COST STICKINESS BEHAVIOR AND FINANCIAL CRISIS: EVIDENCE FROM THE UK CHEMICAL INDUSTRY

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Abstract

The global financial crisis has created pessimism in terms of prospects of sales rebounding in the future. Therefore, this study aims to examine the stickiness behaviors of firm costs pre, during and post the period of the financial crisis. It uses a sample from the UK chemical industry over the period from 2001 to 2015. The ABJ sticky cost model is applied with the following cost categories: total costs, cost of goods sold, operating costs, selling, general and administrative costs, salaries and benefits, and finance costs. The ABJ sticky cost models are run separately for each cost category over pre (2001-2007), during (2007-2009) and post (2010-2015) the financial crisis. The study finds that total costs have behaved as sticky pre the financial crisis and anti-sticky during and post the financial crisis. Furthermore, cost of goods sold has changed from sticky (pre and during the financial crisis) to anti-sticky (post the financial crisis). Furthermore, salaries and benefits costs have changed from sticky (pre the financial crisis) to anti-sticky (during the financial crisis) and financing costs from sticky (pre the financial crisis) to anti-sticky (after the financial crisis). However, there is no variation in the behavior of selling, general and administrative costs pre and post the financial crisis.

Keywords: Cost Stickiness, Financial Crisis, Chemical Industry, the UK

1. INTRODUCTION

Traditional cost behavior assumes that variable costs vary symmetrically according to changes in the level of activity. This means that variable costs change proportionately with changes in the cost driver. The key notion in symmetric cost behavior is that variable costs change identically by the same percentage in the two directions (i.e., upward and downward in cost driver) regardless whether the response rate of variable costs is less, equal or more than the rate of change in cost driver (Balakrishnan & Gruca, 2008; Malik, 2012). However, fixed costs remain constant in total despite changes in the cost driver within the relevant range. On the other hand, some costs are neither precisely variable nor fixed; this type of cost known as *mixed cost*. According to traditional analysis of cost behavior, managerial decisions (i.e., pricing, cost planning, cost control, budgeting, cost variances, cost standardization, cost reduction and cost allocation) are, precisely, based on prior analysis of cost behavior (Novák et al., 2018).

The recent stream of research in cost accounting has criticized prior thinking in terms of traditional cost behavior. More specifically, many researchers have provided empirical evidence that emphasize the asymmetric cost behavior throughout

various periods, regions and cost items. The asymmetric behavior of cost is built based on two cost observations. Firstly, some costs may arise due to managers' deliberate decisions for resource commitment. Secondly, the resource commitments may be modified in the short run, and this may force managers to incur some costs of resource adjustments, which may include, for example, costs of training new workers, installation and disposal costs for equipment (Anderson et al., 2003). In particular, a group of research supports the sticky cost behavior as cost increase rapidly when revenues raise comparatively with its decrease when revenues fall by the same portion (Anderson et al., 2003). Besides, a group of research reveals that costs may change asymmetrically through increasing slighter when revenues increase by somewhat portion relatively with its decrease when revenues decline by the same portion (Weiss, 2010; Banker et al., 2014). Consequently, majority of managerial decisions based precisely on cost allocation will be controversy.

In this study, we investigate the cost stickiness behavior of a comprehensive set of firm costs pre, during and post the period of the financial crisis. In particular, this paper examines whether the following costs: total costs, selling, general and administrative costs (henceforward SG&A), cost of goods sold, operating costs, finance costs, and salaries and benefits costs, behave more symmetric throughout three-time periods: pre (2001-2006), during (2007-2009), and post (2010-2015) the financial crisis period.

The findings of this study provide the updating evidence in terms of the influence of external factors (the financial crisis) on the cost sickness behavior of comprehensive set of cost categories within the UK chemical industry. In particular, the current study contributes to literature as follows: firstly, the study focuses mainly on the UK chemical industry to avoid obfuscation on cost stickiness behavior due to country characteristics (e.g., social, economic, political, legal, environmental and governance regime). In this context, we have scrutinized specifically chemical industry because it is crucial to the UK manufacturing and provides the essential components for the manufacturing process. Secondly, to the best of knowledge, this study is the first to examine the cost stickiness behavior throughout the three-time series periods: pre (2001-2006), during (2007-2009), and post (2010-2015) the financial crisis period. The financial crisis has influenced the decisions of cost allocation, cost control and unutilized cut of resources particularly during period of sales fluctuations. The financial crisis is responsible for demand decline, which creates the occurrence of cost stickiness. Thus, this study covers the research gap between economic consequences of the financial crisis and the phenomena of cost behavior. Thirdly, unlike prior researches (e.g., Weidenmier & Subramaniam, 2003; Homburg & Nasev, 2008; Weiss, 2010) which focus heavily on the cost stickiness behavior of SG&A, the current study focuses on comprehensive set of cost categories over periods of the financial crisis and a non-crisis. These cost categories include total costs, SG&A, cost of goods sold, operating costs, finance expenses, and salaries and benefits. The empirical results of the study report that total costs have behaved as sticky pre the financial crisis and anti-sticky during and post the financial crisis.

Furthermore, cost of goods sold has changed from sticky (pre and during the financial crisis) to anti-sticky (post the financial crisis). Furthermore, salaries and benefits costs have changed from sticky (pre the financial crisis) to anti-sticky (during the financial crisis) and financing costs from sticky (pre the financial crisis) to anti-sticky (after the financial crisis). However, there is no change in the sticky behavior of SG&A pre and post the financial crisis.

The remainder of this study is outlined as follows: Section 2 includes background, reviews of literature and develops the hypotheses; Section 3 shows the methodology; Section 4 presents the findings; Section 5 provides the conclusion.

2. BACKGROUND, LITERATURE, AND HYPOTHESES DEVELOPMENT

This study focuses on chemical industry firms listed on the London Stock Exchange over the period from 2001 to 2015. The chemical industry is considered a crucial industry in the UK manufacturing. This is because it provides the essential components for the manufacturing processes and creates large number of jobs. The chemical industry is equivalent to 1.5% of the UK Gross Domestic Product (GDP). It is a key supplier for components for the manufacturing process. This sector is highly competitive which has led to a great deal of mergers and acquisitions and major companies in the UK chemical industry are global players that are focused on 'core` activities which involve specialized synthesis or final formulation of products.

Analyses of cost behavior effectively help in the process of pricing, planning, controlling, budgeting and subsequently better understanding of realized earnings and analysts' expectations of earnings. Prior research suggests that costs may change their behavior, asymmetrically, through increasing slightly when revenues increase by somewhat portion relatively with its decrease when revenues decline by the same portion (Weiss, 2010). A wide stream of research has tried to analyze the cost sickness behavior of different types of costs and to identify different factors affecting cost stickiness behavior. One of these attempts, Weidenmier and Subramaniam (2003) who analyze the cost sickness of different cost categories. They focus mainly on SG&A and cost of goods sold. Their empirical analysis supports the sticky behavior of both SG&A and cost of goods. Similarly, Homburg and Nasev (2008) and He et al. (2010) focus only on SG&A. They offer empirical evidence of the sticky behavior of SG&A. Moreover, Weiss (2010), as well as Kama and Weiss (2013), focus on total costs to differentiate between sticky and anti-sticky cost behaviors. Their empirical results support the sticky cost behavior of total costs. Nonetheless, Yasukata (2011) focuses on the cost behavior of cost of goods sold in Japanese environment. Their analysis suggests the sticky behavior of cost of goods sold. Furthermore, Balakrishnan and Gruca (2008) examine the behavior of short-term costs for hospitals. They find that operating costs for the hospital as a whole are acting as sticky costs.

However, some prior studies investigate the key incentives and determinants that affect the cost stickiness behavior. This research stream focuses on managers 'deliberate decisions and agency theories to interpret this phenomenon (Kama & Weiss, 2010). For instance, Banker et al. (2011) examine the effect

of labor laws on the stickiness of operating costs. They find an increase in the degree of cost stickiness as a result of the severity of employment protection legislation. Furthermore, Banker et al. (2013) inspect the main determinants of global divergence on asymmetric operating cost behavior. They find that a greater judicial system and a better level of development increase the degree of cost stickiness. Moreover, Balakrishnan et al. (2004) find that current capacity utilization affects cost behavior. In addition, Chen and Sougiannis (2012) use agency problem to interpret cost stickiness behavior. Their results support the existence of sticky cost behavior. Finally, some prior researches (e.g., Banker et al., 2008; Kama & Weiss, 2010) suggest that cost stickiness is affected by existence of managers' optimisms.

Another stream of research examines the economic consequences of cost stickiness behavior. This research stream examines the economic consequences of cost sickness behavior by its impact on the accuracy of analysts' earnings forecast, earnings management practices, and forthcoming earnings and market response. For instance, prior studies (e.g., Bradbury & Scott, 2018; Anderson et al., 2007; Weiss, 2010) find that cost stickiness behavior may prevent analysts from providing accurate earnings forecasts. In addition, other research finds that cost stickiness behavior may induce firms to engage in earnings management practices (e.g., Han et al., 2019; Yang, 2019). Besides, some research examines the association between cost stickiness behavior and corporate social responsibility (e.g., Habib & Hassan, 2019; Hartlieb et al., 2019). Finally, other studies suggest that cost stickiness influences the forthcoming earnings and market response (e.g., Kontesa & Brahmana, 2018).

Despite the above-mentioned research on cost stickiness behavior, the effects of the financial crisis on cost asymmetric behavior are largely unexamined and, thus, needs more investigation. The UK is largely affected by the financial crisis. Therefore, it provides an interesting context within which we can examine the effect of the financial crisis on practice of cost stickiness. In addition, prior research focuses mainly on examining the cost stickiness behavior of cost of goods sold only, or cost of goods sold, SG&A and total costs together. Thus, it ignores different types of costs such as finance costs and salaries and benefits costs. Therefore, this study aims to fill this gaps and, preciously, it investigates whether the following costs: total costs, SG&A, cost of goods sold, operating costs, finance expense, and salaries and benefits costs behave more symmetric during the period of the financial crisis compared to the period after the financial crisis.

The period of the financial crisis represents a fundamental economic disturbance (Bepari et al., 2014) that has a particular impact on the cost stickiness behavior of different cost categories. This is because it has given managers clear signals in terms of the recession of demand. Accordingly, managers may act pessimistically towards any positive variations in sales and they may be less likely to cut unutilized resources during the extant crisis. In addition, managers, in this case, are actually motivated to decrease committed costs to keep target level of earning, especially, when their compensation contracts are linked with earning. This results in a decrease in the degree of cost stickiness during and after crisis period. Hence, it is anticipated that the stickiness degree of total costs will relatively decline during and after the crisis period. In addition, the financial crisis may affect negatively growth rate of sales during time of crisis as well as subsequent periods. Hence, managers will be motivated to respond to recession's side effects through review the debts covenant to decline the firm's risk. This leads to investigating the conjecture of potential changes relative to asymmetric behavior of finance costs before, during and after the financial crisis.

Furthermore, the financial crisis causes pessimistic climate concerning demand increase during the crisis and in subsequent periods. This leads managers to review all committed costs especially human resource committed cost (i.e., employee's dismissal and severance costs) side to side with extent of employment protection legislations. Subsequently, the current study uses salaries and benefits costs as proxy of human committed costs and conjecture that asymmetric behavior of salaries and benefits costs changes differently before and after the financial crisis period.

There is no doubt that before the occurrence of the financial crisis, particularly from 2001 to 2006, managers were extremely optimistic about potential growth in the UK chemical sector and they were reluctant about cutting slack resources and managers had planned to build their managerial empire building. The prior managerial motivations may delay cutting slack resources during the time of temporary decline in sales. Based on the above discussion and review of literature, we conjecture that the cost types of the UK chemical companies may act as sticky costs. In addition, we propose that the cost stickiness behaviors may be significantly different throughout different types of cost before the financial crisis. Accordingly, we developed the following hypotheses *H1* and *H2*:

H1: Cost categories of the UK chemical firms act as sticky costs pre the financial crisis period.

H2: The cost stickiness behaviors of different cost categories of the UK chemical firms vary significantly pre the financial crisis period.

Throughout the period of the financial crisis (2007-2009), many circumstances have been changed. For example, managers were pessimistic in terms of the potential growth in the UK chemical industry. In addition, the temporary decline in sales has been turned to be permanent, managers have stopped their plans to build managerial empire building, and the financial performance was objected to scan. These prior circumstances might affect managerial decisions in terms of cutting slack resources. Subsequently, we propose that the consequences of the financial crisis may have a particular effect on the cost behavior of different cost types within the UK chemical sector and this conjecture is suggested in the following hypothesis *H3*:

H3: Different cost categories in the UK chemical firms change their behavior during the financial crisis period compared with the period pre the crisis.

After the financial crisis period (2010-2015), the UK chemical companies are affected by the negative economic consequences that cause demand decline. This means that managers are motivated to cut all unused resources. Accordingly, we conjecture that the behavior of costs in the UK chemical firms after the financial crisis does not change widely as

compared with the duration of the financial crisis. Subsequently, we suggest the following hypothesis *H4*:

H4: Different cost categories of the UK chemical firms behave differently throughout the period post the financial crisis compared with their behaviors during the financial crisis.

3. METHODOLOGY

3.1. Sample and data collection

This study investigates the cost stickiness behavior of the UK chemical industry over the period from 2001 to 2015. This sample period covers the period of the financial crisis (2007-2009) and provides equilibrium between periods pre (2001-2006) and post (2010-2015) the financial crisis. The study focuses on chemical industry due to the following. Firstly, chemical industry represents 1.5% of the UK Gross Domestic Product (GDP) and is considered crucial to the UK manufacturing process as it provides the essential compounds for the manufacturing processes. Secondly, unlike prior research which examines the impact of regime on cost stickiness (e.g., Calleja et al., 2006), the current study conjectures that the financial crisis also impacts levels of cost stickiness especially chemical industry was largely affected during the period of the financial crisis. Thirdly, the availability of data

concerning chemical industry in UK throughout 2001-2015 is considered a motivation for the study.

The sample of the study comprises of all the UK chemical industry firms listed in London Stock Exchange throughout the period of 2001-2015. However, observations with missing data in terms of sales, total costs, cost of goods sold, operating costs, SG&A, salaries and benefits, and finance costs are excluded from the analysis. In addition, following prior studies (e.g., Anderson et al., 2003), we exclude observations where any of the cost components (total costs, cost of goods sold, operating costs, SG&A, salaries and benefits, and finance costs) are greater than sales revenue. Table 1 shows preliminary and ultimate (final) sample sizes over the whole sample period (2001-2015), period pre (2001-2006), during (2007-2009) and post (2010-2015) the financial crisis. It also shows the breakdown of the sample over the three periods according to the cost components/categories. All sales and costs data are collected from DataStream with the following (data stream codes): sales (WC01001), operating costs (WC01249), SG&A (WC01101), salaries and benefits (WC01084), finance costs (WC01251), cost of goods sold (WC01051). Total costs are calculated as earnings before interest and tax (WC18191) minus sales revenue figures (WC01001).

Table 1. Sample

	Periods			
	Pre the financial crisis (2001-2006)	*During the financial crisis (2007-2009)*	*Post the financial crisis (2010-2015)*	*Full sample*
Total costs				
Preliminary size	66	33	66	165
Less: observation of missing data	(2)	-	-	(2)
Final sample size	64	33	66	163
Cost of goods sold, operating costs, and salaries & benefits				
Preliminary size	66	33	66	165
Less: observations of missing data	-	-	-	-
Final sample size	66	33	66	165
Selling, general & administrative				
Preliminary size	66	33	66	165
Less: observations of missing data	(12)	(6)	(12)	(30)
Final sample size	54	27	54	135
Finance costs				
Preliminary size	66	33	66	165
Less: observations of missing data	(4)	-	(6)	(10)
Final sample size	62	33	60	155

Notes: This table reports the distribution of sample over the periods pre, during and post the financial crisis, in addition to the whole sample period. The sample is classified according to cost categories (total costs, cost of goods sold, operating costs, selling, general and administrative costs, salaries and benefits, and finance costs).

3.2. Empirical models and variables measurements

Following Anderson et al. (2003), the current study evaluates the asymmetrically/non-asymmetrically cost behaviors by specifying each type of costs as a function of sales revenue. Unlike prior research, which focuses only on total costs, cost of goods sold and SG&A, we consider the following costs: total costs, cost of goods sold, operating costs, SG&A, salaries and benefits, and finance costs. Prior research focuses extensively on SG&A as a dependent variable and proxy of costs. However, the empirical results with this theme affirm its sticky behavior, there are some limitations associated with the empirical tests. For instance, Anderson et al. (2003) detect that SG&A were increased and decreased by 0.55% and 0.35%, respectively and they

conclude that this type of costs was changed upward and downward on average by 0.58% and 0.48%. In addition, some prior research focuses on the sticky cost behavior of other types of costs. For example, Kokotakis et al. (2013) assure the sticky behavior of total costs as the costs increase and decrease by 1.011% and .905% when sales rise and fall by 1%. Moreover, Dalla Via and Perego (2014) prove the stickiness of operating costs in Italian firms. Although of the above-mentioned research, there is no conclusion in terms of the cost behaviors of other cost components (e.g., finance costs, and salaries & benefits).

Particularly, the current study focuses on the following comprehensive cost categories: total costs (TC), cost of goods sold (CGS), operating costs (OC), SG&A, salaries and benefits (S&B), and finance costs

(FinC). We use the ABJ sticky cost model, developed by Anderson et al. (2003), to test the asymmetrically/non-asymmetrically behaviors of each type of costs. According to the ABJ model, we calculate the ratios of *each current cost component to revenues* to *previous period cost components to revenues.* Then, these variables are transformed by taking the natural logarithm values *Log.* Besides, we introduce an indicator variable, *Decrease_Dummy*, in the models. This indicator takes the value of "*1*"

when the revenues of current period are lower than revenues of the previous period and "*zero*" otherwise. The indicator variable is multiplied by the natural logarithm *Log* of the ratio of current to previous period revenues. Therefore, to test the cost sickness behaviors for total costs (TC), cost of goods sold (CGS), operating costs (OC), selling, general and administrative costs (SG&A), salaries and benefits (S&B), and finance costs (FinC), models 1, 2, 3, 4, 5, and 6 are developed, respectively as follows:

$$Log\left(\frac{TC_{it}}{TC_{it-1}}\right) = \beta_0 + \beta_1 Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \beta_2 Decrease\_Dummy_{it} * Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \varepsilon_{it} \tag{1}$$

$$Log\left(\frac{CGS_{it}}{CGS_{it-1}}\right) = \beta_0 + \beta_1 Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \beta_2 Decrease\_Dummy_{it} * Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \varepsilon_{it} \tag{2}$$

$$Log\left(\frac{OC_{it}}{OC_{it-1}}\right) = \beta_0 + \beta_1 Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \beta_2 Decrease\_Dummy_{it} * Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \varepsilon_{it} \tag{3}$$

$$Log\left(\frac{SG\&A_{it}}{SG\&A_{it-1}}\right) = \beta_0 + \beta_1 Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \beta_2 Decrease\_Dummy_{it} * Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \varepsilon_{it} \tag{4}$$

$$Log\left(\frac{S\&B_{it}}{S\&B_{it-1}}\right) = \beta_0 + \beta_1 Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \beta_2 Decrease\_Dummy_{it} * Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \varepsilon_{it} \tag{5}$$

$$Log\left(\frac{FinC_{it}}{FinC_{it-1}}\right) = \beta_0 + \beta_1 Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \beta_2 Decrease\_Dummy_{it} * Log\left(\frac{Sales_{it}}{Sales_{it-1}}\right) + \varepsilon_{it} \tag{6}$$

Where, β_0 is the model intercept, β_1, β_2 are the coefficients, and the ε is the error term. In addition, *it* and *it-1* refers to the firm *i* throughout the year *t* and *t-1*. *Decrease_Dummy* is a dummy variable which estimates by 1 if the quotient of current net sales to previous net sales lower than one and this variable estimates by zero otherwise. All models are run for the whole sample period (2001-2015). Then, run separately over the following periods: pre (2001-2007), during (2007-2009) and post (2010-2015) the financial crisis.

4. RESULTS

4.1. Descriptive statistics

The descriptive statistics of different cost categories are presented in Table 2. Panel A reports the descriptive statistics for TC, OGS, OC, SG&A, S&B, and FinC for the whole sample period (2001-2015). Panels B, C and D show the descriptive statistics for the sample over the periods pre (2001-2016), during (2007-2009) and post the financial crisis (2010-2015), respectively. In terms of total costs, Panel A reveals that the TC ratio of revenue has a mean value of 99.4% throughout the period 2001-2015. Moreover, this ratio is 103.4% specifically pre the financial crisis (2001-2006). However, this ratio has been decreased to be 95.0 % during the financial crisis (2007-2009) and then increased slightly and remains at 97.6 % post the financial crisis (2010-2015) as indicated in panels C and D, respectively.

Panel A indicates that the ratio of CGS to revenue has a mean value of 66.3% which is consistent with Weidenmier and Subramaniam (2003). In addition, CGS ratio of revenue was 63.4% pre the financial crisis, as shown in Panel B, and this mean value has increased to be 69.1% during the financial crisis (as shown in Panel C), then, decreased slightly to 67.8% post the financial crisis,

as presented in Panel D. This suggests that the CGS ratio of revenue was higher pre and post the financial crisis than during the financial crisis period. Whereas, the ratio of OC to revenue has a mean value of 96.9 % as reported in Panel A. This ratio is more than that reported by Ibrahim (2015). In addition, the mean value of OC ratio was 98.5%, 94.0% and 96.6% before, during and post the financial crisis, respectively.

Panel A reports that SG&A have a mean value of 27.6% of total sales revenue with maximum and minimum values of 1.902 and .022, respectively. This is relatively consistent with Anderson et al. (2003) and Weidenmier and Subramaniam (2003) who reported the mean values for SG&A of 24.1% and 24.4%, respectively. Furthermore, Panel B reports that SG&A have a mean value of 31.0% of revenue pre the financial crisis (2001-2006). This value is higher than the mean value of SG&A of 22.5% as reported in Panel C during the financial crisis (2007-2009). However, this mean value was increased post the financial crisis (2010-2015) to be 26.8% as reported in Panel D.

With regard to salaries and benefits, it is reported in Panel A that the S&B ratio to sales revenue has mean value of 22.3% and the values reported pre, during and post the period of the financial crisis were 27.1%, 18.7% and 19.2% respectively. This suggests that the S&B ratio has decreased during the financial crisis then increased post the financial crisis. Finally, Panel A reports that the mean value of the ratio of FinC to sales revenue is 1.2%. In addition, Panels B, C and D report the mean values of 1.6%, 1.7% and .6% pre, during and post the financial crisis, respectively. This suggests that the finance costs have increased during the financial crisis. However, they have declined post the crisis.

In sum, variations exist in terms of the ratio of cost categories to the value of sales revenue over the whole sample period. In addition, this variation is

observable pre (2001-2006), during (2007-2009) and post the financial crisis (2010-2015). Thus, more investigations are required in order to identify the

effect of the financial crisis on the cost stickiness behaviors of the different cost components/ categories.

Table 2. Sample descriptive statistics

	N	Minimum	Maximum	Mean	S. E	S. D
Panel A: All sample periods (2001-2015)						
TC ratio	163	-1.367	3.238	0.994	0.036	0.469
CGS ratio	165	0.068	0.941	0.663	0.014	0.181
OC ratio	165	0.565	2.514	0.969	0.020	0.261
SG&A ratio	135	0.022	1.902	0.276	0.026	0.305
S&B ratio	165	0.003	2.069	0.223	0.015	0.197
FinC ratio	155	0.000	0.198	0.012	0.001	.020
Panel B: Pre the financial crisis (2001-2006)						
TC ratio	64	-1.367	3.238	1.034	0.080	0.644
CGS ratio	66	0.068	0.941	0.634	0.024	0.196
OC ratio	66	0.632	2.514	0.985	0.034	0.278
SG&A ratio	54	0.022	1.902	0.310	0.046	0.344
S&B ratio	66	0.030	2.069	0.271	0.034	0.282
FinC ratio	62	0.000	0.198	0.016	0.003	0.025
Panel C: During the financial crisis (2007-2009)						
TC ratio	33	0.602	1.624	0.950	0.029	0.169
CGS ratio	33	0.292	0.924	0.691	0.028	0.161
OC ratio	33	0.609	1.412	0.940	0.025	0.146
SG&A ratio	27	0.026	0.741	0.225	0.030	0.160
S&B ratio	33	0.041	0.324	0.187	0.013	0.080
FinC ratio	33	0.001	0.084	0.017	0.003	0.021
Panel D: Post the financial crisis (2010-2015)						
TC ratio	66	0.563	3.043	0.976	0.044	0.362
CGS ratio	66	0.281	0.927	0.678	0.021	0.175
OC ratio	66	0.565	2.148	0.966	0.035	0.290
SG&A ratio	54	0.025	1.664	0.268	0.043	0.319
S&B ratio	66	0.003	0.661	0.192	0.013	0.108
FinC ratio	60	0.000	0.058	0.006	0.001	0.009

Notes: This table reports the descriptive statistics of the sample. Panel A reports the descriptive statistics for all sampled period (2001-2015). Panels B, C and D report the descriptive statistics for the periods pre, during and post the financial crisis, respectively. TC is the total cost, CSG is cost of goods sold, OC is operating cost, SG&A is selling, general and administrative costs, S&B is salaries and benefits, FinC is finance cost, S.E is standard error and S.D is standard deviation. N stands for the number of observations. All numbers represent ratio of each cost category to sales revenue.

4.2. Empirical results

Table 3 reports the results of regression models (1, 2, 3, 4, 5, and 6) over the whole sample period from 2001 to 2015. The models are statistically significant at 1% level (P < .01)[1] except for S&B costs which indicate that the model for this cost category is not significance. Hence, it is difficult to draw a conclusion in terms of S&B costs over the whole sample period (2001-2015). The adjusted R^2 values range from 9.8% to 88.8% for all models except for the S&B costs model.

Table 3 reports an adjusted R^2 value of 28% for the TC model. This means that a change in sales explains 28% of the variations in the total costs. It also reports that the β_1 coefficient of TC is .721 which indicates that total costs were increased by nearly 72.2% when net sales raised by 1%. Besides, the summation of β_1 and β_2 coefficients of TC indicates that total costs decreased by nearly 59.2% for each 1% decline in the value of sales revenue. In addition, the adjusted R^2 value for the SG&A model is 28.7% which indicates that 28.7% of the variations in SG&A are due to changes in total sales revenue. The β_1 coefficient of SG&A is .426 which indicates that SG&A was increased by nearly 42.6% when net sales raised by 1%. Besides, the summation of β_1 and β_2 coefficients of SG&A indicates that these costs decreased by nearly 19.3% for each 1% decline in the value of sales revenue. Similarly, The R^2 values for CGS and OC are 78.1% and 88.8%, respectively. These

values indicate that the changes in sales revenues approximately explain 78% and 88% of the variations of CGS and OC, respectively. The β_1 coefficients of both CGS and OC indicate that these costs increased by nearly 172% and 79%, respectively when net sales arise by 1%. Besides, the sum of β_1 and β_2 for those costs reveals that these costs decrease by nearly 119% and 71% when sales decline by 1% throughout the period of 2001-2015.

These results suggest the sticky cost behavior of total costs, cost of goods sold, SG&A, and operating costs during the period of 2001-2015. Additionally, the results show crucial differences in terms of the degree of cost stickiness throughout all cost categories. Since the absolute estimated values of β_2 regarding CGS, SG&A, and OC costs are .532, .233, .085, respectively. These values indicate that the costs of goods sold have the highest cost stickiness degree throughout the period of 2001-2015 and the operating costs are the smallest one. It is worth nothing that considering cost stickiness degree for these costs in specific issues such as cost planning, cost reduction, cost control, standard costs and variances. Subsequently, it creates a positive impact on the financial and managerial performance in the UK chemical companies.

Comparing with the results of Anderson et al. (2003), the results of the current study suggest that the degree of stickiness behavior of SG&A is much stronger in the UK chemical industry than in American firms. Plausible explication is that managers in the UK chemical industry may be more

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[1] Finance costs (FinC) are statistically significant at the 10% level.

reluctant in cutting unutilized committed costs than managers in the US firms. Accordingly, ceteris paribus, we expect that earning in the UK chemical companies to be lower than that of the US firms. Conversely, as shown in Table 3 results indicate that both finance costs and salaries and benefits costs change as anti-sticky costs throughout the period of 2001-2015 since the sign of estimated value of coefficient β_2 is permanently positive and insignificant. A potential explanation is that managers dispose the contracts of debts when sales decline to keep their organizational goals and employees in the UK have low protection legislation, which permits managers to cut committed human resources when demand sharply falls.

Table 3. Cost estimation behaviour for all sample period (2001-2015)

Cost	Obs.	β_o	β_1	β_2	$\beta_1 + \beta_2$	Adj. R^2	Sig	H.VIF	F- value
TC	163	- .006 (.012)	.721 (.126)	- .129 (.201)	.592	.280	.000	2.349	32.431***
CGS	165	- .027 (.009)	1.725 (.094)	- .532 (.151)	1.193	.781	.000	2.327	293.389***
OC	165	.003 (.003)	.797 (.032)	- .085 (.052)	.712	.888	.000	2.327	650.363***
SG&A	135	.006 (.007)	.426 (.068)	- .233 (.110)	.193	.287	.000	2.365	27.919***
S&B	165	.024 (.021)	.053 (.220)	.207 (.354)	.261	- .004	.493	2.327	.711
FinC	155	- .056 (.034)	1.089 (.370)	.744 (.919)	1.883	.098	.000	1.546	9.408*

Notes: This table reports the results from models 1, 2, 3, 4, 5, and 6 over the all sample period (2001-2015). Obs. refers to the total number of observation. H.VIF refers to the highest values of VIF in each model. All VIF values are less than 10 that indicates the non-existence of any multicollinearity problem.

*, **, and *** indicate significance at 0.1, 0.05, and 0.01, respectively.

Table 4 reports the findings from the regression models 1, 2, 3, 4, 5, and 6 over the period pre the financial crisis (2001-2006). All models are statistically significant at 1% level (P < .01) and the adjusted R^2 values range from 8.3% to 88.9%. In particular, the adjusted R^2 values indicate that changes in sales revenues approximately explain 73%, 88%, 48%, 18% and 8% of the variations in CGS, OC, SG&A, S&B and FinC, respectively. The results show that β_2 for TC, CGS, OC, SG&A, S&B and FinC are - .641, -1.210, - .135, - .415, - .476 and - .895, respectively. The negative values of β_2 indicate that those cost categories were acted as sticky costs before the period of the financial crisis (2001-2006). Thus, total costs, cost of goods sold, operating costs, SG&A, salaries and benefits, and finance costs are regarded as sticky costs pre the financial crisis. Therefore, the *H1* hypothesis is accepted that *cost categories regarding the UK chemical companies act as sticky costs pre the period of the financial crisis.*

The results also indicate that the β_2 for CGS is -1.210 which is higher than the β_2 coefficients for all other cost categories which are as follows: - .135 for OC, - .415 for SG&A, - .476 for S&B, and - .895 for FinC. This suggests that the stickiness behavior of the cost of goods sold is higher and stronger than those of all other cost categories. Besides, the operating costs have the smallest and weakest stickiness degree pre the period of the financial crisis. Thus, the *H2* hypothesis is accepted that *the cost stickiness behaviors of different cost categories of the UK chemical firms vary significantly pre the period of the financial crisis.*

The results could be explained from the following points of view: firstly, managers of firms in the period pre the financial crisis are usually optimistic toward expanding revenues, so they extend easily the investment with sales increase. Secondly, managers' expectations are extremely high concerning the probability of growth in time pre the financial crisis. Thirdly, the growth of GDP and other economic factors make managers more reluctant towards employee dismissal, cutting unused capacity and adjustment costs, which precisely increase and support cost stickiness behavior.

Table 4. Cost estimation behaviour for period pre the financial crisis (2001-2006)

Cost	Obs.	β_o	β_1	β_2	$\beta_1 + \beta_2$	Adj. R^2	Sig	H.VIF	F- value
TC	64	- .025 (.025)	.940 (.231)	- .641 (.480)	.284	.214	.000	1.663	9.563***
CGS	66	- .045 (.019)	2.109 (.171)	-1.210 (.361)	.899	.739	.000	1.660	92.933***
OC	66	.004 (.005)	.856 (.046)	- .135 (.097)	.721	.889	.000	1.660	261.962***
SG&A	54	.008 (.011)	.610 (.090)	- .415 (.198)	.195	.488	.000	26.303	1.612***
S&B	66	.003 (.013)	.453 (.113)	- .476 (.238)	- .023	.184	.001	1.660	8.346***
FinC	62	- .057 (.057)	1.332 (.514)	- .895 (1.298)	.437	.083	.029	1.446	3.763**

Notes: This table reports the results from models 1, 2, 3, 4, 5, and 6 over the period pre the financial crisis (2001-2006). Obs. refers to the total number of observation. H.VIF refers to the highest values of VIF in each model. All VIF values are less than 10 that indicates the non-existence of any multicollinearity problem.

*, **, and *** indicate significance at 0.1, 0.05, and 0.01, respectively.

Table 5 shows the results of models 1, 2, 3, 4, 5, and 6 during the financial crisis (2007-2009). The TC, CGS & OC models are statistically significant at 1% level (P < .01). Besides, the adjusted R^2 values are 32.1% for the TC model, 96.5% for the CGS model and 80.1% for the OC model. These values suggest that changes in sales revenues approximately explain 32%, 96% and 80% of the variations in TC, CGS and OC, respectively. However, the model in terms of S&B is statistically significant at 5% level (P < .05) with and adjusted R^2 value of 12.8%. On the other hand, the models related to SG&A and FinC are not statistically significant at any significance level. Hence, it is difficult to draw a conclusion in terms of SG&A and FinC costs during the financial crisis (2007-2009).

The β_2 for TC, OC, and S&B are .311, .039 and .453, respectively. These positive values indicate that TC, OC and S&B acted as anti-sticky costs during the financial crisis (2007-2009). On the other hand, the β_2 coefficient for CGS is -.195 indicates that the costs of goods sold behave as sticky cost during the financial crisis. The models in terms of SG&A and

FinC are not statistically significant at any level. Thus, it is difficult to draw a conclusion regarding these costs during the financial crisis (2007-2009). Accordingly, the results suggest that total costs, operating costs and salaries and benefits have changed their behaviors from sticky (pre the financial crisis) to anti-sticky during the financial crisis (2007-2009). Besides, the costs of goods sold remained sticky costs during the financial crisis. Therefore, these results partially support *H3* that *different cost categories in the UK chemical firms change their behavior during the financial crisis period compared with the period pre the crisis.* Eventually, all standard costs, rates of cost variances and budgeting, pricing strategies that prepared pre the financial crisis became controversy during the financial crisis. The crisis had an impact on the managers' decisions concerning cutting unused capacity, adjustment costs and employees dismissal, as managers during the financial crisis are more motivated than time before to respond effectively with recession or demand uncertainty.

Table 5. Cost estimation behaviour for the period during the financial crisis (2007-2009)

Cost	Obs.	β_0	β_1	β_2	$\beta_1 + \beta_2$	Adj. R^2	Sig	H.VIF	F- value
TC	33	.009 (.017)	.498 (.188)	.311 (.479)	.809	.321	.001	1.767	8.553***
CGS	33	-.011 (.005)	1.282 (.055)	-.195 (.141)	1.087	.965	.000	1.767	439.394***
OC	33	.003 (.008)	.774 (.091)	.039 (.232)	.813	.801	.000	1.767	65.328***
SG&A	27	.028 (.016)	.013 (.167)	.532 (.425)	.545	.044	.222	1.877	1.604
S&B	33	.009 (.014)	.160 (.158)	.453 (.402)	.613	.128	.048	1.767	3.357**
FinC	33	-.087 (.070)	.846 (.792)	-.184 (2.015)	.66	-.006	.416	1.767	.902

Notes: This table reports the results from models 1, 2, 3, 4, 5, and 6 over the period during the financial crisis (2007-2009). Obs. refers to the total number of observation. H.VIF refers to the highest values of VIF in each model. All VIF values are less than 10 that indicates the non-existence of any multicollinearity problem.

*, **, and *** indicate significance at 0.1, 0.05, and 0.01, respectively.

In terms of the period post the financial crisis (2010-2015), Table 6 reports the results from models 1, 2, 3, 4, 5, and 6. The models (except for model 5) are statistically significant at 1% level (P < .01). Besides, the adjusted R^2 values are 46.5% for the TC model, 92.6% for the CGS model and 91.8% for the OC model, 14.8% for the SG&A model and 27.6% for FinC model. These values suggest that changes in sales revenues approximately explain 46%, 92%, 91%, 14% and 27% of the variations in TC, CGS, OC, SG&A and FinC, respectively. On the other hand, model 5 (S&B) is not statistically significant at any level. Hence, it is difficult to draw a conclusion in terms of S&B costs over the period after the financial crisis (2010-2015).

Table 6 shows that β_2 for TC, CGS, OC and FinC are .296, .161, .039 & 5.982, respectively. The positive values of β_2 indicate that these cost categories acted as anti-sticky costs after the period of the financial crisis (2010-2015). However, the β_2 for SG&A is -.017 that indicates that SG&A behave as sticky cost post the financial crisis. Moreover, the combined value of the coefficients is 0.195, which includes that SG&A expenses increase by 21% when

sales increase by 1% costs but fall by nearly 19% when sales decline by same percentage. The results suggest that total costs, cost of goods sold, operating costs and financing costs behave as anti-sticky during and post the financial crisis. On the other hand, SG&A were acted as sticky costs post the financial crisis period. However, the absolute estimated value of β_2 of SG&A after crisis (0.017) is less than its peer value before crisis (0.415). This means that the stickiness degree of SG&A post the financial crisis is less than its stickiness degree pre the financial crisis. This may be because cost stickiness is mitigated during and post the financial crisis because managers are extremely motivated to review debt contracts and practice employee's dismissal to keep organizational goals and avoid exposure of risk that in turn affects the behavior of some costs (e.g., finance costs & SG&A). Therefore, the *H4* hypothesis is partially accepted that *different cost categories of the UK chemical firms behave differently throughout the period post the financial crisis comparing with their behaviors during the financial crisis.*

Table 6. Cost estimation behaviour for period post the financial crisis (2010-2015)

Cost	Obs.	β_0	β_1	β_2	$\beta_1 + \beta_2$	Adj. R^2	Sig	H.VIF	F- value
TC	66	.014 (.013)	.413 (.163)	.296 (.216)	.629	.465	.000	4.074	29.243***
CGS	66	- .003 (.007)	1.186 (.092)	.161 (.121)	1.347	.926	.000	4.074	406.062***
OC	66	.006 (.004)	.676 (.053)	.039 (.069)	.715	.918	.000	4.074	363.112***
SG&A	54	.008 (.011)	.212 (.123)	- .017 (.164)	.195	.148	.006	4.214	5.586***
S&B	66	.073 (.052)	- .844 (.632)	1.273 (.835)	.429	.005	.320	1.161	4.074
FinC	60	.006 (.053)	.357 (.738)	5.982 (1.750)	6.339	.276	.000	1.738	12.237***

Notes: This table reports the results from models 1, 2, 3, 4, 5, and 6 over the period post the financial crisis (2010-2015). Obs. refers to the total number of observation. H.VIF refers to the highest values of VIF in each model. All VIF values are less than 10 that indicates the non-existence of any multicollinearity problem.

*, **, and *** indicate significance at 0.1, 0.05, and 0.01, respectively.

In sum, the financial crisis affects significantly the behavior of different cost categories in the UK chemical industry since cost stickiness decreased by considering the financial crisis duration and subsequent periods. Total costs in the UK chemicals industry have behaved as sticky costs pre the occurrence of the financial crisis (2001-2006) since the coefficient β_2 is negative. Conversely, during and post the financial crisis, total costs act as anti-sticky costs. Moreover, with aggregation all periods pre, during and post the financial crisis (2001-2015) the results reveal that there was a decrease in the degree of stickiness of total costs. Furthermore, the

behavior of cost of goods sold has changed from sticky (pre and during the financial crisis) to anti-sticky (post the financial crisis).

Besides, the cost behaviors of SG&A have acted as sticky costs (pre and post the financial crisis). In addition, the degree of stickiness of SG&A pre the financial crisis (2001-2006) is greater than its stickiness throughout the period post the financial crisis (2010-2015). Moreover, operating costs and finance costs have changed their behavior from sticky pre the financial crisis (2001-2006) to anti-sticky post the financial crisis (2010-2015). The empirical findings are summarized in Table 7.

Table 7. Summary of empirical results

Cost categories (β_2)	All sample periods (2001 – 2015)	Pre the financial crisis (2001 – 2006)	During the financial crisis (2007 – 2009)	Post the financial crisis (2010 – 2015)	Comments
Total costs (β_2)	Sticky (- .129)	Sticky (- .641)	Anti-sticky (.311)	Anti-sticky (.296)	The cost stickiness behavior has changed from sticky before the financial crisis to anti-sticky during and after the financial crisis.
Cost of goods sold (β_2)	Sticky (- .532)	Sticky (-1.210)	Sticky (- .195)	Anti-sticky (.161)	The behavior remains sticky during the financial crisis and acted as anti-sticky after the crisis.
Operating costs (β_2)	Sticky (- .085)	Sticky (- .135)	Anti-sticky (.039)	Anti-sticky (.039)	The behavior has changed from sticky before the financial crisis to anti-sticky during and after the financial crisis.
Selling, General &Administrative (β_2)	Sticky (- .233)	Sticky (- .415)	NA	Sticky (- .017)	The behavior remains sticky before, during and after the crisis
Salaries & Benefits (β_2)	NA	Sticky (- .476)	Anti-sticky (.160)	NA	The behavior has changed from sticky during the crisis to anti-sticky after the crisis
Financing costs (β_2)	Anti-sticky (.744)	Sticky (- .895)	NA	Anti-sticky (5.982)	The behavior has changed from sticky before the crisis to anti-sticky after the crisis

Notes: This table summarizes the empirical results from models 1, 2, 3, 4, 5, and 6.

NA indicates that the regression model for this cost item is not statistically significant. Thus, it is difficult to draw a conclusion in terms of this cost item.

5. CONCLUSION

The study is the first to investigate the influence of the financial crisis on the cost stickiness behavior of the UK chemical industry. It examines the stickiness behavior of the following costs: total costs, SG&A, cost of goods sold, operating costs, interest expense, and salaries and benefits pre, during and post the period of the financial crisis. The study reports a significant effect of the financial crisis on the behavior of different costs in the UK chemical industry since cost stickiness decreased by

considering the financial crisis' duration and subsequent periods. Besides, total costs in the UK chemicals industry have acted as sticky costs before the occurrence of the financial crisis. Conversely, total costs have acted as anti-sticky costs during and post the financial crisis. Furthermore, the behavior of cost of goods sold has changed from sticky (pre and during the financial crisis) to anti-sticky (post the financial crisis). Additionally, SG&A have behaved as sticky costs pre and post the financial crisis. Eventually, the behavior of operating costs

and finance costs have changed from sticky pre the financial crisis to anti-sticky post the financial crisis.

The results of the study have theoretical and practical implications as follows. Firstly, firm management should review the behaviors of different cost categories. They have to consider the changes in the degree of cost stickiness, particularly, during periods of financial distress. This is because the cost stickiness behavior, in the chemical industry in particular, directly affects the process of making decisions, which related to critical issues in cost management especially budgeting, pricing, control and estimation of variances. Secondly, the study extends the literature and sheds light on the economic consequences of the financial crisis on cost stickiness. In particular, the results provide new insights to shareholders and financial analysts to deal with the traditional costing models cautiously because of the effect of country economic consequences on the asymmetric cost behavior. Further research regarding cost stickiness is still under investigation with new insights such as cultural factors, social and environmental responsibility, employment protection legislation, investor protection, as we believe that preceding factors have somewhat effect on cost stickiness degree. Consequently, all decisions based on cost analysis will be controversy.

The study, however, has the following limitations, which have to be considered areas for future research. Firstly, the study focuses only on the UK chemical industry. However, costs associated with other industries in the UK could have different cost behaviors. Thus, investigating the effect of the financial crisis on cost stickiness degrees in other industries such as telecommunication or/and technology could be useful in understanding the cost behaviors within the UK. Secondly, the study focuses only on the UK. However, different countries, particularly, developing countries could have different cost behaviors.

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