Impact of competition enforcement in the cement industry in South Africa

Nicola Theron[+] and Albertus van Niekerk[*]

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[+]Nicola Theron is the Managing Director of Econex (Pty) Ltd. as well as an extraordinary professor at the Economics Department of the University of Stellenbosch

[*]Albertus van Niekerk is an economist at Econex (Pty) Ltd.

1 Introduction

The Competition Commission (CC) has successfully prosecuted a large number of cartels in various sectors of the South African economy. However, assessing the impact of such enforcement is not routinely done. This paper is an important contribution in this regard as it analyses the effects of collusion in the cement cartel, the longest standing cartel in South Africa (SA). The South African cement cartel involved price fixing and the allocation of market shares by the four main cement producers (Pretoria Portland Cement ("PPC"), Lafarge, AfriSam and NPC). This was a lawful cartel (dating back from around the 1940s), with a set of institutional arrangements to manage the activities of the cartel. From the 1940s until 1996, the cartel was exempt from competition legislation. This exemption was withdrawn by the then Competition Board in 1995, but the members were given until the end of September 1996 to terminate the lawful cartel. However, despite the termination of the legal cartel, the cement producers reached a new (illegal) agreement in 1998 which allowed them to continue targeting market shares. According to this agreement, cartel members would continue to hold the market shares enjoyed during the official cartel period.

A scoping study into the markets for construction and infrastructure inputs led to an investigation into the cement industry by the CC in June 2008. In reaction to this, the largest cement producer in South Africa, PPC, applied for leniency on the 7th of August 2009. PPC agreed to cooperate with the CC's investigation and provide information regarding the cement cartel. As part of the leniency agreement, PPC stopped the sharing of detailed sales information through the Cement and Concrete Institute ("C&CI''), the industry association used to sustain the cartel.

AfriSam and Lafarge concluded settlement agreements with the CC in November 2011 and March 2012, respectively. The existence of the cartel, as well as information regarding its functioning, were confirmed by these two firms. AfriSam agreed to pay a fine of almost R125 million while Lafarge agreed to pay almost R149 million. As part of the settlement agreements, it was decided that the C&CI could no longer release region-specific sales data as was done previously, but only national data. Previously, sales data were released monthly. It was also decided that, going forward, cement sales figures could only be released on a quarterly basis, including a three month delay.

In this paper we calculate the overcharge amount which resulted from the cartel, i.e. the cartel price compared to a 'but for' price that would have prevailed if the cartel did not exist. We argue that a proper understanding of the cement cartel is necessary to calculate such overcharge damages. The cement cartel is unique in the sense that it existed in the form of a legal cartel for many decades (since the 1940s), and was only disbanded around 1996. However, this was by no means the end of the cartel, as the legal cartel period was followed by an illegal cartel period, lasting until at least 2008. We present an overview of both international and local studies calculating cement cartel overcharge percentages. We use the most recent work by Govinda *et al.* to illustrate some of the problems around the estimation of such damages for cement

in SA. We show that any modelling is very sensitive to assumptions about the time periods and levels of competition in the market. If one works with a short time period like Govinda *et al* (January 2008 to December 2012) various problems arise. The cartel period included is very short (January 2008 – November 2009) and much information is lost due to the commodity price boom during 2008/2009. In addition, it does not seem reasonable to assume that the cartel ended immediately with the CC's intervention in November 2009.

In our modelling, we make use of both monthly and bi-annual data. While the monthly data provides one with a much longer time period (and thus more degrees of freedom), the structure of the dependant variable may violate some of the assumptions of the General Linear Model. As such, we attempt to correct for this using data at a bi-annual frequency.

We follow a similar approach to some of the international and local work, by also using a 'during-and-after' period to estimate the counterfactual price. However, using the monthly data, we improve on previous work by using a much longer time period and by controlling for the financial crisis within this period. Importantly, we use dummy variables to indicate different transition periods, which we find more realistic than assuming the cartel ended on a specific date. There are various reasons why a transition period is expected in the case of the cement cartel. Firstly, the duration of the cartel, i.e. it existed since the 1940s. Secondly, the small number of firms and the oligopolistic structure of the market, which persisted until the entry of Sephaku in 2014. Thirdly, we understand that prices are adjusted infrequently (usually only twice a year) and this would have caused some price stickiness post the cartel. We find that including dummy variables for the transition periods improves the fit of the model. Our model results indicate an overcharge value of between 8.68% and 12.92%. However, given the structural features of this market and the fact that we assume that the cartel behaviour (and pricing) probably persisted until the entry of Sephaku in 2014, we assume these values to form the lower bounds of a range of overcharge percentages.

In addition to the above, we also use data measured at a bi-annual frequency to correct for potential shortcomings when using data measured at a monthly frequency. In particular, due to the fact that the cement price was adjusted only twice a year, there is no variation in the dependant variable apart from periodic increases more or less every six months. Taking bi-annual averages smooths this step-wise structure of the dependant variable. Using the bi-annual data, we estimate the cartel overcharge using both a dummy variable as well as a forecasting approach. The calculated overcharges for the dummy variable and forecasting models are found to be 14.86% and 17.90%, respectively.

2 History of the South African cement cartel

From the 1940s until its official termination in 1996, a legal cement cartel operated in South Africa. The four primary producers of cement, PPC, AfriSam, Lafarge and NPC were involved in this cartel. The cement cartel was exempted from competition regulation during this period. Through the South African Cement Producers Association ("SACPA") these cement manufacturers agreed that each firm's production capacities would determine their market share. The country was initially divided into a Southern and Northern Region, with the Southern Region allocated to PPC, the only producer with manufacturing capacity in the Western Cape. The Northern Region was shared between all producers. NPC was jointly and equally owned by the other 3 producers and was allowed an exclusive territory in KwaZulu-Natal. Indirectly, the remaining three producers effectively shared sales in KwaZulu-Natal equally.[1]

Cartel members formed a company known as Cement Distributors (South Africa) (Pty) Ltd ("CDSA") which was responsible for all sales and distribution of cement and the balancing of the members' interests. The CDSA covered the Northern Regions of the country and producers were required to market their products through the CDSA. A company called Cape Sales performed a similar role in the Southern Region where, as discussed, only PPC operated.

The Twycross pricing model was used to determine the price of cement and to optimise the transport of cement by rail. Lafarge's Lichtenburg plant was used as the base pricing point from which all sales in the Northern Regions were priced. Transport costs from the Twycross pricing model were added to sales from this point. The cartel was therefore able to minimise distribution costs by optimising the rail transport of cement and this function was notionally the reason for the cartel's existence. A system of quota balancing was applied at the end of each accounting period in accordance with the market shares agreed upon. By allocating fixed market shares within territories and simultaneously determining delivered prices to customers, the legal cartel was both a market allocation agreement as well as a price fixing agreement.

The South African Government ultimately decided that the cartel was to be disbanded and that producers should operate independently, giving members until 1996 to comply. This implied that producers would not only have to set prices independently, but also market and distribute their products independently. In anticipation of the of the cartel's disbandment, cement producers reached an agreement in 1995 that the market shares that each producer enjoyed during the official cartel period would be kept intact going forward. However, immediately after the cartel's disbandment a price war ensued (which resulted in poor financial performance), lasting until 1998. In 1998 cement producers held a two-day meeting in the town of Port Shepstone to end the price war and bring stability back to the market.

[1] Note that in the modelling exercise to follow, both the dependent (cement price index) the independent variables are national figures. Though the cartel was regional in nature, a region-wide econometric estimation could have been biased as the independent variables are national and no region was operated by all the 4 firms in any point in time effectively.

The meeting culminated, i*nter alia*, in agreements on market shares for each company per province in South Africa as well as market shares for the Southern African Customs Union ("SACU") market, in line with the legal cartel market shares. The division of markets was as follows: All four producers operated in the northern part of KwaZulu-Natal province, while NPC-Cimpor operated exclusively in southern KwaZulu-Natal. As was agreed under the legal cartel, the Eastern Cape region was divided into the "Border and Transkei" and "Eastern Cape" regions. The "Border and Transkei" region was predominantly allocated to AfriSam while the "Eastern Cape" region was allocated to PPC. The Northern Cape was divided between AfriSam and PPC. PPC was given exclusive access to the Western Cape. PPC, AfriSam and Lafarge shared the remaining regions (North West, Limpopo, Gauteng, Mpumalanga, and Free State). The neighbouring countries were also divided: AfriSam was allocated Namibia, Lesotho and Swaziland. PPC was allocated the Botswana market.

The price-monitoring function also seems to have been augmented by a nodal pricing strategy adopted by PPC, Lafarge, and followed by others from 2001 onwards. The nodal pricing system meant that PPC committed to no discounting on prices (outside of fixed discounts on price lists), and that customers within a node were charged the same price. Prices were determined at executive level for 'nodes', which were geographic regions or zones of supply. Thus towns in any given node would pay the same price irrespective of distance from the core. Different nodal prices were calculated for different cement products and packaging options. As these were transparent to other producers it allowed them to follow.[2]

Cement producers formed an industry association, known as the Cement and Concrete Institute ("C&CI''), through which detailed sales information could be shared to ensure that cartel members complied with the agreement. Firms submitted monthly sales figures (by geographic region, transport and packaging type, customer type and product characteristics) to the association. The association's auditors then aggregated this data before it was distributed to the cement producers. The concentrated nature of the cement industry meant that firms could use this data to monitor any changes in their market share. Using the data, a firm could determine the origin of such changes. Without causing a price war or destabilising the market, targeted punishment or volume shedding could therefore be initiated to keep existing market shares.

The critical point is the role of information exchange on supply volumes and the understanding about market shares in ensuring prices were adhered to. The incentive to discount (or 'cheat' on the arrangement) exists because of the attraction of winning a larger share of the profits, even with the slightly lower margin that would result from the secret discounting. The sales information meant that each firm could see if such a strategy was being followed by a rival and where and in what customer segment the discounting to win over

[2] Mbongwe, T., Nyagol, B.O., Amunkete, T., Humavindu, M., Khumalo, J., Nguruse, G. & Chokwe, E. (2014). Understanding competition at the regional level: an assessment of competitive dynamics in the cement industry across Botswana, Kenya, Namibia, South Africa, Tanzania and Zambia. *Draft paper for presentation at pre-ICN conference, 22 April 2014.*

customers was happening. This in turn means the other firms could retaliate meaning the increase in share would be short-lived and the incentive to cheat is greatly reduced.[3]

The South African Competition Commission ("the CC") conducted a scoping study into the markets for construction and infrastructure inputs and subsequently initiated an investigation into the cement industry in June 2008. Around August 2009, South Africa's largest cement producer, PPC, applied for leniency and agreed to cooperate with the CC by providing information regarding the cement cartel. The CC instructed PPC to stop submitting data to the C&CI in late 2009 as a condition to immunity. In effect this halted the information exchange, as PPC is by far the largest producer of cement in South Africa and therefore submitted a substantial portion of the total data shared. The CC expected that cartel members would find it difficult to monitor compliance with the cartel agreement without the information exchange regime. The cartel would therefore break down naturally as a result of the reduced market transparency, resulting in increased price competition and volatility.

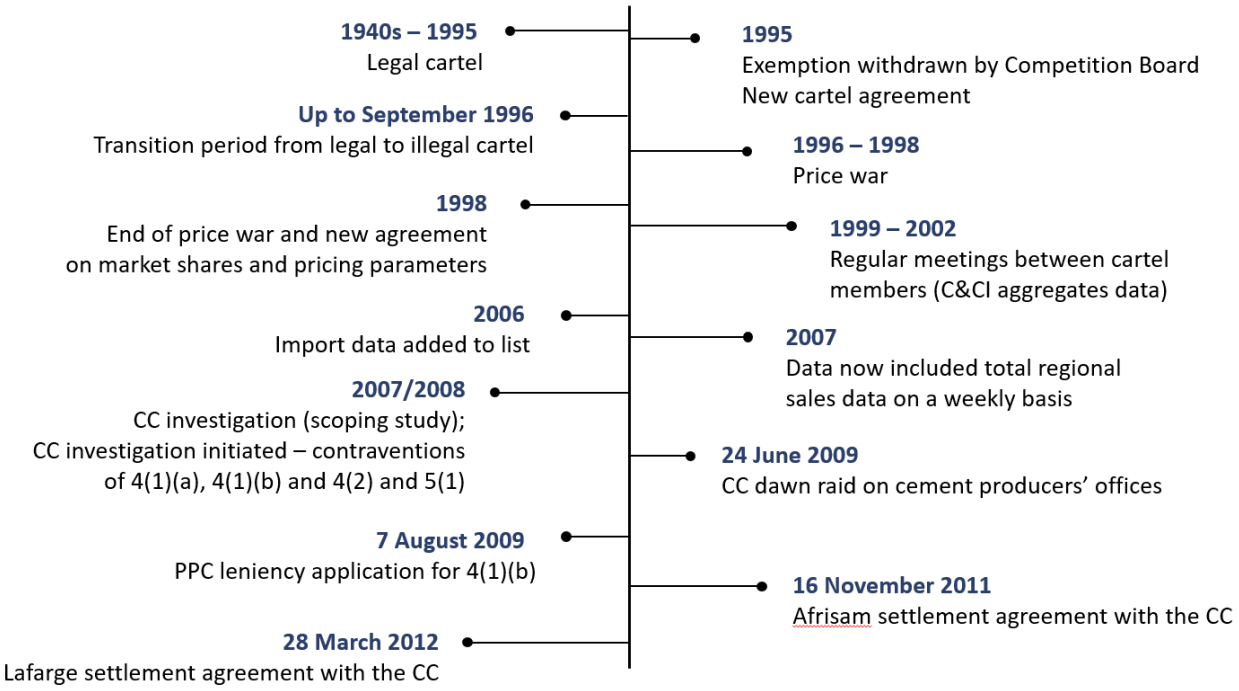
It is worth noting that the CC conducted a previous investigation into the cement market in 2000, which included raids on the premises of Slagment and PPC. However, these firms were successful in legally challenging the raids which resulted in the return of the raided documents. It is possible that these documents contained information regarding the 1998 cartel arrangement, and the cartel could therefore have been uncovered far sooner.

2.1 Timeline of the cartel

In the discussion that follows, it is important to understand the various time periods discussed above. As the periods cannot be distinguished as clearly as one would prefer, the following timeline provides some context for the calculations in later sections of the report.

[3] *Ibid.*

Figure 1: Timeline of cement cartel

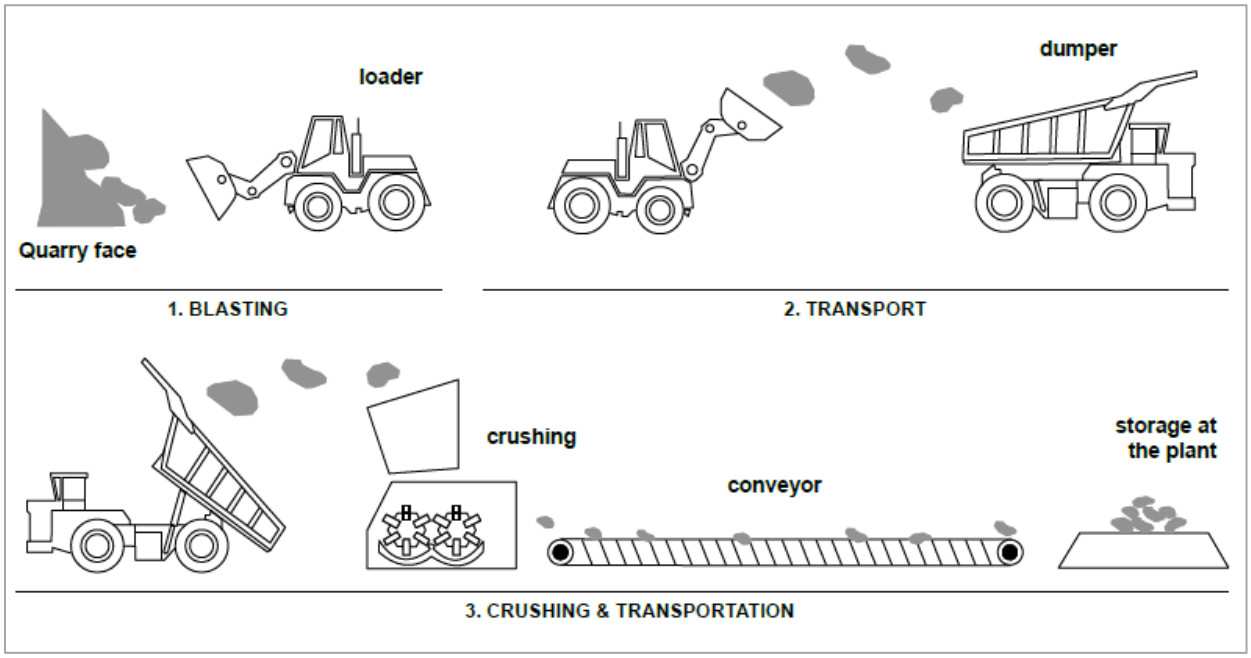


Source: Afrisam/ Lafarge settlement agreements

3 Cement production and value chain

In this section, we briefly set out the production process of cement, as it will inform the selection of appropriate explanatory variables in the modelling section below. We explain the process at the hand of figures constructed by Lafarge[4] and which are in the public domain.

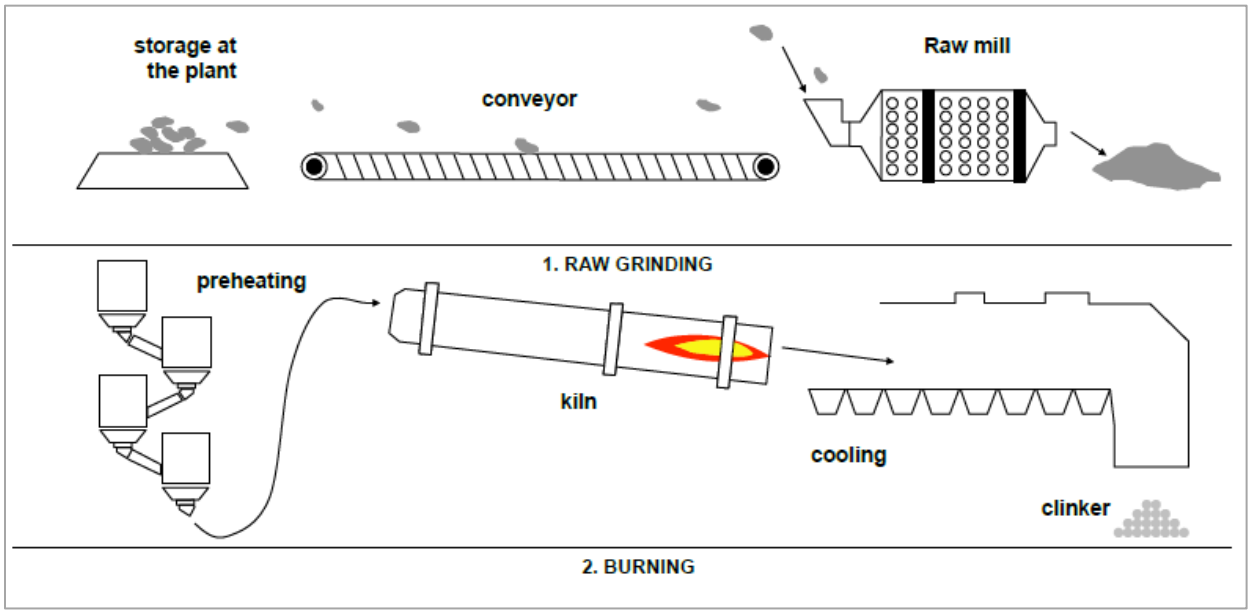
Figure 2: Quarrying stage of cement production



In the quarrying stage of the production of cement, the raw materials that are used to manufacture cement (calcium carbonate ($CaCO_3$)), silica (SiO_2), alumina (Al_2O_3), and iron ore (usually Fe_2O_3)) are generally extracted from limestone rock, chalk, shale, or clay. These raw materials are won from the quarry by either extraction or blasting. These raw materials are then loaded into a dumper and transported, after crushing, to the plant. The plant then stores the materials before they are homogenized.

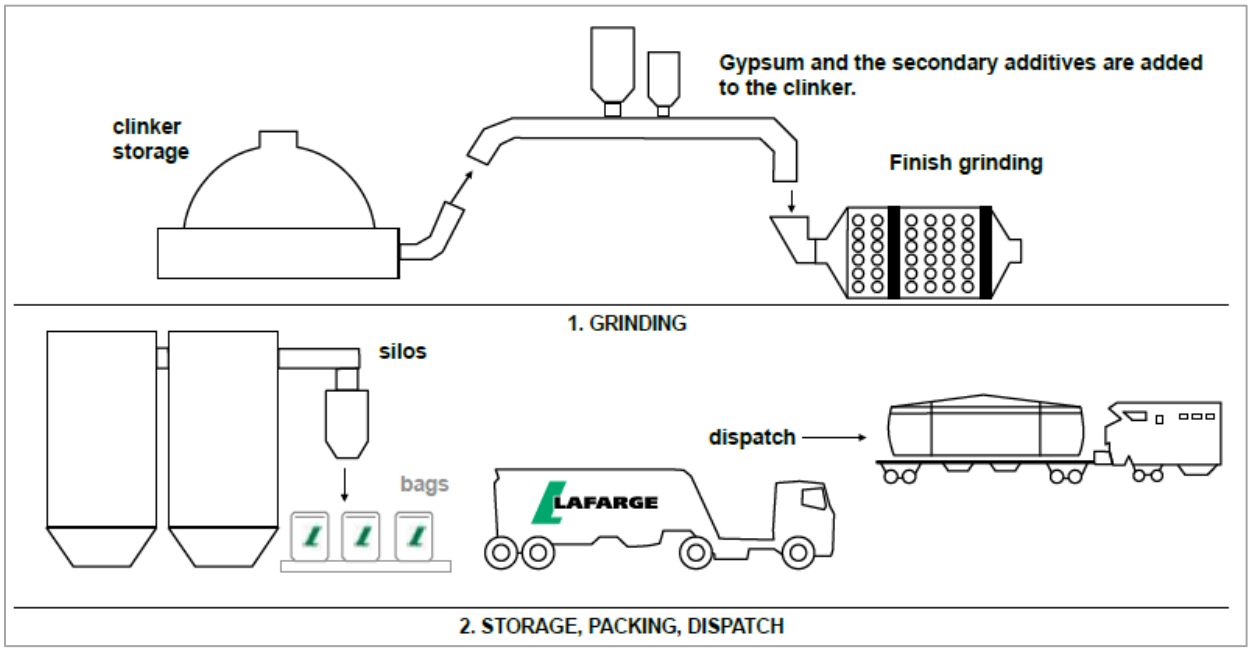
[4] Lafarge. (2010). *Lafarge Lichtenburg Cement Works.*

Figure 3: Raw grinding and burning stages of cement production



The minerals from the quarry are routed to the grinding plant where they undergo initial milling before being reduced to fine powder. The raw materials (80% limestone and 20% clay) are then stored in the pre-homogenization pile. This mixture is called the raw mix. The raw mix is fed into a pre-heating tower at 800°C before returning to the rotary kiln where it is heated to a temperature of 1,450°C. In order to heat the materials to this very high temperature, a 2,000°C flame is required, which can be produced through the use of fossil and waste-derived fuels. The kiln itself is angled by 3 degrees to the horizontal to allow the material to pass through it, over a period of 20 to 30 minutes. Combustion causes a chemical reaction called “decarbonation” which released the CO2 contained in the limestone. The fired materials take the form of hard granules called “clinker”.

Figure 4: Grinding, Storage, Packing and Dispatch stages of cement production



Following re-cooling, the clinker is stored in silos, and then transformed into cement according to production requirements. During the final manufacturing stage, gypsum is added to the clinker, in a proportion of 3 – 5%, and the mixture finely ground. Various substitutable materials – such as fly ash (residue from thermal power plant activity) and slag (from blast furnaces) – can also be used in the composition of cement. The cement is stored in silos before being delivered in bulk using tanker trucks or packaged into 25 – 30 kg bags and stacked on pallets. Various means of transport may be used, depending on the local infrastructure and topography.

4 Literature review

A comprehensive body of literature exists that deals with the identification of possible collusion by cartels and the estimation of damages flowing from such collusive behaviour. This literature often deals with collusion in markets for homogenous products, such as commodities, with regularly occurring sales over extended time periods, and for which there are large amounts of data available for examination.[5]

A major difficulty faced by the relevant parties in a follow-on damage action, is that the harm suffered is difficult to quantify. This quantification is based on a comparison between the actual positions of the claimants after the infringement of the Act has occurred, with the counterfactual position within which claimants would have found themselves absent the infringement (also called the 'but-for' world).

There are various methods available to undertake such a "but-for" quantification, each with various underlying assumptions. Each of these methods and techniques has particular features, strengths and weaknesses that make them relatively more or less suitable for the situation at hand. Counterfactual prices or profits are often not observable, and it is difficult to find similar markets or periods that could serve as suitable benchmarks. Even if such markets or periods could be identified, a further complication is controlling for idiosyncratic demand and supply conditions in order to estimate the counterfactual scenario. As such, there are considerable limits regarding the degree of certainty and accuracy which the methods can provide in terms of quantification of damages. As a result, the choice of method will depend crucially on the specific scenario at hand.

Broadly, the three most common methods to quantify damages are the comparator based methods, the financial analysis based methods and the market structure based methods. Comparator based methods use data (such as prices, sales volumes or profit margins) external to the infringement in order to estimate what would have happened absent the infringement. This is done by looking at other unaffected markets and/or unaffected time periods before and/or after the infringement. The financial analysis based set of methods rely on corporate finance theory and practical techniques used in financial analysis in order to assess the value of damages in anti-trust cases. Market structure based methods uses theoretic models from IO theory that predict a variety of outcomes, ranging from a monopoly market to a perfectly competitive market.

In quantifying the counterfactual scenario, economic and legal issues often arise[6]. In what follows we consider the relevant literature on the quantification of damages both internationally and in South Africa before proceeding to estimate the damages suffered as a result of the cement cartel.

[5] See, for example, Joseph E. Harrington, Jr. (2006). *Behavioural Screening and the Detection of Cartels*.
[6] European Commission, *Quantifying Harm in Actions for Damages Based on Breaches of Article 101 or 102 of The Treaty on The Functioning of The European Union*, Communication of the Commission, 2013.

4.1 Estimation of Damages

The European Commission, via publication of a Green Paper in 2005, a White Paper in 2008, Draft Guidance Paper in 2011, and Commission Staff Working Document in 2013, provides insights into the methods and techniques that are available to quantify harm in follow on damage actions[7]. While these documents have been developed within the framework of the European judiciary system, the methods used are of relevance in any jurisdiction considering quantification of harm in damage actions[8].

In addition to the above, various authors have attempted to address the issues surrounding quantification of damages in anti-trust cases. Connor (2001)[9] examines the sensitivity of overcharges generated by the lysine cartel, which lasted from 1992 to 1995, to several factors such as the time period, seasonality of demand and the price absent collusion. Building on this, a later paper by Connor (2007)[10] examines the antitrust litigation of the lysine cartel and points to potential quantification problems relating to cartel formation after recessions. Van Dijk and Verboven (2008)[11] distinguish between damage quantification methods that use comparator indicators and those which use information directly from the cartelized market. David and Garcés (2010)[12] study the same approaches, albeit from a more practical, econometric based perspective. Friederiszick & Röller (2010)[13] discuss different quantification methods and furthermore discuss the general trade-off between accuracy and practicability in cartel cases.

More recently, Inderst et al. (2013)[14] examine which types of damages can be caused by a cartel and in which direction (at both the upstream and downstream levels) they may have an impact. Maier-Rigaud & Schwalbe (2013)[15] also study the different types of damages caused by cartels, including the upstream as well as downstream effects, in addition to discussing methods of damage quantification in both abuse of dominance and cartel cases.

The quantification of cartel damages in South Africa is a field in its infancy and as a result, studies are very limited. Khumalo et al. (2012)[16] investigate the overcharge in the precast concrete cartel in South Africa, referred to above (which operated for some 30 years). In their estimation, they employ price data and

[7] Scallan, A., Mbikiwa, M. & Blignaut, L. (2013). Compensating for Harm Arising from Anti-competitive Conduct. *Paper presented at the 7th Annual Conference on Competition Law, Economics and Policy*. Johannesburg. September 2013.
[8] *Ibid*.
[9] Connor, J.M. (2001). Our Customers are our Enemies: The Lysine Cartel of 1992-1995. Review of Industrial Organization. 18:5-21.
[10] Connor, J.M. (2007). Optimal Deterrence and Private International Cartels. *Purdue University: American Antitrust Institute*. 09 April 2007.
[11] Van Dijk, T. & Verboven, F. (2008). Quantification of Damages*. Issues in Competition Law and Policy.* 3:2331-2348.
[12] Davis, P. & Garcés, E. (2010). *Quantitative Techniques for Competition and Antitrust Analysis.* Princeton University Press. Princeton and Oxford, 2010.
[13] Friederiszick, H.W. & Röller, L.H. (2010). Quantification of Harm in Damages Actions for Antitrust Infringements: Insights from German Cartel Cases. *ESMT Working Paper*, Number 10-001. Berlin.
[14] Inderst, R., Maier-Rigaud, F. & Schwalbe, S. (2013). Quantification of Damages due to Anticompetitive Violations*. Handbook of Private Cartel Law Enforcement*. Munich.
[15] Maier-Rigaud, F. & Schwalbe, U. (2009). Quantification of Antitrust Damages*. IESEG Working Paper Series*, Working Paper 2013-ECO-09.
[16] Khumalo, J., Mashiane, J. & Roberts, S. Harm and Overcharge in the South African Precast Concrete Products Cartel. *Centre for Competition Economics Working Paper 6/2012*. Johannesburg.

examine mark-ups in regions where the cartel operated against alternative measures of the competitive counterfactual. Smith & Swan (2013)[17] approach the topic from a broader policy perspective, considering the economic principles behind administrative penalties, as well as the estimation of damages, in light of recent developments in both the EU (discussed above), as well as in the UK. Scallan et al. (2013)[18] provide an in-depth discussion of some of the legal issues surrounding damage estimation, with reference to the approaches adopted in the EU and the US. They also provide a brief discussion of the methods of quantification of damages and how they apply to South Africa in general terms.

The recent judgement in the case between South African Airways (SAA) and Nationwide is of particular relevance, as it is the first time that a judgement has been handed down and civil damages ordered in South Africa for a breach of the Competition Act. The genesis of the claim is a complaint made by Nationwide to the Competition Commission in response to incentive agreements between SAA and various travel agents whereby travel agents were financially incentivised to book air tickets with SAA. Subsequent to the investigation by the Commission, the Competition Tribunal ('the Tribunal') found that SAA had abused its dominant position by "inducing a supplier or customer to not deal with a competitor." While there was a dispute regarding the correct dataset and quantification method to use, the court ultimately sided with Nationwide's expert and calculated the quantum of damages by multiplying the number of passengers that it estimated Nationwide had lost as a result of SAA's conduct by Nationwide's average revenue per passenger. The final damages amount concluded upon amounted to R104.6m (plus interest payable from the date of judgement).

There are four important points to note from the judgement. First, in arriving at a damages estimate, the court followed a general but-for approach. Second, the court made it clear that the numerous variables to be taken into account made it an "*impossible exercise*" to quantify the damages with any precision. Nevertheless, the court goes on to state that it does not alleviate the wrongdoer from paying damages. Third, the defendants attempted to argue that no damages was suffered by the plaintiffs. However, the court ruled that it was bound by the Tribunal's finding that Nationwide did in fact suffer damages. As noted, this serves to illustrate that the court was clear that it would entertain arguments as to the quantum of damages and not on the arguments on the existence thereof. Fourth, the method followed by the experts in order to estimate damages – the linear interpolation method – uses data from before and after the anti-competitive period.

Having discussed cartel damage estimation in general, we discuss the estimation of damages specifically related to cement cartels, both internationally and in South Africa.

[17] Smith, P. & Swan, A. (2013). Quantifying Cartel Damages: South Africa Policy and Recent Developments. *Paper presented at the 7th Annual Conference on Competition Law, Economics and Policy.* Johannesburg. September 2013.
[18] Scallan, A., Mbikiwa, M. & Blignaut, L. (2013). Compensating for Harm Arising from Anti-competitive Conduct. *Paper presented at the 7th Annual Conference on Competition Law, Economics and Policy*. Johannesburg. September 2013.

4.2 Studies estimating cartel overcharge in the cement industry

In this section we first consider examples of damage estimates related to international cement cartels, before examining the literature on damage estimation for the South African cement cartel.

4.2.1 International evidence

While international data cannot be used to estimate the overcharge in the SA case, it is nevertheless interesting to note the results (and methodology) of some of the international studies on cement cartels.

4.2.1.1 Germany

One of the most widely studied examples of international cement cartels is the German cement cartel. The German Federal Cartel Office ("the FCO") announced the existence of a hard-core[19] cartel in the German cement market in 2002. It was found during the course of the investigation that a number of German cement producers divided up the German market using a quota system. This system had been in existence since the early 1990s. After a detailed investigation, the FCO found that the members of the cartel had earned significant excess profits from elevated cement price and imposed overall fines of €702 million[20].

A paper by Friederiszick and Röller[21] discusses the quantification of the excessive prices resulting from the German cement cartel. The authors had been commissioned as court experts to propose a methodology and subsequently to quantify the additional earnings. In determining an appropriate methodology to perform the overcharge quantification, cross sectional comparator based methods were discarded due to the high likelihood of cartels in all of the neighbouring countries. Furthermore, considerable differences existed in terms of market structure and population density between countries. The use of other product markets as comparators was also discarded, because of limited comparability. As a result a "during-and-after" time series methodology was chosen, comparing prices during the cartel period with prices after the breakdown of the cartel. Ultimately an overcharge in the range of between 11% and 23% was found to have persisted during the cartel period.[22] The output or specifications of their model are however not disclosed in the article.

A further paper by Hüschelrath *et al.*[23] also estimates the price overcharge resulting from the German cement cartel using publically available data. In particular, they use price index data continuously collected by the German Federal Statistical Office. In their basic econometric approach, they take the cartel period as given and further assume that the end of the cartel led to an immediate transition to the competitive

[19] The categories of conduct most often defined as "hard core" are price fixing, output restrictions, market allocation, and bid rigging.
[20] These fines were later reduced by the Higher Regional Court in Düsseldorf partly due to insufficient data.
[21] Friederiszick, H.W. and Röller, L. (2010). Quantification of Harm in Damages Actions for Antitrust Infringements: Insights from German Cartel Cases. *ESMT Working Paper No. 10-001.*
[22] Connor, J.M. (2014). *Price Fixing Overcharges: Revised 3rd Edition.* Purdue University, American Antitrust Institute (AAI). 24 February 2014.
[23] Hüschelrath, K., Mueller, K. and Veith, T. (2012). Concrete Shoes for Competition - The Effect of the German Cement Cartel on Market Price. *ZEW - Centre for European Economic Research Discussion Paper No. 12-035*

price. They further assume that the price-determining variables are identical during and after the cartel leaving the cartel agreement as the only difference between both periods. They define the following regression equation:

$$p_t^c = \alpha + \beta_{cartel} D_{cartel} + \beta_L p_t^L + \beta_E p_t^E + \beta_{Lig} p_t^{Lig} + \beta_{cprod} cprod_t + \beta_t t + \varepsilon_t$$

In their equation, the cement price index at time t (p_t^c) is determined by the constant term (α) and the following cost- or demand-related variables which vary over time. With respect to cost determinants, they include the price index for lime (p_t^L), the price index for electricity (p_t^E) and the price index for lignite (p_t^{Lig}). The demand side is represented through the inclusion of the index for cement production ($cprod_t$). In order to estimate the effect of the cartel, they include the dummy variable (D_{cartel}) in the regression equation. The corresponding coefficient (β_{cartel}) shows the difference of the price index between the cartel period and the non-cartel period. Finally, t is a time trend variable and ε_t is the error term. Table 1 below shows the results of their estimation using a simple ordinary least squares (OLS[24]) regression based on data from January 1995 to December 2009.

Table 1: Estimation output from OLS model in Hüschelrath *et al.* (2012)

Variable	Model Output
Cartel Period Dummy	0.188 (0.020***)
Price Index Lime	1.224 (0.133***)
Price Index Electricity	0.047 (0.073)
Price Index Lignite	0.612 (0.150***)
Index Cement Production	0.020 (0.011*)
Trend	0.001 (0.000***)
Constant	-0.356 (0.073***)
Number of Observations	*180*
F(6, 173)	*147.54***
R^2	*0.72*

[24] Ordinary Least Squares (OLS) is one of the "simplest" methods of linear regression - an approach for modelling the relationship between a scalar dependent variable y and one or more explanatory variables.

*Note: Significance level: *** < 0.01, ** < 0.05, *< 0.1; Heteroscedasticity consistent standard errors shown in parentheses.*

The table shows the estimation results for the case of the logarithm[25] of the respective variables. The authors find that, based on this model, the price difference between the cartel period and the non-cartel period (i.e., the price overcharge) is 20.7%[26]. Assuming an average cement price of EUR 55 per ton, they find that the price overcharge can be calculated to be EUR 11.38 per ton. With respect to the relationship between the cement price and the lime price, the regression results reveal that a 1% increase in the price of lime leads to a 1.224% increase in the price of cement. For the lignite price index, they find that a price increase of 1% leads to an increase of the cement price of 0.612%. Interestingly, no statistically significant effect for the price of electricity on the price for cement is found. The authors note that this is a surprising result, given the high energy-intensity of the cement production process. They also find a positive relationship between the production of cement and the price of cement. The authors note that this result is understandable given the fact that cement is not easy to store and therefore largely produced on demand.

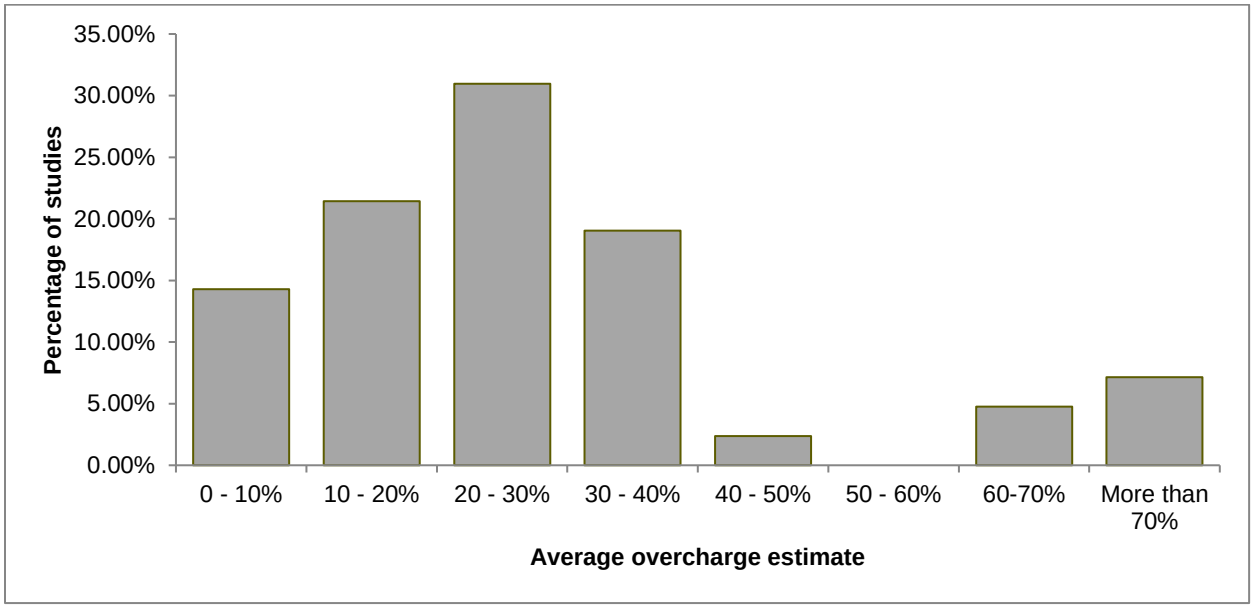
Building on the basic econometric approach, the authors also present some extensions: first, by introducing an instrumental variable, they find the overcharge to be 20.32%. Second, by including dummy variables that account for a transition period, they found the overcharges to range between about 23% and 26%. Furthermore, they also consider a second modelling approach – the so called 'difference-in-differences' approach – which essentially combines the before-and-after approach with a geographic or product related comparator approach. Using this approach, they find overcharges ranging between 26.2% and 26.5%, depending on the method of estimation.

4.2.1.2 Connor (2014) meta-study

In order to comprehend the size of damages that arise from anti-competitive conduct in the cement industry, we consider data from a meta-study conducted by Connor (2014)[27]. The paper surveys more than 700 published economic studies and judicial decisions containing 2,041 quantitative estimates of overcharges of hard-core international cartels. The meta-study includes 42 studies of 15 cartels in the cement industry. These include cement cartels in Brazil, Turkey, India, Germany and Norway. Using the database contained in this report, which has information on cartels up until October 2013, we calculate an average overcharge resulting from cartels in the cement industry of 29.93%[28]. The figure below shows the distribution of the overcharge estimates.

[25] Time series variables are usually transformed to be in logarithmic form. This is because many time series variables have overall trends of exponential growth.
[26] As the model is estimated in logarithmic terns, the coefficient on the overcharge dummy needs to be converted such that it is interpretable. This is done by computing the following: $(e^{0.188} - 1) \times 100$
[27] Connor, J.M. (2014). *Price Fixing Overcharges: Revised 3rd Edition.* Purdue University, American Antitrust Institute (AAI). 24 February 2014.
[28] Excluding estimates above 50%, the average overcharge is 21.99%.

Figure 5: Distribution of Overcharge Estimates from Connor (2014)



Source: Connor (2014), Econex calculations

Clearly, the estimated overcharge values vary quite considerably between different cases, with the bulk of overcharges falling in the 10 – 20% and 20 – 30% categories.

4.2.2 The South African cement cartel

Given the long existence of the South African cement cartel, it is interesting to note that relatively few papers have studied its impact on cement prices. Economic evaluations of the cement cartel by Fourie & Smith (1994)[29] and Leach (1994)[30], focused on the structure of the industry and whether cartel behaviour can be inferred from excess profits. Fourie & Smith did not attempt to estimate a 'but for' price, i.e. constructing a price based on cost elements plus some mark-up. Since this work was done during the legal cartel period, it would also not have been possible to use a time based period to compare cartel and post cartel prices. The authors also rejected any international comparisons, mainly due to exchange rate distortions. They do however refer to an IDC study which concluded that SA cement prices exceeded world prices by approximately 10% (in 1988). This early work therefore does not provide any clear estimates of the price overcharge that can be used for the current study.

[29] Fourie, F.C.V.N. & Smith, A. (1994), The South African Cement Cartel: An Economic Evaluation. *South African Journal of Economics, 62: 80–93.*
[30] Leach, D. F. (1994), The South African Cement Cartel: A Critique of Fourie and Smith. *South African Journal of Economics*, 62: 156–168.

The most recent paper to study the impact of the South African cement cartel on prices is that by Govinda *et al.* (2014)[31]. Similar to Friederiszick and Röller, they also employ a "during-and-after" approach in order to estimate the counterfactual price. To do this, they model the cement price during and after the cartel using a multivariate econometric model that takes into account relevant control variables. These control variables include a set of determinants of the price in the cartel and non-cartel periods such as cost of production, raw materials that go into the production process of cement and variables that account for shifts demand. They define the following regression equation:

$$P_t^{Cement} = \beta_0 + \beta_1 D^c + \beta_2 P_t^{Coal} + \beta_3 P_t^{LS} + \beta_4 P_t^{IO} + \beta_5 P_t^{E} + \beta_6 P_{t-3}^{Oil} + \beta_7 P_{t-4}^{Const} + \varepsilon_t$$

The model estimates the cement price at time t as a function of the price of coal (P_t^{Coal}), limestone (P_t^{LS}), iron ore (P_t^{IO}), energy (P_t^{E}), oil[32] (P_{t-3}^{Oil}) and construction[33] (P_{t-4}^{Const}). The cost shifters are selected based on the inputs that go into the production process of cement. All of the relevant independent variables are captured as price indices and converted to January 2008 constant prices for regression purposes. The price index of construction, which measures the construction activity in the economy, is used as a proxy for the demand of cement. In order to estimate the effect of the cartel, they include a dummy variable in the regression equation (D^c), which takes a value of '1' during the cartel period and a '0' otherwise. The corresponding coefficient (β_1) captures the difference of the price between the cartel period and the non-cartel period. Table 2 below shows the results of their estimation using a simple ordinary least squares (OLS) regression based on data from January 2008 to December 2012.

Table 2: Estimation output from OLS model in Govinda *et al.* (2014)

Variable	Model Output
Cartel Period Dummy	0.072 (2.63***)
Constant	0.570 (0.43)
Coal	0.016 (0.23)
Limestone	-0.468 (-2.15**)
Iron ore	0.070 (2.07**)
Energy	0.241 (2.92***)
Oil	-0.103 (-3.45***)

[31] Govinda, H., Khumalo, J. and Mkhwanazi, S. (2014). On measuring the economic impact: savings to the consumer post cement cartel bust. *Paper submitted for the Competition Commission and Tribunal 8th Annual Conference on Competition Law, Economics and Policy*, 4-5 September 2014.
[32] Allowing for a lag of 3 months to adjust the industry response to exchange rate and availability of oil for domestic consumption.
[33] Lag of 4 months are allowed to adjust industry response to twice a year price revision by the cement companies.

Construction	1.134 (3.54***)
Number of Observations	*56*
F(7, 48)	*28.99****
R^2	*0.80*
Adj. R^2	*0.78*

*Note: Significance level: *** < 0.01, ** < 0.05, *< 0.1*

The table shows the estimation results for the case of the natural logarithm of the respective variables. Except coal and the constant term, all the other independent variables are statistically significant. The authors find that, based on this model, the price difference between the cartel period and the non-cartel period (i.e., the price overcharge) is 7.5%[34]. Assuming an average cement price of R 1000 per ton, the price overcharge can be calculated to be R 75 per ton. While most of the variables are of the expected sign, it is found by the authors that the variables for limestone and for oil, though statistically significant, are negatively related to cement price indices. The authors note that this might point to some inconsistencies in the data – an aspect which we elaborate on below. The authors also extend their econometric analysis to include a 2SLS estimation, finding an overcharge of 9.7%.

While the analysis of Govinda et al. provides a useful first attempt at quantifying the damage resulting from the cement cartel, their analysis suffers from certain conceptual and econometric issues. First, they use a very short sample period which also includes the commodity cycle boom period around 2008/ 2009. As such, their parameter coefficients are unlikely to be robust to model specification. Second, their cartel dummy variable is designed in such a manner that it is assumed that the cartel ended immediately following the Commission's intervention in November 2009. In their model therefore the cartel period is only captured between January 2008 and November 2009. This is an unlikely scenario – the first entrant following the breakdown of the cartel (Sephaku) only entered the market and commenced operations in 2014. As such, due to the oligopolistic nature of this market and the length of the cartel, it is likely that the essence of the cartel agreements persisted following its breakdown.

In the modelling that follows, we add to the analysis by Govinda *et al.* in two main ways. First, as shown in Figure 1, it is not clear exactly when the cartel ended. While the CC started investigating the cartel during 2009, some settlement agreements were only reached during 2011 and 2012. To account for this, we consider various possible dates that can be interpreted as the end of the cartel. In addition, it is noted by Govinda *et al.* that they found '*no evidence of the existence of a transition period, as the transition period*

[34] Again, due to the fact that the variables are measured in logarithmic terms, the following transformation was applied: $(e^{0.072} - 1) \times 100$

dummies proved to be statistically insignificant'[35]. As we argue that it is highly likely that the cartelised prices persisted post the end of the cartel, we include for various transition periods and test for their significance. Second, Govinda *et al.* make use of a short time period for their analysis – in other words, they do not have a large amount of observations for the model to fit. In addition, their sample of data (between January 2008 and December 2012) includes the financial crisis period and the commodity cycle boom which could potentially distort their results – especially given the fact that they have a small sample size. We attempt to account for this by fitting a model over a much longer time period and by controlling for the financial crisis period. Before turning to this analysis, however, we first discuss some issues related to estimating damages in the South African cement cartel.

[35] Govinda, H., Khumalo, J. and Mkhwanazi, S. (2014). On measuring the economic impact: savings to the consumer post cement cartel bust. *Paper submitted for the Competition Commission and Tribunal 8th Annual Conference on Competition Law, Economics and Policy*, 4-5 September 2014.

5 Issues with estimation of damages as a result of the cement cartel in South Africa

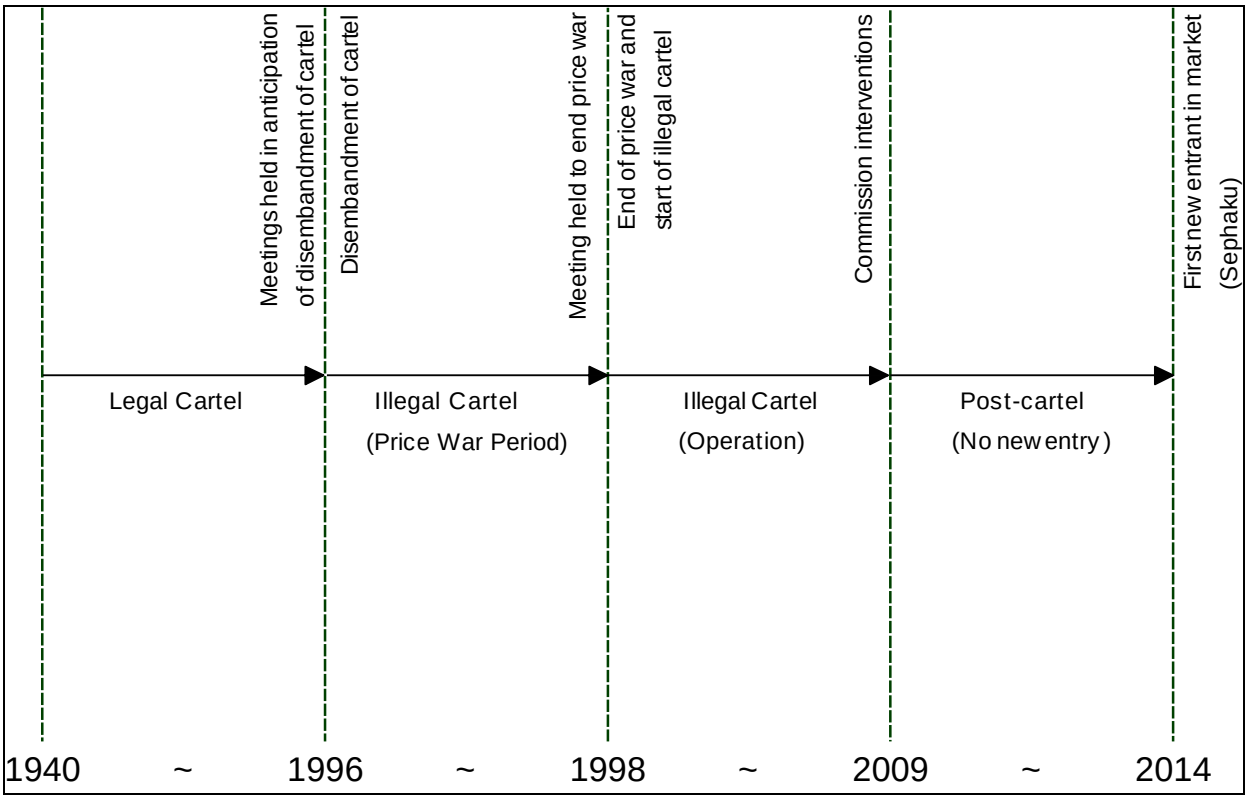
There are various complicating factors that make any analysis of the overcharge as a result of the cement cartel difficult.

5.1 Time periods

First, at the broadest level, the nature of the cartel makes any analysis of prices difficult. As noted above, and shown in Figure 6 below, a legal cartel existed from the early 1940s until 1996. When the legal cartel ended in 1996, a price war followed, which resulted in the continuation of the cartel (now in illegal form) from around 1998 until approximately 2009. One therefore has to be very clear about the different periods, i.e. the legal cartel, the price war, the illegal cartel, the dawn raids and finally the settlement agreements. We note that it is not correct to assume that the price war period might be indicative of a competitive market, as this was simply the period between the legal and illegal cartels with some price movement but no indication of a competitive price. In addition, it should be noted that, even after the cartel officially ended, there was no new entrant into the market until 2014[36], when Sephaku started operations. As such, due to the oligopolistic nature of the market, one would a priori expect that some of the cartel features continued for some time. Cartel members had knowledge of how the other players in the market operate, thereby sustaining some form of tacit collusion. Also, we understand that prices are set infrequently (twice a year), which would add to the expectation of price stickiness post the end of the cartel period. Given these factors, we assume that post-cartel prices are likely to be higher than in a competitive market, and these prices can only serve to make a lower-bound estimate for the damages suffered.

[36] Sephaku Holdings Limited. (2014). Delmas milling plant site visit presentation dated 25 March 2014. *Available online: http://www.sephakuholdings.com/wp-content/downloads/Delmas_site_visit_presentation_25_March_2014.pdf*

Figure 6: Cartel periods

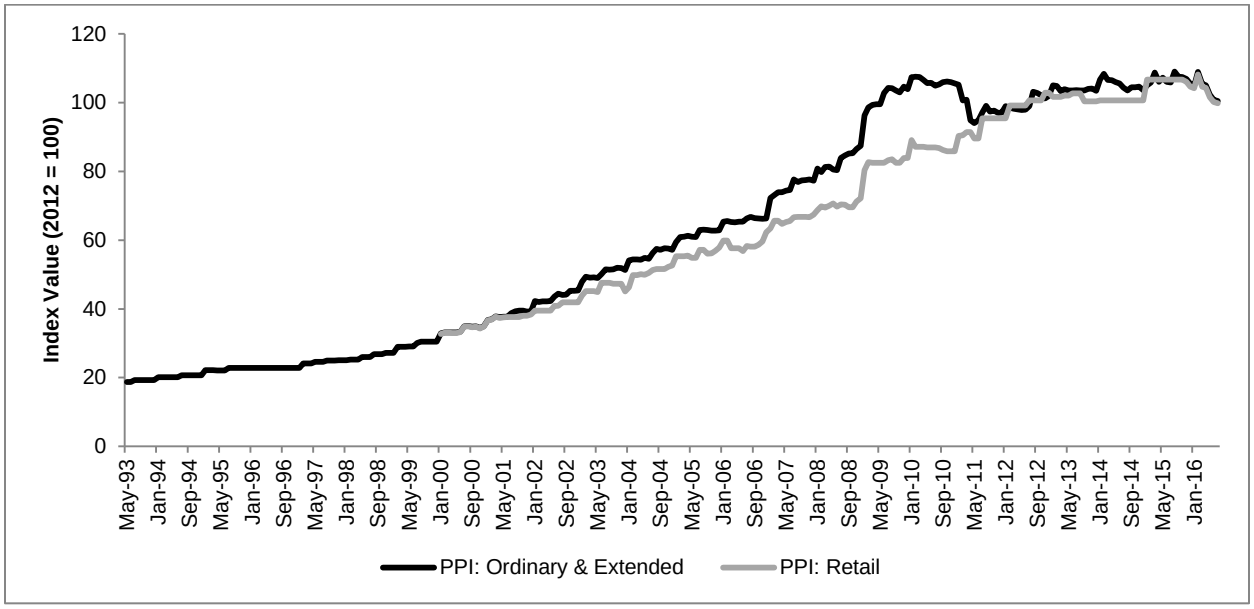


5.2 Data issues

Furthermore, the fact that there was an agreement on market shares for each company per province in South Africa also complicates the analysis. In particular, it makes it difficult to make use of a nationally representative price series to measure the extent of the cartel overcharge. One would ideally require the proprietary prices from each cement producer in order to analyse the cartel at a more disaggregated level. However, as pointed out below, such information is not available in the public domain and the only viable option is a price index which captures national prices.

Second, the choice of price variable used to capture the cement prices complicates the analysis. While proprietary prices from the companies operating in the cartel would be the most accurate prices to use, these are not available in the public domain. The only other price series related to cement, which are available in the public domain, are two price index series published by StatsSA: the PPI for ordinary and extended cement; and the PPI for the retail price of cement. The former is calculated by using 42grade strength cement which is at producer/manufacturer level, while the latter is calculated using 32grade strength and blenders from various outlets (mainly used by households). These prices are shown in Figure 7 below for comparative purposes.

Figure 7: Comparison of different price indices for cement



Source: StatsSA

From the figure, it is clear that the two price indices differ somewhat. However, we understand from industry sources that the 42grade cement is the more appropriate series to use as this is what the downstream users bought from the large cement manufacturers, and as such, we use this in our modelling below.

The impact in terms of maintaining closely matched price increases (and firms sticking to the price) is also evident from the price index data. In particular, the PPI for Ordinary and Extended Cement exhibits a stepwise pattern – indicating that the firms all increased their prices at the same time. The fact that the price index variable remains constant for six time periods, might cause the dependant variable to violate the assumptions of the General Linear Model. We attempt to control for this below by smoothing the data over a six month period.

Third, the period of analysis coincides with the commodity price boom. As such, variables that measure commodity prices were distorted in this period. This complicates the measurement of an overcharge, as there is a structural change in the data. As a result of this radical change in market characteristics, one would ideally use data from the period before the infringement. However, as explained above, this is not possible due to the presence of the legal cartel directly preceding the illegal cartel (see Figure 6).

6 Estimation of damages

Estimating the overcharge as a result of the cement cartel involves comparing the price realised during the cartel period, with a price predicted to have prevailed in the industry but-for the cartel. In essence, this involves constructing a 'but-for' price and comparing this to the realised price. In order to estimate the but-for price, one implicitly assumes that the structure of the market during and after the cartel period is the same but-for the existence of the cartel. As noted above, there are various methods to estimate damages. Owing to the nature of the cartel and data available from the public domain, this study uses a during-and-after approach, comparing the prices during the cartel with the prices after the cartel. We fit a model of cement prices over the entire sample period (which we discuss in more detail below) and use dummy variables to calculate what the overcharge was as a result of the cement cartel. The dummy variables used in the estimation are intended to capture the duration of the cartel and also allows for a transition period in which the market converges on a competitive equilibrium.

We conduct two distinct analyses – the first uses monthly data and transition period dummies, whereas the second makes use of bi-annual data. Each of these analyses are discussed in turn below.

6.1 Analysis using monthly data

6.1.1 Data

Notwithstanding the discussion regarding the potential issues with the data above, we provide the data sources and variables employed in the analysis to follow in Table 3 below. All the variables are measured in real terms, deflated by using the PPI for Building Construction. Also, all variables are indexed such that December 2012 = 100, for comparative purposes. The sample period is May 1993 to September 2015. The sample period therefore includes the period of the "illegal" collusive agreement (after the formal collusion broke down).

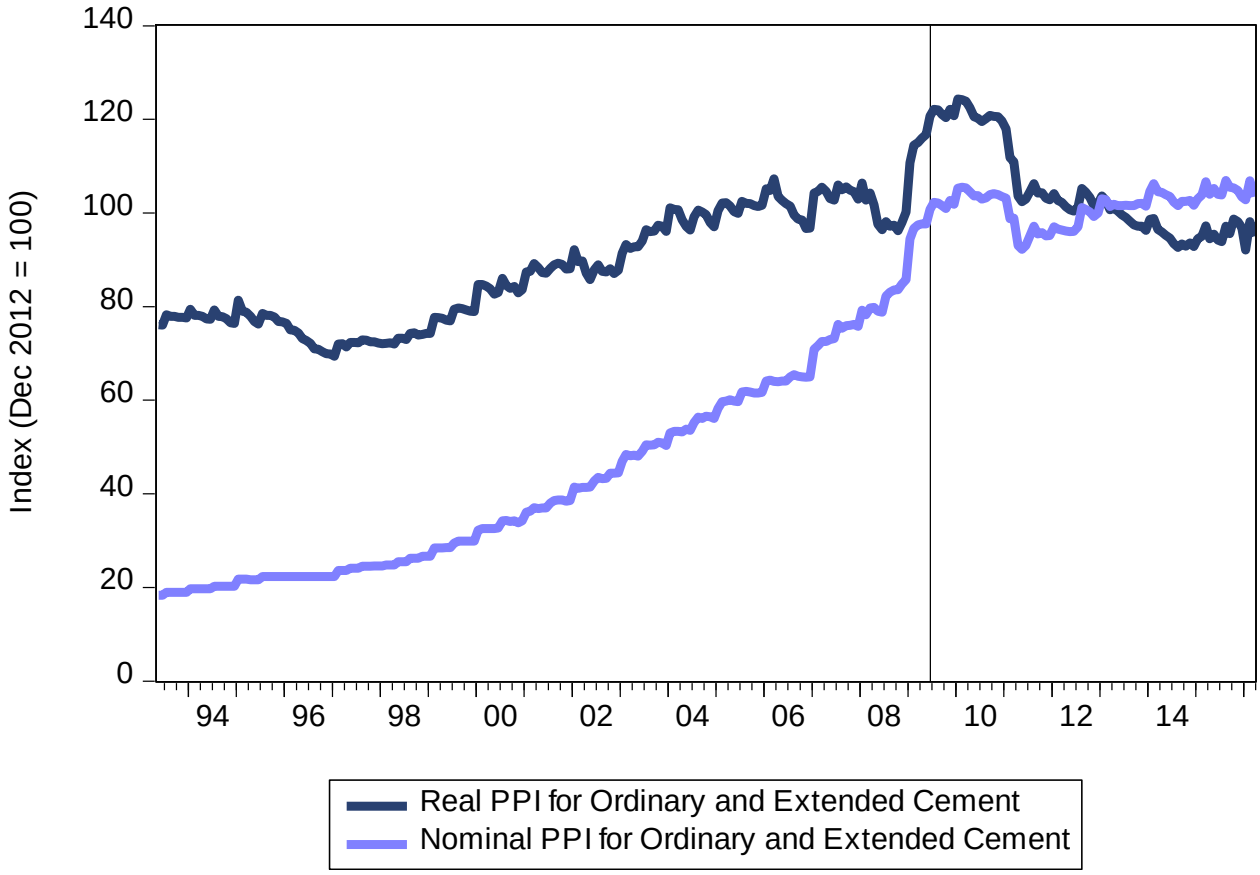
Table 3: Data and variables

Variable	Source	Description
Cement Price Index	StatsSA	PPI of Selected Materials - Building materials: Ordinary & Extended Cement
Limestone and Lime	Department of Mineral Resources	Industrial minerals: Limestone and lime: Total - Local sales [South Africa] (Unit value (Rand/t))
Coal	Department of Mineral Resources	Energy minerals: Coal: Bituminous - Local sales [South Africa] (Unit value (Rand/t))

Gypsum	Department of Mineral Resources	Industrial minerals: Non-metallic other: Gypsum - Local sales [South Africa] (Unit value (Rand/t))
Oil	South African Reserve Bank	Brent crude oil price in US Dollar
Demand	StatsSA	Building Plans Passed (R'000) in current prices, seasonally adjusted

The first data series relates to the price of cement. As noted above, the prices of the cement companies are confidential in nature and as such we are not able to use their actual prices. Instead, the most approximate price series which we can obtain is the PPI for Ordinary and Extended cement collected and compiled by StatsSA. As noted, the only other potential variable to use would be the PPI for the retail price of cement. However, this price series was calculated using 32grade strength and blenders from various outlets (mainly used by households) and this product has gone out of market. As such, the PPI for ordinary and extended cement seems to be the only viable alternative – it is calculated by using 42grade strength cement which is at producer/manufacturer level. Consider Figure 8, which shows the nominal and real cement price index over the sample period.

Figure 8: Comparison of monthly cement price index at current and constant prices, 1993 - 2016 (base year 2012)



Source: Statistics South Africa

From the figure, the price war period is clearly visible, with prices declining at the start of the sample until more or less 1999. Following this, prices started to increase, with a noticeable jump in the series during 2008/2009. As noted, during this period, all commodity prices saw a marked increase. It is also interesting to note from the figure how the prices started to stabilise and decline following the first dawn raid carried out by the commission (solid line in the figure).

As noted, apart from prices, we also used certain cost- and demand-related variables. We employ limestone, coal, gypsum and oil as cost variables and use building plans passed as a proxy for cement demand. The building plans passed variable is constructed by StatsSA and records the building plans passed by larger municipalities, respectively.

Having discussed the method of analysis as well as the sources of the data, we now proceed to estimate the overcharge as a result of the cement cartel using the above data.

6.1.2 Basic econometric approaches

6.1.2.1 Dummy variable approach

6.1.2.1.1 Design of dummy variables

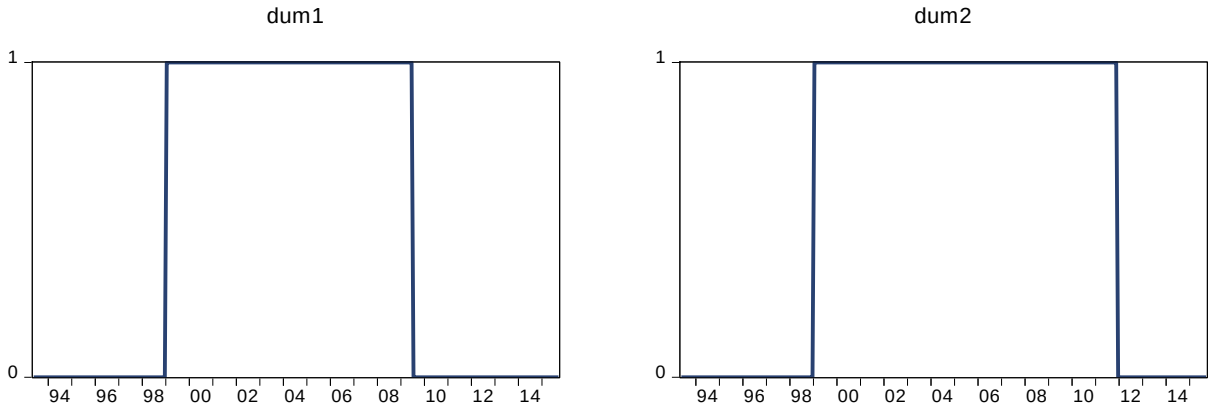
As a first approach in order to estimate damages, we employ the dummy variable approach. In essence, this approach entails using a dummy variable (also called an 'indicator variable') in order to quantify the percentage overcharge as a result of the cartel. The dummy variables are designed in such a manner that they are equal to one during the cartel period and zero otherwise. The coefficient on the cartel dummy variable would then indicate whether the average price during the cartel was significantly different and also whether it was higher than the average price during the competitive period.[37] One can think of the dummy variable, if found to be significant, as being a shift in the price line under study rather than causing a change in its shape.

In the basic econometric approach to follow, we study four different time periods in which the cartel operated and choose dummy variables that appropriately capture this. Note that, owing to data availability of the variables deemed relevant, our sample period for the dummy variable model is from May 1995 to September 2015. As noted, a price war took place between 1996 and 1998, which we take into account when designing the dummy variables.[38] While the legal cartel ended in September 1996 already, we take January 1999 as a starting point for what we term the 'illegal cartel' and design our dummy variable to start from this point. As there were various different events which could be argued to signal the end of the cartel, we consider different dates for the end of the cartel period.

First, we assume that the cartel ended in June 2009, following the first dawn raids on the participants' offices (the first dawn raid was carried out at Afrisam's offices). Second, we assume that the cartel ended in November 2011, following the first settlement agreement with the CC (Afrisam's settlement agreement). Note that in both these instances, we assume that there was an immediate end to the cartel. In other words, we assume that none of the cartel related information persisted following its breakdown. We relax this assumption later. As such, we assume that there is no transition period and design the dummy variables to take values of 1 during the cartel and 0 immediately after the end of the cartel. The design of the first two dummy variables, as discussed above, is depicted graphically in Figure 9.

[37] Rubinfield, D. & Steiner, O. (1983). Quantitative method in antitrust litigation. *Law and Contemporary problems.* 46:69-144
[38] Consent agreement between the Competition Commission and Afrisam, para. 3.3.1

Figure 9: Design of dummy variable 1 (January 1999 to June 2009) and dummy variable 2 (January 1999 to November 2011)



The dummy variables chosen therefore assume that the cartel period is followed immediately by the non-cartel period. The economic literature explains, however, that there might be a transition period after the uncovering of a cartel during which prices continue to behave similarly compared to the cartel period. This is to be expected – while firms may no longer be meeting formally, they would still have an understanding of the day-to-day operation of each other's firms. This would allow for a tacit collusive agreement to persist even after the explicit collusive agreement has ended.[39] In addition, the duration of the cartel is often also cited as a contributing factor to a longer transition period. Given the fact that the cement cartel lasted more than 70 years, one might expect some aspects of the behaviour to have persisted post the formal cartel period. Another important factor is the lag between when prices are determined and when product is delivered to construction projects. As indicated above, prices were set twice-yearly and therefore there was probably some stickiness in prices after the cartel period. Structural features are also important.

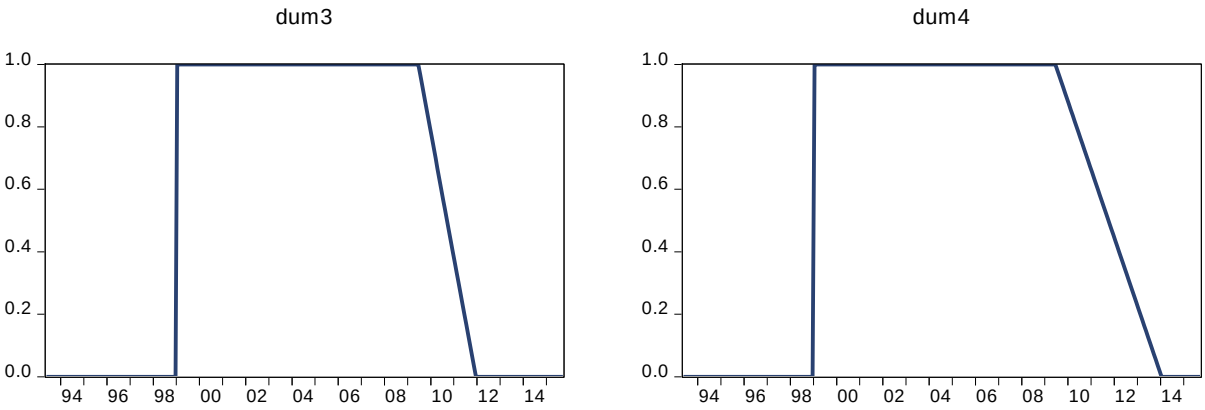
As such, the likely existence of a transition period is accounted for econometrically. As the transition period is determined by the nature of the cartel, the smaller but still elevated prices in the transition period must be included in the overcharge estimation and subsequent calculation of damages. As the actual transition period is not known, the econometric model has to make simplified assumptions about the transition period. In our analysis, we assume that the transition periods are linear. In other words, the cartel price decline linearly (by the same amount each month) over the transition period. We assume two transition periods and design dummy variable to account for these. First, we assume the cartel was in operation from January 1999 until November 2011, but that there was a linear transition to competitive prices from July 2009 (following the first dawn raid) until November 2011 (following the first settlement agreement). Second, we assume that the cartel was in operation from January 1999 until December 2013, just before Sephaku Cement (SepCem) entered the market,[40] but that there was a linear transition period from July 2009 until

[39] Govinda, H., Khumalo, J. and Mkhwanazi, S. (2014). On measuring the economic impact: savings to the consumer post cement cartel bust. *Paper submitted for the Competition Commission and Tribunal 8th Annual Conference on Competition Law, Economics and Policy*, 4-5 September 2014.

[40] Sephaku Holdings Limited. (2014). Delmas milling plant site visit presentation dated 25 March 2014. *Available online: http://www.sephakuholdings.com/wp-content/downloads/Delmas_site_visit_presentation_25_March_2014.pdf*

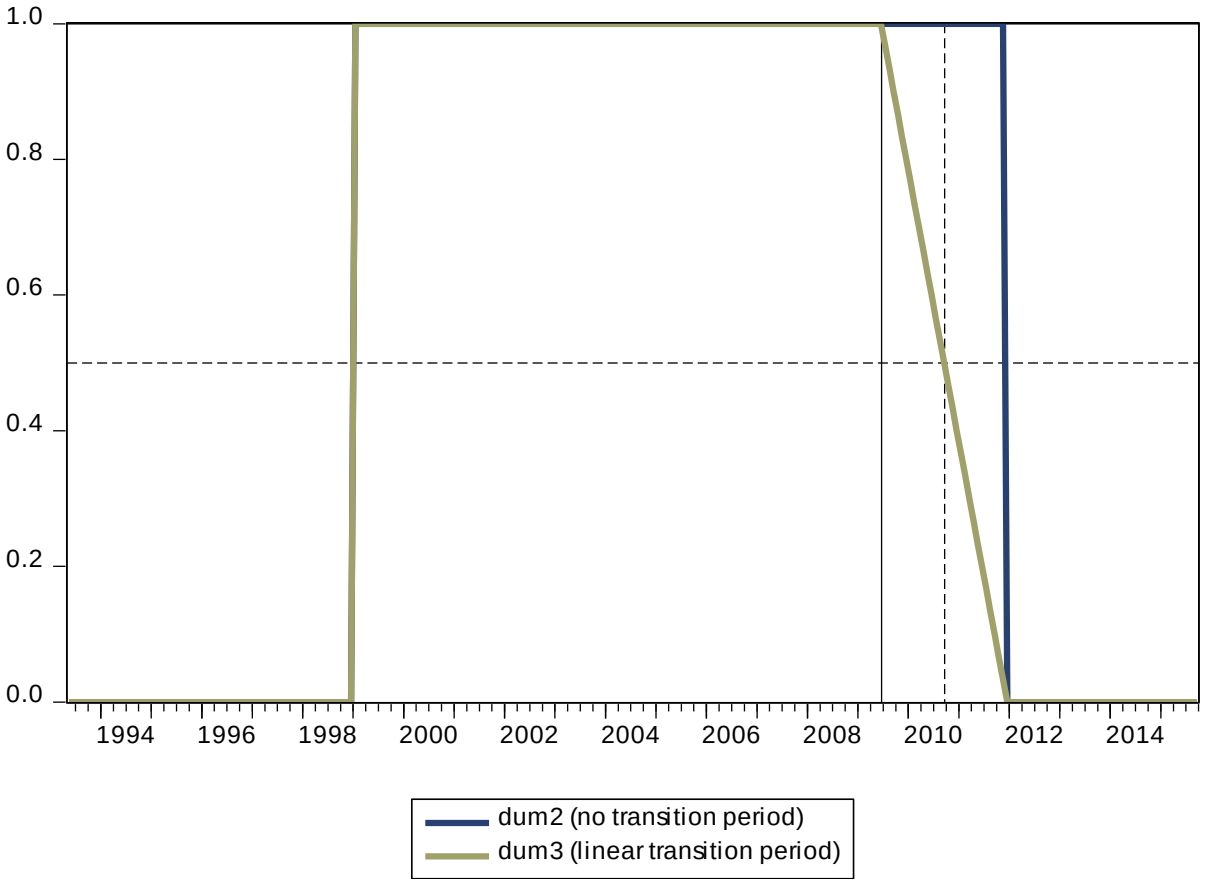
December 2013. Sephaku is the first new entrant into the cement market in the recent past. In other words, while the cartel ended with the dawn raid in June 2009, prices declined only gradually until the entry of Sephaku, i.e. some of the cartel behaviour persisted during this period. The second set of dummy variables, i.e. those taking into account a linear transition period, is depicted graphically in Figure 10.

Figure 10: Design of dummy variable 3 (January 1999 to June 2009 with a linear transition period from July 2009 until November 2011) and dummy variable 4 (January 1999 to June 2009 with a linear transition period from July 2009 until December 2013)



To better understand how the dummy variables capturing a transition period work, consider Figure 11. It shows dummy variable 2, which was designed under the assumption that the cartel starts in January 1999 and ends immediately after November 2011 and dummy variable 3, which captures the same time period, but with a linear transition period from July 2009 until November 2011.

Figure 11: Comparison of dummy variable 2 (no transition period) and 3 (linear transition period)



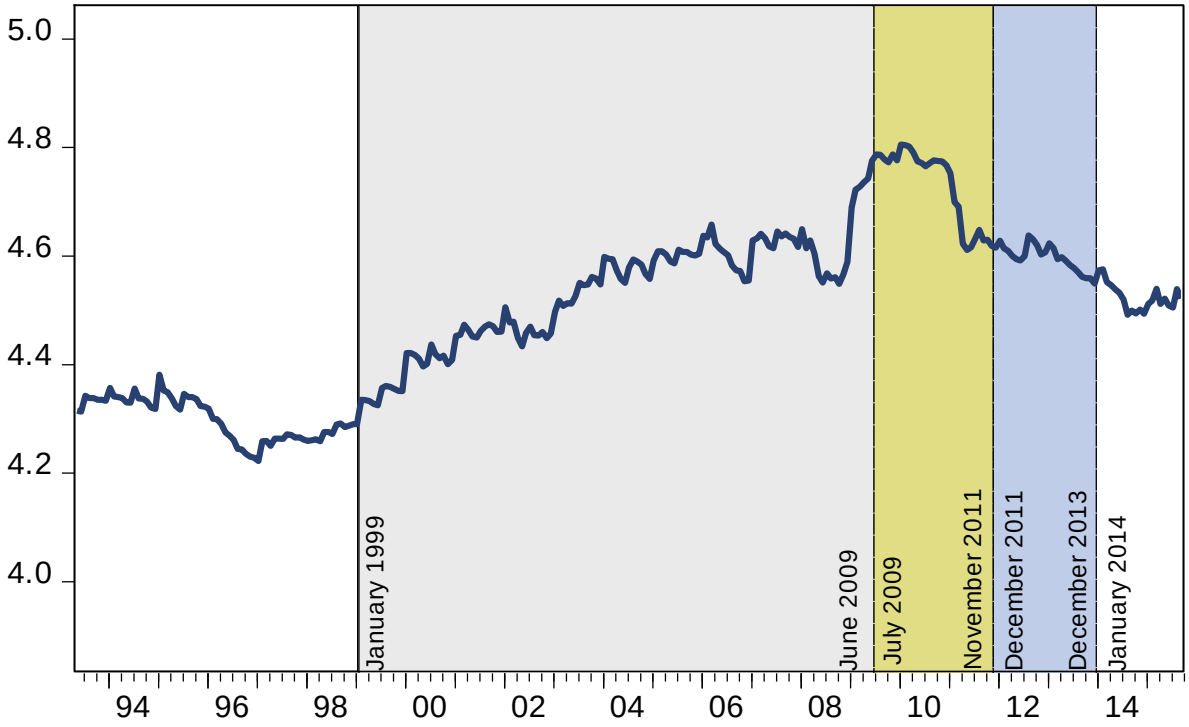
From the figure, one can clearly see how the dummy variable accounts for a transition period, based on the assumption that it is linear. In June 2009 (vertical solid line) the value of the dummy is 1, i.e. 100% of the cartel price is still captured in the market price. In September 2010 (vertical dotted line) the value of the dummy variable is 0.5 (horizontal dotted line), i.e. only 50% of the cartel price is still captured in the market price at this point. Table 4 below captures the above information.

Table 4: Summary of dummy variables used to account for cartel

Dummy	Description
Dummy 1	Dummy variable for cartel period when it is assumed that the cartel period runs from the beginning of January 1999 until the end of June 2009 with no transition period.
Dummy 2	Dummy variable assuming that the cartel period runs from the beginning of January 1999 until the end of November 2011 with no transition period.
Dummy 3	Dummy variable assuming that the cartel period runs from the beginning of January 1999 until the end of November 2011, with a linear transition period between July 2009 and November 2011.
Dummy 4	Dummy variable assuming that the cartel period runs from the beginning of January 1999 until the end of December 2013, with a linear transition period between July 2009 and December 2013.

These dates are also shown in Figure 12 below.

Figure 12: Real Cement PPI (key dates highlighted)



Source: StatsSA

The vertical solid line corresponds to the assumed start of the illegal cartel (January 1999). The first shaded area corresponds to the first assumed cartel period (ending immediately in June 2009). The first and second shaded areas combined correspond to the second assumed cartel period (ending immediately in November 2011). The third cartel period assumed, can be also be characterised by the first and second shaded areas above. The first shaded area show the cartel period (January 1999 to June 2009), while the second shaded area shows the transition period assumed (July 2009 to November 2011). In the same manner, adding the third shaded area shows the fourth assumed cartel period. In particular, the first shaded area shows the cartel period (January 1999 to June 2009), while the second and third shaded areas show the transition period assumed (July 2009 to December 2013).

6.1.2.1.2 Econometric model

Taking the above into account, we estimate the following equation in logarithmic form:

$$\widehat{P}_t^{Cement} = \gamma_0 + \gamma_1 P_t^{Limestone} + \gamma_2 P_t^{Coal} + \gamma_3 P_t^{Gypsum} + \gamma_4 P_t^{Oil} + \gamma_5 BPassed_t + D_{spike} + D_{cartel} + \varepsilon_t$$

The price index of ordinary and extended cement at time *t* ($\widehat{P}_t^{\text{Cement}}$) is determined by the constant term γ_0 and the following cost- or demand-related variables which vary over time. With respect to cost determinants, we include the price of limestone ($P_t^{\text{Limestone}}$), the price of coal (P_t^{Coal}), the price of gypsum (P_t^{Gypsum}) and the international price of oil (P_t^{Oil}). The demand side is represented through the inclusion of the value of building plans passed (BPassed_t), measured by StatsSA. Note that all variables are converted into indexed form and, where relevant, deflated (i.e. expressed in real terms).[41] We deflate the series as this eliminates the inflationary component of growth, which theoretically makes the variance of the errors more consistent over time. The effect of the cartel is captured by the inclusion of the dummy variable ($D_{cartel,i}$) where i corresponds to the specific dummy variable as set out above (dummy 1 to dummy 4). Dummies were also included to account for certain outliers in the model. We also include a dummy variable (D_{spike}) to account for a significant and temporary structural shift in the cement price index (see Figure 12). The shift, which coincides with the commodity price boom, can be explained to a certain degree by some of the variables in the model. As such, we have again considered various different specifications of the dummy (specifically different starting and ending dates) and eventually chose one which results in the best fit of the overall model.

Table 5 below shows the output for the respective models (each model using one of the cartel dummy variables discussed above).

[41] Variables are indexed such that December 2012 = 100. Relevant series are deflated using the PPI for Building and Construction Materials.

Table 5: Results from dummy variable model

Variable	Model 1	Model 2	Model 3	Model 4
Constant term	3.0541 (0.285***)	3.0232 (0.300***)	2.9821 (0.289***)	2.8336 (0.315***)
Limestone and Lime	0.1214 (0.039***)	0.0854 (0.039**)	0.1151 (0.039***)	0.0916 (0.036**)
Coal	0.1024 (0.050**)	0.1267 (0.055**)	0.1145 (0.052**)	0.1522 (0.052***)
Gypsum	-0.0830 (0.021***)	-0.0697 (0.020***)	-0.0729 (0.020***)	-0.0586 (0.021***)
Oil	0.0989 (0.016***)	0.0801 (0.021***)	0.0938 (0.017***)	0.0688 (0.020***)
Demand	0.0859 (0.022***)	0.1065 (0.024***)	0.0899 (0.023***)	0.1130 (0.023***)
Spike Dummy	0.2236 (0.016***)	0.1522 (0.017***)	0.1737 (0.016***)	0.1640 (0.015***)
Cartel Period Dummy	0.0832 (0.019***)	0.0977 (0.023***)	0.0942 (0.020***)	0.1215 (0.025***)
Observations	*269*	*269*	*269*	*269*
F-statistic	*338.940****	*351.076****	*355.124****	*397.315****
Adjusted R-squared	*0.90*	*0.90*	*0.90*	*0.91*
Log likelihood	*453.60*	*439.87*	*441.27*	*455.00*

*Note: Significance level: *** < 0.01, ** < 0.05, *< 0.1; Heteroscedasticity consistent standard errors shown in parentheses.*

The table shows the estimation results for the case of the natural logarithm[42] of the respective variables. Given that all variables are expressed in logarithmic terms, estimated regression coefficients can be interpreted as elasticities. Moreover, taking natural logs of the data typically narrows the range of the variables which makes any statistical analysis less sensitive to outliers.[43] All models considered seem to fit the data relatively well and the F-test for overall significance of the respective models confirms that the models provide a better fit than the intercept-only model[44].

As one would expect, the variable capturing the price of limestone is statistically significant in all of the models considered – for a 10% increase in the price of limestone, there is an increase of between 0.85% and 1.2% in the price of cement, depending on the specific model. Other than limestone, it is also found that coal is a significant contributing factor – for a 10% increase in the price of coal, there is a more or less

[42] See footnote 26 for an explanation for the use of logarithms.
[43] Nieberding, J. (2005). *Estimating overcharges in antitrust cases: using a reduced-form approach: methods and issues.* Journal of applied economics. 9(2):361-380
[44] In other words, it shows that the variables in the model are useful in explaining the dependant variable.

1% - 1.5% increase in the price of cement. Interestingly, the coefficient of gypsum, while statistically significant, is negative in all of the models. We also tested the models when excluding the gypsum variable, and the results were not materially different. It is also found that the price of cement is positively related to demand to a statistically significant degree.

The models indicate a consistent positive and significant overcharge regardless of how the collusive period (and hence the dummies) are defined. In addition, the dummy variables that account for the transition period are statically significant at a 1% level. We also tested models where the dummy variables that account for a transition period are included separately – this allows one to test whether a transition period is found to be statistically significant. Both the transition period dummies, when included separate from the cartel dummy, are significant at a 1% level. This implies that there is indeed a transition period and as such the cartel prices seem to have persisted following the end of the cartel. The overcharges for the respective models are shown in Table 6 below.

Table 6: Estimated overcharges from dummy variable model

	Model 1	**Model 2**	**Model 3**	**Model 4**
Cartel Period	January 1999 to June 2009	January 1999 to November 2011	January 1999 to November 2011	January 1999 to December 2013
Transition Period	None	None	July 2009 to November 2011	July 2009 to December 2013
Coefficient in logarithmic terms	0.0832	0.0977	0.0942	0.1215
Calculated percentage overcharge	**8.68%**	**10.27%**	**9.88%**	**12.92%**

Note: Overcharges percentages are calculates as $(\exp(dummy\ coefficient) - 1) \times 100$

From the table, it is clear that the calculated overcharge as a result of the cement cartel, based on the models and dummy variables defined above, ranges between 8.68% and 12.92%. As noted above, there are certain data issues. In particular, one of the issues with the dependant variable is that it exhibits a step-wise increase. This is due to the agreement whereby cement producers only increase their prices twice a year – as a result, the cement price variable only shows variation more or less every six months. In order to attempt to control for this, we conduct an alternative analysis, whereby we focus on bi-annual data.

6.2 Analysis using bi-annual data

6.2.1 Data

We make use of similar data sources as above. However, due to the fact that we now make use of bi-annual data, the model is redesigned so as to provide a reasonable fit. In other words, we do not simply

use the same variables as in the monthly model and average them over six months. Rather, we assess a new model (with the same dependant variable) on its own merits. As such, while the dependant variable in the below is the same as above, the independent variables need not be. All the variables are measured in real terms, deflated using the PPI for Building Construction. Also, all variables are indexed such that 2012H2[45] = 100, for comparative purposes. The sample period is 1993H2 to 2016H1[46]. The sample period therefore includes the period of the "illegal" collusive agreement (after the formal collusion broke down). The relevant variables are shown in Table 7.

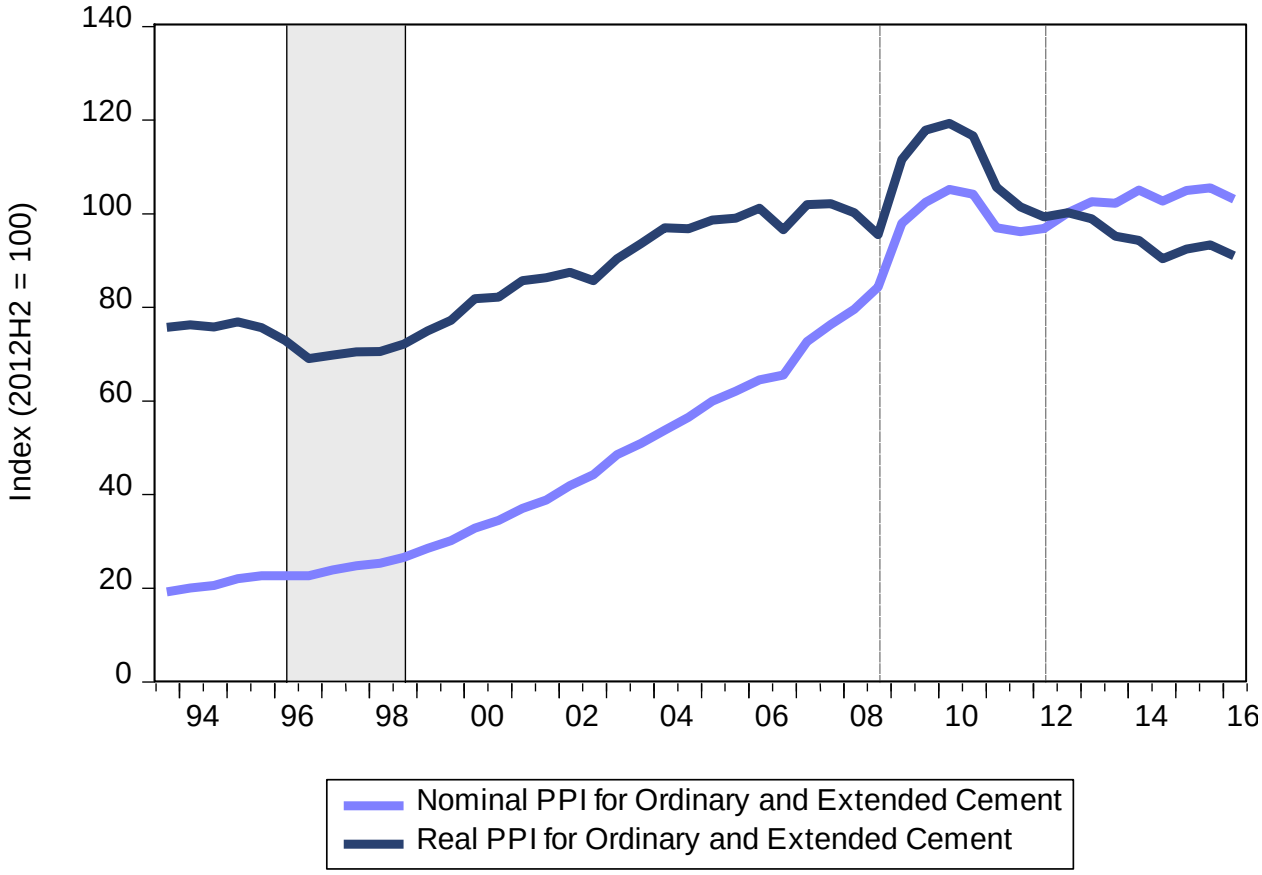
Table 7: Data and variables

Variable	Source	Description
Cement Price Index[47]	StatsSA	PPI for Selected Materials - Building materials: Ordinary & Extended Cement
Crushed Stone	StatsSA	PPI for Selected Materials – Aggregate Crushed Stone
Diesel[48]	StatsSA	PPI for selected materials: Diesel fuel - Coast and Witwatersrand; PPI for final manufactured goods: Diesel
Gypsum	Department of Mineral Resources	Industrial minerals: Non-metallic other: Gypsum - Local sales [South Africa] (Unit value (Rand/t))
Demand	South African Reserve Bank (SARB)	KBP6118: Gross fixed capital formation: Construction works - Total (Investment)

As with the monthly data, the first data series relates to the price of cement, again proxied by the PPI for Ordinary and Extended cement compiled by StatsSA. Consider Figure 13, which shows the nominal and real cement price indices over the period.

[45] Due to the fact that data is measured at a bi-annual frequency, we adopt the terminology H1 for the first half of the year and H2 for the second half of the year.
[46] We start our sample from 1993H2, as this is the starting date of the data as published by StatsSA (PPI for ordinary and extended cement).
[47] Note that there was a major outlier in June 2009 in this series, which we take to be an error in the value of the variable. It seems that the decimal point for this observation is one position too far to the right. We adjust accordingly.
[48] A consistent diesel price index was not available and as such we constructed one from data available as follows: For the period 1993 to 2011, we made use of the "PPI for selected materials: Diesel fuel - Coast and Witwatersrand" series. For the period between 2012 and July 2014, we take the average value between the "PPI for selected materials: Diesel fuel - Coast and Witwatersrand" and "PPI for final manufactured goods: Diesel" series. For the period from August 2014, we use the "PPI for final manufactured goods: Diesel" series. All indices were rebased such that Dec 2012 = 100 before taking the averages, as such they were directly comparable. Note that, for the period where the PPI series overlap, the prices are, on average, almost 100% identical and as such, we take it to confirm that these PPI series are more or less measuring the same diesel price.

Figure 13: Comparison of bi-annual cement price index at current and constant prices, 1993H2 – 2016H1 (base 2012H2)



Source: StatsSA

When smoothing the data, the major dates of the cartel, as well as their effects are more clearly visible. The price war period is again apparent from the figure (first shaded area in the figure), with prices being depressed between 1996 and 1998. Following this, prices started to increase, with a noticeable jump in the series towards the end of 2008 (first dashed line in the figure). As noted, during this period, all commodity prices saw a marked increase. It is also interesting to note from the figure that, following the period in which the companies reached settlement agreements with the CC (second dashed line in the figure), there was a decline in the real prices of cement.

As above, we also used certain cost- and demand-related variables. We employ crushed stone, diesel and gypsum as cost variables and use gross fixed capital formation in the construction industry as a proxy for cement demand. Note that, as we will elaborate on below, certain other cost variables were also tested in line with the model that uses monthly data. Having discussed the sources of the data, we now proceed to discuss the basic econometric approaches used to estimate the overcharge as a result of the cement cartel.

6.2.2 Basic econometric approaches

The two most common methods for estimating cartel overcharges are the dummy variable ('DV') and forecasting approach. In the analysis using monthly data, we only used the DV approach, as the model was not found to produce reliable forecasts. In the analysis that follows, however, we use both the dummy variable as well as the forecasting methods – this will allow for a robustness test of the one method against the other. If the fitted model is stable and robust, one would expect that the overcharge calculated when using the dummy variable approach is in line with the overcharge when using the forecasting approach. We first proceed with the dummy variable approach, before considering the forecasting approach.

6.2.2.1 Dummy variable approach

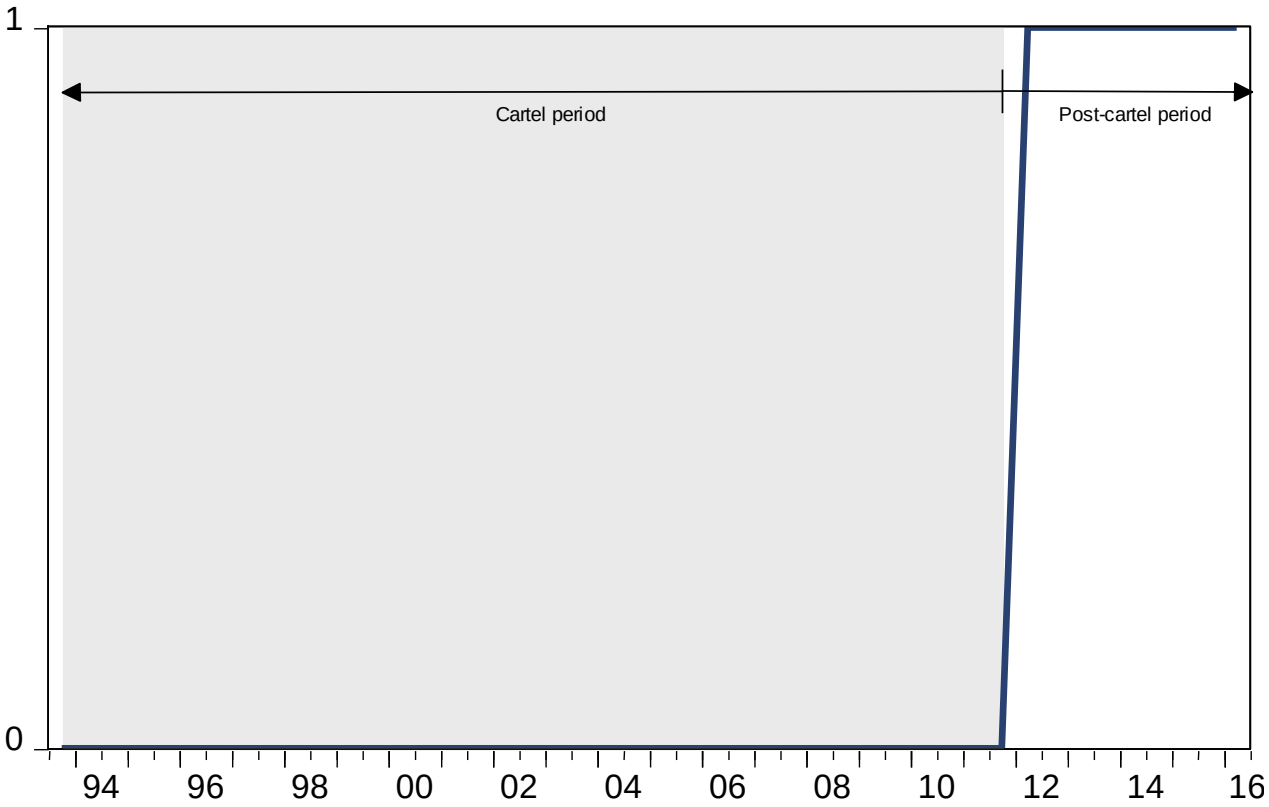
As noted, under the DV approach, one would estimate the econometric model for all time periods for which data is available, cartel and non-cartel. However, the model would include one additional variable, called a dummy variable, which measures the impact of the cartel. Due to the fact that the cement cartel has been, in some form or another, in existence since the early 1940s, we design the dummy variable measuring the impact of the cartel to be equal to 1 in the period after the cartel is assumed to have ended and 0 otherwise. This is somewhat different to what was done using the monthly data above, where the dummy variable was specified to be 1 during the cartel and 0 otherwise. The coefficient of the cartel dummy variable indicates whether the average price during the cartel was significantly different and also how much higher it was than the average price during the competitive period.[49] One can think of the dummy variable, if found to be significant, as being a shift in the price line under study rather than causing a change in its shape.[50]

In designing the cartel dummy variable, one needs to take a position on when the illegal cartel ended. As noted above, Afrisam settled with the CC during November 2011 and Lafarge during March 2012. As such, as we are making use of bi-annual data (as discussed above), we assume that the cartel ended at the end of 2011. Therefore, we design our dummy variable to be equal to 0 from the second half of 1993 (the start of our sample) to the end of 2011 and equal to 1 afterwards (up until the most recent period for which data is available). This is the longest sample period for which reliable data is available in the public domain. The design of the dummy variable is shown in Figure 14 below.

[49] Rubinfield, D. & Steiner, O. (1983). Quantitative method in antitrust litigation. *Law and Contemporary problems.* 46:69-144

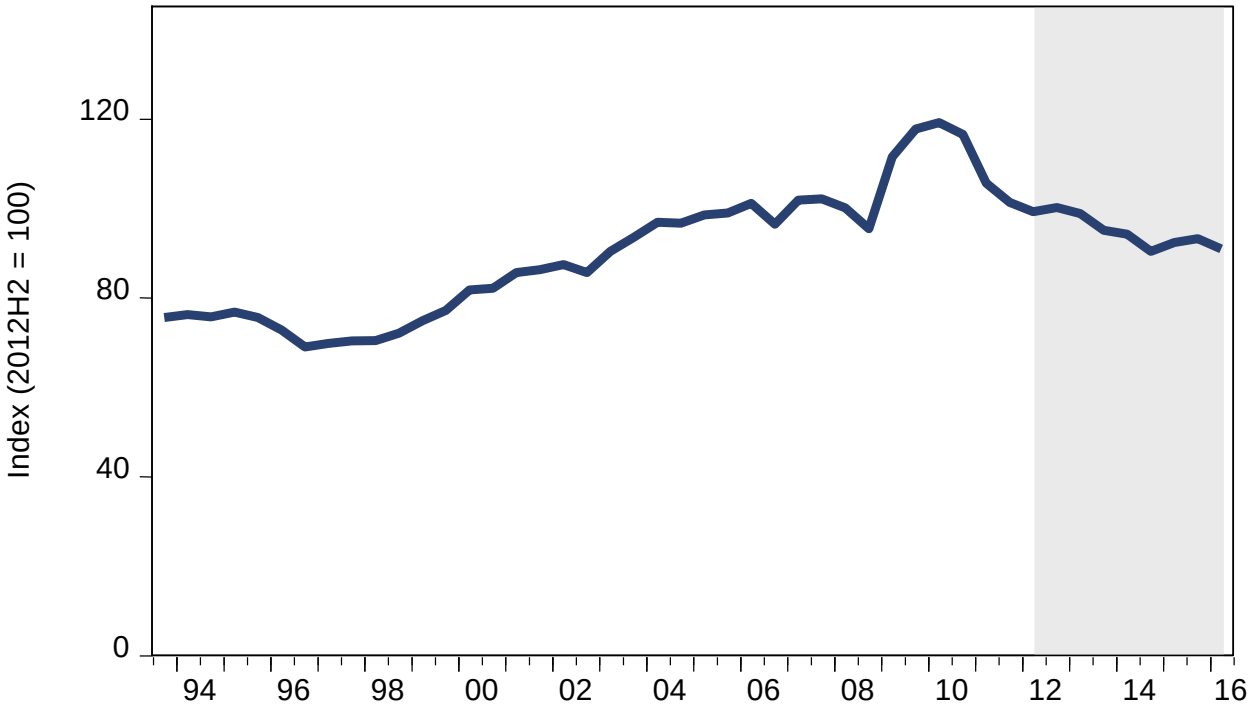
[50] Note that, by design, an overcharge will manifest itself as an negative coefficient on the dummy variable – this would imply that the prices after the cartel was lower than prices during the cartel (the actual coefficient on the dummy variable would measure by how much).

Figure 14: Cartel dummy variable design



In designing the dummy variable in this manner, we are essentially decomposing the sample into two periods: the first period is when the cartel was in operation (unshaded area in Figure 15) and the second is the period after the cartel ceased operations (shaded area in Figure 15). It is notable from the figure that, following the end of the illegal cartel, there has been a decline in the price of cement – even before the new entrant into the market commenced operations towards the start of 2014. We also tested a dummy specification that allows for a transition period. Interestingly, however, when using bi-annual data, the dummy that controls for a transition period is found to be insignificant. This is somewhat contradictory to what was found when using the monthly data.

Figure 15: Real Cement PPI – post-cartel period highlighted



Source: StatsSA

Taking the above into account, we estimate the following equation in logarithmic form:

$$\widehat{P}_t^{\text{Cement}} = \gamma_0 + \gamma_1 P_{t-1}^{\text{Crushed Stone}} + \gamma_2 P_{t-1}^{\text{Diesel}} + \gamma_3 P_{t-1}^{\text{Gypsum}} + \gamma_5 \text{Demand}_{t-1} + D_{\text{pricewar}} + D_{2008\text{H2}} + D_{2011\text{H2}} + D_{\text{cartel}} + \varepsilon_t$$

The price index of ordinary and extended cement at time *t* ($\widehat{P}_t^{\text{Cement}}$) is determined by the constant term γ_0 and the following cost- or demand-related variables which vary over time. With respect to cost determinants, we include the price of crushed stone ($P_{t-1}^{\text{Crushed Stone}}$) which we understand to be a reasonable proxy for raw material used in cement manufacture (such as limestone or shale)[51], the price of diesel (P_{t-1}^{Diesel}) and the price of gypsum (P_{t-1}^{Gypsum}). The demand side is represented through the inclusion of the value of gross fixed capital formation in the construction sector, measured by the SARB. Note that all explanatory variables are lagged by one period – as noted, we understand that the cement price was set twice per year (after meetings were held). As such, we anticipate that a rational price-setting firm would consider the preceding six months in deciding what price to set. We also include dummy variables to account for the price war

[51] See for instance Govinda, H., Khumalo, J. and Mkhwanazi, S. (2014). On measuring the economic impact: savings to the consumer post cement cartel bust. *Paper submitted for the Competition Commission and Tribunal 8th Annual Conference on Competition Law, Economics and Policy*, 4-5 September 2014., also published in *Competition Law Enforcement in the BRICS and in Developing Countries* by Jenny, F. & Katsoulacos, Y., page 325. This authors argue that Aggregated Crushed Stone can be used as a proxy based on the similar mining processes.

period and for certain outliers in the data. Note that various other specifications of the model were tested using different sources for the explanatory variables (both the cost drivers and demand drivers). However, the model presented above was found to be the most robust and stable (we report misspecification tests in the appendix). Regardless of the chosen model, the estimated overcharge in all of the different models tested was similar. The results of the dummy variable model are shown below in Table 8.

Table 8: Results from dummy variable model

Variable	Model Coefficient Values
Constant term	2.578 (0.000***)
Aggregate Crushed Stone	0.364 (0.002***)
Diesel	0.111 (0.003***)
Gypsum	-0.121 (0.000***)
Demand	0.109 (0.000***)
Price War Dummy	-0.105 (0.000***)
Outlier Dummy 2008H2	-0.158 (0.000***)
Outlier Dummy 2011H2	-0.104 (0.000**)
Cartel Dummy	**-0.161** **(0.000***)**
Observations	*45*
F-statistic	*75.432****
Adjusted R-squared	*0.93*
Log likelihood	*1.58*

*Note: Significance level: *** < 0.01, ** < 0.05, *< 0.1; Heteroscedasticity consistent standard errors shown in parentheses.*

The table shows the estimation results for the case of the natural logarithm[52] of the respective variables. Given that all variables are expressed in natural logarithmic terms, estimated regression coefficients can be interpreted as elasticities. The model fits the data relatively well and the F-test for overall significance of the respective models confirms that the models provide a better fit than the intercept-only model[53]. The

[52] As the model is estimated in logarithmic terns, the coefficient on the overcharge dummy needs to be converted such that it is interpretable. This is done by computing the following: $(e^{-0.161} - 1) \times 100$

[53] In other words, it shows that the variables in the model are useful in explaining the dependant variable.

model passes all the usual misspecification tests, the output of which is available on request. Note that the time series properties of the included variables were also tested. It was found that all the series are I(1) and are co-integrated – as such, the results reported above can be interpreted as the long-run equilibrating relationship between the variables.

As one would expect, the variable capturing the price of crushed stone is statistically significant – for a 10% increase in the price of crushed stone, there is an increase of about 3.6% in the price of cement[54]. Other than crushed stone, it is also found that diesel is a significant contributing factor – for a 10% increase in the price of diesel, there is a more or less 1.1% increase in the price of cement[55]. Interestingly, the coefficient of gypsum, while statistically significant, is negative. We also tested the models when excluding the gypsum variable and the results were not materially different.[56] It is also found that the price of cement is positively related to demand to a statistically significant degree. While we have tested various other specification of the model, the coefficient on the cartel dummy does not vary to a significant degree.[57] The model presented above was ultimately the one which passed all the misspecification tests and had the highest log-likelihood. The model indicates that there is a positive and significant overcharge as a result of the cement cartel. It is found that prices post the cement cartel are 14.86%[58] lower than during the cartel. In other words, the cartel resulted in prices being inflated by 14.86%, according to this method.

Having estimated the percentage overcharge as a result of the cement cartel using the dummy variable approach, we now employ a second approach – the forecasting approach.

6.2.2.2 Forecasting approach

A second approach is to forecast the 'but-for' price that would have prevailed absent the conspiracy. Using data during a suitable time period, the effect of the determinants of demand and cost shifters on price can be estimated. Those values of the parameters can be used to predict the "but-for" price. One assumption implicit in the forecasting approach is that the structural relationship between the variables remains

[54] Note that we also tested a model were we use a price index constructed from data from the Department of Mineral Resources (DMR) measuring the limestone price. Including this variable does not alter the results of the model significantly, but the variable is found to be insignificant in explaining movement in cement prices. This does not make theoretic sense and as such we opted for the use of the price index of aggregate crushed stone. Nevertheless, even when using the limestone variable from the DMR, the misspecification tests are again passed and the coefficient on this variable does not differ significantly (-0.173 vs -0.161).
[55] Note that we also tested a model were we use the oil price, rather than diesel. When using the USA oil price, there is some issues of serial correlation, albeit not at a significant statistical level. Nevertheless, the coefficient estimate of the cartel dummy does not differ significantly (-0175 vs. -0.161).
[56] While a model that excluded gypsum does result in a somewhat higher cartel dummy coefficient (-0.215 vs. -0.161), it does not pass all the misspecification tests and as such we do not employ this model.
[57] It should also be noted that we do not include the electricity price in the model above, as this is an administered price (with little variation) and as such we therefore assume that the price of diesel is a better proxy for energy movements. Note that even when we include an electricity variable, it is found that the variable is not statistically significant, nor does it have the correct sign. This indicates possible misspecification of the model when including the electricity variable – indeed when including this variable the model does not pass all the usual misspecification tests. One might also argue that using oil, rather than diesel, is a better proxy for energy prices. As noted, we ran a model using oil prices rather than diesel prices, but the coefficient estimate of the cartel dummy was not materially influenced (-0175 vs. -0.161).
[58] Due to the fact that variables are measured in natural logarithmic terms, the coefficient on the cartel dummy needs to be converted to normal terms by taking the exponent of the coefficient: : $(e^{-0.161} - 1) \times 100$ = -0.149.

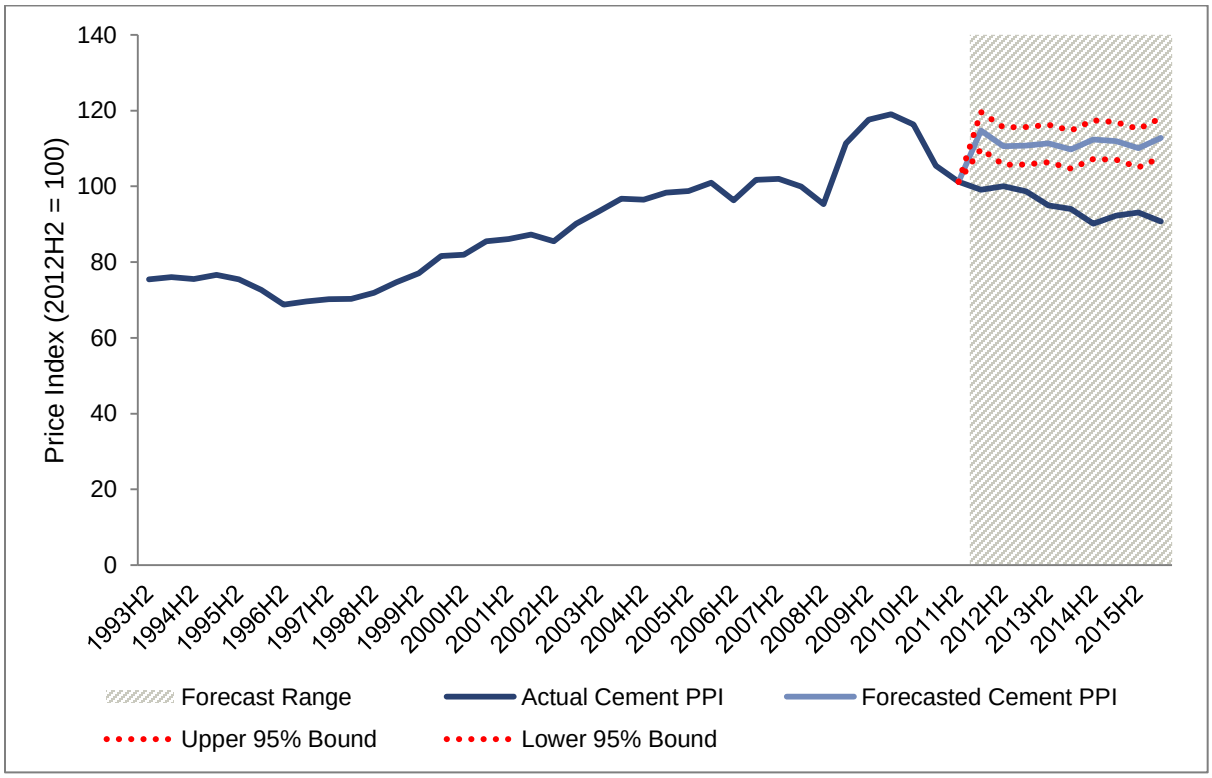
unchanged. In particular, it supposes that the conduct of the firms and that the way demand and cost affected prices would each have remained stable.

Ideally one would make use of data before and after the cartel period to estimate a model and then use it to forecast prices during the cartel. However, as noted, data from before the cartel are not available. As such, we take an opposite approach: we estimate a model of cement prices during the cartel period and use it to forecast prices after the cartel is assumed to have ended. The difference between the realised prices after the cartel and the prices forecasted by the model would then give us an indication of the overcharge. The model fit over the cartel period is defined as follows:

$$\widehat{P}_t^{Cement} = \gamma_0 + \gamma_1 P_{t-1}^{Crushed\ Stone} + \gamma_2 P_{t-1}^{Diesel} + \gamma_3 P_{t-1}^{Gypsum} + \gamma_5 Demand_{t-1} + D_{pricewar} + D_{2008H2} + D_{2011H2} + \varepsilon_t$$

As above, the price index of ordinary and extended cement at time *t* ($\widehat{P}_t^{Cement}$) is determined by the constant term γ_0 and the same cost- or demand-related variables as in the dummy variable model using bi-annual data. The model is fit over the period 1993H2 and 2011H2 and is then used to forecast prices over the period from 2012H1 until the most recent period for which data are available (2016H1). The forecasted prices from the model, along with a 95% confidence interval are shown in Figure 16. The model again passes all the usual misspecification tests.

Figure 16: Actual vs forecasted real cement PPI



From the figure, it is clear that a model that is fit over the cartel period, forecasts prices after the cartel period that are fairly stable and above the prices actually realised, as expected. The forecasted values seem stable, with the forecast being consistently inside the 95% confidence interval. Also, the confidence interval does not overlap with the actual prices, clearly indicating a statistically significant difference between the forecasted and realised prices. On average, over the forecasting period, it is found that the realised prices are 17.90% lower than the forecasted prices. In other words, the cartel resulted in prices which were inflated by 17.90%, based on this method.

7 Conclusion

We illustrated in the paper the difficulties in calculating overcharge percentages that resulted as a consequence of the long standing cement cartel in South Africa. Using both monthly as well as bi-annual data, we provide estimates of the damages caused by the cement cartel using two of the most common methods for estimating cartel damages.

Using monthly data, we improve on previous work by using a longer time period and controlling for the financial crisis (2008/2009). We also employ dummy variables to model various transition periods after the end of the cartel. The specific time periods need to be examined carefully, i.e. the end of the legal cartel in 1996, the price war period between 1996 and 1998, the illegal cartel until the CC interventions in 2009, the signing of settlement agreements and finally the entry of Sephaku in 1996. We show that using a dummy variable which assumes a gradual transition period improves the econometric modelling. Nevertheless, given the difficulty in identifying the various periods and considering the price stickiness post the cartel period, we expect our cartel overcharge results to present the lower bounds of possible damages.

We also make use of bi-annual data, which alleviates some of the issues experienced when using monthly data. We employ both the dummy variable as well as the forecasting approaches and find overcharges that are somewhat higher than when using monthly data.