

Model Misspecification in the Sticky Cost Literature

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Abstract

Beginning with Anderson et al., multiple studies have used a common model to investigate “sticky costs.” This model regresses the log change in SG&A on the log change in revenues. However, Balakrishnan et al. assert that the finding of sticky costs is the result of model misspecification, and using an alternative model that regresses the change in costs scaled by lagged revenues on the changes in revenues scaled by lagged revenues, they find no evidence of sticky costs. I assert that their model also suffers from misspecification, and I propose a new model for measuring sticky costs that addresses misspecification in both prior models. Using this model, I again find evidence of sticky costs.

Keywords: Sticky costs; Regression model; Misspecification; Independent variables

Introduction

This study provides evidence that multiple models used in the sticky cost literature to measure cost changes with respect to changes in revenue are misspecified. I explain how these misspecifications affect the observed results, and I provide an alternative model that is free of the limitations manifest in earlier studies.

Beginning with Anderson et al. [1,2] (ABJ), a relatively new stream of literature has investigated the phenomenon referred to as “sticky costs.” ABJ originally coined this phrase and defined it as a larger increase in costs with an increase in revenue than a decrease in costs with a corresponding decrease in revenue. By using selling, general, and administrative expenses (SG&A) as a proxy for costs, ABJ found evidence of the sticky cost phenomenon using the following regression model:

$$\ln\left(\frac{TC_{i,t}}{TC_{i,t-1}}\right) = \alpha + \beta_1 * \ln\left(\frac{S_{i,t}}{S_{i,t-1}}\right) + \beta_2 * DEC * \ln\left(\frac{S_{i,t}}{S_{i,t-1}}\right) + \varepsilon_{i,t} \quad (1)$$

Where TC represents SG&A, S is sales, and DEC is an indicator equal to 1 if the change in sales is negative and 0, otherwise. They found that the absolute change in costs for an increase in sales was larger than the absolute change in costs for a decrease in sales. This equates to a negative β_2 in equation (1). The authors opined that this may be evidence of a deliberate managerial hesitation to reduce costs in the face of a decrease in sales.

Several studies have relied on the finding in ABJ to document the existence of sticky costs. Anderson et al. [3] find that the size of the change in current cost of goods sold (CGS) is also smaller for decreases versus increases in sales. Subramanian et al. [4] extend this study and determine that the observed asymmetric adjustment of current SGA and current CGS only holds for large changes in current sales revenues. Balakrishnan et al. [5] employ private data from physical therapy clinics to show that stickiness is influenced by the extent to which capacity constraints bind, whereas Balakrishnan et al. [6], using department-level data from hospitals, find that cost stickiness is more strongly observable with respect to an organization’s core competency. Calleja et al. [7] investigate cost stickiness in an international setting and find results supportive of the existing literature. Banker et al. [8] and Weiss [9] show that analyst’ earnings forecasts do not account for cost stickiness and are, as a result, less accurate. Kama et al. [10] create a measure of demand uncertainty as a proxy for the choice to

invest in more flexible technologies which allow for less costly capacity changes; they find that cost stickiness is less observable in firms with high demand uncertainty.

Balakrishnan et al. [2] (BLS) refute the findings in ABJ and assert that evidence of cost stickiness is the result of misspecification. Specifically, they demonstrate how the use of the natural log artificially creates differing slopes for β_1 and $\beta_1 + \beta_2$ that ABJ attribute to managerial discretion. They then investigate two alternative specifications. The first alternative model replaces each log change with a percent change:

$$\frac{TC_{i,t} - TC_{i,t-1}}{TC_{i,t-1}} = \alpha + \beta_1 * \frac{S_{i,t} - S_{i,t-1}}{S_{i,t-1}} + \beta_2 * DEC * \frac{S_{i,t} - S_{i,t-1}}{S_{i,t-1}} + \varepsilon_{i,t} \quad (2)$$

Although the percent change avoids the issues related to the log change, BLS explain that this is not the preferred model choice because firm size and growth affect the relation between the percent change in costs and the percent change in sales. BLS then proposes a second model that addresses the concerns of both prior models. This model retains the percent specification for the independent variables, but it changes the denominator of the dependent variable to match the denominator of the independent variables:

$$\frac{TC_{i,t} - TC_{i,t-1}}{S_{i,t-1}} = \alpha + \beta_1 * \frac{S_{i,t} - S_{i,t-1}}{S_{i,t-1}} + \beta_2 * DEC * \frac{S_{i,t} - S_{i,t-1}}{S_{i,t-1}} + \varepsilon_{i,t} \quad (3)$$

By making this slight modification to the percent specification, BLS identify a model whose coefficients capture variable costs. Because fixed costs are, by definition, fixed, a model of sticky costs should exclude the effects of fixed costs on cost adjustment. As a result, BLS promote this model. Using this model, BLS fail to find consistent empirical evidence of cost stickiness.

Model

However, just as BLS assert the model in ABJ contained misspecification. The model in BLS is also misspecified. I propose a

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modification to equation (3) that addresses the existing misspecification while also avoiding the misspecification from equation (1).

The first issue with the BLS model is that they select $S_{i,t-1}$ as the scalar for the dependent and independent variables. Because $S_{i,t-1}$ is found in both the denominator and the numerator of the independent variable, the lower bound of the independent variable is -1, whereas the dependent variable has no such lower bound. A lower bound on the x-axis without a corresponding lower bound on the y-axis can result in a steeper slope. Panels A and B of Figure 1 explain the consequence of this misspecification graphically.

In order to avoid this issue, it is necessary to select an alternative scalar. The primary premise of this model as proposed by BLS is that the independent and dependent variables must have the same scalar in order for the coefficients to capture variable costs independent of firm size and cost structure. Replacing the scalar throughout with $TC_{i,t-1}$ would simply mirror the issue with $S_{i,t-1}$ as a scalar, except along the y-axis. However, lagged total assets represents an alternative scalar that has similar characteristics to lagged sales in that it scales the change by firm size, and it would not result in a different arithmetic lower bound for the independent and dependent variables:

$$\frac{TC_{i,t} - TC_{i,t-1}}{TA_{i,t-1}} = \alpha + \beta_1 * \frac{S_{i,t} - S_{i,t-1}}{TA_{i,t-1}} + \beta_2 * DEC * \frac{S_{i,t} - S_{i,t-1}}{TA_{i,t-1}} + \varepsilon_{i,t} \quad (4)$$

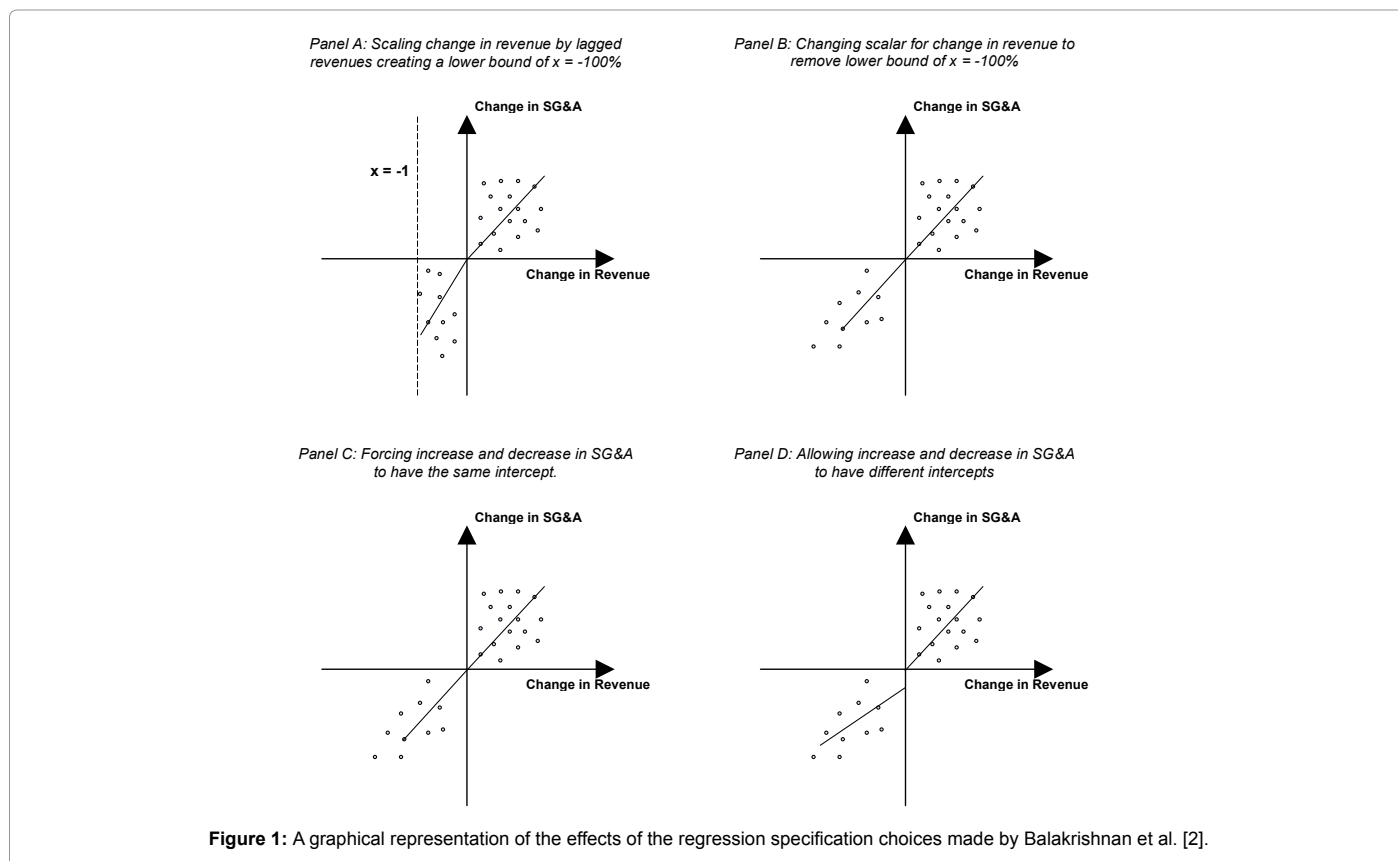
Interestingly, the second misspecification is common to ABJ and BLS. Both studies propose models that exclude the main effects of DEC , the indicator for a decrease in sales, from the model. Because this indicator represents the shift in regression intercept for the group of firms with a decrease in sales, excluding the main effects of DEC forces the intercept to be the same for both groups. Although an empirical

test of this assumption follows, intuitively, the intercept for firm-years with a decrease in sales would be below the intercept for firm-years with an increase in sales. In other words, the signed change in costs with an increase in sales is greater than the signed change in costs for a decrease in sales. This is consistent with the understanding that an increase in costs accompanies an increase in sales, whereas a decrease in costs accompanies a decrease in sales. Forcing the intercept to be the same for firm-years with an increase in sales and firm-years with a decrease in sales increases the slope for the negative group (i.e., makes β_2 less negative) when the true intercept for the negative group sits below the true intercept for the positive group. Panels C and D of Figure 1 graphical represent this effect. By including the indicator DEC as a separate term in the model, the intercepts, as well as the slopes, can vary by group:

$$\frac{TC_{i,t} - TC_{i,t-1}}{TA_{i,t-1}} = \alpha_1 + \beta_1 * \frac{S_{i,t} - S_{i,t-1}}{TA_{i,t-1}} + \alpha_2 * DEC + \beta_2 * DEC * \frac{S_{i,t} - S_{i,t-1}}{TA_{i,t-1}} + \varepsilon_{i,t} \quad (5)$$

Equation (5) avoids the misspecifications present in ABJ and BLS, but it also has one additional benefit. By specifying separate slopes and intercepts for firm-years with positive and negative changes in sales, it is possible to test predictions about the difference in the marginal change in costs, as well as the difference in the average change in costs, whereas the prior models could only measure marginal change.

I have the following predictions for equation (5). Consistent with the underlying premise of the sticky cost literature as proposed by ABJ, I predict that β_2 will be negative. This implies a lower marginal reduction in variable costs for a decrease in sales than a marginal increase in variable costs for an increase in sales. Along with this prediction is the expectation that β_1 will be positive, which is both germane to this



	Predicted Sign	Sample restrictions						
		Sales and SGA Unrestricted			Sales and SGA change ≤ 100%		Sales and SGA change ≤ 75%	
		VC ratio Unrestricted	VC ratio ≤ 5	VC ratio ≤ 1	VC ratio ≤ 5	VC ratio ≤ 1	VC ratio ≤ 5	VC ratio ≤ 1
Constant		0.01	0.01	0.01	0.01	0.01	0.01	0.01
		(37.1)	(38.8)	(31.8)	(30.3)	(26.4)	(28.0)	(24.5)
DEC _{it}	-	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
		(-19.5)	(-19.6)	(-12.9)	(-17.5)	(-10.7)	(-16.9)	(-10.1)
ΔSales _{it} /Assets _{it-1}	+	0.13	0.13	0.13	0.14	0.14	0.13	0.13
		(85.1)	(84.8)	(84.2)	(70.5)	(69.7)	(64.8)	(63.9)
DEC _{it} *ΔSales _{it} /Assets _{it}	-	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
		(-3.8)	(-3.8)	(-3.9)	(-3.5)	(-3.5)	(-3.3)	(-3.3)
Number of Observations		235,066	230,808	213,844	223,486	207,013	217,511	217,404
Adjusted R-Squared		0.36	0.37	0.42	0.36	0.40	0.34	0.39

Table 1: Regression of change in SG&A scaled by lagged total assets on change in sales scaled by lagged total assets, an indicator for decrease in sales, and the interaction between these two terms with sample restrictions as explained in table of Balakrishnan et al. [2].

literature and intuitive: an increase in sales results in an increase in costs. Secondly, I predict that α_2 will be negative. Paired with my first prediction, this implies that the average reduction in costs for decrease in sales is also smaller than the average increase in costs for an increase in sales. Because this is the first study, to my knowledge, to include separate intercepts for firm-years with increases and decreases in sales, this is the first study to test this prediction directly. By excluding this indicator, ABJ and BLS confound average and marginal effects. This confound not only masks the nature of sticky costs, but, as in the case of BLS, it can mask the existence of sticky costs, as well.

Results

Table 1 shows the results of an OLS regression of equation (5) using the sample restrictions as in BLS table (except that the sample period runs through 2014). Unlike BLS who finds no consistent evidence of stickiness, I find a negative and significant β_2 coefficient for all sample restrictions. This finding supports the initial assertion by ABJ and counters the rebuttal by BLS by again documenting the existence of sticky costs.

I also find that α_2 are negative and significant. This reinforces the claim that forcing the intercepts to be the same for all firm-years results in model misspecification. α_1 and β_1 are both positive and significant indicating that an increase in sales results in a marginal, as well as an average, increase in costs. Furthermore $\alpha_1 + \alpha_2$ and $\beta_1 + \beta_2$ are respectively smaller than α_1 and β_1 . This implies that the marginal and the average reduction in costs for a decrease in sales are smaller than the marginal and average increase in costs for an increase in sales.

Conclusion

Although the investigation of cost structure and the determinants of cost adjustment predate Anderson et al. this study was the first to coin the phrase “sticky costs,” and the first to introduce a model that measures sticky costs empirically. Several studies have since relied on the model that these authors introduce. However, disagreement exists regarding the specification of the model.

Specifically, Balakrishnan et al. [2] assert that the finding of sticky costs is the result of using the natural log of the change in sales and costs. They propose an alternative model that avoids the misspecification issues associated with log changes. Using this model, they find no consistent empirical evidence of sticky costs.

This study addresses additional misspecification in the original model, as well as misspecification that the model in Balakrishnan et al.

[2] introduces. By reversing the misspecification in the Balakrishnan et al. [2] model and by removing an additional component of misspecification from the model in Anderson et al. [1], I once again provide evidence of sticky costs. I also provide evidence that sticky costs are found in not only marginal, but also in average cost changes.

These findings support the assertions in Anderson et al. [1] and counter the rebuttal by Balakrishnan et al. [2]. Just as Balakrishnan et al. [2] claim that the finding of sticky costs was the result of misspecification, their finding of no sticky costs is the result of misspecification.

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