COMPETITION COMMISSION

AGGREGATES, CEMENT AND READY-MIX CONCRETE MARKET INVESTIGATION

Price parallelism in bulk cement

Introduction and summary

1. This paper looks at the relationship between the major cement producers' ((the Majors') ie Cemex UK Operations Limited (Cemex), Hanson, Lafarge Aggregates Limited and Lafarge Cement UK Limited (together Lafarge) and Tarmac Group Limited (Tarmac)) prices for bulk cement.[1] We first compare the Majors' prices to find out the magnitude of any correlation between the price series. We then compare the Majors' prices with those of a number of cement importers (Aggregate Industries, [Importer A], [Importer B] and [Importer C]). Finally, we compare the Majors' prices with their variable costs to find out whether the Majors' costs are similar and whether the Majors' prices are driven by their costs.

2. Analysis of price correlation (ie the extent to which prices of cement charged by the different Majors move closely together) is informative for understanding the nature of competition between the Majors. If the Majors coordinate, we could expect a high degree of correlation between their prices. This would be particularly the case if the focal point for coordination was prices, or if there are some patterns of price leadership/price following in the industry (eg through price announcement letters). However, a high degree of correlation between prices can also be consistent with intense competition; for instance if prices increase in the same way due to common costs. Therefore, we analyse both the correlation between the prices of cement charged by the Majors, and the correlation of cement prices to cement costs. If we find that the Majors' price series are highly correlated, and that the Majors' price series are highly correlated with their variable costs, this would be consistent with

[1] For the purposes of this analysis, we classify Aggregate Industries as a cement importer, as it does not produce any cement in the UK.

both coordination and intense competition. However, if we find that the Majors' price series are highly correlated, and that the Majors' price series are not correlated with their variable costs, this may be inconsistent with intense competition, and could instead be evidence of dampened competition, which may be due to coordination.

3. We find that the Majors' prices are highly correlated, and that the Majors' and cement importers' prices are highly correlated. This holds for most Majors and some importers even when we control for any trends observed in prices. We also find that changes in prices are not (fully) explained by changes in variable costs for the Majors.

Data and methodology

4. The prices are calculated using revenues and volumes provided by the Majors and cement importers in their Transaction data. The Majors' Transactions data is available on a monthly basis, while the cement importers' Transactions data is available on a quarterly basis. The Majors' variable costs are available on a quarterly basis. Therefore, we calculate a quarterly average delivered price for each Major and cement importer, by adding up the revenues (including haulage) and volumes for each quarter, and then dividing the quarterly revenues with quarterly volumes to obtain a quarterly average delivered price.[2] However, we have also calculated the ex-shipping-point prices for those Majors for which we have the relevant data, by subtracting the quarterly haulage costs from the quarterly revenues, and then dividing by quarterly volumes. All prices are calculated on a nominal basis (ie they have not been deflated).

[2] Separate haulage costs have not been provided by all companies. Also, where haulage costs have been provided separately, these have in some cases been collated specifically for the CC, and may not reflect the actual haulage costs paid by customers on each transaction. Therefore, we consider it is more appropriate to use delivered prices.

5. We have excluded from this analysis data on bagged/packed cement and plant-to-plant transfers of bulk cement.[3] It is worth noting that Tarmac have provided revenues which have not netted off rebates and discounts (to the extent that they apply). However, Tarmac has provided a separate dataset with the rebates and discounts, and we have netted off rebates and discounts from the revenues for Tarmac in order to obtain prices which are, as far as possible, equivalent to those of the other Majors.

6. In this working paper, we focus on delivered prices of CEM I for Sales to Independents, in order for the prices to be directly comparable across Majors and importers. As the Majors' revenues comprise different proportions of CEM I sales, this is expected to be reflected in the price for all types of cement, as CEM I tends to be more expensive than CEM II/III/IV. The cement importers supply only CEM I. CEM I makes up the majority of the Majors' sales, as well as being an input into non-CEM I products, and therefore, we consider that it is relevant to look at CEM I separately.

7. In addition, we consider that it is relevant to look at Sales to Independents, ie excluding Sales to other Majors and Internal sales from the analysis. Internal sales are priced at an Internal transfer price which may not reflect a transaction price, and could be used as a means of transferring profits from one part of the company into another. Sales to other Majors may not reflect a market price if coordination is present (for instance, prices charged for cement to other Majors could be used as a mechanism for side-payments if coordination exists).

[3] [✂]

8. The variable costs are calculated using costs provided by the Majors in Part 3 of the Transaction data request, alongside volumes from the Transaction data.[4] Variable costs per tonne of production are calculated by dividing the quarterly variable costs across all cement and blending plants with the quarterly transaction volumes across the same cement and blending plants. As such, these variable costs only relate to costs incurred at the plant, and do not include variable costs of delivery.[5] Any hedging strategies which the Majors have in relation to their fuel and electricity purchases have been incorporated into the calculation of variable costs per tonne. All costs are calculated on a nominal basis.

CEM I prices faced by Independent customers

9. This section looks at correlations between the Majors' delivered prices for CEM I for Sales to Independent customers. We first look at correlations between the Majors' delivered prices for CEM I, and between the Majors' and importers' CEM I prices. We then look at the correlation between the Majors' delivered prices for CEM I and their quarterly variable costs.

Correlations between the Majors', and Majors and importers' prices

10. Figure 1 displays the quarterly average prices for CEM I for Sales to Independents for the four Majors, across the period Q1 2007 to Q4 2011. The figure shows that there appears to be a strong relationship between the Majors' prices.

FIGURE 1

[✂]

Majors' quarterly average prices for CEM I for Sales to Independents, Q1 2007 to Q4 2011

Source: Transaction data submitted by Cemex, Hanson, Lafarge and Tarmac, and CC analysis.

[4] Variable costs include costs of fuel, electricity and labour. In the case of Cemex, [✂]. Tarmac has noted that the use of sales volumes instead of production volumes would not take into account the impact of stock movements or planned maintenance shutdown of the cement plant.

[5] As fuel is included in the variable costs of a plant, it may already capture some of the variation in delivery costs.

11. Figure 2 shows the quarterly average prices for CEM I for Sales to Independents for the four Majors and for four cement importers ([Importer A], [Importer B], [Importer C] and Aggregate Industries),[6] across the period Q1 2007 to Q4 2011. As the figure shows, there seems to be a strong relationship between the Majors' and [Importers A-C]'s prices. For Aggregate Industries, the relationship is [✂].

FIGURE 2

Majors' and importers' quarterly average prices for CEM I for Sales to Independents, Q1 2007 to Q4 2011

[✂]

Source: Transaction data submitted by Cemex, Hanson, Lafarge, Tarmac, [Importer A], [Importer B], [Importer C] and Aggregate Industries, and CC analysis.

12. Table 1 shows the correlation coefficients between the quarterly average CEM I prices for Sales to Independents of the four Majors as well as [Importers A – C][7], across the period Q1 2007 to Q4 2011. A correlation coefficient is a single number that describes the degree of relationship between two variables. Correlation coefficients range between –100 per cent and 100 per cent. The closer the correlation coefficient is to 100 per cent, the more changes in one variable (eg costs) are associated with changes of the same sign in the other variable (eg price). The closer the correlation coefficient is to –100 per cent, then the more changes in one variable are associated with opposite changes in the other variable. It is not unusual for time series (eg prices) to have high (positive) correlation coefficients.

13. The correlations between the Majors' CEM I prices are very high, ranging from 87 to 98 per cent (top left-hand box). Correlations between the Majors' and the importers' prices are also high, ranging from 82 to 98 per cent (top right-hand box), while correlations between the importers' prices range from 92 to 98 per cent (bottom right-

[6] These importers make up between 71 and 81 per cent (varies by year) of volumes of cement imports (excluding imports by Great Britain producers). [✂]
[7] These importers make up between 41 and 48 per cent (varies by year) of volumes of cement imports (excluding imports by Great Britain producers) and represent the majority of imported cement (excluding imports by Great Britain producers) which is sold to Independents.

hand box). This suggests that the Majors' and importers' prices are closely aligned over time.

TABLE 1 **Correlation coefficients between the quarterly average prices for CEM I for Sales to Independents, Q1 2007 to Q4 2011**

per cent

	Hanson	*Lafarge*	*Tarmac*	*[Importer A]*	*[Importer B]*	*[Importer C]*
Cemex	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Hanson		[✂]	[✂]	[✂]	[✂]	[✂]
Lafarge			[✂]	[✂]	[✂]	[✂]
Tarmac				[✂]	[✂]	[✂]
[Importer A]					[✂]	[✂]
[Importer B]						[✂]

Source: Transaction data submitted by Cemex, Hanson, Lafarge, Tarmac, [Importer A], [Importer B] and [Importer C], and CC analysis.

14. We see from Figures 1 and 2 that the average prices for all Majors and importers display an upward trend over the period in question. Therefore, we also calculate correlations between differences in prices, in order to remove any correlation impacts driven purely by trend.[8] The results are shown in Table 2.

15. As Table 2 shows, there is high correlation between Cemex's, Hanson's and Lafarge's price difference series (ranging between [70 and 95] per cent), which is independent of trend in the actual price series. The correlations between Tarmac's and other Majors' price difference series are lower, ranging between [40 and 50] per cent.

16. The correlations between the Majors' and importers' price difference series show greater variation. [Importer A]'s and [Importer B]'s price difference series show higher correlations with Cemex's, Hanson's and Lafarge's price difference series ([70 to 90] per cent), and somewhat lower with Tarmac's price difference series ([30 to 65] per

[8] In particular, we calculate a price difference series for each company by subtracting two successive quarters (eg price in Q2 2007 minus price in Q1 2007), and we do this across the whole period (or mathematically, Δy_t). We then calculate an average difference for the period Q1 2007 – Q1 2009 ($\Delta \bar{y}_0$), and an average difference for the period Q2 2009 – Q4 2011 ($\Delta \bar{y}_1$) for each company, as we can see from Figure 1 that the series have different trends in the two periods. We then subtract the average difference from the calculated difference for each quarter ($\Delta y_t - \Delta \bar{y}_0$ for the first period, and $\Delta y_t - \Delta \bar{y}_1$ for the second period) to obtain price differences controlled for trend. This reduces the number of degrees of freedom for the detrended data by 2. We then calculate correlation coefficients between these price difference series.

cent). [Importer C]’s price difference series, on the other hand, shows lower correlations with all Majors’ price difference series, ranging from [20 to 40] per cent.

17. We have also checked whether the results in Table 2 are statistically significant at the 95 and 99 per cent level, and have marked the results accordingly. We looked up the significance thresholds in a standard statistics book, which gave thresholds of 48.2 and 60.6 per cent at 95 and 99 per cent significance levels respectively where there are 15 degrees of freedom.[9]

TABLE 2 **Correlation coefficients between the quarterly detrended prices for CEM I for Sales to Independents, Q1 2007 to Q4 2011**

per cent

	Hanson	*Lafarge*	*Tarmac*	*[Importer A]*	*[Importer B]*	*[Importer C]*
Cemex	[✂]*	[✂]*	[✂]	[✂]*	[✂]*	[✂]
Hanson		[✂]*	[✂]	[✂]*	[✂]*	[✂]
Lafarge			[✂]	[✂]*	[✂]*	[✂]
Tarmac				[✂]*	[✂]	[✂]
[Importer A]					[✂]*	[✂]
[Importer B]						[✂]

Source: Transaction data submitted by Cemex, Hanson, Lafarge, Tarmac, [Importer A], [Importer B] and [Importer C], and CC analysis.

*Significant at 99 per cent level.
Note: n=19, d.f.=15.

18. We can conclude the following from this analysis of cement price correlations.

(a) Cement price correlation among three Majors (Cemex, Hanson and Lafarge) has been very high in the period Q1 2007 to Q4 2011, even when controlling for trend.

(b) Price correlation between Tarmac and the other Majors are in line with the correlations for the other Majors when not controlling for trend but are much lower across the period, when controlling for trend.

(c) Cement price correlation has been high between Majors and two Importers ([Importer A] and [Importer B]), and lower between Majors and [Importer C], in the period Q1 2007 to Q4 2011.

[9] G.M. Clarke and D. Cooke, ‘A Basic Course in Statistics’, p359.

Evolution of the Majors' prices and variable costs

19. The Majors told us that the rationale for announced prices increases over the last few years had been increases in their own costs. In particular, we were told by Hanson that it sent general price increase notifications to customers in order to attempt to recover its cost increases (eg energy costs which had risen substantially in recent years). Tarmac told us that to the extent that there had been any correlation between the timing and the amounts of the price letters sent by the different cement producers, this could be explained by the need to respond to customer requests for their own budgeting/costing purposes and to address increased input costs (which were common to all producers) annually or, in more exceptional circumstances, as they could no longer continue to be absorbed.[10] Lafarge told us that price increases were driven by a mixture of costs including the price of coal, oil and sea freight costs. In this section we seek to test these statements by looking at the correlations between the Majors' prices and their variable costs, both average variable production costs,[11] as well as average energy costs for production of cement (which include fuel and electricity only). Fuel and electricity costs tend to vary more on a quarterly basis than labour costs, and therefore may have a closer association with prices than labour costs.

20. Figure 3 shows the Majors' quarterly average variable costs. The Majors' average variable costs move somewhat together over time, though the correlation coefficients between the average variable costs of the Majors are low, or negative, ranging between –[✂] per cent ([✂]/[✂]) and [✂] per cent ([✂]/[✂]).

FIGURE 3

Majors' quarterly average variable costs, Q1 2007 to Q4 2011

[✂]

Source: Cost data submitted by Cemex, Hanson, Lafarge and Tarmac, and CC analysis.

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[10] Section 5.2 of Response to Issues Statement.
[11] Variable costs include costs of fuel, electricity and labour. In the case of Cemex, [✂].

Cemex

21. Figure 4 shows Cemex's quarterly delivered price of CEM I faced by Independent customers alongside Cemex's average variable costs of production (in £/tonne) across all of Cemex's cement/blending plants (of which there were five in 2007, reducing to three in 2008, and increasing to four in 2009) and Cemex's average energy costs across the same plants. The variable costs are calculated across all production at the relevant plants, and therefore include bagged sales and non-CEM I products. [✄], and therefore, we believe that it is relevant to use the variable costs across all of Cemex's production in our analysis. Also, the variable costs only relate to costs incurred at the plant, and do not include variable costs of delivery.[12] It is not possible to do correlations between average ex-shipping-point prices (which exclude haulage) and average variable costs, as Cemex have not provided data on haulage costs ([✄]), which is necessary to calculate average ex-shipping-point prices.

22. [✄]

23. [✄]

24. One possible explanation [✄] is that cement producers may not be able to fully pass on increases in variable costs to their customers. [✄], we can see in Figure 4 that, during the period in question, [✄].

FIGURE 4

Cemex's quarterly average prices for CEM I for Sales to Independents and variable costs, Q1 2007 to Q4 2011

[✄]

Source: Transaction and cost data submitted by Cemex, and CC analysis.

[12] As fuel is included in the variable costs of a plant, it may already capture some of the variation in delivery costs.

TABLE 3 **Correlation coefficients between Cemex's quarterly average prices for CEM I for Sales to Independents and variable costs, Q1 2007 to Q4 2011**

	Average delivered price %
Average variable costs	
No lag	[✂]
Lag of 1 quarter	[✂]
Lag of 2 quarters	[✂]
Lag of 3 quarters	[✂]
Lag of 4 quarters	[✂]
Average energy costs	
No lag	[✂]
Lag of 1 quarter	[✂]
Lag of 2 quarters	[✂]
Lag of 3 quarters	[✂]
Lag of 4 quarters	[✂]

Source: Transaction and cost data submitted by Cemex, and CC analysis.

25. We next calculate correlations between Cemex's prices and variable costs controlling for trend, as described in footnote 9 above. The results are shown in Table 4. The table shows that [✂].

TABLE 4 **Correlation coefficients between Cemex's quarterly detrended prices for CEM I for Sales to Independents and detrended variable costs, Q1 2007 to Q4 2011**

	Price differences %
Average variable cost differences	
No lag	[✂]
Lag of 1 quarter	[✂]
Lag of 2 quarters	[✂]
Lag of 3 quarters	[✂]
Lag of 4 quarters	[✂]
Average energy cost differences	
No lag	[✂]
Lag of 1 quarter	[✂]
Lag of 2 quarters	[✂]
Lag of 3 quarters	[✂]
Lag of 4 quarters	[✂]

Source: Transaction and cost data submitted by Cemex, and CC analysis.

Note: n=19, d.f.=15 where no lag is assumed; n=18, d.f.=14 where lag of 1 quarter is assumed; n=17, d.f.=13 where lag of 2 quarters is assumed; n=16, d.f.=12 where lag of 3 quarters is assumed; and n=15, d.f.=11 where lag of 4 quarters is assumed. The corresponding significance thresholds are as follows: 48.2 per cent and 60.6 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=15; 49.7 per cent and 62.3 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=14; 51.4 per cent and 64.1 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=13; 53.2 per cent and 66.1 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=12; and 55.3 per cent and 68.4 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=11.

Hanson

26. Figure 5 shows Hanson's quarterly delivered and ex-shipping-point prices of CEM I faced by Independent customers alongside Hanson's average variable costs (in £/tonne) across Hanson's three cement/blending plants and Hanson's average energy costs across the same three plants. The variable costs are calculated across all production at the three plants, and therefore include bagged sales and non-CEM I products. We have not seen any evidence from Hanson to suggest that electricity, fuel or labour costs differ significantly between types of cement, or between bulk and bagged, and therefore, we believe that it is relevant to use the variable costs across all of Hanson's production in our analysis. Also, the variable costs only relate to costs incurred at the plant, and do not include variable costs of delivery.[13] Therefore, we show both the average delivered price and the ex-shipping-point price, in order to test whether variable costs explain ex-shipping-point prices better than average delivered prices.[14] The prices and costs are both increasing over time, with fairly high correlations, as shown in Table 5 below.

27. It may be the case that price changes lag behind any changes in variable costs, and therefore, Table 5 also includes correlations between prices and variable costs lagged up to 4 quarters. Lagging costs by 1 quarter seems to increase the correlations somewhat, reaching [✂] per cent in the case of average delivered prices and average variable costs, and [✂] per cent in the case of average ex-shipping-point prices and average variable costs. This suggests that total variable costs may explain a large part of the variation in Hanson's prices.

[13] As fuel is included in the variable costs of a plant, it may already capture some of the variation in delivery costs.
[14] Average ex-shipping point prices are calculated by subtracting total quarterly haulage costs from total quarterly revenues, and then dividing by total quarterly volumes.

FIGURE 5

Hanson's quarterly average prices for CEM I for Sales to Independents and variable costs, Q1 2007 to Q4 2011

[✂]

Source: Transaction and cost data submitted by Hanson, and CC analysis.

TABLE 5 **Correlation coefficients between Hanson's quarterly average prices for CEM I for Sales to Independents and variable costs, Q1 2007 to Q4 2011**

per cent

	Average delivered price	*Average ex-shipping-point price*
Average variable costs		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]
Average energy costs		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]

Source: Transaction and cost data submitted by Hanson, and CC analysis.

28. We next calculate correlations between Hanson's prices and variable costs controlling for trend, as described in footnote 9 above. The results are shown in Table 6. The table shows that when we control for trend in both the price and variable costs, we get lower, or negative, correlations between prices and costs. The highest positive correlation between price differences and variable cost differences is [✂] per cent in the case of average delivered prices (when cost differences are lagged by 1 quarter), and [✂] per cent in the case of average ex-shipping-point prices (when costs are lagged by 1 quarter), and this is significant at 95 per cent, but not at 99 per cent.

TABLE 6 **Correlation coefficients between Hanson's quarterly detrended prices for CEM I for Sales to Independents and detrended variable costs, Q1 2007 to Q4 2011**

per cent

	Average delivered price differences	*Average ex-shipping-point price differences*
Average variable cost differences		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]*	[✂]*
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]
Average energy cost differences		
No lag	[✂]*	[✂]*
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]

Source: Transaction and cost data submitted by Hanson, and CC analysis.

*Significant at 95 per cent level.
Note: n=19, d.f.=15 where no lag is assumed; n=18, d.f.=14 where lag of 1 quarter is assumed; n=17, d.f.=13 where lag of 2 quarters is assumed; n=16, d.f.=12 where lag of 3 quarters is assumed; and n=15, d.f.=11 where lag of 4 quarters is assumed. The corresponding significance thresholds are as follows: 48.2 per cent and 60.6 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=15; 49.7 per cent and 62.3 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=14; 51.4 per cent and 64.1 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=13; 53.2 per cent and 66.1 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=12; and 55.3 per cent and 68.4 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=11.

29. Overall, therefore, we conclude from this analysis that changes in Hanson's variable costs of production explain a large part of the variation in its average ex-shipping-point prices, but that they do not fully explain these changes. We note that Hanson's average prices have tended to increase more than average variables costs in the period analysed.

Lafarge

30. Figure 6 shows Lafarge's quarterly delivered and ex-shipping-point prices of CEM I faced by Independent customers alongside Lafarge's average variable costs (in £/tonne) across Lafarge's six cement/blending plants and Lafarge's average energy costs across the same six plants. The variable costs are calculated across all production at the six plants, and therefore include bagged sales and non-CEM I products. Lafarge told us that its variable costs may vary between different types of

cement; however, at present we do not have sufficient information to split out costs between different types of cement.[15] Also, the variable costs only relate to costs incurred at the plant, and do not include variable costs of delivery.[16] Therefore, we show both the average delivered price and the ex-shipping-point price, in order to test whether variable costs explain ex-shipping-point prices better than average delivered prices.[17] The prices and costs are positively correlated, as shown in Table 7 below.

31. It may be the case that price changes lag behind any changes in variable costs, and therefore, Table 7 also includes correlations between the variable costs and prices lagged up to 4 quarters. Lagging prices by 1 quarter seems to increase the correlations somewhat in the case of average variable costs. This suggests that variable costs may partly explain price changes in the case of Lafarge.

FIGURE 6

Lafarge’s quarterly average prices for CEM I for Sales to Independents and variable costs, Q1 2007 to Q4 2011

[✂]

Source: Transaction data submitted by Lafarge, and CC analysis.

[15] Lafarge stated that Energy prices vary significantly between cement types (bulk and packed). According to Lafarge, fuel costs are directly related to clinker content and CEM III has approximately 43 per cent clinker, whilst CEM I has approximately 92 per cent clinker, while CEM III PLC (packed) is only coarse ground and therefore require less grinding per tonne relative to a much more finely ground CEM I product.
[16] As fuel is included in the variable costs of a plant, it may already capture some of the variation in delivery costs.
[17] Average ex-shipping point prices are calculated by subtracting total quarterly haulage costs from total quarterly revenues, and then dividing by total quarterly volumes.

TABLE 7 **Correlation coefficients between Lafarge's quarterly average prices for CEM I for Sales to Independents and variable costs, Q1 2007 to Q4 2011**

per cent

	Average delivered price	*Average ex-shipping-point price*
Average variable costs		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]
Average energy costs		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]

Source: Transaction data submitted by Lafarge, and CC analysis.

32. We next calculate correlations between Lafarge's prices and variable costs controlling for trend, as described in footnote 9 above. The results are shown in Table 8. The table shows that when we control for trend in both the price and variable costs, we get lower, or negative, correlations between prices and costs. The highest positive correlation between price differences and variable cost differences is 36 per cent in the case of average delivered prices and average energy costs (when price differences are lagged by 2 quarters), and 38 per cent in the case of average ex-shipping-point prices and average energy costs (when prices are lagged by 2 quarters), and this is not significant at 95 per cent. Once we control for trends, the correlations become much lower which suggests that changes in variable costs do not explain well the observed changes in prices.

TABLE 8 **Correlation coefficients between Lafarge's quarterly detrended prices for CEM I for Sales to Independents and de-trended variable costs, Q1 2007 to Q4 2011**

per cent

	Average delivered price differences	*Average ex-shipping-point price differences*
Average variable cost differences		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]*	[✂]*
Lag of 4 quarters	[✂]	[✂]
Average energy cost differences		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]*	[✂]*
Lag of 4 quarters	[✂]	[✂]

Source: Transaction and cost data submitted by Lafarge, and CC analysis.

*Significant at 95 per cent level.
Note: n=19, d.f.=15 where no lag is assumed; n=18, d.f.=14 where lag of 1 quarter is assumed; n=17, d.f.=13 where lag of 2 quarters is assumed; n=16, d.f.=12 where lag of 3 quarters is assumed; and n=15, d.f.=11 where lag of 4 quarters is assumed. The corresponding significance thresholds are as follows: 48.2 per cent and 60.6 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=15; 49.7 per cent and 62.3 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=14; 51.4 per cent and 64.1 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=13; 53.2 per cent and 66.1 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=12; and 55.3 per cent and 68.4 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=11.

Tarmac

33. Figure 7 shows Tarmac's quarterly delivered and ex-shipping-point prices of CEM I faced by Independent customers alongside Tarmac's average variable costs (in £/tonne) for Tarmac's only cement plant, and Tarmac's average energy costs for the same plant. The variable costs are calculated across all production at the plant, and therefore include bagged sales and non-CEM I products. Tarmac has told us that its variable costs can differ across production of different cement types (eg CEM I vs CEM II, bulk vs bagged), however, we do not at present have sufficient information to split out costs between different types of cement. Also, the variable costs only relate to costs incurred at the plant, and do not include variable costs of delivery.[18] Therefore, we show both the average delivered price and the ex-shipping-point price, in order to test whether variable costs explain ex-shipping-point prices better than

[18] As fuel is included in the variable costs of a plant, it may already capture some of the variation in delivery costs.

average delivered prices.[19] The prices and costs are not highly correlated, as shown in Table 9 below.

34. It may be the case that price changes lag behind any changes in variable costs, and therefore, Table 9 also includes correlations between the variable costs and prices lagged up to 4 quarters. Lagging prices seems to increase the correlations somewhat, reaching 51 per cent in the case of average delivered prices and average variable costs when prices are lagged by 2 quarters, and 47 per cent in the case of average ex-shipping-point prices and average variable costs when prices are lagged by 3 quarters. This suggests that average variable costs may explain some of the variation in Tarmac's prices.

FIGURE 7

Tarmac's quarterly average prices for CEM I for Sales to Independents and variable costs, Q1 2007 to Q4 2011

[✂]

Source: Transaction data submitted by Tarmac, and CC analysis.

TABLE 9 **Correlation coefficients between Tarmac's quarterly average prices for CEM I for Sales to Independents and variable costs, Q1 2007 to Q4 2011**

per cent

	Average delivered price	*Average ex-shipping-point price*
Average variable costs		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]
Average energy costs		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]

Source: Transaction data submitted by Tarmac, and CC analysis.

[19] Average ex-shipping point prices are calculated by subtracting total quarterly haulage costs from total quarterly revenues, and then dividing by total quarterly volumes.

35. We next calculate correlations between Tarmac's prices and variable costs controlling for trend, as described in footnote 9 above. The results are shown in Table 10. The table shows that when we control for trend in both the price and variable costs, we get lower, or negative, correlations between prices and costs. The highest positive correlation between price differences and variable cost differences is 28 per cent in the case of average delivered prices and average energy costs (when price differences are lagged by 3 quarters), and 23 per cent in the case of average ex-shipping-point prices and average energy costs (when prices are lagged by 3 quarters), and this is not significant at 95 per cent. When we control for trends in prices and costs, we find that changes in variable costs do not explain well the observed changes in prices.

TABLE 10 **Correlation coefficients between Tarmac's quarterly detrended prices for CEM I for Sales to Independents and detrended variable costs, Q1 2007 to Q4 2011**

per cent

	Average delivered price differences	*Average ex-shipping-point price differences*
Average variable cost differences		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]
Average energy cost differences		
No lag	[✂]	[✂]
Lag of 1 quarter	[✂]	[✂]
Lag of 2 quarters	[✂]	[✂]
Lag of 3 quarters	[✂]	[✂]
Lag of 4 quarters	[✂]	[✂]

Source: Transaction and cost data submitted by Tarmac, and CC analysis.

Note: n=19, d.f.=15 where no lag is assumed; n=18, d.f.=14 where lag of 1 quarter is assumed; n=17, d.f.=13 where lag of 2 quarters is assumed; n=16, d.f.=12 where lag of 3 quarters is assumed; and n=15, d.f.=11 where lag of 4 quarters is assumed. The corresponding significance thresholds are as follows: 48.2 per cent and 60.6 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=15; 49.7 per cent and 62.3 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=14; 51.4 per cent and 64.1 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=13; 53.2 per cent and 66.1 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=12; and 55.3 per cent and 68.4 per cent at 95 per cent and 99 per cent significance levels respectively where d.f.=11.

Preliminary conclusions

36. Our analysis shows that there is a high correlation between the Majors' prices over the period Q1 2007 to Q4 2011, as well as between the Majors' and some importers'

prices over the same period. This holds for most Majors and some importers even when we control for any trends observed in prices. Cemex's, Lafarge's and Tarmac's prices (delivered prices in the case of Cemex, and ex-shipping-point prices in the case of Lafarge and Tarmac) are somewhat correlated with their respective variable costs, though the costs may only explain a (low) proportion of the changes in prices. Changes in Hanson's ex-shipping-point prices are explained somewhat better by Hanson's average variable costs of production, though not fully. In addition we note that, in all cases, the fact that changes in prices are not fully explained by changes in average variable costs is unlikely to be due the fact that Majors are unable to pass on increases in average variable costs to their customers: indeed, the Majors' prices have generally increased more than average variable costs. When we control for trends in prices and costs, we find that the correlations between prices and costs are low, or negative, for all Majors, suggesting that changes in costs do not explain well changes in prices.

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