A new perspective on the benefits of slack building under participative budgeting

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Abstract

In contrast to authoritative budgeting, participative budgeting may improve the superior’s knowledge and increase the subordinate’s motivation, but often comes at the costs of padding budgets and slack building. Consequently, most analytical studies identify slack as one of the major costs of participative budgeting that significantly reduce its benefits. Despite these research findings, participative budgeting is widely used in corporate practice. In this paper, we identify a beneficial effect of participative budgeting that has been neglected so far in analytical accounting research. In particular, we argue that slack might have benefits for the firm if the impact of participative budgeting on the firm’s supply side is taken into account. We employ a tractable adverse selection model to capture the interactions between budgetary slack and decisions made inside the firm with the firm’s choice of production quantity and the supplier’s input price decision. We demonstrate that slack building induces an increase in the costs of production, but at the same time might soften supplier pricing. Overall, the interplay between frictions within the firm that are due to agency problems and the supplier’s pricing response crucially affect the firm’s choice of participative budgeting over authoritative budgeting. The main insight of our paper is that an exclusive focus on intra-firm aspects of budgeting might miss important effects of participative budgeting. It seems fruitful to consider the interaction between external stakeholders and a firm’s budgeting approach in future empirical research.
1 Introduction

Budgets are one of the most widely used management accounting tools all over the world. Extensive discussions of budgeting techniques and problems can be found in almost every management accounting textbook (e.g. Drury 2018, Bhimani/Horngren/Datar/Foster 2015 or Atkinson/Kaplan/Matsumura/Young 2007). Research also documents a wide use in corporate practice in medium and large firms (see e.g. Shastri/Stout 2008). Budgets are perceived as highly useful as they embody multiple functions in corporations, ranging from planning and controlling annual operations, communicating information, coordinating activities, motivating managers, and evaluating managerial performance. It is obvious that these functions face increasing importance in decentralized large companies, where managers of different hierarchical layers typically have more decision making authority. It has a long tradition in the budgeting literature to ask if it is beneficial for the firm to let managers participate in the process of preparing a budget. This important question was previously addressed by different research approaches (see for a survey Covaleski/Evans/Luft/Shields 2007). However, the academic literature has not provided a clear-cut answer. In fact, it instead gives rise to a sort of budgeting puzzle: research concludes that participation may be beneficial or not whereas practice quite frequently relies on it. Our aim in this paper is not to solve the puzzle, but to highlight a potential benefit of participative budgeting that has been neglected up to now. The potential benefit we are concentrating on deals with the positive impact of slack under participative budgeting if inter-
actions with vertically related markets are taken into account. Economics-based accounting research emphasizes the role of asymmetric information and its effect on firm profit. If managers are able to bias communicated information, the question arises if and how the superior information of the subordinate manager can be exploited in the budgeting process. By padding the budget and building budgetary slack, the subordinate manager communicates underestimated revenues or overestimated costs to the superior. This results in more easily achievable targets and in inefficient resource consumption. Although participation in the budgeting process has the (potential) benefit of improving the knowledge of the superior, participative budgeting comes at the costs of slack compared to authoritative (top down) budgeting. Consequently, a common view of slack in the budgeting literature is that slack is harmful for the firm. Slack leads to distorted information causing inefficient decisions like biased resource allocation, biased targets for subordinates or inefficient effort choices and resource consumption. Accordingly, textbooks suggest to find mechanisms to reduce the amount of slack (e.g. Atkinson/Kaplan/Matsumura/Young 2007, 490).

Contrastingly, psychology-based research focuses on the positive influence of participative budgeting on motivation and behavior. It is argued that involvement in the budgeting process may increase job satisfaction and morale. This leads to greater commitment and acceptance of goals fixed in the budget. As a consequence, performance of managers and of the company may increase. Being involved in the

\footnote{Throughout the paper, we use the notions of authoritative or top down budgeting and participative or bottom-up budgeting interchangeably.}
process may also provide incentives for the subordinate to work harder. Empirical research addressing these aspects finds mixed evidence. Several studies find a significant positive relationship of participation and performance, others observe no relationship and some even find a negative association (Maiga/Nilsson/Jacobs 2014, 6). Other empirical research shows that a large majority of firms listed at the Amsterdam Stock Exchange allows for slack at least sometimes. Slack in these firms is often tolerated despite the fact that the firm’s top management is convinced to have sufficient information to detect slack (De With/Dijkman 2008, 32f). This seems to support the idea that top management sees slack as a benefit that exceeds its costs.

In this paper, we want to explore the idea that slack that emerges under a participative budgeting regime has a positive effect, not because it motivates the manager but because it impacts input supplier pricing. Our parsimonious economic model considers a firm that offers its product in a monopolistic market. To produce the final product, the firm purchases an input from a monopoly supplier. Depending on the budgeting process – participative/bottom-up or authoritative/top down – the production cost budget for the production division is determined differently. Under participative budgeting the manager observes the true marginal production costs, high or low, and submits a potentially biased report to the firm’s headquarters (principal). To elicit a truthful report, the principal uses an incentive-compatible mechanism that consists of a budget for production and a production schedule. On the positive side, information about marginal costs enables the prin-

\[2\] In this paper, we use the notions “firm”, “principal”, and “headquarters” interchangeably.
cipal to “fine-tune” the production schedule to the actual realization of the firm’s marginal costs. On the negative side, the principal has to incur agency costs since it has to pay an information rent to the manager. Although this increases the firm’s real costs as the slack is consumed by the manager, it might nevertheless be beneficial for headquarters to use participative budgeting since an additional positive effect arises in the presence of a supplier. The increase in the total production budget caused by information asymmetry between headquarters and the manager results in a decrease in the firm’s expected production quantity. The supplier tries to stimulate demand for its input by reducing the input price. This input price effect can be sufficiently large to make participative budgeting preferable despite the associated agency costs.

Consequently, participative budgeting may be beneficial despite budgetary slack and the associated increase in real production costs because of its influence on the input market. Three effects drive the choice between participative budgeting and authoritative budgeting. First, there is the supplier pricing effect described above. Inflated production budgets soften supplier pricing and increases, ceteris paribus, the firm’s profit. Second, the firm has to pay an information rent to the manager and this budgetary slack decreases the benefits of participative budgeting. Third and finally, the manager has superior information about marginal production costs that are reported truthfully to the firm due to the designed mechanism. This information effect has a positive impact on the firm’s profit under participative budgeting since it enables the firm to condition the production quantity on true – and not on expected – marginal production costs.
Overall, we find in our binary setting that for an increasing difference in high and low marginal production costs, the firm might make multiple switches from one budgeting method to the other. Specifically, a switch from top down budgeting to participative budgeting might be motivated by a strategic motive, i.e. by getting a softer pricing response from the supplier, or by pure cost-saving reasons.

Our paper makes several contributions to the literature. First, in contrast to existing work, we address the question how a firm’s internal choice of the budgeting regime might trigger a favorable change in the behavior of an independent third party. In particular, we incorporate supply side considerations into the choice problem of the preferred budgeting regime. This adds a new perspective to the budgeting puzzle which has been neglected so far. Our findings may be helpful to further explain why participative budgeting is widely used in corporate practice.

Second, we show that budgetary slack associated with participative budgeting can serve as a commitment to increase the firm’s total profit. We further contribute to the literature searching for contingencies that drive the benefits of the design of the budgeting process. Our research also highlights that models focusing exclusively on the effects of the budgeting process inside the firm boundaries are at risk of missing important effects on external stakeholders. As a consequence, recommendations on the optimal budgeting regime may be misleading. Our analysis also offers a complementary explanation for the mixed empirical results on the costs and benefits of participative budgeting (see for an overview Heinle/Ross/Saouma 2014, 1026f). As most of the models used in analytical research on budgeting, our framework is highly stylized. Nevertheless, we believe that the important drivers
of our results are (to some extent) observable, which might allow for empirical investigation. For example, the required information to test our input price effect (e.g., characteristics of the input market, the reputation of a firm being top down or participative) is accessible to some extent for empirical research.

The paper proceeds as follows. The next section discusses the related literature. Section 3 provides the model setup. Section 4 studies the firm’s situation under top down budgeting. Section 5 provides a detailed analysis of the case of participative budgeting. Section 6 derives the optimal budgeting approach – authoritative or participative – for varying levels of marginal production costs. Section 7 considers the firm’s situation if it can observe the true marginal costs and compares it to the outcomes under authoritative and participative budgeting. Finally, Section 8 discusses our findings and concludes. Proofs of the results are relegated to an Appendix, unless stated otherwise.

2 Related Literature

Very recently, participative budgeting again gains increasing interest in analytical management accounting research. Heinle/Ross/Saouma (2014) compare authoritative (top down) and participative (bottom up) budgeting in a setting different from ours. They assume that either the principal (top down budgeting) or the agent (manager, bottom up budgeting) receives and communicates private information. In each of the two budgeting mechanisms the better informed player has an incentive to misreport. For participative budgeting, the manager has an incen-
tive to bias the report pessimistically to allow for a reduction in effort, building slack. For top down budgeting, the principal has an incentive to bias the report optimistically to motivate the manager to exert higher effort. The authors find that the level of information asymmetry drives the choice of the preferred budgeting mechanism. There is a switch from top down budgeting to participative budgeting as the amount of private information increases. In their setting, slack is a cost that negatively affects the benefits of participative budgeting. However, slack is also a commitment device of the principal to signal truthful reporting when top down budgeting is implemented. Our analysis differs from Heinle/Ross/Saouma (2014) as we do not restrict ourselves to consider budgeting as a communication mechanism within the firm. In our setting, the choice of the budgeting method also serves as a tool to influence the decisions of a third party outside the firm. In this context, slack may not only have negative effects on the principal but in fact may convey benefits. Weiskirchner-Merten (2014) provides an analysis for a budgeting setting with one principal and two agents (managers). The divisions of the managers are interdependent and jointly generate the firm’s profit. For both divisions, cost budgets for production have to be determined either based on top down or participative budgeting. Weiskirchner-Merten finds that if the profit potential is low, top down budgeting is preferred. As the profit potential increases, participative budgeting becomes more favorable. The level of cooperation between the two divisions and the effectiveness of the principal’s coordination of the two divisions also has an impact on the choice of the preferred budgeting regime. Differing from her analysis, we consider budgeting as a tool to influence the pricing decision of
an input supplier. In this regard, slack might induce a favorable price response from the supplier. In our setting, we find that top down budgeting is preferred for a small difference in marginal production costs (which could be seen as high profit potential). This is in contrast to the findings of Weiskirchner-Merten and highlights the importance of considering different contextual factors and settings to get a more complete picture of the drivers of the benefits of participative budgeting. Several (earlier) analytical papers have addressed the role of communication and target setting on the effort choice of an agent in the budgeting process (e.g. Demski/Feltham 1978, Christensen 1982 or Baiman/Evans III 1983). Like us, this work emphasizes that in most cases the principal has to offer rents (i.e. slack) to the agent to induce truthful reporting (or to motivate the desired effort choice). The principal balances the trade-off between the costs of paying rents and the benefits of getting informed truthfully. This trade-off is also present in our setting, but additionally we consider the effect on an external supplier’s pricing behavior. We also highlight that it is not always in the best interest of the principal to be able to actually observe the true marginal costs and avoid paying the information rent because by incurring agency costs the principal can achieve a softer price response from the supplier. We provide conditions such that the total effect on the firm’s profit is positive, despite the fact that slack induces real costs and decreases the real profit of the firm.

Some papers have addressed the trade-off that is inherent in delegation of decision-making authority. Decentralization increases the incentives for the manager to acquire information, but there is an agency cost since the interests of the manager
and the firm are typically not aligned. For example, Aghion and Tirole (1997) study the allocation of formal authority within organizations and the separation of formal authority and real authority (i.e. the effective control over decisions). Dessein (2002) argues that an uninformed principal may grant formal decision rights to a better informed agent despite the fact that the objectives of the agent and the firm are different because the principal tries to avoid noisy communication and the associated loss of information. Like these contributions, our paper also assumes that once the principal delegates the production task to the manager, the principal is committed to this choice (see also Waldman 2013, footnote 44). We also consider the trade-off between the costs (due to slack) and the benefits of delegation. However, the benefits of delegation in our work arise not because of increased managerial incentives or savings in communication costs, but because of the associated price reduction of an independent outside supplier. The economic forces that drive the result are related to the findings of Sappington/Weisman (2005) on self-sabotage. They find that increasing the cost of an upstream input may actually increase the profit of a vertically integrated producer (VIP) that sells this input to competitors. This occurs if the cost increase disadvantages downstream rivals of the VIP more than the VIP’s own retail unit. This insight on cost-increasing sabotage holds under price and quantity competition whereas with demand-reducing sabotage the results are mixed (Mandy and Sappington 2007). An important difference to our analysis is that their self-sabotage result fails to hold if there is – as in our setting – no downstream competition.

Our analysis also relates to strategic transfer pricing. Previous studies (e.g. Göx
have shown that although decentralization of decision-making entails transfer prices above marginal costs, it nevertheless may increase all firms’ profits under price competition with differentiated products. The reason is that higher transfer prices work as a collusion device and translate into higher market prices for the firms’ products. The main difference to the insight presented in our paper is that under transfer pricing only the (virtual) costs driving the delegated decision of the downstream unit are biased, not the real costs of production within the firm. Furthermore, if downstream competition is absent like in our setting, transfer prices above marginal costs only reduce profits. A further difference to this literature is that in our setting the choice of the budgeting method, but not the details of the communication between the firm and the manager is observable to parties outside the firm. We demonstrate that the possibility of inflated budgets under participative budgeting cause a favorable price response of the supplier. Accordingly, our paper is closely related to work that considers the benefits and costs of delegation in oligopolistic markets under the assumption that decisions within firms are private rather than public (see Kopel and Pezzino 2018 for references).

Another related contribution is Arya and Mittendorf (2007). They study a model of a single-product firm which offers a product on an oligopolistic market. The firm’s product requires two inputs, where one input is produced in-house and the other input is purchased from an independent supplier. A transfer price above marginal cost for an internally produced input induces the independent supplier of the other input to lower its input price. Overall, they show that despite the distortion caused by the higher transfer price, this may be a profitable strategy.
for the firm. Our model differs as the effect we identify holds without competition on the final product market. Moreover, in their model while “.. inflating actual costs is itself not worthwhile, the firm benefits from inflated pseudo-costs (transfer prices).” (Arya and Mittendorf 2007, p. 553). In contrast, we show that in our setting incurring real agency costs is beneficial for the firm.

3 The Model

We consider the relationship between a firm (principal) and a manager (agent). The manager runs the production division of the firm. We assume that the firm and the manager are risk-neutral. The firm serves a monopolistic output market, i.e. we (intentionally) abstract from product market competition. The demand for the product is described by \( p = a - x \), where \( p \) and \( x \) denote, respectively, the market price and the market quantity of the final product. The intercept \( a \) measures the (gross) market size. The firm and the manager both know the demand function. We denote the firm’s marginal production costs by \( c \) and assume that \( c = 0 \) with probability \( p \) and \( c = C \) with probability \( 1 - p \). In what follows, we assume that \( a > C/(1 - p) \), i.e. the highest willingness-to-pay in the market is sufficiently large compared to the adjusted marginal costs. This assumption avoids case distinctions and guarantees that production quantities are positive.

To enable production, an input is purchased from a monopolistic supplier and there is no alternative source for the input. We assume that the supplier also knows the market demand and the firm’s distribution of marginal costs, but does not know
the firm’s true costs. The supplier charges an input price, \( q \), to maximize its profit given the firm’s expected quantity. For simplicity, we assume that each unit of the final product requires one unit of the input. We normalize the marginal costs of the supplier to zero but our findings do not change qualitatively for positive marginal costs. Given the supplier’s ex ante information about the firm’s marginal costs, the choice of the input price is a profit-maximizing response to the anticipated firm’s demand for the input. The input price decision in our model is, however, not a strategic move of the supplier (see Banerjee and Lin 2003).

The division manager receives a cost budget for production based on the budgeted production costs per unit. The budget is prepared at the beginning of the period. The budgeting process may be either designed authoritative (top down) or participative (bottom up). To introduce a possible source of asymmetric information, we assume that the firm has the option to implement an information system (costlessly) revealing the true production costs to the manager. Only the manager has the expertise to use the information provided.

If the firm chooses top down budgeting, the firm does not install the information system. Information is symmetric for all players, i.e. the firm, the manager, and the supplier share the same (ex ante) expectations about the marginal production costs. The supplier – anticipating the firm’s quantity decision – first determines the input price \( q \). The firm also relies on its ex ante knowledge of the distribution of marginal production costs and subsequently fixes the budget and the associated production quantity based on the expected marginal costs. Then, the production quantity is produced and sold in the market and profits are realized.
If, on the other hand, the firm commits to use participative budgeting, the firm installs the (costless) information system. This leads (ex ante) to asymmetric information between the players. The supplier first uses its ex ante information about marginal costs to determine its input price based on the expected quantity demanded by the firm. Nature then determines the firm’s true marginal cost – either \( c = 0 \) with probability \( p \) or \( c = C \) with probability \( 1 - p \). The manager learns the true production costs by using the information system. Then, given the input price the firm asks the manager to submit a report \( m \) about the true marginal costs. Based on the report \( m \), the manager obtains a budget \( B(m) \) and is obliged to produce \( x(m) \) units. Obviously, the manager might use its private information to overstate marginal costs. The manager then might consume resources not needed for production. This is in line with the general idea of slack in the literature that is captured by offering an informational rent to the manager that is due to the manager’s private information (e.g. Schiff/Lewin 1970). In the subsequent analysis, we will focus on the firm’s design of an optimal (truth-telling) mechanism under participative budgeting. We will show under which conditions the firm will prefer participative budgeting to top down budgeting despite the fact that under participative budgeting the firm has to pay an information rent to induce a truthful report from a manager who has observed low marginal costs.

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3 Considering fixed costs of the information system do not change the results qualitatively. Obviously, such fixed costs of the information system favor the use of top down budgeting.

4 Concerning the communication game with the supplier, we could have alternatively assumed that the firm provides (potentially biased) information about its marginal costs to the supplier. The supplier offers two input prices to the firm, one price if the firm reports high marginal costs and one price if the firm report low marginal costs. Note, however, that the firm has an incentive to always report the information which yields the lower input price. Consequently, as this renders information provided by the firm to the supplier completely uninformative, the supplier can as
4 Top-down budgeting

We first analyze top-down budgeting. We use backward induction and therefore start with the production decision. Given an input price of $q$, the firm maximizes its expected profit

$$\Pi^f(x) = (a - x - (1 - p) \cdot C - q) \cdot x.$$ 

Optimization with respect to $x$ yields

$$x(q) = \frac{1}{2}(a - (1 - p) \cdot C - q)$$

as long as $a - (1 - p) \cdot C - q \geq 0$ and 0 otherwise. We have

$$x(q) = \begin{cases} \frac{1}{2}(a - (1 - p) \cdot C - q) & a \geq (1 - p) \cdot C + q \\ 0 & a < (1 - p) \cdot C + q. \end{cases}$$

As we will see, the quantity will always be positive in equilibrium due to the assumption that $a > C/(1 - p)$. Based on this expected quantity, the firm provides the budget to the agent. Note that it is not possible to condition $x$ on the true costs or a report about these costs.

Next, we determine the supplier’s decision. The supplier anticipates $x(q)$ and determines $q^*$ by maximizing

well restrict to a single price as assumed in our analysis.
This yields

\[ q^* = \frac{1}{2}(a - (1 - p) \cdot C). \]

Note that \( q^* > 0 \). Finally, we can compute the firm’s and supplier’s equilibrium payoffs by inserting \( q^* \) and \( x(q^*) \) into \( \Pi^f(x) \) and \( \Pi^s(x) \). The following lemma summarizes our findings where the subscript \( td \) indicates the top down approach. The proof of the lemma is straight-forward and is therefore omitted.

**Lemma 1** Under top down budgeting, the following quantity is optimal:

\[ x_{td} = \frac{a - (1 - p) \cdot C}{4}. \]

The supplier charges the following price for the input

\[ q_{td} = \frac{a - (1 - p) \cdot C}{2}. \]

The firm’s equilibrium payoff is

\[ \Pi_{td}^f = \frac{(a - (1 - p) \cdot C)^2}{16}, \]
and the supplier’s equilibrium profit is

\[ \Pi_{td}^* = \frac{(a - (1 - p) \cdot C)^2}{8}. \]

5 Participative Budgeting

Under participative budgeting, the firm’s headquarters (principal) asks the manager for a report about marginal costs, \( m \), and based on this report, the manager obtains a budget \( B(m) \) and is obliged to produce \( x(m) \) units. Recall that although the choice of the budgeting method is observable, the details of the communication process between the firm and the manager is not revealed to the supplier.

As the analysis of the problem is rather complex, we break up the solution of the game into several steps. First, we analyze the optimal incentive-compatible direct mechanism that induces the manager (types) to report the marginal costs truthfully (subsection 5.1). Second, we derive the supplier’s optimal input price (subsection 5.2). Third, we determine the firm’s quantities and the payoffs of the parties (subsection 5.3).

5.1 The firm’s optimal mechanism under participative budgeting

The marginal production costs are only known to the manager who submits a (potentially biased) report to the firm. According to the revelation principle, the firm can restrict its attention to mechanisms that induce truth-telling, i.e. the
manager reports the true marginal costs $c = 0$ or $c = C$. Assume that the supplier charges an input price of $q$. Then, the principal’s mechanism design problem can be written as

$$\max_{B(\cdot), x(\cdot)} p((a - x(0) - q)x(0) - B(0)) + (1 - p)((a - x(C) - q)x(C) - B(C))$$

subject to

$$(PC_1) \quad B(C) - Cx(C) \geq 0$$

$$(PC_2) \quad B(0) \geq 0$$

$$(IC_1) \quad B(C) - Cx(C) \geq B(0) - Cx(0)$$

$$(IC_2) \quad B(0) \geq B(C).$$

In addition to the participation constraints $(PC1)$ and $(PC2)$, if the marginal costs are unknown to the firm the mechanism design problem has to include (i) a constraint $(IC1)$ which ensures that the manager reports truthfully if the true marginal cost is $C$, and (ii) a constraint $(IC2)$ which ensures that the manager reports truthfully if the true marginal cost is 0.

In the appendix, we show that the participation constraint $(PC1)$ and the incentive compatibility constraint $(IC2)$ are binding. We also argue why the remaining two
inequalities can be ignored. This leads to

\[ B(C) = C \cdot x(C), \tag{2} \]
\[ B(0) = B(C) = C \cdot x(C). \]

Obviously, the manager who observes low marginal costs, \( c = 0 \), receives an information rent since \( B(0) = C \cdot x(C) > 0 \). Inserting the expressions in (2) into the principal’s objective function yields the unconstrained problem:

\[
\max_{x} p(a - x(q, 0) - q)x(q, 0) + (1 - p)(a - x(q, C) - q - \frac{C}{1 - p})x(q, C),
\]

where we additionally emphasize the dependence of the production quantities on the supplier’s given input price. Solving the first order conditions for \( x(q, C) \) and \( x(q, 0) \) leads to

\[ x(q, 0) = \frac{1}{2}(a - q) \quad \text{and} \quad x(q, C) = \frac{1}{2}(a - q - \frac{C}{1 - p}). \]

as long as these quantities are positive. We have \( x(q, 0) = 0 \) if and only if \( q > a \). Furthermore, we have \( x(q, C) = 0 \) if and only if \( q > a - C/(1 - p) \).

### 5.2 The supplier’s optimal input price

Now consider the supplier’s input price choice. Although the supplier can anticipate the quantities \( x(q, 0) \) and \( x(q, C) \) that are induced by the mechanism in case

\footnote{See the mathematical appendix.}
of low and high marginal costs, \( c = 0 \) and \( c = C \) respectively, the supplier is not able to condition the input price on the true marginal costs. Therefore, the supplier charges an input price based on the expected quantity. Hence, the input price is determined by maximizing

\[
\Pi^*(x, c) = (p \cdot x(q, 0) + (1 - p)x(q, C)) \cdot q.
\]

Note that in the case \( q > a \), the supplier’s expected profit is zero. Such a high input price is never optimal, however, since the supplier could achieve a positive profit by setting an input price \( q < a \). Therefore, we can restrict our analysis to the interval \( 0 < q < a \). In detail, the supplier’s profit is now given by

\[
\Pi^*(x, c) = \begin{cases} 
(p \cdot \frac{a-q}{2} + (1 - p) \cdot \frac{a-q-C/(1-p)}{2}) \cdot q & 0 < q \leq a - \frac{C}{1-p} \\
p \cdot \frac{a-q}{2} \cdot q & a - \frac{C}{1-p} < q \leq a
\end{cases}
\]

The optimal input price of the supplier can be determined by finding the globally optimal values of \( q \) for the two cases \( 0 < q \leq a - \frac{C}{1-p} \) (Region 1) and \( a - \frac{C}{1-p} < q \leq a \) (Region 2). Note that in Region 1 the firm produces under high and low marginal costs and the resulting supplier’s profit is given by the first line in (3). In Region 2, the firm only produces under low marginal costs and the supplier’s profit is given by the second line in (3). At the threshold value \( q = a - \frac{C}{1-p} \), the two profits coincide and, therefore, the supplier’s expected profit is continuous in \( q \) (but not differentiable). The following lemma summarizes the supplier’s locally optimal input price in the two regions where the subscript “\( p \)” denotes participative
budgeting. A proof of the lemma can be found in the mathematical appendix.

**Lemma 2** The locally optimal input price of the supplier is given by:

(i) In region 1, i.e. \(0 < q \leq a - \frac{C}{1-p}\), we have \(q_{p,1} = \frac{a-C}{2}\) for \(C \leq \frac{a(1-p)}{1+p}\) and \(q_1 = a - \frac{C}{1-p}\) for \(C > \frac{a(1-p)}{1+p}\).

(ii) In region 2, i.e. if \(a - \frac{C}{1-p} < q \leq a\), we have \(q_{p,2} = \frac{a}{2}\) for \(C > \frac{a(1-p)}{2}\) and \(q_2 = a - \frac{C}{1-p}\) for \(C \leq \frac{a(1-p)}{2}\).

Figure 1 illustrates the supplier’s locally optimal values of the input price as a function of the marginal costs \(C\).

![Insert figure 1 about here.](image)

The threshold value \(q = a - \frac{C}{1-p}\) that marks the transition from region 1 to region 2 can never represent the global optimum. The supplier’s globally optimal input price is always given by either one of the interior values, \(q_{p,1}\) or \(q_{p,2}\), that are derived from the first order conditions. In order to see this, first note that for \(C < \frac{a(1-p)}{2}\), the optimal input price in region 1 is obtained from the first order condition, i.e. \(q_{p,1} = \frac{a-C}{2}\), while in region 2 it is attained for \(q_2 = a - \frac{C}{1-p}\). In the former case the supplier’s profit is \(\Pi_{p,1}^s = \frac{1}{8}(a-C)^2\) while in the latter it is \(\Pi_2^s = \frac{pC(a(1-p)-C)}{2(1-p)^2}\).

Since \(\Pi_{p,1}^s - \Pi_2^s = \frac{(a(1-p)-C)(1+p)^2}{8(1-p)^2} > 0\), the supplier is better off with the input price \(q_{p,1} = \frac{a-C}{2}\) and the firm produces the product if cost are \(c = 0\) and if costs are \(c = C\). Figure 2 depicts the supplier’s expected profit for such a scenario where the local maximum in region 1 is feasible. In region 2 the maximum is attained at the left boundary value \(q = a - \frac{C}{1-p}\). The global maximum is attained for \(q_{p,1} = \frac{a-C}{2}\).
Second, for $C > \frac{a(1-p)}{1+p}$ the optimal input price in region 2 is obtained from the first order condition, i.e. $q_{p,2} = \frac{a}{2}$, while in region 1 it is attained for $q_1 = a - \frac{C}{1-p}$.

In the former case, the supplier’s profit is $\Pi^*_p,2 = p \cdot \frac{a^2}{8}$ while in the latter it is again $\Pi^*_1 = \frac{p C(a(1-p)-C)}{2(1-p)^2}$. Since $\Pi^*_p,2 - \Pi^*_1 = \frac{p(2C-a(1-p))^2}{8(1-p)^2} > 0$, the supplier is better off with the input price $q_{p,1} = \frac{a}{2}$ and the firm produces only if cost are $c = 0$. Figure 3 illustrates this case where the local maximum in region 2 is feasible. In region 1 the maximum is attained at the right boundary value $q = a - \frac{C}{1-p}$. Since the supplier’s expected profit increases for $q < q_{p,1} = \frac{a-C}{2}$ in region 1 and the supplier’s expected profit is continuous, the global maximum is attained for $q = \frac{a}{2}$.

Finally, for the intermediate region, $\frac{a(1-p)}{2} \leq C \leq \frac{a(1-p)}{1+p}$, the optimal input price in both regions can be obtained from the corresponding first-order condition. The supplier’s globally optimal input price in this region can be determined by comparing the two local maxima. We have $q_{p,1} = \frac{a-C}{2}$ with a supplier’s profit of $\Pi^*_p,1 = \frac{1}{8}(a-C)^2$ and we have $q_{p,2} = \frac{a}{2}$ with a profit of $\Pi^*_p,2 = p \frac{a^2}{8}$. Solving for the value of $C$ for which $\Pi^*_p,1 = \Pi^*_p,2$ yields $\widehat{C} = a(1 - \sqrt{p})$. It can be easily seen that $\widehat{C}$ is in the intermediate region, i.e. $\frac{a(1-p)}{2} < \widehat{C} < \frac{a(1-p)}{1+p}$ (see Figure 1). Note that in the case where $\frac{a(1-p)}{2} < C < \widehat{C}$, the firm produces if marginal costs are $c = 0$ and $c = C$, while if $\widehat{C} < C < \frac{a(1-p)}{1+p}$ the input price is such that the firm produces only if marginal costs are low, $c = 0$.

---

First, we have $a(1 - \sqrt{p}) - \frac{a(1-p)}{2} = \frac{1}{2}(1 - \sqrt{p})^2 > 0$, which shows the left inequality. Second, we have $\frac{a(1-p)}{1+p} - a(1 - \sqrt{p}) = \frac{a \sqrt{p}}{1+p}(1 - \sqrt{p})^2 > 0$, which shows the right inequality.
In the interval between $\frac{a(1-p)}{2}$ and $\frac{a(1-p)}{1+p}$ both local optima of the supplier’s expected profits are feasible. The local maximum in region 1 is strictly (and continuously) decreasing in $C$ while the maximum in region 2 is unaffected. Therefore, for relatively low values of $C$ the global optimum yielding the supplier’s input price is the local maximum in region 1. Since all functions are continuous, there must be a value of $C$ such that both local maxima yield the same expected profit for the supplier. Such a situation is depicted in Figure 4. Finally, if $C$ further increases the local maximum in region 2 is the unique global maximum.

The following lemma summarizes our findings. The proof of the lemma rests on the arguments provided above and is, therefore, omitted.

**Lemma 3** There exists a value $\frac{a(1-p)}{2} < \hat{C} = a(1 - \sqrt{p}) < \frac{a(1-p)}{1+p}$ such that

(i) for $C < \hat{C}$ the supplier charges $q_{p,1} = \frac{a-C}{2}$.

(ii) for $C > \hat{C}$ the supplier charges $q_{p,2} = \frac{a}{2}$.

In the boundary case $C = \hat{C}$ the supplier is indifferent between $q_{p,1} = \frac{a-C}{2}$ and $q_{p,2} = \frac{a}{2}$.

Figure 5 illustrates the findings of lemma 3. For simplicity, we assume that in case of indifference the supplier charges the lower price.

Insert Figure 5 about here

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5.3 The firm’s optimal quantities and the parties’ payoffs

The previous subsection has shown that for $C \leq \hat{C}$ the input price is $q_{p,1} = \frac{a-C}{2}$ and for $C > \hat{C}$ the input price is $q_{p,2} = \frac{a}{2}$. The firm’s corresponding quantities follow from inserting the supplier’s input price $q_{p,i}$ for $i = 1, 2$ in $x(q, 0) = \frac{1}{2}(a-q)$ and $x(q, C) = \frac{1}{2}(a-q - \frac{C}{1-p})$, where we note that in regime 2 we have $x_{p,2}(C) = 0$.

Using the supplier’s input price and the firm’s production quantities in the two regimes, the expected profits of the firm and the supplier can be derived. The next lemma summarizes the results. The derivation is straightforward and is therefore omitted.

**Lemma 4** There exists a value $\frac{a(1-p)}{2} < \hat{C} = a(1 - \sqrt{p}) < \frac{a(1-p)}{1+p}$ such that the following results hold.

(i) For $C < \hat{C}$, the firm’s quantities are $x_{p,1}(0) = \frac{a+C}{4}$ and $x_{p,1}(C) = \frac{a(1-p)-C(1+p)}{4(1-p)}$.

The resulting expected profit of the firm is

$$\Pi_{p,1} = \frac{(a-C)^2 - p(a-3C)(a+C)}{16(1-p)}.$$  \hspace{1cm} (4)

The expected profit of the supplier is given

$$\Pi_{p,1}^s = \frac{(a-C)^2}{8}.$$  

(ii) For $C > \hat{C}$, the firm’s quantities are $x_{p,2}(0) = \frac{a}{4}$ and $x_{p,2}(C) = 0$. The
resulting expected profit of the firm is

\[ \Pi^f_{p,2} = \frac{pa^2}{16}. \]  

(5)

The expected profit of the supplier is given

\[ \Pi^s_{p,2} = \frac{pa^2}{8}. \]

6 The firm’s optimal choice of budgeting approach

Lemma 4 implies that for \( C < \hat{C} \) an increase in the firm’s marginal costs \( C \) leads to a decrease of the firm’s expected quantity, \( px_{p,1}(0) + (1-p)x_{p,1}(C) = \frac{a-C}{4} \).

Lemma 3 shows that the supplier’s optimal input price \( q(C) \) falls from \( q(0) = \frac{a}{2} \) to \( q(\hat{C}) = \frac{a\sqrt{\Pi}}{2} \). This leads to the conclusion that as a reaction to a decrease in the firm’s expected production quantity, the supplier lowers its input price in order to stimulate demand for the input. Lemma 3 further implies that at the threshold value \( \hat{C} \), the supplier’s optimal price suddenly jumps up to \( q(C) = \frac{a}{2} \) and stays constant for all \( C > \hat{C} \). Such a sudden increase in the input costs decreases the firm’s profit and – as we now demonstrate – further influences the firm’s choice of budgeting approach.

To see how the firm’s decision at the first stage of the game is influenced by the supplier’s input price, it is helpful to compare the input price under participative budgeting, \( q_{p,i} \), with the input price in case of top down budgeting, \( q_{td} \), given in
Lemma 1. Figure 6 illustrates the two input prices as a function of the firm’s marginal costs $C$ for the parameter values $a = 6$ and $p = 0.4$.

Insert Figure 6 about here

Figure 6 shows that for $C \leq \hat{C}$ the input price $q_{p,1}$ in the case of participative budgeting (bold line) is lower than under top down budgeting (dashed line). Also, the difference between the two input prices increases in $C$. At $C = \hat{C}$, the input price in case of participative budgeting jumps up to $q_{p,2} = \frac{a}{2}$ and for all $C > \hat{C}$ the supplier’s input price is so high that the firm only produces in case of low marginal costs $c = 0$. Now, the input price in case of top-down budgeting is significantly smaller. Also, the (absolute) difference between the two input prices increases in $C$. The conclusion that can be drawn from these arguments is that the supplier’s input price depends on the firm’s budgeting approach and, therefore, the firm will anticipate the supplier’s price reaction when it chooses its budgeting approach.

**Firm switches to participative budgeting to soften supplier pricing**

We first study the case where $C < \hat{C}$. Here the supplier’s input price under participative budgeting is smaller than under top down budgeting, i.e. $q_{p,1} = \frac{a-C}{2} < \frac{a-(1-p)C}{2} = q_{TD}$, see Lemma 1. The reason is that for $C < \hat{C}$ the firm’s expected production quantity under participative budgeting, $px_{p,1}(0) + (1-p)x_{p,1}(C) = \frac{a-C}{4}$, is smaller than the expected quantity under top down budgeting, i.e. $x_{TD} = \frac{a-C}{4}$.

\footnote{In subsection 7 we additionally study the case where the firm can observe the realization of the marginal production costs. We note that the supplier’s input price under participative budgeting is also smaller than if the firm can observe its marginal costs, i.e. $q_{p,1} < q_1^* = q_{TD}$, see Lemma 5.}
\[-\frac{a(1-p)}{4}C\] (see Lemma 1). Since a decrease in the firm’s production quantity induces a decrease in the demand for the input, the supplier counters this decrease by softening its input price response. A comparison of the firm’s profits under participative budgeting, \(\Pi_{p,1}^f\) (see lemma 4), and under top down budgeting, \(\Pi_{td}^f\) (see lemma 1), shows that there exists a cutoff value, \(\bar{C} = \frac{2a(1-p)}{6-(3-p)p}\), with \(0 < \bar{C} < \hat{C} = a(1 - \sqrt{p})\) such that \(\Pi_{td}^f \geq \Pi_{p,1}^f\) if \(C \leq \bar{C}\).

In other words, the firm prefers top down budgeting if the firm’s marginal costs \(C\) are sufficiently low, i.e. \(C < \bar{C}\), while the firm achieves a higher profit under participative budgeting if \(\bar{C} < C < \hat{C}\). The following proposition summarizes our findings. Again, the proof follows from the arguments provided in the text above and is, therefore, omitted.

**Proposition 1** Consider the range of marginal costs \(C\) where \(0 \leq C \leq \hat{C}\). Then, there exists a value \(\bar{C} = \frac{2a(1-p)}{6-(3-p)p}\) with \(0 < \bar{C} < \hat{C} = a(1 - \sqrt{p})\) such that the following results hold.

(i) The firm’s profit under top-down budgeting is higher than under participative budgeting, \(\Pi_{td}^f > \Pi_{p,1}^f\), if \(C \leq \bar{C}\).

(ii) The firm’s profit under top-down budgeting is lower than under participative budgeting, \(\Pi_{td}^f < \Pi_{p,1}^f\), if \(C > \bar{C}\).

An illustration of the trade-off the firm has to consider in its choice of the budgeting approach is provided by Figure 7. The figure shows the difference in the firm’s

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8The observation that \(C < \bar{C}\) follows easily from \(\hat{C} - \bar{C} = a(1 - \sqrt{p})(4 + 2\sqrt{p - p^2}p) > 0\).

9In contrast, if marginal costs are observable by the firm, then participative budgeting always leads to a higher firm’s profit than top down budgeting since the firm can condition the production quantity on the true marginal costs without any agency costs. See subsection 7 for further details.
profits $\Pi_{p,1} - \Pi_{td}$ as a function of $C$ for $C \leq \hat{C}$ and $a = 6$ and $p = 0.4$. For $C = 0$, the firm’s profits are identical under the two budgeting approaches. If $C$ increases, the (absolute) profit difference increases, but then decreases and for $C > \underline{C}$ the difference is strictly positive. Participative budgeting is then strictly better than top-down budgeting. Intuitively, the firm has to consider three effects. First, a switch to participative budgeting is accompanied by agency costs, $B(0) = C_{x_{p,1}}(C) = C \frac{a(1-p) - C(1+p)}{4(1-p)}$, since the firm has to pay an information rent to the manager to elicit a truthful report under low marginal costs. This information rent is increasing in $C$ as long as $C < a(1-p)/(2(1+p))$. Second, under participative budgeting the firm can condition the production quantities on the true (instead of expected) marginal costs. The difference in the production quantities in case of participative budgeting and top down budgeting is increasing in $C$. Therefore, the firm’s option value of conditioning the production quantities on the true marginal costs is increasing. Third and finally, the switch to participative budgeting is associated with savings in input costs since $q_{TD} > q_{p,1}$ and these savings become more pronounced for higher marginal costs $C$. If the joint effects of the reduction in the supplier’s input price and the firm’s option value of cost information are sufficiently large to outweigh the negative effect of agency costs (which is the case for $C > \underline{C}$), the firm prefers participative budgeting to top down budgeting.

A final observation for the range where $0 < C < \hat{C}$ is that when the firm switches from top down budgeting to participative budgeting at $C$, the supplier is worse off.

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This can be seen by comparing the supplier’s profit $\Pi_{ps,1} = \frac{(a-C)^2}{8}$ in lemma 4 with the profit $\Pi_{td}^{s} = \frac{(a-(1-p)C)^2}{8}$ under top down budgeting in lemma 1. Additionally, the expected quantity decreases, so that consumers have to pay a higher expected price. This raises the question how the firm’s decision to use participative budgeting affects the joint (supply chain) profit of the firm and the supplier and welfare if additionally expected consumer surplus is considered. Straightforward calculations show that there exists a threshold $C_w$ such that the supply chain profit and welfare is higher under participative budgeting than under top down budgeting if $C_w < C < \hat{C}$ and the probability $p$ is sufficiently small.\footnote{Expected consumer welfare is calculated as $p \frac{x_{p,1}(0)^2}{2} + (1 - p) \frac{x_{p,1}(C)^2}{2}$. The exact values of the threshold value is $C_w = \frac{6a(1-p)}{10-5p(3-p)}$ and $C_w < \hat{C}$ if $p < 0.175456$.}

**Firm switches to participative budgeting to save production costs**

We are now turning to the case where $C > \hat{C}$ and compare the firm’s profits under the two budgeting regimes. Recall from lemma 3 that the supplier’s optimal input price in this case is $q_{p,2} = \frac{a}{2}$ and the firm’s quantities are $x_{p,2}(0) = \frac{a}{4}$ and $x_{p,2}(C) = 0$. A comparison of the firm’s profit under participative budgeting, $\Pi_{p,2}^{f}$, and under top down budgeting, $\Pi_{td}^{f}$, shows that there exists a cutoff value, $\overline{C} = \frac{a}{1+\sqrt{p}}$ which is smaller than $C_{\text{max}} = a(1-p)$ only if $p < \frac{3-\sqrt{5}}{2}$. In this case, the firm prefers top down budgeting if $C < \overline{C}$ and prefers participative budgeting if $C > \overline{C}$. It is important to note, however, that the present case is very different from the previous situation where $C < \hat{C}$. In the previous situation the firm strategically switches to participative budgeting to induce a softer price response.
from the supplier, while in the present case the supplier’s input price is constant for all $C > \hat{C}$ under participative budgeting. Hence, the firm switches from top down budgeting to participative budgeting for pure cost-saving purposes.\footnote{In section \ref{sec:inhouse} we briefly discuss the firm’s situation if the firm makes the input in-house and there is no supplier. In this case, there is no strategic effect on the price response of the supplier and the firm’s tradeoff just includes the option value and the agency costs. There is only a single switch from top down budgeting to participative budgeting and this switch is made for cost savings purposes only.} Intuitively, while under top down budgeting the firm’s profit $\Pi_{td}^f$ decreases if the marginal costs $C$ increase, the firm’s profit under participative budgeting $\Pi_{p,2}^f$ is constant for the whole range $C > \hat{C}$. If the marginal costs $C$ are too high, then the firm’s profit under top down budgeting becomes too small and the firm switches to participative budgeting. However, such a switch is only indicated if the probability of high costs is sufficiently large (i.e. $p$ is sufficiently small) as otherwise the firm prefers top down budgeting over the whole range of marginal costs $C$.\footnote{Note that this is due to our assumption that $a > C/(1 - p)$. Otherwise, $\bar{C}$ would always exist.} The next proposition summarizes our findings.

**Proposition 2** Consider the range of marginal costs $C$ where $\hat{C} < C \leq a(1 - p)$. Then, the following results hold.

- If the probability $p$ of low marginal cost is sufficiently low, i.e. $p < \frac{3 - \sqrt{5}}{2} \approx 0.38197$, then there exists a value $\bar{C} = \frac{a}{1 + \sqrt{p}} < C_{\max} = a(1 - p)$ such that for $C < \bar{C}$ the firm’s expected profit is higher under under top-down budgeting and for $C > \bar{C}$ the firm’s expected profit is higher under participative budgeting.
• If the probability \( p \) is sufficiently high, i.e. \( p > \frac{3-\sqrt{5}}{2} \), the firm’s expected profit under top-down budgeting is always higher than under participative budgeting.

• If the probability \( p \) satisfies \( p = \frac{3-\sqrt{5}}{2} \), the firm’s expected profit is always higher under under top-down budgeting for all \( C \neq a(1-p) \). For \( C = a(1-p) \), the firm’s expected profit is identical under both regimes.

The full range of the firm’s choice of budgeting approaches in the first stage of our game is obtained by combining the results provided in Propositions 1 and 2. Figure 8 illustrates the situation for \( p < \frac{3-\sqrt{5}}{2} \).

Insert Figure 8 about here

In the first region, \( C < \hat{C} \), top-down budgeting is optimal. As outlined, in this region the agency costs outweigh the benefits of improved cost information and a smaller input price. For \( C = \hat{C} \) both budgeting regimes yield the same expected profit for the firm. In the region \( \hat{C} < C \leq \tilde{C} \), participative budgeting is optimal. For \( C = \tilde{C} \), the supplier’s pricing decision changes. The input price jumps to \( \frac{a}{2} \). Now, the input price is significantly higher under participative budgeting than under top-down budgeting. (See also Figure 6.) This holds for all \( C > \tilde{C} \) and under participative budgeting the firm only produces if marginal costs are \( c = 0 \). Consequently, under participative budgeting the input price and the firm’s expected profit are independent of \( C \). In case of top-down budgeting, the firm has to produce independent of the true costs. Therefore, its expected profit decreases in
If $C$ is sufficiently large, the benefit of participative budgeting again dominates. For $\overline{C} = \frac{a}{1+\sqrt{p}}$, both budgeting regimes yield the same expected profit for the firm and for $C > \overline{C}$ participative budgeting is again optimal.

7 The firm’s choice under observable marginal costs

Conventional wisdom suggests that the firm suffers from agency problems. In our setting, under participative budgeting the firm has to pay a costly information rent to the manager if the (unobservable) marginal costs are low in order to induce the manager to truthfully reveal this private information to the firm. This obviously reduces the firm’s benefit of using participative budgeting. In the case of top down budgeting, the firm relies on ex ante information about marginal costs and, therefore, uses expected marginal costs to determine its production decisions.

The question we want to answer in this section is: would the firm unambiguously benefit if it could observe the true marginal costs? The answer seems to be affirmative since in this case the firm does not need to rely on the manager’s report and instead could centrally determine the optimal production quantities based on true costs. Notice, however, that in the case of $C < \hat{C}$, the firm chooses participative budgeting in order to elicit a softer pricing response from the supplier. Due to the information asymmetry between the firm and the manager, the firm reduces its expected production quantity and the supplier tries to stimulate demand by decreasing its input price. The benefit of this strategic effect on supplier pricing
is lost if the firm can observe marginal costs and can determine the production quantities based on true marginal costs. The question then arises if the input cost effect can outweigh the detrimental influence of the agency costs due to unobservable marginal costs. We will show in this section that under certain conditions, the firm would rather prefer to ignore information about marginal costs and rely on the manager’s cost report since the information rent works as a pledge against excessive supplier pricing. The solution of the game with observable marginal costs is straightforward. Working backwards, we first derive the firm’s optimal production quantities. Next, we determine the supplier’s price response. Finally, we compare the firm’s profits under observable marginal costs with the firm’s profits under top down budgeting and participative budgeting.

Assume that the supplier charges an input price of $q$. Then, based on its true marginal costs and the supplier price, the firm chooses its production quantities such that its corresponding (monopoly) profit is maximized. The first-order conditions yield the quantities

$$x(q, 0) = \frac{1}{2}(a - q), \quad x(q, C) = \frac{1}{2}(a - C - q),$$

as long as these quantities are nonnegative.\(^{13}\) Next, we determine the supplier’s decision. Again, since the supplier does not observe the firm’s true marginal costs, it cannot condition the input price on marginal costs. Instead, the supplier takes

\(^{13}\)The quantities are zero otherwise. However, this never occurs in equilibrium.
the expected quantity to be purchased by the firm, \( p \cdot x(q, 0) + (1 - p) \cdot x(q, C) \), and determines the profit-maximizing input price. Hence, the supplier maximizes

\[
\Pi^* = \left[ p \cdot \frac{a - q}{2} + (1 - p) \cdot \max\left\{ \frac{a - C - q}{2}, 0 \right\} \right] q.
\]

As in subsection 5.2, it can be shown that there exists a threshold value \( \hat{C}^* := \frac{a}{1 + \sqrt{p}} \) for the firm’s marginal costs such that the supplier’s input price for \( C \leq \hat{C}^* \) is

\[
q_1^* = \frac{a - (1 - p)C}{2}.
\]

while for \( C > \hat{C}^* \) we have

\[
q_2^* = \frac{a}{2}.
\]

Using these input prices, the resulting equilibrium market quantities and the equilibrium profits of the firm and the supplier can be derived. The following lemma summarizes these outcomes and payoffs where the profit of the firm follows from

\[
\Pi_f^* = p(x^*(0))^2 + (1 - p)(x^*(C))^2.
\]

**Lemma 5** If the firm can observe the marginal costs, then there exists a value \( \hat{C}^* := \frac{a}{1 + \sqrt{p}} \) such that the following holds.

(i) For \( C \leq \hat{C}^* \) the firm’s optimal quantities are:

\[
x_1^*(0) = \frac{a + (1 - p)C}{4} \quad \text{and} \quad x_1^*(C) = \frac{a - (1 + p)C}{4}.
\]

The supplier charges the following price for the input: \( q_1^* = \frac{a - (1 - p)C}{2} \). The firm’s
equilibrium profit is

$$\Pi_{f^*} = p \frac{(a + (1 - p)C)^2}{16} + (1 - p) \frac{(a - (1 + p)C)^2}{16},$$

and the supplier’s equilibrium profit is

$$\Pi_{s^*} = \frac{(a - (1 - p)C)^2}{8}.$$

(ii) For $C > \hat{C}^*$ the firm’s optimal quantities are:

$$x_2^*(0) = \frac{a}{4} \quad \text{and} \quad x_2^*(C) = 0.$$  

The supplier charges the following price for the input: $q_2^* = \frac{a}{2}$. The firm’s equilibrium profit is

$$\Pi_{f^*} = pa^2 \frac{a}{16},$$

and the supplier’s equilibrium profit is

$$\Pi_{s^*} = pa^2 \frac{a}{8}.$$  

We note that $\hat{C}^* \geq \hat{C} = a(1 - \sqrt{p})$ with strict inequality for $p \neq 0$ (see the appendix). In fact, $\hat{C}^* = \frac{a}{1 + \sqrt{p}}$ satisfies the assumption $\hat{C}^* < a(1 - p)$ if and only if $p < \frac{1}{2} \left(3 - \sqrt{5}\right) \approx 0.38197$. So the second case of Lemma 5 only occurs for $p < \frac{1}{2} \left(3 - \sqrt{5}\right).$
If the firm can observe the marginal costs, it can condition its production quantity on the true marginal costs without relying on the manager’s report and paying a costly information rent to the manager. In line with intuition, it turns out that the firm’s profit with observable marginal costs is always higher than under top down budgeting. Consider first the case $C \leq \hat{C}^*$. Then the quantity that the supplier expects is the same as under top down budgeting, i.e. $px_1^*(0) + (1 - p)x_1^*(C) = \frac{a - (1 - p)C}{4} = x_{td}$ (see Lemma 1). Consequently, the supplier’s input price is identical, $q_1^* = q_{td}$, and the supplier’s (expected) profit is the same. However, comparing $\Pi_{td}^f$ from Lemma 1 and $\Pi_{td}^f$ from Lemma 5, we can see that the firm’s profit with observable marginal costs is indeed higher than under top down budgeting,

$$\Pi_{td}^f - \Pi_{td}^f = \frac{1}{4}C^2 (1 - p) p \geq 0.$$ 

Consider next the case $C > \hat{C}^*$. Then, we have

$$\Pi_{td}^f - \Pi_{td}^f = p \frac{a^2}{16} - \frac{(a - (1 - p) \cdot C)^2}{16} > p \frac{a^2}{16} - \frac{(a - (1 - p) \cdot \frac{a}{\sqrt{p+1}})^2}{16} = 0,$$

again confirming that the firm’s profit with observable marginal costs is higher.

The following proposition summarizes these findings that contrast with the results reported in Propositions 1 and 2. The proof follows immediately from the arguments provided above and is therefore omitted.

**Proposition 3** If the firm can observe the realization of marginal costs, then the firm always achieves a higher profit than under top down budgeting for all $C \neq 0$. 

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We end this section by highlighting a main message of our analysis. Although the firm suffers from agency costs if only the manager can observe the firm’s marginal costs, in the presence of a third party (here a supplier) the firm might nevertheless prefer this situation of asymmetric information to the situation where it has access to this private information. The reason is that the firm’s “handicap” turns into an advantage and results in a higher profit since it impacts the supplier’s price response. To see this, we consider the range $C \leq \hat{C}$ and compare the firm’s profit if marginal costs are observable, $\Pi_{1}^{f^*}$, with the profit if marginal costs are unobservable and the firm uses participative budgeting, $\Pi_{p,1}^{f}$. Using the profit expressions provided in Lemmas 5 and (4), we get

$$\Pi_{p,1}^{f} - \Pi_{1}^{f^*} = \frac{Cp(2a(p - 1) + C(-3p^2 + 5p + 2))}{16(p - 1)}.$$ 

Setting this expression to zero yields a cutoff value $\tilde{C} = \frac{2a(1-p)}{(2-p)(1+3p)}$ with $C < \tilde{C}$ and $\tilde{C} < \hat{C}$ if $p > \frac{7 - \sqrt{33}}{6} \approx 0.2092$. Consequently, under the condition that $p > \frac{7 - \sqrt{33}}{6}$, there is a range of marginal costs, $\tilde{C} < C < \hat{C}$, where the firm’s profit is higher if marginal costs are unobservable and the firm uses participative budgeting (see Figure 8). Put differently, even if the firm could obtain information about its true marginal costs, the firm would prefer to ignore this information since the resulting agency problem can be used by the firm as a commitment to induce a reduction of the supplier’s input price that outweighs the firm’s agency costs.

**Proposition 4** If the probability $p$ is sufficiently large, i.e. $p > \frac{7 - \sqrt{33}}{6}$, then there exists a value $\tilde{C} = \frac{2a(1-p)}{(2-p)(1+3p)} > C$ such that for $\tilde{C} < C \leq \hat{C}$ the firm’s profit under
participative budgeting and unobservable marginal costs, $\Pi^f_{p,1}$, is higher than the firm’s profit with observable marginal costs, $\Pi^f_{1^*}$.

Figure 9 illustrates Proposition 4. The figure depicts the difference between the profit if the firm can observe marginal costs, $\Pi^f_{1^*}$, and the profit if the firm uses participative budgeting, $\Pi^f_{p,1}$, for increasing marginal costs $C$. As long as $C < \bar{C}$, the firm is better off if it can observe marginal costs and does not suffer from agency costs. However, for $C \geq \bar{C}$ the firm is more profitable with participative budgeting. In this case, the information rent the firm has to pay to the manager to elicit the manager’s private information works as a defense against the supplier’s tendency to charge a high input price.

8 Discussion and concluding remarks

Management accounting research has mainly focused on questions concerning the design of control and incentives within firm boundaries. Broadly speaking, our paper makes the point that a firm interacts with a variety of external non-financial stakeholders like customers, suppliers, and rivals. The decisions that are made within the firm have an impact on the behavior of other stakeholders and, vice versa, decisions made by these external stakeholders influence decisions within the organization. In this sense, we contribute to the emerging line of – mainly empirical – accounting research that studies the interaction between a firm’s corporate policy

The common view in the accounting and economics literature is that participative budgeting may be useful for the principal to elicit information from better-informed lower-level managers but that participative budgeting comes at the cost that a better informed manager has an incentive engage in budget padding. The principal has to allow for slack building to induce a truthful report and this makes participative budgeting costly. Depending on the expected value of the information and the size of the slack, the principal prefers either top down or participative budgeting. In corporate practice, both types of budgeting mechanism are observed supporting the existence of this trade-off.

Empirical research studies the drivers of this trade-off facing the challenge of observability and data availability. However, Shields and Shields (1998) argue that empirical research is also affected by incomplete theory as we simply do not fully understand the range of possible benefits and costs of participative budgeting. While existing models commonly focus on the optimal choice of the budgeting approach based on drivers within firm boundaries, in this paper we offer a novel perspective on budgeting and slack building by highlighting the important interaction between the choice of the budgeting regime and the firm’s input market. We show that the choice of budgeting mechanism has a crucial impact on a supplier’s input price and since supplier pricing impacts the firm’s profit, reflects back on the optimal choice of budgeting approach. In particular, under participative budgeting the firm’s expected production is lower than under top down budgeting and the
supplier tries to stimulate the demand for its input by reducing the input price. This positive effect of participative budgeting together with the positive effect that the principal can condition the production quantity on true (and not expected) marginal production costs has to be traded off against the negative effect of slack building (i.e. paying an information rent to the manager to elicit a truthful report on the true marginal production costs).

A critical assumption in our model is that the supplier is able to observe the firm’s choice of budgeting regime, but not the details of the budgeting process (i.e. the communication between the principal and the manager). For example, based on a firm’s reputation, the market might obtain a signal about the firm’s authoritative or participative leadership style but commonly external parties do not have access to detailed information and communication about the budgeting process. This assumption is in line with the criticism raised about strategic transfer prices where observability of the chosen transfer prices is key. It has been argued (e.g. Göx 2000) that this issue can be resolved if the choice of the method of setting transfer prices (full cost versus marginal cost) can be observed.

Our findings might be able to explain the empirical evidence that corporate practice sometimes allows for slack building of managers despite the fact that headquarters would be able to detect the slack of managers in many cases, see, for example, De With/Dijkman (2008). Furthermore, managers commonly judge slack-building behavior as unethical (e.g. Mittendorf 2006). However, if the consequences of slack building benefit the firm’s bottomline, such ethical concerns of managers regarding slack building are less severe (Walker/Fleischman 2013, 22).
To further highlight the important role of the external supplier for the firm’s choice of budgeting approach, we briefly report on the results for the case of a vertically integrated firm which is able to make the input in-house at marginal costs of zero.\footnote{Note that this assumption makes input production in-house comparable with input production by the supplier in our paper. For brevity, we do not provide the details of the derivations. Calculations are available from the authors.}

Abstracting from internal double marginalization issues, we find several important differences to the case where the firm procures the input from an external supplier. First, a vertically integrated firm always produces independent if marginal costs are high or if marginal costs are low. Consequently, the vertically integrated firm only switches from top down to participative budgeting once. Second, this single switch from top down to participative budgeting occurs for different levels of marginal costs than in the case of an external supplier.\footnote{This threshold value of marginal costs is always between \( C \) and \( \bar{C} \).}

In particular, while in the presence of a supplier the firm switches strategically to participative budgeting at \( C = C \) to induce a softer price response from the external party, the vertically integrated firm switches to participative budgeting at a higher threshold value of marginal costs \( C \).

This threshold value of marginal costs might be even higher than \( \hat{C} \) (which is the case if the probability of low marginal costs \( p \) is sufficiently large), which implies that the vertically integrated firm might switch to participative budgeting while the firm that procures the input from the supplier switched back to top down budgeting. Taken together, the conclusion is that the two scenarios yield quite different predictions about the firm’s optimal budgeting approach highlighting the important role of the external supplier. The third and final difference is that in contrast to the case with a supplier, the vertically integrated firm is always better.
off if it can observe the true marginal costs. This is in line with conventional wisdom as the vertically integrated firm pays an information rent to the manager but is not compensated by a lower input price from the supplier.

9 Proofs

Subsection 5.1: The optimal mechanism under participative budgeting

In this appendix, we are considering the optimal mechanism under participative budgeting for a slightly more general problem than in the main text of the paper. Denote the high marginal costs of the firm by $c_H$ and the low marginal costs by $c_L$, where $c_H > c_L$. Then the firm’s problem is to find a mechanism that solves

$$\max_{B(\cdot),x(\cdot)} p((a - x(c_L) - q)x(c_L) - B(c_L)) + (1 - p)((a - x(c_H) - q)x(c_H) - B(c_H))$$

subject to

(\text{PC}_1) \quad B(c_H) - c_H x(c_H) \geq 0

(\text{PC}_2) \quad B(c_L) - c_L x(c_L) \geq 0

(\text{IC}_1) \quad B(c_H) - c_H x(c_H) \geq B(c_L) - c_H x(c_L)

(\text{IC}_2) \quad B(c_L) - c_L x(c_L) \geq B(c_H) - c_L x(c_H).

We will show that this optimization problem is equivalent to the following uncon-
strained problem

\[
\max_{x(\cdot)} p(a - x(c_L) - q - c_L)x(c_L) + (1 - p)(a - x(c_H) - q - \frac{c_H - p c_L}{1 - p})x(c_L).
\]

We first show that \(PC_2\) can be ignored. The following sequence of inequalities shows that \(PC_2\) follows from \(PC_1\) and \(IC_2\),

\[
B(c_L) - c_L x(c_L) \overset{\text{(IC_2)}}{\geq} B(c_H) - c_L x(c_H) > B(c_H) - c_H x(c_H) \overset{\text{(PC_1)}}{\geq} 0.
\]

Therefore, we can ignore \(PC_2\). We next prove that the production quantity in case of high marginal costs is smaller than for low marginal costs, i.e. \(x(c_H) \leq x(c_L)\). Let us indirectly assume the opposite, \(x(c_H) > x(c_L)\). Then we have

\[
B(c_H) - c_H x(c_H) \overset{\text{(IC_1)}}{\geq} B(c_L) - c_H x(c_H) + B(c_L) - B(c_H) \\
\overset{\text{(IC_2)}}{\geq} B(c_H) - c_H x(c_H) + c_L (x(c_L) - x(c_H)) < 0.
\]

Taken together, these inequalities show that \(c_L (x(c_H) - x(c_L)) \geq c_H (x(c_H) - x(c_L))\).

Hence, \(c_L \geq c_H\), which yields a contradiction. Therefore, we can conclude that \(x(c_H) < x(c_L)\). Finally, we show that \(IC_1\) can be ignored. The smallest possible choices for \(B(c_L)\) and \(B(c_H)\) that satisfy \(PC_1\) and \(IC_2\) (and as we already know \((PC_2)\) are such that \(PC_1\) and \(IC_2\) are binding. This yields \(B(c_H) = c_H x(c_H)\) and \(B(c_L) = c_L x(c_L) + (c_H - c_L)x(c_H)\). It is easy to see that these budgets satisfy \(IC_1\). Hence, we have found the optimal solution. Inserting these budgets
into the firm’s objective function yields the unconstrained problem stated above. □

**Proof of Lemma 2:** We first derive the supplier’s locally optimal input price in region 1 (i.e., \( q \leq a - \frac{C}{1-p} \)). In this region, the objective function is given by the first line in (3), which can be rewritten as \( E[\Pi(x, c)] = \frac{1}{2}(a - C - q)q \). The first order condition yields the input price \( q_{p,1} = \frac{a-C}{2} \) as long as this value is in region 1, i.e., as long as \( q_{p,1} = \frac{a-C}{2} \leq a - \frac{C}{1-p} \). This latter condition translates into the requirement that \( C \leq \frac{a(1-p)}{1+p} \). Since the objective function in region 1 is concave, this is the locally optimal value in region 1 as long as \( q_{p,1} \) is in region 1. If this is not the case, then the locally optimal input price in region 1 is attained at the upper bound of the region (\( q_1 = a - \frac{C}{p} \)).

Second, we derive the supplier’s locally optimal input price in Region 2 (i.e., for \( a \geq q > a - \frac{C}{1-p} \)) where the firm only produces under low marginal costs. The objective function is given by the second line in (3) and the first order condition yields the input price \( q_{p,2} = \frac{a}{2} \). Since the objective function is concave, this is the locally optimal input price in region 2 as long as the value \( q_{p,2} = \frac{a}{2} \) is in region 2, i.e., as long as \( \frac{a}{2} > a - \frac{C}{1-p} \). This translates into the requirement that \( C > \frac{a(1-p)}{2} \).

If the local optimum is not in region 2, the local optimum is attained at the lower bound of the region, i.e., \( q_2 = a - \frac{C}{1-p} \). □

**Proof of Proposition 2:** It remains to be shown that
\( \hat{C} = \frac{a}{1 + \sqrt{p}} < C_{\text{max}} = a(1 - p) \)

if and only if \( p < \frac{3 - \sqrt{5}}{2} \). It is not difficult to show that \( \frac{1}{1 + \sqrt{p}} = 1 - p \) if and only if \( p = 0 \) or \( p = \frac{3 - \sqrt{5}}{2} \). Substituting \( p = Q^2 \) yields

\[
1 - (1 - p)(1 + \sqrt{p}) = Q \left( Q^2 + Q - 1 \right).
\]

The polynomial is strictly positive for \( Q = 1 \) and its derivative

\[
\frac{\partial}{\partial Q} Q \left( Q^2 + Q - 1 \right) = -1 + Q + Q^2 + Q(1 + 2Q)
\]

is negative for \( Q = 0 \). Therefore \( \frac{1}{1 + \sqrt{p}} < 1 - p \) if and only of \( 0 < p < \frac{3 - \sqrt{5}}{2} \). This finishes the proof. \( \square \)

**Proof of Lemma 5.** The proof of Lemma 5 follows along the lines of the proof of Lemma 2. The value \( \hat{C}^* \) is the unique solution of the equation

\[
\Pi_{1}^{*} = \frac{1}{8} (a - C(1 - p))^2 = p\frac{a^2}{8} = \Pi_{2}^{*}
\]

that satisfies \( a - C(1 - p) > 0 \). We have

\[
\hat{C} = a(1 - \sqrt{p}) < \hat{C}^* = \frac{a}{1 + \sqrt{p}}
\]

if and only if \( a(1 - p) < a \) which is satisfied for all \( p \neq 0 \). \( \square \)
Proof of Proposition 4

For \( C \leq \hat{C}^* \) we can calculate

\[
\Pi_{1}^{f} - \Pi_{1}^{f*} = \frac{(a - C)^2 - p(a - 3C)(a + C)}{16(1 - p)} - \left( p \frac{(a + (1 - p)C)^2}{16} + (1 - p) \frac{(a - (1 + p)C)^2}{16} \right) = \frac{C p (2a(p - 1) + C (-3p^2 + 5p + 2))}{16(p - 1)}.
\]

This difference is positive if and only if

\[
C > \hat{C} : = \frac{2a(1 - p)}{(2 - p)(1 + 3p)}.
\]

It remains to compare the threshold value \( \hat{C} \) with \( \overline{C} \) (see also Figure 8).

Recall that \( \overline{C} = \frac{2a(1-p)}{6-(3-p)p} \) and \( \hat{C} = a(1 - \sqrt{p}) \). Comparing the first two values, we get

\[
\hat{C} - \overline{C} = \frac{8(1 - p)^3}{(2 - p)(1 + 3p)(6 - (3 - p)p)} \geq 0.
\]

For the second comparison, we have

\[
\hat{C} - \hat{C} = \frac{2a(1 - p)}{(2 - p)(1 + 3p)} - a(1 - \sqrt{p}).
\]

This difference equals 0 if and only if
2(p − 1) − (1 − \sqrt{p}) (3p^2 − 5p − 2) = 0. \quad (7)

It is not difficult to show that the above equation has exactly the following three zeros:

\[ p = 1, p = 0, \text{and } p = \frac{1}{6} \left( 7 - \sqrt{33} \right). \]

and that the derivative of \( \tilde{C} - \hat{C} \) is \( \infty \) for \( p = 0 \). Also, substituting \( p = Q^2 \) in (7) yields the polynomial (as is easily checked)

\[ (Q − 1)^2 Q \left( 3Q^2 + 3Q − 2 \right). \]

Since this has a single root at \( \frac{1}{6} \left( \sqrt{33} − 3 \right) \) the derivative cannot be zero at \( \frac{1}{6} \left( \sqrt{33} − 3 \right) \). Therefore, it must be strictly increasing or strictly decreasing at \( Q = \frac{1}{6} \left( \sqrt{33} − 3 \right) \) and (since a polynomial is continuously differentiable) this also holds in a neighborhood of \( Q = \frac{1}{6} \left( \sqrt{33} − 3 \right) \). Since it is strictly positive for \( Q < \frac{1}{6} \left( \sqrt{33} − 3 \right) \) it must be decreasing and therefore for \( Q > \frac{1}{6} \left( \sqrt{33} − 3 \right) \) the polynomial is negative. This translates directly to the difference \( \tilde{C} - \hat{C} \). Therefore, \( \tilde{C} - \hat{C} \) is negative for \( p > \frac{7 - \sqrt{33}}{6} \). □
10 References


Waldman, M.: Theory and Evidence in Internal Labor markets, in: Gibbons,


11 Figures

Figure 1: Illustration of the results reported in Lemma 2

$q_{p,1} = \frac{a - C}{2}$  
$q_{p,1} = a - \frac{C}{1-p}$

$q_2 = a - \frac{C}{1-p}$  
$q_2 = \frac{a}{2}$

Region 1  
Region 2  

$0$  
$\hat{C}$  
$a(1-p)$  
$a(1-p)$  
$C$  
$a(1-p)$  
$a(1-p)$
Figure 2: Supplier’s expected profit as a function of the supplier’s price $q$ for the parameters $a = 6$, $p = 0.4$ and $C = 1.5$. The value of $C = 1.5$ is sufficiently small such that only the lower local maximum at $q = 2.25$ is feasible. This has to be the global maximum.
Figure 3: Supplier’s expected profit as a function of the supplier’s price $q$ for the parameters $a = 6$, $p = 0.4$ and $C = 2.8$. For the value of $C = 2.8$, only the upper local maximum at $q = 3$ is feasible. This has to be the global maximum.
Figure 4: Supplier’s expected profit as a function of the supplier’s price $q$ for the parameters $a = 6$, $p = 0.4$ and $C = \hat{C} = a(1 - \sqrt{p}) \approx 2.20527$. The value of $C \approx 2.20527$ is the unique value for which the supplier is indifferent between the two local maxima at $q \approx 1.89737$ and at $q = 3$. 
Figure 5: Illustration of the results reported in lemma 3.
Figure 6: The figure shows the input price $q_{td}$ in case of top-down budgeting (dashed line) and the input prices $q_{p,1}$ and $q_{p,2}$ in case of participative budgeting (bold line) as a function of the marginal costs $C$ for $a = 6$ and $p = 0.4$. 
Figure 7: Difference of the firm’s expected profits under participative budgeting \( \Pi_{p,1}^f \) and under top-down budgeting \( \Pi_{td}^f \) as a function of \( C \) for \( a = 4, p = 0.4 \) and \( C \leq \hat{C} \).
The top-down budgeting is optimal for the firm in the case $p < \frac{3 - \sqrt{5}}{2}$. 

Figure 8: Regions of marginal costs $C$ in which participative (top-down) budgeting is optimal for the firm in the case $p < \frac{3 - \sqrt{5}}{2}$. 

\[
0 < C = \frac{2a(1-p)}{6-(3-p)p} \quad \hat{C} \quad C = \frac{a}{1+\sqrt{p}}
\]
Figure 9: Difference between the firm’s expected profits if the true marginal costs can be observed and under participative budgeting ($\Pi_{f}^{*} - \Pi_{p,1}^{f}$) for $a = 6$ and $p = 0.4$ in the case $C \leq \hat{C}$. For $C > \hat{C}$ the firm is more profitable if only the manager (but not the firm) can observe the true marginal costs.