customers might want to buy a higher quality product for a higher price, they may revert to a basic product when the high-quality product becomes too expensive. But when they buy a basic product anyway, they might just save a bit more money and go for the private label. Since the private label product is very popular conditional on buying the basic product, most of the substitution away from the high-price products is to the private label product.

Table 3.8: Cat Food: Relative Diversion Ratios vs. Relative Market Shares

	Retailer 1				
	Felix	Gourmet	Kitekat	Sheba	Whiskas
Felix (Nestle)		**20.6**	**20.3**	**23.7**	**24.5**
		12.2	13.3	12.6	12.9
Gourmet (Nestle)	**4.3**		**7.9**	**9.3**	**1.8**
	4.2		4.2	4.0	4.1
Private Label	**29.6**	**35.5**	**53.5**	**36.8**	**31.3**
	61.1	56.0	61.0	57.8	59.1
Kitekat (Mars)	**33.0**	**18.8**		**12.8**	**28.5**
	13.2	12.1		12.5	12.8
One (Nestle)	**5.0**	**2.5**	**1.4**	**2.0**	**5.1**
	4.0	3.7	4.0	3.8	3.9
Sheba (Mars)	**14.0**	**17.7**	**9.0**		**8.8**
	7.5	6.9	7.5		7.3
Whiskas (Mars)	**14.0**	**5.0**	**7.9**	**15.5**	
	10.0	9.1	10.0	9.4	
	Retailer 2				
	Felix	Gourmet	Kitekat	Sheba	Whiskas
Felix (Nestle)		**35.5**	**27.3**	**21.7**	**48.1**
		20.9	22.1	21.0	21.8
Gourmet (Nestle)	**11.0**		**7.1**	**25.3**	**2.6**
	10.7		10.1	9.6	9.9
Private Label	**16.6**	**14.4**	**41.9**	**19.5**	**12.4**
	38.4	34.0	36.1	34.2	35.4
Kitekat (Mars)	**34.7**	**6.7**		**19.0**	**26.4**
	17.2	15.3		15.3	15.9
One (Nestle)	**2.9**	**4.8**	**-1.6**	**7.6**	**6.6**
	7.1	6.3	6.7	6.4	6.6
Sheba (Mars)	**11.2**	**20.8**	**10.3**		**3.9**
	11.3	10.0	10.6		10.4
Whiskas (Mars)	**23.6**	**17.8**	**15.0**	**6.8**	
	15.3	13.6	14.4	13.6	

Relative diversion ratio of standardised quantities to the row product due to a price change for the column product in larger bold numbers. Corresponding relative market shares in smaller unbolded numbers below the relative diversion ratio.

Note that these conclusions may depend on the quality of the private label product. To see this note that for Retailer 2 the relative diversion ratios from any branded product (except for the even lower priced Kitekat) to the private label product is relatively small and far below the relative market share. In this case substitution is much more strongly towards the base product of the other brand or to the lowest priced brand.

These examples show that the market share is not always the best guide to determining the closest competitor. But generally high market shares combined with low prices relative to branded products imply that the private label product imposes a tight competitive constraint not only on products at the same quality level but also at higher quality levels and in very significantly higher price brackets.

3.7.2 Dishwashing Liquid: The Impact of Private Label Products in a Fragmented Market

Dishwashing liquid is the most fragmented market in our sample. There is a private label product at each retailer. In addition, there are 5 brands with substantial market shares. Henkel is the leading brand, achieving more than 30% average market share at two of the retailers. But even the market shares of Henkel are volatile across different stores and retailers. The average market share of Henkel at Retailer 2 is only 21.3%. Prices also vary significantly across retailers and stores. Table 9 gives an overview of the distribution of average market shares and average prices across the three retailers considered in this study.

Table 3.9: Dishwashing Liquid: Average Shares and Average Prices (St.Dev.)

	Retailer 1		Retailer 2		Retailer 3	
	Share (%)	Price(€)*	Share (%)	Price(€)*	Share (%)	Price(€)*
Colgate	13.53	1.15	6.23	0.84	9.96	1.02
	(10.55)	(0.24)	(7.03)	(0.19)	(8.00)	(0.21)
Fit	11.41	0.95	8.05	1.36	9.77	0.93
	(12.78)	(0.20)	(8.57)	(0.50)	(12.46)	(0.16)
Private L.	20.90	0.67	29.56	0.76	22.01	0.63
	(9.34)	(0.08)	(12.06)	(0.13)	(8.75)	(0.06)
Henkel	33.08	1.25	21.32	1.18	31.50	1.30
	(15.31)	(0.21)	(11.19)	(0.15)	(13.23)	(0.18)
Procter	9.51	1.50	10.28	1.29	13.14	1.43
	(8.79)	(0.27)	(7.46)	(0.20)	(9.64)	(0.22)
Werner	11.57	1.26	24.56	1.66	13.62	1.29
	(8.24)	(0.26)	(10.28)	(0.35)	(8.11)	(0.29)

*Price per 500ml.

Note that the market share of Henkel at Retailer 1 and Retailer 3 is given by 33% and 31.5% respectively, while the market share of the Private Label product is at 21% and 22% respectively. At Retailer 2 this relationship is reversed. Henkel has a market share slightly exceeding 21% and the Private Label product has a market share just under 30%. Note also that the Private Label product has a higher average price and Henkel a lower average price at Retailer 2. This is an indication that the perceived quality of Private Label products appears to vary between different retailers.

Other brands have market shares in the order of magnitude of 10%. But the positioning also varies between the retailers. While Werner prices are on average at about the level of Henkel at Retailer 1 and 3, it has a much higher price at Retailer 2. At the same time, Werner also commands about twice the market share in comparison to Retailer 1 and 3. In contrast, Procter has the highest price at Retailer 1 and Retailer 3, but prices like Henkel at a significantly lower level at Retailer 2. Similarly, the pricing strategies of Colgate and Fit appear to differ between Retailers 1 and 3 on one hand and Retailer 2 on the other. At Retailer 1 and 3 Fit has the second lowest price, below €1, but prices above Procter at Retailer 2. Colgate, in contrast, prices above €1 at Retailers 1 and 2, but drops its average price to close to that of the Private Label product at Retailer 3. We therefore expect to see patterns of diversion ratios that are much more similar for Retailer 1 and 3 than for Retailer 2.

While the price positioning of some brands differs by retailer, we see stable patterns for the distribution of price levels. One brand prices at least at €1.40, a second tier of brands prices between €1.20 and €1.30, and a third tier of prices is much closer to the Private Label price at around 1€. We, therefore, expect similar patterns of diversion depending on the price band at which brands are positioned independently of retailer.

Table 3.10 provides an overview of the relative diversion ratios and compares them to the relative market shares for price increases for each of the brands for which a meaningful regression result could be derived. Table 3.10 reveals that there is a basic structure of competition in the market that relates to the different price levels we identified above. Henkel prices in the upper middle price tier and has diversions from price increases both to higher priced products and lower priced products. The diversion ratio to Colgate is consistently large with 33% to 35% although Colgate has much smaller market share. But even where the Colgate market share is only slightly above 6%, as for Retailer 2, Colgate is the closest competitor to Henkel measured in terms of diversion generated from a price increase.

The reason for this result is that the cross-price elasticity between those products is persistently large across different retailers. The two products are therefore perceived as very close substitutes. However, it is also notable that the price of Colgate is higher, the higher its market share, indicating that Colgate compensates with a lower price at a retailer like Retailer 2, where Colgate demand is low. The impact on substitution to Colgate from Henkel is fairly consistent across the three retailers as a result.

The second regularity is that the (generally) highest priced product in the market is Procter. It loses the greatest share of demand to Henkel when raising prices. This again reflects the typical vertical differentiation strategy (possibly supported through advertising) , where the highest priced firm will lose customers with high willingness to pay for perceived higher quality to the next pricing tier, when it raises the price.

The pricing constraint from the private label product varies considerably between the different retailers. At Retailer 1, the relative diversion ratio is somewhat below the relative market share, but with a substantial impact at about 20% for all brands except for Procter.

However, at Retailer 2, where the private label product has almost 30% market share, the impact of diversion to the private label product is much lower (except with respect to Fit, which primarily loses customers from price increases to the private label product and Procter). In fact, it appears that the private label product has a relatively high price and a higher market share relative to branded products than at other retailers.

The low diversions to the private label product at Retailer 2 appears to be explained by Colgate, which is priced only slightly above the private label product at this retailer. It thus absorbs a much greater share of substitution away from the other branded products. This makes sense because it is estimated to be a closer substitute to Henkel than the private label product, which must partially arise from low horizontal product differentiation. When Colgate prices at a price close to the private label product it will absorb a much greater proportion of the diversions from Henkel relative to the private label product when Colgate prices at a higher price point.

Table 3.10: Dishwashing Liquid: Relative Diversion Ratios vs. Relative Market Shares

	Retailer 1			
	Colgate	Fit	Henkel	Procter
Colgate		**26.0**	**35.0**	**27.7**
		15.3	20.2	15.0
Fit	**10.8**		**14.1**	**14.2**
	13.2		17.1	12.6
Private Label	**19.4**	**21.9**	**21.1**	**6.2**
	24.2	23.6	31.23	23.1
Henkel	**41.8**	**20.7**		**42.6**
	38.3	37.3		36.6
Procter	**15.4**	**16.0**	**18.4**	
	11.1	10.7	14.2	
Werner	**12.6**	**15.4**	**11.3**	**9.2**
	13.4	13.1	17.3	12.8
	Retailer 2			
	Colgate	Fit	Henkel	Procter
Colgate		**0**	**34.8**	**5.4**
		6.8	7.9	6.9
Fit	**10.4**		**6.5**	**8.7**
	8.6		10.2	9.0
Private Label	**9.0**	**45.6**	**15.5**	**9.8**
	31.5	32.1	37.6	32.9
Henkel	**59.3**	**6.1**		**66.2**
	22.7	23.2		23.8
Procter	**7.4**	**48.3**	**33.2**	
	11.0	11.2	13.1	
Werner	**13.9**	**0**	**10.0**	**9.9**
	26.2	26.7	30.5	27.4
	Retailer 3			
	Colgate	Fit	Henkel	Procter
Colgate			**33.5**	**25.3**
			14.5	11.5
Fit	**0.8**		**6.4**	**5.9**
	10.9		14.2	11.2
Private Label	**44.7**		**35.8**	**24.9**
	24.4		32.2	25.3
Henkel	**43.0**			**39.7**
	35.0			36.3
Procter	**11.5**		**15.9**	
	14.6		19.2	
Werner	**0**		**5.1**	**4.1**
	15.1		19.9	15.7

Relative Diversion of units to the row product due to a price change by the column product and relative market share when the product that changes the price is not considered.

Where Colgate is priced above €1, and the private label product at a significantly lower price, market shares of the private label product may be smaller overall, but the diversions from price increases at branded products are across the board higher. For example, at retailer 3, where the private label price is particularly low, its relative diversion ratio from Colgate, Henkel, and Procter is far greater than its actual market share. These differences may arise not only from differences in the private label perceived quality but also from the product placement strategy of the retailer facing a fairly fragmented market of branded competitors.

These observations are a warning that market shares do not always fully capture the competitive interaction in the market. But this does not suggest that private label products should not be considered as part of the same market from the start of the analysis. The deviation between market share and actual impact on competition is far larger for the branded products than for the private brands. As a rule of thumb, high-priced brands impose less of a competitive constraint on the market than private label brands, which tend to constrain the prices of branded products at all price levels.

3.7.3 Frozen Pizza: The Role of Private Labels when two Brands Compete Head-to-Head

The frozen pizza market is among the two very concentrated markets presented in this study. There are only two significant brands in the market: Dr. Oetker and Wagner. As can be seen in Table 11, the prices of Dr. Oetker and Wagner frozen pizza are almost identical with Wagner pricing a fraction below Dr. Oetker on average. The private label product is sold on average at a discount of at least 46% from the average Dr. Oetker price. Dr Oetker has between 41% to 46% market share and Wagner achieves between 26% to 35%. The remainder goes to the private label product of the retailer, which means that the market share of the private label product is greater than that of Wagner by a little under 5 percentage points at Retailer 1 and 3 and smaller by 13.5 percentage points at Retailer 2.

The large discount on the prices of the branded products therefore does not result in a very large market share for the private label product in contrast to the case of UHT-milk. This observation may suggest that the private label products are less close a substitute for frozen pizza of branded products than is the case for UHT-milk. Nevertheless, the private label product does command a higher market share than Wagner at Retailers 1 and 3.
However, in contrast to the markets studied earlier, differentiation between Dr. Oetker and Wagner does not appear to be vertical. The perceived quality of the products appears to be similar. This results in almost equal pricing. This implies

Table 3.11: Frozen Pizza: Average Shares and Average Prices

	Retailer 1		Retailer 2		Retailer 3	
	Share	Price	Share	Price	Share	Price
Dr. Oetker	41.33	0.69	45.44	0.70	42.17	0.71
	(19.27)	(0.07)	(19.88)	(0.07)	(18.36)	(0.07)
Private Label	32.62	0.36	20.99	0.38	31.31	0.38
	(22.51)	(0.08)	(15.94)	(0.08)	(18.73)	(0.05)
Wagner	27.29	0.68	34.49	0.70	26.63	0.68
	(17.65)	(0.10)	(18.99)	(0.10)	(14.74)	(0.09)

*Share in % of quantity sold, **Price in €per 100g

that one would expect Dr. Oetker and Wagner to be closer competitors than the private label product at a much lower price but with similar market share to Wagner.

This intuition is reflected in the relative diversion ratios in Table 12. The relative diversion ratios between Dr. Oetker and Wagner are fairly symmetric (except, possibly, for Retailer 3) and much higher than the relative diversion ratios of Dr. Oetker and Wagner to the private label product. However, on average the relative diversion ratios to the private label product range from about 30% at retailer 1 to above 40% at retailer 2.

While substantially smaller than the diversions among the higher priced firms, these diversion ratios are so substantial that they must lead to a considerable constraint on the ability of Dr. Oetker and Wagner to raise prices. In fact, at retailer 2 this competitive constraint is even stronger than the relative market shares would suggest. Again, there is no question that the private label product is in the same market and starting the assessment based on market shares is appropriate. As in any differentiated products market such an assessment is not sufficient to determine, which goods are the closest substitutes.

Note also that this example gives further insight into how to assess the relative closeness of competition between brands and private label products. Where a low price of the private label product is related to significantly higher market shares than the branded products as with UHT-milk and cat food, it is likely that the private label product is a very close substitute of the branded product. Where despite the low price of the private label the branded products have similar or higher market share (as in the case of frozen pizza), it is more likely that the branded products are the closer competitors. However, this does not mean that the constraint from private label products is not significant.

Table 3.12: Frozen Pizza: Relative Diversion Ratios vs. Relative Market Shares

	Dr. Oetker	Wagner
Retailer 1		
Dr. Oetker		**68.7**
		55.9
Private Label	**28.9**	**31.3**
	54.4	44.1
Wagner	**71.1**	
	45.6	
Retailer 2		
Dr. Oetker		**58.9**
		68.4
Private Label	**41.2**	**41.1**
	37.8	31.6
Wagner	**58.8**	
	62.2	
Retailer 3		
Dr. Oetker		**68.3**
		57.4
Private Label	**38.6**	**31.7**
	54.0	42.6
Wagner	**61.4**	
	46.0	

Relative Diversion of units to the row product due to a price change by the column product and relative market share when the product that changes the price is not considered.

3.7.4 Diapers: Private Label Products Impose Pricing Constraints not just on Functionally Equivalent Products

The market for diapers in German supermarkets is heavily concentrated. Procter with its brand Pampers dominates the market, while there are many brands, most of these brands have negligible market share at the three retailers covered in this study. At these retailers, the main competition to Procter comes from the private label products.

However, for our study it is of interest to consider whether the competitive effect of private label standard baby diapers only constrain pricing of Procter baby diapers or whether a related Procter product, namely training pants, also constrained by the private label product.

Training pants are used for potty training and are essentially diapers in pant format that a toddler can pull down when going to the potty. They are physically quite different products from a standard baby diaper and private label versions are not available.

However, there is potentially substitution between regular baby diapers and training pants. One can do potty training without training pants. But training pants make potty training easier for the parents. If training pants get more expensive a parent may thus just forego the convenience training pants give to the parent. Since training pants are used for a much shorter time period than regular diapers, even price sensitive buyers who purchase the regular baby diapers, might buy them for a short period time. In that case we might see a competitive constraint from regular private label diapers on Procter training pants.

As Table 3.13 shows training pants have, as expected, a small share of the overall market between 5% and 14% depending on the retailer. At Retailer 2, where training pants have small market share, the market share of the private label brand is particularly high. In Retailer 1 and 3 Procter's regular diaper has almost three times the market share as the private label product.

Table 3.13: Diapers: Average Shares and Average Prices

Products	Retailer 1		Retailer 2		Retailer 3	
	Share (%)	Price	Share (%)	Price	Share (%)	Price
Private Label	22.35	0.15	54.66	0.16	22.53	0.16
	(18.60)	(0.01)	(19.26)	(0.01)	(15.19)	(0.01)
Procter Normal	66.47	0.24	40.39	0.24	63.32	0.25
	(19.66)	(0.03)	(16.17)	(0.02)	(16.88)	(0.04)
Procter Sport	11.18	0.32	4.95	0.31	14.14	0.32
	(9.24)	(0.05)	(5.84)	(0.03)	(10.16)	(0.05)

Price in euros per unit

Since the private label product is the only product that can constrain pricing of Procter products, it is of particular interest in this case to see how strongly the private label product constrains both Procter Normal (regular diaper) and Procter Sport (training diaper) relative to the option of buying less, i.e. the diversion to the no purchase option. We therefore first consider the absolute diversion ratios in this case.

Unfortunately, demand for Procter Normal can only be estimated for Retailer 2 because for the other retailers there is too little variation in price to make that feasible.

For that reason, we only show the diversion ratios for Retailer 2 in Table 3.14.

As Table 3.14 shows, about half of the sales Procter Normal loses from a price increase are diverted to the private label product, but only 5% to the training pants. The diversion to the private label product is therefore large. The small diversion to training pants is, in contrast, obvious. Training pants can only be used in a fairly short time window. On the other hand, the diversion ratios for a price increase for Procter Sport shows that there is hardly any diversion to non-consumption when the price of this product goes up. Parents and toddlers still need diapers. However, this substitution splits evenly between Procter Regular and the Private Label (there is statistically no difference between the two diversion ratios).

This result arises because the private label product has bigger market share than Procter Regular at a significantly lower price. For Retailer 2 the constraint on Procter Sport due to the private label is therefore as large as that on Procter Regular, implying a very significant constraint.

Table 3.14: Diversion Ratios Diapers

	Procter normal	Procter sport
Handels	48	47.4
Procter normal		48.2
Procter sport	5	

Diversion of quantities to the row product due to a price change on the column product

However, the constraint on training pants from the private label product differs considerably between the retailers. For Retailer 1 only a quarter of sales divert to the private label after a price increase for Procter sport. For Retailer 3 this rises to a third. For retailer 2 it is a half.

Table 3.15: Procter Sport: Relative Diversion Ratios vs. Relative Market Shares

Product	**Retailer 1**	**Retailer 2**	**Retailer 3**
Private Label	**75.8**	**49.6**	**35.5**
	25.2	57.5	26.2
Procter normal	**24.2**	**50.4**	**64.5**
	74.8	42.5	73.8

Relative Diversion of units to the row product due to a price change by the column product and relative market share when the product that changes the price is not considered.

The important insight gained from this example is that the market share together with the price differential does not only imply the degree to which the private label product imposes a constraint in the same product type, namely a normal diaper, but also on a product for which normal diapers are a substitute if it becomes too expensive. It would therefore also be incorrect to consider the private label normal diaper as being in a different market from the Procter training diaper – at least for sizes that correspond to the toddler age group. In fact, analysis of this type suggests that market definition might have to be done on the basis of age/size group for diapers, where training pants are only a relevant substitute for the older age/larger size diapers.

3.8 Conclusion

In this chapter we have demonstrated that private label products in supermarket retailing are generally in the same market as branded products and must be considered to assess competition in the market overall. Where private label products do not just have large price discounts but also large market shares as in markets with fairly homogeneous goods, the competitive constraints on prices arising from private label products are so strong that the private label tends to be the closest competitor of all branded products.

With smaller market shares, private label products tend to be a less severe constraint on branded product pricing, but the constraints remain significant even when branded products are the closest competitors in the market. The analysis of our examples from a broad range of fragmented and concentrated markets suggest that any analysis must start from the presumption that private label products are a competitor in the market and counting private label production fully for market analysis when performing an initial market screen based on market shares.

These results have important implications for competition policy assessment in mergers and antitrust cases. In antitrust cases, critical market share benchmarks should be applied to all products in a product group including the private label product. For example, the private label sales should be included when applying the market share thresholds for the Vertical Block Exemption Regulation.

In the review of mergers between brands, private label sales should also be included in the measurement of market shares for the purposes of a first assessment. However, our analysis also points out, that there is no market definition short cut to the assessment of the competitive effects of mergers in markets with product differentiation. Products can seem superficially quite different – like diapers and training pants

– but the private label generalist product may nevertheless be a close substitute to a more specialized product like training pants. Only careful analysis reveals that, for example, market definition for diapers should be done along different age groups, where, for toddlers, regular diapers and training pants may be in the same market. Such results stress that market definition based on listing similar characteristics of products, as is still a common practice at many competition authorities, is simply not an appropriate approach to market definition. Some of the substitution patterns we have unveiled in this study can only be verified by careful empirical analysis.

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Appendix A

Part I Appendix

A.1 Theoretical model

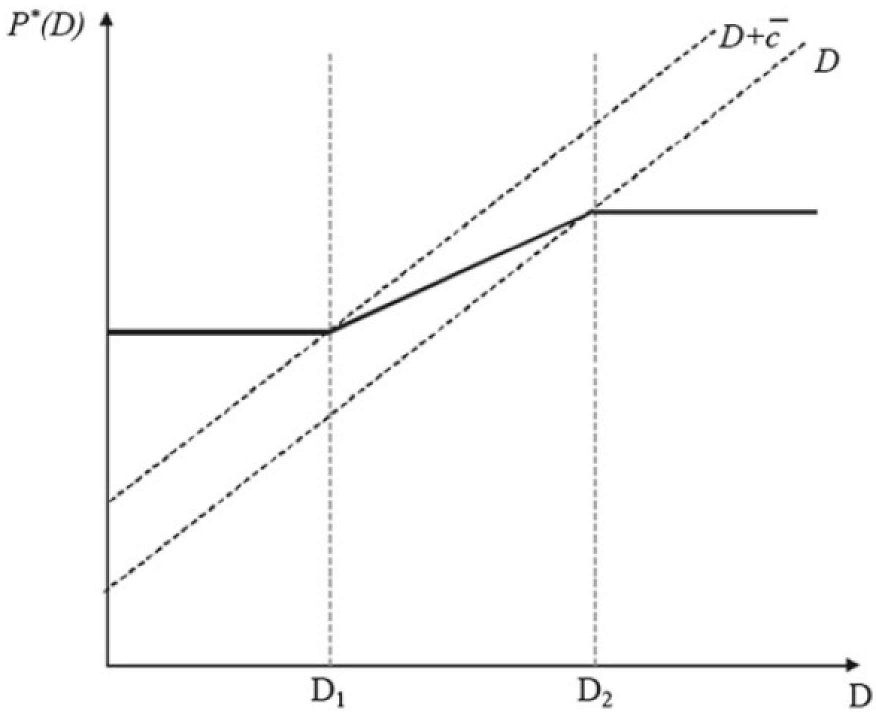
Following Moore et al. (2014) it can be shown that a regulated monopolist has an incentive to strategically increase gearing in order to achieve higher prices. Consider a setting in which the regulator sets a pricing rule of the form $p = a + (1-b)C$, where C is the expected cost and the parameter $b \in [0,1]$ represents the degree of cost pass-through (i.e. a lower value of b brings the pricing rule closer to a rate-of-return type of regulation, while the contrary moves towards a price cap, in which the incentives to increase efficiency are bigger (see Cowan 2002).

The firm faces a unitary demand and its cost c is uniformly distributed over $[0, \bar{c}]$. An exogenously defined amount of investment K needs to be financed, either by debt (D) or equity (E). Ex post, D must be repaid using $p - c$, the net payoff of the firm. If this payoff does not cover the amount of debt, then the firm's existing shareholders are responsible for bankruptcy costs, T. The probability of bankruptcy, represented by $\varphi(p, D)$, is therefore:

$$\varphi(p, D) = \begin{cases} 0 & \text{if} \quad D \leqslant D_1 \\ (1 - \frac{p-D}{\bar{c}}) & \text{if} \quad D_1 < D \leqslant D_2 \\ 1 & \text{if} \quad D_2 < D \end{cases} \tag{A.1}$$

And so the expected cost is $C = \frac{\bar{c}}{2} + \varphi(p, D)T$. Intuitively, if the regulated price covers $D + \bar{c}$, the probability of bankruptcy is 0, and when $p < D$, it is 1. For the intermediate case, $\varphi(p, D) = (1 - \frac{p-D}{\bar{c}})$. The timing of the game is as follows: first, the regulator announces the pricing rule. On the next stage, the firm choose its capital structure to cover K. Finally, given the pricing rule announced, the firm's cost is revealed and outputs and payoffs are realised.

Figure A.1: The Regulated Price as a Function of Debt



From A.1 we can infer the regulator's pricing rule as:

$$p^*(D) = \begin{cases} p_1 = a + (1-b)\frac{\bar{c}}{2} & \text{if} \quad D \leqslant D_1 \\ p_2 = a + (1-b)(\frac{\bar{c}}{2} + (1 - \frac{p-D}{\bar{c}})T) & \text{if} \quad D_1 < D \leqslant D_2 \\ p_3 = a + (1-b)(\frac{\bar{c}}{2} + T) & \text{if} \quad D_2 < D \end{cases} \tag{A.2}$$

Where $D1 = p_1 - \bar{c}$, $D2 = p_3, D1 < D2$, and $p_1 < p_2 < p_3$. Figure A.1 shows how the regulated price varies as a function of debt.
In this setting, it follows that the regulated price is increasing in the level of debt for the interval $D1 - D2$.

The firm maximizes the revenue for its existing shareholders:

$$Y(D) = p(D) - C - (1 + r_E)E - (1 + r_D)D \text{ s.t. } K = E + D \tag{A.3}$$

With r_E and r_D being the cost of equity and debt, respectively. It can be showed that for a big enough cost pass-through, $b > b^*$, the optimal level of debt is $D^* = D2$ (see Moore et al. 2014 for the proof).

A.2 Granger tests

In this section we reproduce the methodological approach in Bortolotti et al. (2011) and Cambini and Rondi (2011) as a robustness check in order to test the hypothesis of whether higher leverage results in higher prices in the England and Wales water sector. This methodology consists in applying Granger causality tests (Granger, 1969; Sims, 1972). This allows us to see whether an increase/decrease in one variable is preceded by an increase/decrease in another variable: Granger-causality. If an increase/decrease in prices is preceded by an increase/decrease in gearing rations, and not vice-versa, we can state that gearing Granger-causes prices. The same applies for the relation between gearing and investment. If Granger-causality is found in both directions, the results would suggest that a third variable is Granger-causing both of our two variables, or that the two variables are simply correlated. If the results do not report Granger-causality in either direction, the variables might simply not be correlated at all.

For the relation between regulated prices and gearing ratios the model to be estimated is the following:

$$P_{i,t} = \alpha_1 P_{i,t-1} + \alpha_2 P_{i,t-2} + \beta_1 L_{i,t-1} + \beta_2 L_{i,t-2} + \mu_i + \delta_t + \epsilon_{i,t} \tag{A.4}$$

$$L_{i,t} = \delta_1 L_{i,t-1} + \delta_2 L_{i,t-2} + \gamma_1 P_{i,t-1} + \gamma_2 P_{i,t-2} + \mu_i + \delta_t + \nu_{i,t} \tag{A.5}$$

Where P is the the regulated price and L the leverage ratio. We use both the logarithm of the average bill and K factors as a proxy for the regulated price. If the hypothesis that higher leverage results in higher regulated prices is true, then we should expect that $\beta_1 + \beta_2$ are positive and significant while $\gamma_1 + \gamma_2$ are not. If these coefficients are significant in both directions, we are not able to identify which variable Granger-causes the other one, but mere correlation.

These equations include the lagged dependent variable, which gives rise to dynamic panel bias. To deal with this bias we use the dynamic system GMM estimator as proposed in Arellano and Bond (1991) and Blundell and Bond (1998). This model estimates a system of level and first-differenced equations using lags of first-differenced variables as instruments for equations in levels and lags of variables in levels as instruments for equations in first-differences.[1]. For the validity of the GMM estimates it is crucial, however, that the instruments are exogenous. We thus calculate the Sargan statistic under the null hypothesis of joint validity of the instruments. We report the p-values with the regression results.

[1]See also Roodman (2009) for a more detailed description

This model was originally meant to be useful for short and broad panels (small T large N). Our dataset is the opposite (T>N). This creates the problem of too many instruments, as described in Roodman (2009). However, we have restricted the number of lags used as instruments as much as possible, and it can be seen in Tables A.1 and A.2 that Sargan tests are rejected, as well as Arellano-Bond test for AR(2), which is reassuring. Yet we abstain of considering these results as robust.

Table A.1 we can observe that there is no causality from leverage to prices. This corresponds with Chapter 1 results. On the other direction, we do not observe any significant effect from prices to leverage either. This fact is consistent with our findings of Chapter 1 but seem to contradict Chapter 2 conclusions. This is not the case. As explained in Section 2.3.1, K factors nor bills do not constitute a good proxy for regulatory tightening, but these need to be interacted with regulatory period dummies. In here, we are not trying to infer causality from regulatory tightening to leverage but from prices to leverage.

Table A.1: Leverage - Price GMM estimations

	K factor	Bill
L.P	0.124*	1.039***
	(0.0711)	(0.0492)
L2.P	0.0498	-0.0315
	(0.0490)	(0.0496)
L.Leverage	0.0204	0.0169
	(0.0248)	(0.0228)
L2.Leverage	-0.0149	-0.0157
	(0.0230)	(0.0215)
Obs.	441	442
Arellano-Bond test for AR(1)	0.000381	0.000141
Arellano-Bond test for AR(2)	0.480	0.717
Sargan test(p-value)	0.0820	0.509
H0: L1.Leverage=L2.Leverage=0(p-value)	0.692	0.747
H0: L1.Leverage+L2.Leverage=0(p-value)	0.600	0.914

Standard errors in parentheses
GMM System Dynamic Panel Data Estimation. All regressions include time dummies.
Instruments restricted to t-3 and t-4
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.2: Price- Leverage GMM estimations

	Leverage (K factor)	Leverage (Bill)
L.Leverage	1.097***	1.056***
	(0.356)	(0.375)
L2.Leverage	-0.187	-0.167
	(0.237)	(0.247)
L.P	-0.0718	-0.178
	(0.0946)	(0.116)
L2.P	0.423**	0.191
	(0.203)	(0.118)
Obs.	451	452
Arellano-Bond test for AR(1)	0.0373	0.0464
Arellano-Bond test for AR(2)	0.567	0.620
Sargan test(p-value)	0.940	0.936
H0: L1.P=L2.P=0(p-value)	0.0974	0.165
H0: L1.P+L2.P=0(p-value)	0.102	0.161

Standard errors in parentheses

GMM System Dynamic Panel Data Estimation. All regressions include time dummies.

Instruments restricted to t-3 and t-4

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix B

Part II Appendix

B.1 Data selection

Our sample contains five products group: milk, cat food, dishwashing liquid, frozen pizza, and diapers. Each product in a product group is identified by a unique product code (EAN). For each product we observe average weekly prices and quantities at the product/store level. We simplify the data set in two ways. First, we drop products that generally have very small market share because there are too few observations to identify quantity responses to price changes from the data. Second, we aggregate products to the brand level. Thus, we abstract from various product characteristics like different "flavours" and package sizes, but we retain separate products, where manufacturers sell several brands as in cat food. In particular, we aggregate the data in the following way for each product group.

Milk: We consider only UHT-milk. This segment of the milk market represents roughly half of the sales in the overall sample and is sufficiently differentiated from fresh milk to be treated as a separate product group. While fresh milk is supplied by many local brands, making it impossible to estimate across regions, UHT-milk is produced by national manufacturers under national brand names.

Table B.1: Cat Food. Sales (%) by product segment and characteristics

package / type	General	Supplement	Cat Grass	Cat's milk	Snack	Total
Bag-(Dry)	71%	0%	0%	0%	3%	74%
Bowl-(Wet)	11%	0%	0%	0%	0%	11%
Others	7%	1%	0%	3%	3%	15%
Total	89%	2%	0%	3%	6%	100%

We use data for both dry and wet cat food and aggregate to the brand level, which covers 85% of the sales in the sample.

Dishwashing: All products are kept in the sample. Product characteristics contained in our data set are "type" of dishwashing liquid (Normal, Skin-care, perfumed) and "fragrance" (lemon, normal, etc.). We aggregate across these products since they are largely priced the same with the exception of promotions, where sometimes only one type or fragrance of a brand is discounted while others are not.

Frozen Pizza: Types of pizza include "Flammkuchen", "Minipizza", "Pizzataschen" and "Pizza". We analyze only "Pizza", which accounts for 87.5% of total sales. We aggregate overall varieties sold.

Diapers: There are two main types of diapers, normal diapers and sport/training diapers. These represent 85% and 13% of sales, respectively. We keep both of them as separate products that are potential substitutes. The rest of the sample consists of adult and swimming products, which we discard.

B.2 The Brands in the Data Set

One feature of the AIDS model is that estimation requires product line to be the same for all geographic markets considered. In our sample, the "geographic market" is the store. This requirement restricts us from including smaller brands in our analysis, since smaller brands are not present in all stores of a given retailer. We therefore select the main brands in each product category and discarded brands that have on average less than 3% market share across the three retailers. With such small market shares, sales are too infrequent to generate meaningful estimates for the demand parameters.

Except for cat food, where the two main manufacturers, Mars and Nestle Purina, sell several brands (e.g. Nestle Purina produces Gourmet and Felix, among others), each manufacturer has a single brand in each product category. In cat food we aggregate to the brand level to simplify the exposition. The results are not fundamentally different when one disaggregates to the product level, but they get more unwieldy to present. For each of the product categories except for UHT-Milk, the selected main manufacturers are the same across all retailers (see Table B.2. For UHT-Milk we call two brands produced by two different manufacturers (Schwarzwaldmilch und Hochwald) jointly "Waldmilch". Waldmilch therefore refers to different manufacturers when estimating for different retailers. This is done to preserve anonymity of the retailers.

B.3 Aggregation of Products to the Brand Level

The products retained in the data set still vary by characteristics like flavour and package size. We have normalized prices across different sized package to a standardized unit, presented in Table B.2 below. We then calculate the weighted average price across all variants (e.g. flavours) of the product.

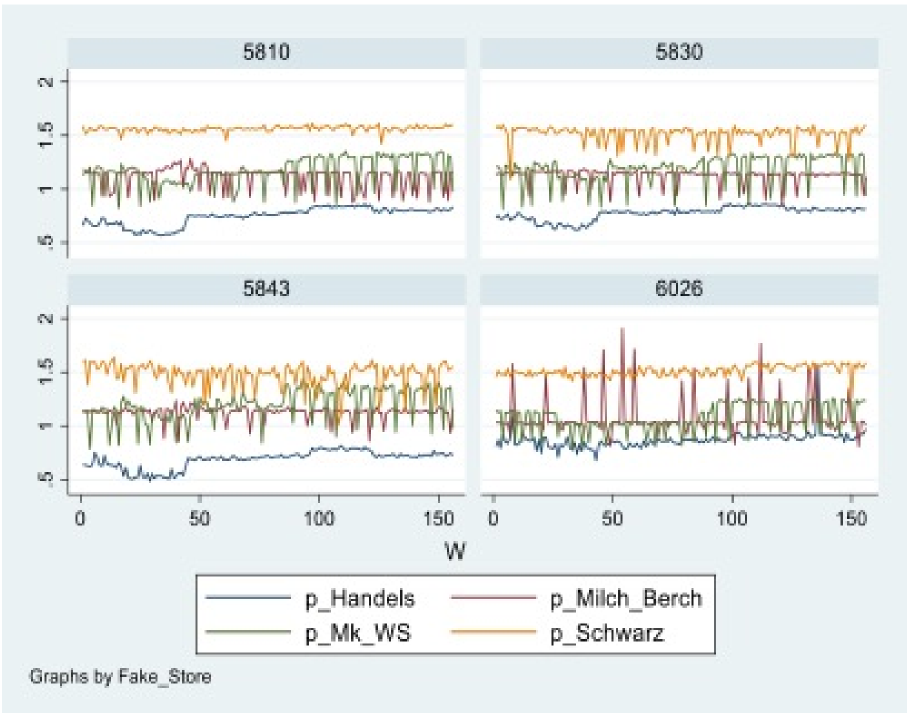
Table B.2: Selected brands in each product category

Product category	**Brand**	**Normalised at**
UHT-milk	Handelsmarke	100ml
	Waldmilch	
	Milchwerke Berchtesgaden	
	MK Weihenstephan	
Cat Food	Felix (Nestle)	100g
	Gourmet (Nestle)	
	One (Nestle)	
	Handelsmarke	
	Sheba (Mars)	
	Whiskas (Mars)	
	Kitekat (Mars)	
Frozen Pizza	Dr. Oetker	100g
	Handelsmarke	
	Wagner	
Dishwashing liquid	Colgate Palmolive	500ml
	Fit	
	Handelsmarke	
	Henkel	
	Procter & Gamble	
	Werner & Mertz	
Diapers	Handlemsarke - Normal Diapers	Unit (diaper)
	Procter & Gamble - Normal Diapers	
	Procter& Gamble - Sport Diapers	

B.4 Identification problems

The reader will notice that in most of the tables that we report private label appears only in rows but not columns. This is due to the fact that we encountered identification problems for private label price movements, which are mostly non-existent throughout our sample. We can therefore consistently identify the effect of a change in price in the branded products on private label quantities, but in many cases we cannot do the opposite because private label own-elasticities are not identified. This can be seen clearly be seen in Figure B.1. The blue line, p_Handels, is the price of the private label. The figure also includes the price of the other three main branded products in four randomly selected stores. It can be seen that the Handelsmarke (private label) has no short-run variation. This is partially the case with Schwarz. Furthermore, the long-run price variation tracks Mk_WS prices. This price pattern results in under-estimates of own and cross elasticities. When this is the case we are thus not able to identify the necessary parameters and abstain from reporting them in the main text.

Figure B.1: Price time series in four random stores



Stores are identified by 4-digits code. W stands for week.

B.5 Uncompensated Price Elasticities

Table B.3: Uncompensated price elasticities – UHT-Milk

		Retailer 1		
Q/P	Private Label	MW Bercht.	MK WS	Schwarz
Private Label	-0.879***	0.053***	0.281***	0.123***
	[-0.91,-0.85]	[0.03,0.08]	[0.26,0.30]	[0.09,0.16]
MW Bercht.	-0.582***	-1.497***	0.616***	0.428***
	[-0.77,-0.40]	[-1.64,-1.36]	[0.50,0.74]	[0.23,0.63]
MK WS	0.111	-0.062	-2.918***	0.032
	[-0.02,0.24]	[-0.16,0.04]	[-3.00,-2.83]	[-0.11,0.18]
Schwarz.	-0.424***	0.098*	0.185***	-2.007***
	[-0.53,-0.32]	[0.02,0.18]	[0.12,0.25]	[-2.12,-1.89]
		Retailer 2		
Q/P	Private Label	Hochwald	MW Bercht.	MK WS
Private Label	-1.262***	0.116***	0.292***	0.442***
	[-1.28,-1.25]	[0.11,0.12]	[0.27,0.32]	[0.43,0.46]
Hochwald	0.013	-2.542***	0.043	0.345***
	[-0.09,0.11]	[-2.60,-2.49]	[-0.14,0.23]	[0.23,0.46]
MW Bercht.	0.656***	-0.062***	-3.370***	0.625***
	[0.61,0.70]	[-0.09,-0.04]	[-3.46,-3.28]	[0.57,0.68]
MK WS	0.513***	0.094***	0.312***	-2.927***
	[0.47,0.55]	[0.07,0.12]	[0.24,0.38]	[-2.97,-2.88]
		Retailer 3		
Q/P	Private Label	Hochwald	MW Bercht.	MK WS
Private Label	-1.068***	0.036***	0.200***	0.349***
	[-1.08,-1.06]	[0.03,0.04]	[0.19,0.21]	[0.34,0.36]
Hochwald	0.374***	-2.936***	1.058***	1.596***
	[0.28,0.46]	[-3.00,-2.88]	[1.00,1.12]	[1.54,1.65]
MW Bercht.	0.018	0.050***	-2.361***	0.639***
	[-0.02,0.05]	[0.03,0.07]	[-2.39,-2.34]	[0.62,0.66]
MK WS	0.115***	0.213***	0.267***	-2.796***
	[0.08,0.15]	[0.19,0.23]	[0.25,0.29]	[-2.81,-2.78]

95% C.I. in brackets.
*** p<0.01, ** p<0.05, * p<0.1
Legend. MW Bercht: Milchwerke Berchtesgaden. MK WS: MK Weihenstephan.

Table B.4: Uncompensated price elasticities – Cat Food

Retailer 1

Q/P	Felix	Gourmet	Private Label	Kitekat	One	Sheba	Whiskas
Felix	-1.898***	0.191***	-0.199***	0.191***	0.062***	0.410***	0.229***
	[-1.92,-1.87]	[0.17,0.22]	[-0.24,-0.16]	[0.16,0.22]	[0.03,0.09]	[0.38,0.44]	[0.20,0.26]
Gourmet	0.113***	-2.728***	0.046	0.235***	0.203***	0.507***	0.053**
	[0.08,0.15]	[-2.76,-2.69]	[-0.00,0.10]	[0.19,0.28]	[0.16,0.24]	[0.47,0.54]	[0.02,0.09]
Private Label	0.054***	0.072***	-0.757***	0.110***	0.026***	0.138***	0.064***
	[0.05,0.06]	[0.06,0.08]	[-0.77,-0.75]	[0.10,0.12]	[0.02,0.04]	[0.13,0.15]	[0.06,0.07]
Kitekat	0.279***	0.176***	-0.130***	-2.674***	-0.082***	0.224***	0.269***
	[0.25,0.31]	[0.15,0.21]	[-0.17,-0.09]	[-2.71,-2.64]	[-0.12,-0.05]	[0.19,0.26]	[0.24,0.30]
One	0.137***	0.077***	-0.259***	0.043*	-1.599***	0.116***	0.163***
	[0.10,0.17]	[0.05,0.11]	[-0.30,-0.21]	[0.01,0.08]	[-1.64,-1.56]	[0.08,0.15]	[0.13,0.20]
Sheba	0.208***	0.291***	-0.259***	0.151***	0.034*	-2.536***	0.145***
	[0.18,0.23]	[0.27,0.31]	[-0.29,-0.22]	[0.12,0.18]	[0.01,0.06]	[-2.56,-2.51]	[0.12,0.17]
Whiskas	0.157***	0.062***	-0.346***	0.098***	0.01	0.357***	-2.075***
	[0.13,0.18]	[0.04,0.09]	[-0.38,-0.31]	[0.07,0.13]	[-0.02,0.04]	[0.33,0.38]	[-2.10,-2.05]

Retailer 2

Q/P	Felix	Gourmet	Private Label	Kitekat	One	Sheba	Whiskas
Felix	-3.024***	0.399***	-0.231***	0.140***	-0.124***	0.273***	0.362***
	[-3.04,-3.01]	[0.39,0.41]	[-0.25,-0.22]	[0.13,0.15]	[-0.14,-0.11]	[0.26,0.29]	[0.35,0.38]
Gourmet	0.407***	-2.620***	-0.196***	0.081***	0.278***	0.696***	0.044***
	[0.39,0.43]	[-2.63,-2.61]	[-0.21,-0.18]	[0.06,0.10]	[0.26,0.29]	[0.68,0.71]	[0.03,0.06]
Private Label	0.171***	0.100***	-0.685***	0.131***	0.051***	0.151***	0.057***
	[0.16,0.18]	[0.09,0.11]	[-0.69,-0.68]	[0.12,0.14]	[0.04,0.06]	[0.14,0.16]	[0.05,0.06]
Kitekat	0.794***	0.102***	-0.154***	-2.769***	0.193***	0.327***	0.271***
	[0.77,0.82]	[0.08,0.12]	[-0.18,-0.13]	[-2.79,-2.74]	[0.17,0.22]	[0.30,0.35]	[0.25,0.30]
One	0.162***	0.177***	-0.155***	-0.030***	-2.093***	0.318***	0.165***
	[0.14,0.18]	[0.16,0.19]	[-0.17,-0.14]	[-0.05,-0.01]	[-2.11,-2.08]	[0.30,0.34]	[0.15,0.18]
Sheba	0.393***	0.488***	-0.078***	0.112***	0.128***	-2.596***	0.060***
	[0.38,0.41]	[0.48,0.50]	[-0.09,-0.06]	[0.10,0.13]	[0.11,0.14]	[-2.61,-2.58]	[0.05,0.07]
Whiskas	0.610***	0.309***	-0.191***	0.118***	0.134***	0.131***	-2.165***
	[0.59,0.63]	[0.29,0.32]	[-0.21,-0.17]	[0.10,0.13]	[0.12,0.15]	[0.11,0.15]	[-2.18,-2.15]

Retailer 3

Q/P	Felix	Gourmet	Private Label	Kitekat	One	Sheba	Whiskas
Felix	-1.677***	0.190***	-0.002	-0.038***	-0.079***	0.151***	0.123***
	[-1.69,-1.67]	[0.18,0.20]	[-0.01,0.01]	[-0.05,-0.03]	[-0.09,-0.07]	[0.14,0.16]	[0.11,0.13]
Gourmet	0.146***	-2.162***	-0.029***	0.055***	-0.008	0.255***	0.142***
	[0.14,0.16]	[-2.17,-2.15]	[-0.04,-0.02]	[0.04,0.07]	[-0.02,0.00]	[0.25,0.27]	[0.13,0.15]
Private Label	0.136***	0.127***	-0.892***	-0.025***	0.008**	0.078***	0.054***
	[0.13,0.14]	[0.12,0.13]	[-0.90,-0.89]	[-0.03,-0.02]	[0.00,0.01]	[0.07,0.08]	[0.05,0.06]
Kitekat	0.194***	0.152***	0.035***	-1.037***	0.021**	0.222***	-0.013*
	[0.18,0.21]	[0.14,0.17]	[0.02,0.05]	[-1.05,-1.02]	[0.01,0.03]	[0.21,0.23]	[-0.03,-0.00]
One	-0.065***	-0.082***	-0.208***	-0.023***	-0.802***	-0.029***	0.008
	[-0.08,-0.05]	[-0.10,-0.07]	[-0.22,-0.20]	[-0.04,-0.01]	[-0.81,-0.79]	[-0.04,-0.02]	[-0.00,0.02]
Sheba	0.036***	0.218***	-0.104***	0.039***	-0.023***	-1.532***	-0.009*
	[0.03,0.04]	[0.21,0.23]	[-0.11,-0.10]	[0.03,0.05]	[-0.03,-0.02]	[-1.54,-1.52]	[-0.02,-0.00]
Whiskas	0.132***	0.222***	-0.036***	0.037***	-0.005	0.026***	-1.438***
	[0.12,0.14]	[0.21,0.23]	[-0.05,-0.03]	[0.03,0.05]	[-0.01,0.00]	[0.02,0.04]	[-1.45,-1.43]

95% C.I. in brackets.

*** p<0.01, ** p<0.05, * p<0.1

Legend: Nestle brands: Felix, Gourmet and One. Mars brands: Kitekat, Sheba and Whiskas.

Table B.5: Uncompensated price elasticities – Dishwashing Liquid

			Retailer 1			
Q/P	Colgate	Fit	Private Label	Henkel	Procter	Werner
Colgate	-3.731***	0.274***	0.171***	1.111***	0.507***	0.051*
	[-3.78,-3.69]	[0.21,0.33]	[0.07,0.27]	[1.06,1.16]	[0.46,0.55]	[0.01,0.09]
Fit	0.310***	-2.327***	-0.161***	0.488***	0.284***	0.085***
	[0.27,0.35]	[-2.37,-2.28]	[-0.24,-0.08]	[0.45,0.53]	[0.25,0.32]	[0.05,0.12]
Private Label	0.250***	0.114***	-1.303***	0.329***	0.057***	0.017
	[0.23,0.27]	[0.09,0.14]	[-1.35,-1.26]	[0.30,0.35]	[0.04,0.08]	[-0.00,0.04]
Henkel	0.480***	0.096***	0.136***	-2.293***	0.342***	0.019
	[0.46,0.50]	[0.07,0.12]	[0.09,0.18]	[-2.32,-2.27]	[0.32,0.36]	[-0.00,0.04]
Procter	0.736***	0.309***	-0.063	1.067***	-3.714***	0.189***
	[0.68,0.79]	[0.23,0.39]	[-0.19,0.07]	[1.00,1.13]	[-3.77,-3.66]	[0.13,0.24]
Werner	0.466***	0.232***	0.142**	0.516***	0.240***	-1.372***
	[0.43,0.50]	[0.18,0.28]	[0.06,0.23]	[0.47,0.56]	[0.20,0.28]	[-1.41,-1.34]
			Retailer 2			
Q/P	Colgate	Fit	Private Label	Henkel	Procter	Werner
Colgate	-5.716***	-0.004	0.056***	1.399***	0.160***	-0.112***
	[-5.75,-5.68]	[-0.02,0.01]	[0.03,0.08]	[1.37,1.43]	[0.13,0.19]	[-0.13,-0.10]
Fit	0.339***	-1.162***	-0.193***	0.266***	0.258***	-0.003
	[0.32,0.36]	[-1.17,-1.15]	[-0.21,-0.18]	[0.25,0.28]	[0.24,0.28]	[-0.01,0.01]
Private Label	0.065***	0.017***	-0.561***	0.140***	0.065***	-0.115***
	[0.06,0.07]	[0.01,0.02]	[-0.57,-0.56]	[0.13,0.15]	[0.06,0.07]	[-0.12,-0.11]
Henkel	0.744***	0.004	-0.338***	-2.552***	0.767***	-0.092***
	[0.73,0.76]	[-0.00,0.01]	[-0.35,-0.33]	[-2.56,-2.54]	[0.76,0.78]	[-0.10,-0.08]
Procter	0.213***	0.073***	-0.081***	1.185***	-3.498***	-0.091***
	[0.19,0.24]	[0.06,0.08]	[-0.10,-0.06]	[1.16,1.21]	[-3.52,-3.48]	[-0.10,-0.08]
Werner	0.271***	-0.001	-0.152***	0.242***	0.176***	-0.715***
	[0.26,0.28]	[-0.01,0.00]	[-0.16,-0.14]	[0.23,0.25]	[0.17,0.18]	[-0.72,-0.71]
			Retailer 3			
Q/P	Colgate	Fit	Private Label	Henkel	Procter	Werner
Colgate	-1.997***	-0.075***	0.234***	0.923***	0.608***	-0.089***
	[-2.01,-1.98]	[-0.10,-0.05]	[0.21,0.26]	[0.90,0.94]	[0.59,0.63]	[-0.10,-0.08]
Fit	0.007	-1.066***	-0.103***	0.169***	0.133***	-0.082***
	[-0.00,0.02]	[-1.08,-1.05]	[-0.12,-0.08]	[0.15,0.18]	[0.12,0.15]	[-0.09,-0.07]
Private Label	0.142***	0.048***	-1.355***	0.324***	0.197***	0.002
	[0.14,0.15]	[0.04,0.06]	[-1.37,-1.34]	[0.32,0.33]	[0.19,0.21]	[-0.00,0.01]
Henkel	0.167***	0.027***	0.147***	-1.812***	0.382***	-0.074***
	[0.16,0.17]	[0.02,0.04]	[0.14,0.16]	[-1.82,-1.80]	[0.37,0.39]	[-0.08,-0.07]
Procter	0.119***	0.030***	-0.011	0.468***	-2.944***	-0.023***
	[0.11,0.13]	[0.01,0.05]	[-0.03,0.01]	[0.45,0.49]	[-2.96,-2.93]	[-0.03,-0.01]
Werner	-0.007	-0.065***	0.134***	0.142***	0.101***	-0.689***
	[-0.02,0.00]	[-0.08,-0.05]	[0.12,0.15]	[0.13,0.15]	[0.09,0.12]	[-0.70,-0.68]

95% C.I. in brackets.
*** p<0.01, ** p<0.05, * p<0.1

Table B.6: Uncompensated price elasticities – Frozen Pizza

Retailer 1			
Q/P	Dr. Oetker	Private Label	Wagner
Dr. Oetker	-2.371***	-0.068***	0.770***
	[-2.39,-2.35]	[-0.09,-0.05]	[0.75,0.79]
Private Label	0.563***	-0.755***	0.453***
	[0.54,0.59]	[-0.78,-0.73]	[0.44,0.47]
Wagner	1.619***	-0.129***	-2.650***
	[1.59,1.65]	[-0.16,-0.10]	[-2.67,-2.63]
Retailer 2			
Q/P	Dr. Oetker	Private Label	Wagner
Dr. Oetker	-2.718***	0.012**	0.915***
	[-2.73,-2.70]	[0.00,0.02]	[0.91,0.92]
Private Label	1.845***	-0.904***	1.392***
	[1.82,1.87]	[-0.92,-0.88]	[1.37,1.41]
Wagner	1.606***	-0.067***	-3.090***
	[1.59,1.62]	[-0.08,-0.05]	[-3.10,-3.08]
Retailer 3			
Q/P	Dr. Oetker	Private Label	Wagner
Dr. Oetker	-2.265***	-0.191***	0.696***
	[-2.27,-2.26]	[-0.19,-0.19]	[0.69,0.70]
Private Label	0.763***	-0.407***	0.435***
	[0.76,0.77]	[-0.41,-0.40]	[0.43,0.44]
Wagner	1.435***	-0.169***	-2.478***
	[1.43,1.44]	[-0.17,-0.16]	[-2.48,-2.47]

95% C.I. in brackets.
*** p<0.01, ** p<0.05, * p<0.1

Table B.7: Uncompensated price elasticities – Diapers

	Retailer 1		
Q/P	Private Label	Procter normal	Procter sport
Private Label	-1.034***	0.05	0.476***
	[-1.13,-0.94]	[-0.01,0.11]	[0.44,0.52]
Procter normal	0.016	-1.021***	0.051***
	[-0.03,0.06]	[-1.05,-0.99]	[0.03,0.07]
Procter sport	-0.011	0.007	-1.758***
	[-0.12,0.10]	[-0.06,0.07]	[-1.81,-1.71]
	Retailer 2		
Q/P	Private Label	Procter normal	Procter sport
Private Label	-1.157***	0.562***	0.104***
	[-1.16,-1.15]	[0.55,0.57]	[0.10,0.11]
Procter normal	-0.056***	-1.583***	0.143***
	[-0.06,-0.05]	[-1.59,-1.58]	[0.14,0.15]
Procter sport	1.165***	0.652***	-2.430***
	[1.14,1.19]	[0.62,0.68]	[-2.45,-2.41]
	Retailer 3		
Q/P	Private Label	Procter normal	Procter sport
Private Label	-0.633***	-0.234***	0.281***
	[-0.66,-0.60]	[-0.26,-0.21]	[0.26,0.30]
Procter normal	-0.088***	-0.816***	0.174***
	[-0.10,-0.08]	[-0.83,-0.81]	[0.17,0.18]
Procter sport	-0.038**	-0.386***	-1.807***
	[-0.07,-0.01]	[-0.41,-0.36]	[-1.82,-1.79]

95% C.I. in brackets.

*** p<0.01, ** p<0.05, * p<0.1

B.6 LA/AIDS Estimates

Table B.8: UHT-Milk – LA/AIDS model estimates

Retailer 1

Var.	w1	w2	w3	w4
lnp1	0.0718***	-0.0453***	0.0278***	-0.0543***
	(0.011)	(0.007)	(0.009)	(0.006)
lnp2	0.0344***	-0.0388***	-0.00687	0.0112**
	(0.009)	(0.006)	(0.007)	(0.005)
lnp3	0.186***	0.0480***	-0.255***	0.0213***
	(0.007)	(0.005)	(0.006)	(0.004)
lnp4	0.0806***	0.0334***	0.00651	-0.120***
	(0.012)	(0.008)	(0.010)	(0.007)
lnY_P	-0.0136***	8.16E-05	0.0192***	-0.00564***
	(0.004)	(0.002)	(0.003)	(0.002)
Const.	0.751***	0.0352*	0.0384*	0.175***
	(0.027)	(0.018)	(0.023)	(0.016)
Obs.	6,972	6,972	6,972	6,972
R-sq.	0.305	0.135	0.445	0.126

Retailer 2

Var.	w1	w2	w3	w4
lnp1	-0.157***	-0.0113***	0.0693***	0.0992***
	(0.005)	(0.003)	(0.003)	(0.004)
lnp2	0.0756***	-0.0871***	-0.00665***	0.0182***
	(0.003)	(0.002)	(0.001)	(0.002)
lnp3	0.191***	0.000412	-0.251***	0.0601***
	(0.009)	(0.005)	(0.005)	(0.007)
lnp4	0.289***	0.0157***	0.0662***	-0.371***
	(0.006)	(0.003)	(0.003)	(0.004)
lnY_P	0.0183***	-0.0187***	-0.000471	0.000808
	(0.003)	(0.002)	(0.001)	(0.002)
Const.	0.475***	0.188***	0.113***	0.224***
	(0.025)	(0.014)	(0.013)	(0.019)
Obs.	17,550	17,550	17,550	17,550
R-sq.	0.458	0.442	0.367	0.492

Retailer 3

Var.	w1	w2	w3	w4
lnp1	-0.0722***	0.0200***	0.0157***	0.0365***
	(0.004)	(0.002)	(0.003)	(0.003)
lnp2	0.0197***	-0.0731***	0.00876***	0.0447***
	(0.002)	(0.001)	(0.002)	(0.002)
lnp3	0.111***	0.0417***	-0.211***	0.0584***
	(0.003)	(0.001)	(0.002)	(0.002)
lnp4	0.198***	0.0626***	0.105***	-0.366***
	(0.002)	(0.001)	(0.002)	(0.002)
lnY_P	-0.0526***	0.00976***	0.0216***	0.0213***
	(0.001)	(0.000)	(0.001)	(0.001)
Const.	0.931***	-0.0410***	-0.0144***	0.124***
	(0.007)	(0.003)	(0.005)	(0.006)
Obs.	140,628	140,628	140,628	140,628
R-sq.	0.372	0.456	0.297	0.522

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$
Legend. 1-Private Label, 2-Milchwerke Berchtesgaden for Retailer 1, Hochwald for Retailers 2 and 3, 3-MK Weihenstephan for Retailer 1, Milchwerke Berchtesgaden for Retailers 2 and 3, 4-Schwarzwaldmilch for Retailer 1, MK Weihenstephan for Retailers 2 and 3.

Table B.9: Cat Food, Retailer 1 – LA/AIDS model estimates

Var.	w1	w2	w3	w4	w5	w6	w7
lnp1	-0.103***	0.00817***	0.0231***	0.0200***	0.00743***	0.0285***	0.0154***
	(0.00156)	(0.00125)	(0.00204)	(0.00120)	(0.000923)	(0.00170)	(0.00135)
lnp2	0.0222***	-0.116***	0.0321***	0.0126***	0.00419***	0.0391***	0.00606***
	(0.00146)	(0.00117)	(0.00191)	(0.00112)	(0.000865)	(0.00159)	(0.00127)
lnp3	-0.0214***	0.00529***	0.105***	-0.00970***	-0.0140***	-0.0300***	-0.0347***
	(0.00213)	(0.00171)	(0.00278)	(0.00163)	(0.00126)	(0.00232)	(0.00185)
lnp4	0.0222***	0.0162***	0.0495***	-0.120***	0.00232**	0.0206***	0.00966***
	(0.00173)	(0.00139)	(0.00226)	(0.00132)	(0.00102)	(0.00188)	(0.00150)
lnp5	0.00727***	0.0139***	0.0112***	-0.00593***	-0.0325***	0.00503***	0.000970
	(0.00171)	(0.00137)	(0.00224)	(0.00131)	(0.00101)	(0.00186)	(0.00148)
lnp6	0.0474***	0.0348***	0.0617***	0.0160***	0.00630***	-0.202***	0.0354***
	(0.00154)	(0.00124)	(0.00201)	(0.00118)	(0.000911)	(0.00168)	(0.00134)
lnp7	0.0266***	0.00405***	0.0280***	0.0193***	0.00885***	0.0200***	-0.107***
	(0.00154)	(0.00124)	(0.00202)	(0.00118)	(0.000914)	(0.00168)	(0.00134)
lnY_P	0.00320***	0.00477***	-0.0154***	-0.000749	6.57e-05	0.00905***	-0.000889*
	(0.000606)	(0.000487)	(0.000793)	(0.000465)	(0.000359)	(0.000661)	(0.000526)
Const.	0.0787***	0.0487***	0.913***	-0.0816***	0.0244***	0.0339***	-0.0175***
	(0.00660)	(0.00530)	(0.00864)	(0.00506)	(0.00391)	(0.00720)	(0.00573)
Obs.	51,146	51,146	51,146	51,146	51,146	51,146	51,146
R-sq.	0.270	0.328	0.153	0.276	0.111	0.392	0.233

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Legend. 1: Felix (Nestle), 2: Gourmet (Nestle), 3: Private Label, 4: Kitekat (Mars), 5: One (Nestle), 6: Sheba (Mars), 7: Whiskas (Mars)

Table B.10: Cat Food, Retailer 2 – LA/AIDS model estimates

Var.	w1	w2	w3	w4	w5	w6	w7
lnp1	-0.290***	0.0551***	0.0577***	0.0458***	0.0117***	0.0599***	0.0596***
	(0.00124)	(0.00131)	(0.00130)	(0.000832)	(0.000750)	(0.00128)	(0.000977)
lnp2	0.0562***	-0.212***	0.0333***	0.00581***	0.0128***	0.0740***	0.0301***
	(0.000928)	(0.000984)	(0.000971)	(0.000623)	(0.000562)	(0.000958)	(0.000732)
lnp3	-0.0350***	-0.0222***	0.105***	-0.00915***	-0.0116***	-0.00851***	-0.0191***
	(0.00113)	(0.00119)	(0.00118)	(0.000756)	(0.000682)	(0.00116)	(0.000888)
lnp4	0.0197***	0.0113***	0.0449***	-0.102***	-0.00221***	0.0172***	0.0114***
	(0.00108)	(0.00114)	(0.00113)	(0.000723)	(0.000652)	(0.00111)	(0.000850)
lnp5	-0.0181***	0.0374***	0.0168***	0.0111***	-0.0799***	0.0197***	0.0131***
	(0.00106)	(0.00113)	(0.00111)	(0.000715)	(0.000645)	(0.00110)	(0.000840)
lnp6	0.0382***	0.0933***	0.0507***	0.0188***	0.0231***	-0.237***	0.0127***
	(0.00119)	(0.00126)	(0.00125)	(0.000801)	(0.000722)	(0.00123)	(0.000941)
lnp7	0.0511***	0.00676***	0.0188***	0.0156***	0.0119***	0.00987***	-0.114***
	(0.00104)	(0.00110)	(0.00109)	(0.000698)	(0.000630)	(0.00107)	(0.000820)
lnY_P	-0.00552***	0.0104***	-0.0112***	-0.000744***	-0.000834***	0.00895***	-0.00106***
	(0.000398)	(0.000422)	(0.000416)	(0.000267)	(0.000241)	(0.000411)	(0.000314)
Const.	-0.0698***	0.0756***	0.793***	-0.0134***	0.0323***	0.125***	0.0572***
	(0.00382)	(0.00405)	(0.00400)	(0.00257)	(0.00232)	(0.00395)	(0.00302)
Obs.	148,768	148,768	148,768	148,768	148,768	148,768	148,768
R-sq.	0.425	0.453	0.167	0.273	0.223	0.384	0.275

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Legend. 1: Felix (Nestle), 2: Gourmet (Nestle), 3: Private Label, 4: Kitekat (Mars), 5: One (Nestle), 6: Sheba (Mars), 7: Whiskas (Mars)

Table B.11: Cat Food, Retailer 3– LA/AIDS model estimates

Var.	w1	w2	w3	w4	w5	w6	w7
lnp1	-0.0920***	0.0176***	0.0452***	0.0113***	-0.00386***	0.00707***	0.0146***
	(0.000597)	(0.000591)	(0.000805)	(0.000380)	(0.000399)	(0.000710)	(0.000536)
lnp2	0.0259***	-0.135***	0.0421***	0.00885***	-0.00496***	0.0381***	0.0249***
	(0.000663)	(0.000657)	(0.000895)	(0.000423)	(0.000444)	(0.000789)	(0.000596)
lnp3	6.31e-05	-0.00174***	0.0346***	0.000736*	-0.0125***	-0.0160***	-0.00520***
	(0.000622)	(0.000617)	(0.000840)	(0.000397)	(0.000417)	(0.000741)	(0.000559)
lnp4	-0.00513***	0.00672***	-0.00876***	-0.00255***	-0.00135***	0.00706***	0.00401***
	(0.000621)	(0.000615)	(0.000838)	(0.000396)	(0.000416)	(0.000739)	(0.000558)
lnp5	-0.0107***	-0.000612	0.00217***	0.00101**	0.0125***	-0.00367***	-0.000777
	(0.000623)	(0.000618)	(0.000841)	(0.000397)	(0.000417)	(0.000742)	(0.000560)
lnp6	0.0207***	0.0306***	0.0253***	0.0129***	-0.00148***	-0.0905***	0.00248***
	(0.000600)	(0.000594)	(0.000809)	(0.000382)	(0.000401)	(0.000714)	(0.000539)
lnp7	0.0168***	0.0171***	0.0177***	-0.00126***	0.000713*	-0.000857	-0.0502***
	(0.000602)	(0.000596)	(0.000812)	(0.000384)	(0.000403)	(0.000716)	(0.000541)
lnY_P	0.000954***	0.00476***	-0.00607***	-0.00411***	0.00176***	0.00582***	-0.00313***
	(0.000227)	(0.000225)	(0.000307)	(0.000145)	(0.000152)	(0.000271)	(0.000204)
Const.	0.0455***	0.129***	0.514***	0.101***	0.0485***	0.0694***	0.0924***
	(0.00226)	(0.00224)	(0.00305)	(0.00144)	(0.00151)	(0.00269)	(0.00203)
Obs.	519,392	519,392	519,392	519,392	519,392	519,392	519,392
R-sq.	0.305	0.494	0.260	0.264	0.215	0.519	0.254

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Legend. 1: Felix (Nestle), 2: Gourmet (Nestle), 3: Private Label, 4: Kitekat (Mars), 5: One (Nestle), 6: Sheba (Mars), 7: Whiskas (Mars)

Table B.12: Dishwashing Liquid, Retailer 1 – LA/AIDS model estimates

Var.	w1	w2	w3	w4	w5	w6
lnp1	-0.368***	0.0336***	0.0367***	0.172***	0.0740***	0.0510***
	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
lnp2	0.0402***	-0.150***	0.0115***	0.0414***	0.0330***	0.0240***
	(0.004)	(0.003)	(0.003)	(0.005)	(0.004)	(0.003)
lnp3	0.0286***	-0.0199***	-0.0827***	0.0623***	0.00119	0.0105**
	(0.007)	(0.005)	(0.005)	(0.008)	(0.006)	(0.005)
lnp4	0.160***	0.0517***	0.0321***	-0.407***	0.112***	0.0508***
	(0.004)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)
lnp5	0.0714***	0.0310***	0.00177	0.122***	-0.252***	0.0255***
	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
lnp6	0.0100***	0.00849***	-0.00873***	0.0161***	0.0219***	-0.0478***
	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
lnY_P	0.0265***	-0.00925***	-0.103***	0.0821***	0.0351***	-0.0310***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Const.	0.0360***	0.109***	0.698***	-0.0890***	-0.0148	0.261***
	(0.012)	(0.008)	(0.008)	(0.015)	(0.011)	(0.009)
Obs.	28,275	28,275	28,275	28,275	28,275	28,275
R-sq.	0.434	0.206	0.302	0.495	0.338	0.147

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

1: Colgate-Palmolive, 2: FIT, 3: Private Label, 4: Henkel, 5: Procter & Gamble, 6: Werner & Mertz.

Table B.13: Dishwashing Liquid, Retailer 2 – LA/AIDS model estimates

Var.	w1	w2	w3	w4	w5	w6
lnp1	-0.294***	0.0263***	0.0154***	0.161***	0.0245***	0.0664***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
lnp2	-0.000578	-0.0143***	0.000186	0.00417***	0.0109***	-0.000402
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
lnp3	0.00235***	-0.0202***	0.112***	-0.0600***	0.00400***	-0.0377***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnp4	0.0863***	0.0181***	0.0282***	-0.322***	0.131***	0.0591***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnp5	0.00958***	0.0192***	0.0129***	0.168***	-0.252***	0.0431***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnp6	-0.00789***	-0.00407***	-0.0490***	-0.00961***	0.000859	0.0697***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
lnY_P	-0.00375***	-0.0158***	-0.0613***	0.0405***	0.0416***	-0.00140***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Const.	0.0454***	0.150***	0.691***	0.0184***	-0.0774***	0.173***
	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)
Obs.	375,617	375,617	375,617	375,617	375,617	375,617
R-sq.	0.243	0.098	0.205	0.263	0.216	0.153

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

1: Colgate-Palmolive, 2: FIT, 3: Private Label, 4: Henkel, 5: Procter & Gamble, 6: Werner & Mertz.

Table B.14: Dishwashing Liquid, Retailer 3 – LA/AIDS model estimates

Var.	w1	w2	w3	w4	w5	w6
lnp1	-0.0978***	-0.000584	0.0230***	0.0597***	0.0182***	-0.00254***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnp2	-0.00593***	-0.00753***	0.00270***	0.0147***	0.00652***	-0.0105***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnp3	0.0268***	-0.0126***	-0.0948***	0.0611***	0.00456***	0.0149***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
lnp4	0.0972***	0.0123***	0.0451***	-0.238***	0.0695***	0.0144***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
lnp5	0.0627***	0.0112***	0.0324***	0.130***	-0.249***	0.0119***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
lnp6	-0.00665***	-0.00961***	-0.0105***	-0.0146***	0.000791	0.0405***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
lnY_P	0.0161***	-0.0124***	-0.0802***	0.0649***	0.0275***	-0.0158***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
Const.	0.00521*	0.144***	0.574***	0.0288***	0.0586***	0.190***
	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)	(0.002)
Obs.	378,756	378,756	378,756	378,756	378,756	378,756
R-sq.	0.389	0.099	0.269	0.446	0.505	0.219

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

1: Colgate-Palmolive, 2: FIT, 3: Private Label, 4: Henkel, 5: Procter & Gamble, 6: Werner & Mertz.

Table B.15: Frozen pizza – LA/AIDS model estimates

	Retailer 1				**Retailer 2**				**Retailer 3**		
Var.	w1	w2	w3	Var.	w1	w2	w3	Var.	w1	w2	w3
lnp1	-0.604***	0.127***	0.477***	lnp1	-0.854***	0.304***	0.550***	lnp1	-0.593***	0.161***	0.432***
	(0.005)	(0.004)	(0.005)		(0.004)	(0.003)	(0.004)		(0.001)	(0.001)	(0.001)
lnp2	-0.0265***	0.0509***	-0.0244***	lnp2	0.00503**	0.0115***	-0.0165***	lnp2	-0.0875***	0.130***	-0.0426***
	(0.004)	(0.003)	(0.004)		(0.002)	(0.002)	(0.002)		(0.001)	(0.001)	(0.001)
lnp3	0.347***	0.107***	-0.454***	lnp3	0.452***	0.231***	-0.682***	lnp3	0.332***	0.0906***	-0.423***
	(0.004)	(0.003)	(0.004)		(0.003)	(0.002)	(0.003)		(0.001)	(0.001)	(0.001)
lnY_P	0.0145***	-0.0583***	0.0438***	lnY_P	-0.00479***	-0.0291***	0.0339***	lnY_P	0.0115***	-0.0400***	0.0284***
	(0.002)	(0.001)	(0.002)		(0.001)	(0.001)	(0.001)		(0.001)	(0.000)	(0.000)
Const.	0.245***	0.774***	-0.0191	Const.	0.397***	0.564***	0.0396***	Const.	0.241***	0.712***	0.0470***
	(0.012)	(0.009)	(0.012)		(0.010)	(0.007)	(0.009)		(0.003)	(0.002)	(0.003)
Obs.	42,930	42,930	42,930	Obs.	75,945	75,945	75,945	Obs.	616,476	616,476	616,476
R-sq.	0.615	0.239	0.639	R-sq.	0.786	0.461	0.795	R-sq.	0.718	0.319	0.722

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Legend. 1-Dr. Oetker, 2-Private Label, 3-Wagner.

Table B.16: Diapers – LA/AIDS model estimates

	Retailer 1				Retailer 2				Retailer 3		
Var.	w1	w2	w3	Var.	w1	w2	w3	Var.	w1	w2	w3
lnp1	-0.00856	0.0113	-0.00271	lnp1	-0.0708***	-0.0207***	0.0915***	lnp1	0.0627***	-0.0548***	-0.00794***
	(0.011)	(0.013)	(0.010)		(0.002)	(0.002)	(0.001)		(0.003)	(0.004)	(0.003)
lnp2	0.00883	-0.00811	-0.000721	lnp2	0.232***	-0.282***	0.0497***	lnp2	-0.0422***	0.120***	-0.0778***
	(0.006)	(0.008)	(0.006)		(0.002)	(0.002)	(0.001)		(0.002)	(0.003)	(0.002)
lnp3	0.105***	0.0316***	-0.137***	lnp3	0.0431***	0.0726***	-0.116***	lnp3	0.0478***	0.111***	-0.159***
	(0.005)	(0.006)	(0.004)		(0.001)	(0.001)	(0.001)		(0.001)	(0.002)	(0.002)
lnY_P	-0.00396***	0.00742***	-0.00346***	lnY_P	-0.0107***	0.0165***	-0.00578***	lnY_P	-0.00313***	0.00632***	-0.00319***
	(0.000)	(0.001)	(0.000)		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
Const.	-0.336***	0.463***	0.873***	Const.	-0.551***	1.507***	0.0440***	Const.	-0.0958***	-0.300***	1.396***
	(0.058)	(0.074)	(0.055)		(0.012)	(0.013)	(0.008)		(0.017)	(0.025)	(0.019)
Obs.	23,862	23,862	23,862	Obs.	365,607	365,607	365,607	Obs.	220,071	220,071	220,071
R-sq.	0.116	0.171	0.152	R-sq.	0.314	0.511	0.376	R-sq.	0.075	0.127	0.137

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Legend. 1-Private Label, 2-Procter & Gamble normal diapers, 3-Procter & Gamble sport diapers.