



Article

Product Market Competition and Commodity Hedging: Evidence from the Metals Industry

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Abstract

This study examines the associations among product market competition, commodity hedging, and income smoothing in the metals industry. Using a text-based measure of competition intensity, we find that firms facing stronger competitive pressures are more likely to hedge commodity price risk. We also find a positive association between commodity hedging and income smoothing through discretionary accruals, suggesting a complementary relationship in reducing performance volatility. Moreover, this positive association weakens as product market competition intensifies. Collectively, these results contribute to our understanding of the associations between product market competition, firms' risk management, and financial reporting behavior.

Keywords: product market competition; commodity hedging; income smoothing; risk management; metals industry

1. Introduction

Product market competition plays an important role in shaping managerial behavior. Prior research suggests that competition can serve as an external disciplinary mechanism that influences a wide range of corporate decisions. For example, [Giroud and Mueller \(2011\)](#) show that the positive association between corporate governance and key outcomes, including firm value and operating performance, declines monotonically with the intensity of product market competition. Similarly, [Chhaochharia et al. \(2012\)](#) find that firms operating in less competitive industries experience larger efficiency gains following the implementation of the Sarbanes–Oxley Act, while [Ammann et al. \(2013\)](#) document that the value-enhancing effect of corporate governance is concentrated in non-competitive industries. Collectively, these studies suggest that product market competition affects managerial behavior and corporate decision-making.

Despite this evidence, relatively little is known about how product market competition influences firms' risk-management choices. This question is particularly important in industries exposed to substantial commodity price risk, where managers may employ commodity hedging and earnings management to mitigate earnings volatility and maintain a competitive position. Accordingly, this paper examines whether and how product market competition influences managerial risk-management behavior through these two channels.



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Prior literature highlights several benefits of hedging for risk-management purposes. [Smith and Stulz \(1985\)](#) argue that derivative hedging can increase firm value by mitigating adverse shocks and reducing the likelihood of financial distress. [Allayannis and Weston \(2001\)](#) further contend that hedging improves the alignment of cash inflows and outflows, thereby reducing firms' reliance on costly external financing. Consistent with these arguments, [Graham and Rogers \(2002\)](#) provide empirical evidence that derivative usage stabilizes cash flows and earnings streams and, in turn, lowers firms' borrowing costs.

Firms may engage in commodity hedging to mitigate negative shocks associated with competition in product markets. Intensified price competition compresses profit margins, which heightens firms' sensitivity to exogenous input-cost shocks, such as fluctuations in material prices. As margins shrink, firms in highly competitive markets become increasingly sensitive to cost volatility ([Gaspar & Massa, 2006](#); [Irvine & Pontiff, 2009](#)). Commodity hedging can therefore serve as an effective tool for stabilizing cash flows and earnings by offsetting adverse movements in material prices.

We focus on commodity hedging because it primarily protects firms from supply-side risk, whereas other hedging strategies, such as currency hedging, can reflect both supply-side and demand-side exposures. Consistent with this distinction, we verify that all firms in our sample use commodity derivatives to manage procurement-side exposures in their production processes, while none of these firms engage in commodity hedging related to sales-side exposures. This institutional feature provides a cleaner setting to assess how product market competition affects supply-side risk management.

In addition to commodity hedging, managers may respond to competitive pressure by smoothing reported income through discretionary accruals. Intensified competition may increase incentives to manage reported performance in order to maintain firms' relative standing. [Shleifer \(2004\)](#) further argues that career concerns are particularly salient in highly competitive industries and may induce managers to engage in earnings manipulation. Prior empirical evidence provides support for this view. [Markarian and Santaló \(2014\)](#) find that competitive environments increase firms' propensity to engage in accrual-based earnings management, especially when managers' compensation is closely tied to short-term market outcomes. Likewise, [Shi et al. \(2018\)](#) document that product market competition is positively associated with accounting irregularities and accrual-based earnings management. Collectively, these studies suggest that competition may induce managers to distort financial reporting to mask its adverse effects on firm performance.

However, commodity hedging and income smoothing differ along several dimensions as mechanisms to mitigate the adverse effects of product market competition. Derivative hedging involves real operating commitments, whereas accrual-based income smoothing reflects accounting adjustments without changes in the underlying operations. The use of discretionary accruals is inherently constrained by firms' prior reporting choices and the degree of accounting flexibility, which can limit managers' ability to rely on this tool in current or future periods ([Dechow et al., 1995](#); [Barton & Simko, 2002](#)). By contrast, hedging activities are constrained by firms' financial capacity, as weaker firms may lack the liquidity to implement hedging strategies. These different constraints imply that managers' cost-benefit trade-offs are central to the choice of instruments used to mitigate shocks arising from product market competition. Accordingly, we examine commodity hedging and accrual-based income smoothing as two salient mechanisms for managing competition-related risk and assess whether they operate as complements or substitutes.

Consistent with prior research advocating industry-specific analysis (e.g., [Campbell et al., 2019](#)), we focus on firms in the metals industry, where commodity input costs are economically crucial to their operations. We select this setting because other industries with high commodity-hedging intensity (e.g., energy and agriculture) are subject to pervasive

regulatory oversight or exhibit unique features (e.g., perishability) that may confound inferences. We measure competitive intensity using product market fluidity, a text-based metric derived from firms' 10-K disclosures, developed by [Hoberg et al. \(2014\)](#). We also control for sub-industry variation in the Herfindahl–Hirschman Index and other characteristics within the metals industry.

Using a panel dataset of metals-industry firms from 2001 to 2021, we find that greater product market competition is associated with more intensive use of commodity hedging. The hedging evidence contrasts with the findings of [Haushalter et al. \(2007\)](#), who document a positive association between industry concentration and the use of currency derivatives.¹ In our setting, firms are more likely to employ commodity hedging to stabilize input costs and protect their margins when they face stronger competitive pressure in product markets.

Moreover, we find that commodity hedging and income smoothing operate as complements: firms that engage more extensively in accrual-based income smoothing are also more likely to use derivatives for hedging purposes. However, additional analyses indicate that the positive association between derivative usage and income smoothing attenuates as product market competition intensifies. This attenuation is consistent with theoretical predictions that heightened competition enhances financial transparency and market monitoring ([Fama, 1980](#); [Bushman & Smith, 2001](#)), thereby constraining managers' discretion to deploy both commodity hedging and income smoothing simultaneously.

Product market competition, commodity hedging, and income smoothing are likely jointly determined, raising concerns about endogeneity and biased inferences in standard single-equation models. Firms facing intense competition may simultaneously adjust their risk-management policies and financial reporting strategies, while unobserved firm characteristics could influence both decisions. To address these concerns, we employ a seemingly unrelated regression (SUR) framework to examine cross-equation dependence and assess whether these decisions are systematically interrelated. We then implement a two-stage residual inclusion (2SRI) approach within a nonlinear framework to address potential endogeneity in the commodity-hedging equation, which features a binary dependent variable. Together, these approaches provide additional evidence regarding the robustness of the documented associations.

This study makes two main contributions. First, to the best of our knowledge, it provides novel evidence on commodity-derivative usage through the lens of product market competition. A closely related study, [Haushalter et al. \(2007\)](#), examines how competitive threats shape corporate cash holdings and currency-derivative policies. In contrast, our study focuses on how competitive pressure informs commodity-hedging behavior. Commodity hedging primarily addresses input-cost risk, whereas currency hedging reflects exposure related to foreign sales as well as foreign purchases. Our results thus provide more direct evidence of hedging in response to input-side risk rather than output-side risk.

Second, our findings extend the earnings management literature by documenting how firms jointly use commodity hedging and discretionary accruals in response to competitive dynamics. This perspective advances understanding of how managers employ both financial-contract-based and accrual-based mechanisms when navigating heightened product market competition. Our evidence also suggests two distinct associations involving product market competition and firms' risk-management activities. First, greater product market competition is positively associated with firms' use of commodity hedging. Second, the positive association between income smoothing and commodity hedging becomes weaker as product market competition increases.

The remainder of the paper proceeds as follows. The next section reviews the relevant literature and develops the hypotheses. Section 3 describes the empirical design and

methodology. Section 4 presents the main results, and Section 5 reports robustness analyses. The final section concludes the paper.

2. Related Literature and Hypothesis Development

2.1. Product Market Competition and Firm Value

Product market competition can affect firm value through both adverse and beneficial channels. On the one hand, intensified competition reduces a firm's ability to exercise pricing power, thereby squeezing profit margins (Porter, 1980), and increases the likelihood of financial distress (Schmidt, 1997). Irvine and Pontiff (2009) provide evidence that more intensive competition lowers expected profits and increases firms' exposure to default risk. On the other hand, competitive pressure can mitigate agency problems by aligning managerial incentives more closely with shareholder interests. Raith (2003) demonstrates that managers operating in highly competitive markets face stronger incentives to eliminate inefficiencies and pursue value-enhancing, positive net present value projects. Consequently, higher levels of competition are associated with lower agency costs. This reasoning underlies prior studies showing that competition can serve as a partial substitute for formal corporate governance mechanisms (Ammann et al., 2013; Byun et al., 2012; Chou et al., 2011; Giroud & Mueller, 2011). The related theory characterizes product market competition as an external disciplinary force on managerial behavior (Hart, 1983; Raith, 2003), while empirical evidence indicates that competitive pressure can offset weaknesses in internal governance (e.g., Giroud & Mueller, 2011).

2.2. Product Market Competition and Commodity Hedging

Prior to the mandatory adoption of Statement of Financial Accounting Standards No. 133 (FASB, 1998), it was difficult to systematically identify firms' commodity hedging activities because many commodity-based contracts fell outside the scope of prevailing accounting standards. This limitation did not imply the absence of commodity hedging, but rather reflected the narrow definition of derivative instruments under earlier standards. In particular, contracts requiring the physical delivery of nonfinancial goods were often treated as executory contracts rather than derivative instruments and thus were not subject to recognition or detailed disclosure requirements. With the implementation of SFAS 133 for fiscal years beginning after 15 June 2000, firms were required to recognize most derivative instruments at fair value and provide substantially expanded disclosures, thereby increasing the visibility of commodity hedging activities.²

Prior research has explored the role of market competition in shaping derivative hedging. Allayannis and Ihrig (2001) posit that firms in highly competitive industries have stronger incentives to hedge, whereas Adam et al. (2007) show that the effect of competition on hedging can be either positive or negative, depending on the underlying equilibrium conditions. Specifically, while hedging can reduce risk and stabilize firm performance, it may also affect firms' strategic flexibility and competitive interactions, potentially reducing the incentive to hedge in certain settings. Although theoretical models therefore offer mixed predictions, both studies suggest that the competitive environment plays an important role in shaping firms' hedging decisions. In settings characterized by substantial commodity-price exposure, however, stabilizing earnings and cash flows may become increasingly important as competitive pressure intensifies, suggesting a greater incentive to hedge. For instance, Brown (2001) provides a case study showing that a major U.S. durable goods manufacturer bases its foreign exchange hedging decisions primarily on competitive pricing considerations in the product market, rather than on conventional hedging theories. Haushalter et al. (2007) further examine how interdependence among industry competitors shapes firms' financial policies. They find that firms whose growth

prospects are closely linked to those of their rivals are more likely to use currency derivatives or retain substantial cash buffers.

Despite these advances, the impact of product market competition on commodity hedging remains underexplored. Much of the focus in [Haushalter et al. \(2007\)](#), for instance, is on currency derivatives and their links to growth opportunities shaped by competitors. As a result, the interaction between commodity derivatives and product market competition has received limited attention.

For manufacturing firms, material costs are a key determinant of profit margins. Firms that cannot readily mitigate commodity-price risk through alternative operational mechanisms, such as passing higher input costs on to customers or diversifying suppliers, are particularly vulnerable to fluctuations in commodity prices. As product market competition intensifies, maintaining competitive pricing becomes increasingly important, which may further limit firms' ability to offset adverse cost shocks. Consequently, unexpected increases in commodity prices may have a greater impact on profitability in more competitive product markets. Under these circumstances, firms may have stronger incentives to use commodity derivatives to reduce input-price uncertainty and stabilize operating performance. Commodity derivative hedging therefore represents a key mechanism for managing input-price volatility. As product market competition intensifies, firms are expected to increase their use of commodity hedging to stabilize input costs and protect profitability. Such derivative usage can enhance firm value by buffering against adverse shocks and reducing the probability of financial distress ([Smith & Stulz, 1985](#); [Allayannis & Weston, 2001](#)). Unlike accrual-based earnings management, however, commodity hedging entails real operational and investment commitments, and it may not always generate net benefits given its associated costs. Building on this insight, this study examines whether heightened product market competition incentivizes firms to undertake commodity hedging activities. Accordingly, we propose the following hypothesis:

H1. *Firms exposed to more intense product market competition are more likely to engage in commodity hedging.*

2.3. Product Market Competition and Earnings Management

Intensified product market competition may also create incentives for managers to engage in earnings management to protect their firms' competitive positions. [Shleifer \(2004\)](#) further argues that career concerns in highly competitive industries can induce managers to manipulate reported performance. Empirical studies generally support this view. [Datta et al. \(2013\)](#) document that firms with stronger pricing power, or those operating in less competitive industries, exhibit a lower propensity to manipulate earnings through discretionary accruals. [Markarian and Santaló \(2014\)](#) similarly find that stronger competitive pressures increase accrual-based earnings management, particularly among managers whose compensation depends heavily on short-term market performance. [Shi et al. \(2018\)](#) further show that product market competition is associated with higher levels of accrual-based earnings management but lower levels of real earnings management. [Li and Walton \(2023\)](#) provide similar evidence that firms operating in more competitive environments have a higher likelihood of restatements and internal control weaknesses. Collectively, this literature suggests that competition can distort financial reporting practices and serve as an important external influence on managerial behavior.

In contrast, if product market competition disciplines managers, it may weaken incentives to engage in aggressive financial reporting. [Lakshmana and Yang \(2014\)](#) find that both accrual-based and real activity-based manipulation are more prevalent in less competitive industries. [El Diri et al. \(2020\)](#) similarly report that firms operating in less competitive markets use more accrual and real earnings management than those in more

competitive markets. Consistent with the disciplinary role of competition, they further find that corporate governance is more effective in mitigating earnings management in less competitive markets.

Against this backdrop, managers' cost-benefit assessments become central to their strategic responses to product market competition. In this context, earnings management emerges as an important mechanism through which managers respond to competitive pressure.

2.4. Competition, Commodity Hedging, and Income Smoothing

Prior research shows that managers frequently engage in income smoothing to reduce earnings volatility, often driven by career-related incentives. Fudenberg and Tirole (1995) present a model in which managers smooth earnings because of job security concerns and the private benefits of control. Ahmed et al. (2006b) provide empirical evidence that when managers face job security concerns due to more intensive product market competition, their firms exhibit a higher degree of income smoothing. Financial derivatives can serve a similar function by enabling managers to mitigate risk and stabilize reported performance. This parallel motivates the question of whether commodity hedging and income smoothing operate as complements or substitutes under competitive pressure.

Barton (2001) provides early evidence that managers treat derivative use and discretionary accruals as partial substitutes in smoothing earnings streams. Consistent with this view, Pincus and Rajgopal (2002) find that oil and gas companies use abnormal accruals and derivative hedging interchangeably to manage reported earnings. Lambert (1984) further argues that firms have incentives to employ both accounting-based choices and real operational actions to produce smoother income streams. Related research similarly indicates that firms rely on accounting adjustments and operational decisions—including discretionary accruals and real activities adjustments—to moderate earnings fluctuations (Zang, 2012; Shi et al., 2018).

However, the choice among these tools involves trade-offs. Real activities adjustments, such as derivative hedging, involve tangible operational and investment decisions, and the benefits of reducing earnings volatility may not always outweigh the associated costs; accordingly, derivative hedging may represent a relatively costly income-smoothing mechanism for some firms. In contrast, discretionary accruals are subject to greater scrutiny from external stakeholders due to the degree of managerial discretion involved. When firms face a trade-off between accrual-based and real activity-based income smoothing, managers are likely to optimize their use of accrual-based tools given the costs and constraints associated with real activities. Overall, firms' choices among these mechanisms depend on their economic environments and the relative costs and benefits of each approach.

Although Pincus and Rajgopal (2002) document a substitutive association between abnormal accruals and derivative use in the oil and gas industry, their results may not generalize to the metals industry, given differences in regulatory conditions and competitive dynamics. Specifically, the metals industry faces fewer federal or state pricing restrictions and operates under distinct competitive pressures relative to the oil and gas industry. In this setting, firms may focus more directly on the net benefits of alternative responses to competitive pressure. Heightened product market competition may increase firms' demand for earnings stability while simultaneously strengthening incentives to hedge commodity-price risk. To the extent that commodity hedging reduces earnings volatility arising from commodity-price fluctuations, managers may rely less on discretionary accrual-based income smoothing. Consequently, even if commodity hedging and income smoothing are used jointly, the positive association between the two mechanisms may weaken as product market competition intensifies. At the same time, competitive pressure may also encourage firms to employ both mechanisms jointly. Ultimately, whether commodity hedging and

income smoothing function as substitutes or complements remains an empirical question. Based on the preceding discussion, we propose the following two competing hypotheses:

H2a. *Firms that engage in greater income smoothing are less likely to use commodity hedging as a response to increased product market competition (a substitutive relation).*

H2b. *Firms that engage in greater income smoothing are more likely to use commodity hedging as a response to increased product market competition (a complementary relation).*

3. Sample Selection, Measurement, and Research Design

3.1. Research Setting

Existing derivatives research largely focuses on industry-specific analyses. For instance, Campbell et al. (2019) note that prior research largely concentrates on specific sectors such as oil and gas, mining, airlines, and financial institutions. These industries are characterized by intrinsic risk exposures related to their core operations, the existence of liquid derivatives markets that support cost-effective hedging strategies, and a high prevalence of derivative usage prompted by the substantial price volatility of the underlying assets.

We select the industry for our empirical tests based on the availability and liquidity of exchange-traded futures markets, focusing on commodities with actively traded derivatives. Using Bloomberg futures data—specifically, information on contract availability, trading volume, and open interest across commodity categories (Bloomberg, Commodity Futures: Metals, Energy, and Agriculture)—we find that energy products, agricultural commodities, and industrial metals constitute the primary categories of actively traded commodity derivatives. However, both the energy and agricultural sectors exhibit distinctive institutional features that make them less suitable for analyzing firms' commodity derivative hedging behavior. Energy markets are subject to extensive regulatory oversight at the federal, state, and international levels, including price controls and restrictions on market participation, which substantially constrain managerial discretion. In the agricultural sector, firms typically operate with numerous supplier contracts and deal with perishable inputs, conditions that often grant firms greater bargaining power relative to their suppliers and reduce incentives to hedge commodity price risk. As a result, hedging activities in energy and agricultural commodities may be influenced by regulatory and contractual factors that confound our analysis. Accordingly, we focus on industrial metals, where liquid, well-developed futures markets allow firms' hedging decisions to more directly reflect discretionary risk management considerations.

Moreover, firms in the metals industry tend to use commodity derivatives more frequently than firms in other industries. For instance, empirical data collected for this study show that the proportion of firms engaged in commodity hedging in the metals industry is 25.8%, compared with only 8.8% in the agricultural sector. Consequently, focusing our empirical analysis on the metals industry enhances the robustness of our findings by reducing the likelihood that the results are driven by a relatively small subset of firms that engage in hedging.

3.2. Sample Selection

We begin by identifying all Compustat-listed firms in the metals industry (SIC codes 3300–3499) for fiscal years 2001–2021. The metals industry includes the primary metal industries (SIC codes 3300–3399) and the fabricated metal products industry (SIC codes 3400–3499). Our sample period begins in 2001 because the disclosure requirements for derivatives before 2001 were substantially different from those after 2001 (as discussed

in Section 2). Our sample period ends in 2021, which is the last available year when we started this research.

Commodity derivatives data are manually collected from SEC filings. We primarily extract this information from the notes to financial statements, which provide the most detailed disclosure on commodity derivatives. We also use Item 7A, “Quantitative and Qualitative Disclosures About Market Risk,” in 10-K filings to verify our data collection. For firms without explicit disclosure of derivatives usage, we further review Item 7A to identify potential hedging activities and confirm non-engagement in such activities.

During the screening process, we also identify firms whose disclosures indicate that commodity price risk is primarily managed through operational mechanisms rather than derivative contracts. Specifically, we review firms’ 10-K filings to identify language suggesting that management mitigates input price fluctuations by (i) passing cost increases on to customers, (ii) relying on diversified supplier bases, or (iii) employing other operational strategies that reduce exposure to commodity price risk.

To enhance transparency, we implement a structured, text-based screening procedure. We construct a coding dictionary consisting of keywords and phrases commonly associated with operational risk management (e.g., “pass-through pricing,” “supplier diversification,” and “long-term supply agreements”) and commodity derivative usage (e.g., “futures contracts,” “hedging instruments,” and “derivative contracts”), as well as semantically equivalent terms conveying the same meaning. Each firm-year observation is manually reviewed and classified based on the predominant risk management mechanism reflected in its disclosures. Appendix B provides representative disclosure excerpts illustrating both included and excluded observations, together with the corresponding coding rationale.

Because firms that primarily rely on operational mechanisms may not use commodity derivatives as their primary risk management tool, their inclusion could introduce heterogeneity that is not central to our research question. Accordingly, we exclude these firms to maintain a relatively homogeneous setting in which commodity derivatives are more likely to represent the primary mechanism for managing commodity price risk. We also exclude observations with missing values for variables required in the empirical analyses. Table 1 summarizes the detailed sample selection process.³

Table 1. Sample Selection Process.

Sample Selection Criteria	Observations
Initial observations in the metals industry (SIC codes 3300–3499) from Compustat	16,667
Exclude observations with missing data required to construct the following variables:	
• Total revenue; • Cost of goods sold; • Total assets; • Common stock outstanding; • Total property plant and equipment; • Total receivables; • Product market fluidity; • Income smoothing; • Book value; • Market value.	4859
Keep firms whose hedging incentives are economically meaningful under the following conditions:	
• The firm is exposed to input commodities with active hedging markets. • The firm has limited ability to substitute inputs or switch suppliers. • The firm has limited ability to pass input cost increases to customers. • The absence of hedging is not explained by disclosures in the notes (e.g., statements about passing costs to customers or relying on various suppliers).	1779

3.3. Measurement of Product Market Competition

We measure the degree of product market competition using the text-based variable, *FLUIDITY*, following Hoberg et al. (2014). This variable captures the evolution of competitive threats by examining changes in the vocabulary used to describe products in 10-K filings, thereby reflecting shifts in a firm's product market positioning relative to its competitors. Using cosine similarity among product-related words, *FLUIDITY* measures the overlap and change in product-related disclosures, with higher values indicating a more dynamic, rapidly evolving, and competitive product market environment. Cosine similarity is a measure of textual similarity that increases as firms use more similar product-related language in their disclosures. Thus, higher *FLUIDITY* values suggest that competitors are increasingly converging in their product offerings and competitive positioning. Notably, *FLUIDITY* is defined at the firm-year level, unlike the traditional industry-year measures of competition described below.⁴

We also consider several industry-level characteristics that might influence firms' incentives to use commodity derivatives and engage in income smoothing. We first consider the Herfindahl–Hirschman Index (*HHI*), which quantifies industry concentration at the 4-digit SIC level. Although *HHI* is often used as an inverse measure of industry-level competition (e.g., Giroud & Mueller, 2010, 2011; Markarian & Santaló, 2014; El Diri et al., 2020), it is also criticized for its construct validity (e.g., Demsetz, 1973; Einav & Levin, 2010) and measurement problems (e.g., Ali et al., 2009). Therefore, we use *HHI* as a control variable rather than a direct measure of competition. Moreover, following Karuna (2007), we use three additional control variables at the 4-digit SIC industry level: product differentiation (*DIFF*), product market size (*MKTSIZE*), and entry costs (*ENTCOST*). As Raith (2003) points out, these variables may capture different dimensions of product market competition. Therefore, our analysis based on *FLUIDITY* provides conservative results in that we control for industry-level characteristics that might capture product market competitiveness. See Appendix A for detailed definitions of all our research variables.

3.4. Empirical Models

In our empirical analysis, we employ a logistic regression framework to investigate the relationship among commodity derivatives hedging, product market competition, and income smoothing. Specifically, we use the following two logistic regression specifications to test our hypotheses.

$$\begin{aligned} DRV = & \beta_0 + \beta_1 FLUIDITY + \beta_2 SMTH + \beta_3 HHI + \beta_4 DIFF \\ & + \beta_5 MKTSIZE + \beta_6 ENTCOST + \beta_7 SIZE + \beta_8 VOL + \beta_9 BM + \beta_{10} RET \\ & + \beta_{11} ROA + \text{Year Fixed Effects} + \text{Industry Fixed Effects} + \varepsilon \end{aligned} \quad (1)$$

$$\begin{aligned} DRV = & \beta_0 + \beta_1 FLUIDITY + \beta_2 SMTH + \beta_3 FLUIDITY \times SMTH + \beta_4 HHI + \beta_5 DIFF \\ & + \beta_6 MKTSIZE + \beta_7 ENTCOST + \beta_8 SIZE + \beta_9 VOL + \beta_{10} BM + \beta_{11} RET \\ & + \beta_{12} ROA + \text{Year Fixed Effects} + \text{Industry Fixed Effects} + \varepsilon \end{aligned} \quad (2)$$

where the dependent variable *DRV* is a binary indicator that equals one if a firm engages in commodity derivatives hedging activities during the period, and zero otherwise. We focus on firms' participation in commodity derivatives hedging rather than the magnitude of hedging positions because firms disclose hedging information using heterogeneous units and reporting formats, making notional amounts difficult to compare consistently across observations. Accordingly, a binary measure provides a more consistent and comparable indicator of hedging activity across firms while mitigating measurement error arising from disclosure differences.⁵ *FLUIDITY* represents product market fluidity, as described in the preceding subsection. Higher values of *FLUIDITY* indicate more dynamic and competitive

market conditions, characterized by frequent shifts in competitive threats and product positioning. *SMTH* denotes income smoothing, measured as the Spearman correlation between changes in discretionary accruals and changes in pre-managed income (Tucker & Zarowin, 2006). This measure captures the extent to which managers use discretionary accruals to offset fluctuations in pre-managed earnings. A stronger negative correlation indicates a greater tendency to smooth reported earnings by increasing discretionary accruals when pre-managed earnings are low and decreasing discretionary accruals when pre-managed earnings are high.⁶ Pre-managed income is computed as net income minus discretionary accruals. Discretionary accruals are estimated as the residuals from the performance-adjusted modified Jones model of Kothari et al. (2005), estimated by industry-year (2-digit SIC). Following Tucker and Zarowin (2006), we transform the Spearman correlation into a reversed fractional ranking within each industry-year, such that more negative correlations correspond to higher *SMTH* values. Consequently, higher *SMTH* values indicate a greater degree of income smoothing through discretionary accruals. Refer to Appendix A for detailed definitions of the regression variables.

Equation (1) presents the regression of commodity hedging on product market competition and income smoothing. If firms facing higher competition are more likely to use commodity hedging (H1), we will observe a positive coefficient on *FLUIDITY* (β_1). If firms with greater income smoothing are less likely to use commodity hedging, conditional on product market competition (H2a: a substitutive relation), we will observe a negative coefficient on *SMTH* (β_2). In contrast, if firms with greater income smoothing are more likely to use commodity hedging, conditional on product market competition (H2b: a complementary relation), we will observe a positive coefficient on *SMTH* (β_2). In Equation (2), we further include *FLUIDITY*SMTH* in Equation (1) to examine whether the relation between commodity hedging and income smoothing varies with the degree of product market competition.

Both equations include a series of control variables to mitigate the potential influence of correlated omitted variables. As discussed in the preceding subsection, we include the Herfindahl–Hirschman Index (*HHI*), product differentiation (*DIFF*), product market size (*MKTSIZE*), and entry costs (*ENTCOST*) to capture industry characteristics that may affect product market competition. We also control for firm characteristics that may influence firms' decisions to use commodity derivatives, including firm size (*SIZE*), trading volume (*VOL*), book-to-market ratio (*BM*), stock returns (*RET*), and return on assets (*ROA*). In both equations, we include year and industry fixed effects to account for unobservable time-specific or industry-specific factors. We do not include firm fixed effects because our dependent variable (*DRV*) is a binary indicator of commodity hedging participation, and many firms exhibit little variation in hedging status over time. Consequently, a firm fixed-effects specification would rely primarily on firms that switch their hedging status during the sample period, while firms that consistently hedge or consistently do not hedge would contribute little or no identifying variation, substantially reducing the effective sample size. Collectively, this empirical design provides a rigorous framework for examining the determinants of commodity derivatives hedging, with particular attention to product market competition and income smoothing.

4. Empirical Results

4.1. Descriptive Statistics

Table 2 presents descriptive statistics for our regression variables. The mean values for *DRV*, *FLUIDITY*, and *SMTH* are approximately 0.45, 3.96, and 0.10, respectively, indicating that approximately 45% of firms in the sample use commodity derivatives for hedging. The mean value of *HHI*, 0.54, reflects a moderate level of industry concentration across the

sample. The descriptive statistics for the other control variables are overall consistent with those in prior studies (e.g., Karuna, 2007; Haushalter et al., 2007).

Table 2. Descriptive Statistics (N = 1779).

	Mean	SD	P10	P25	P50	P75	P90
DRV	0.450	0.498	0.000	0.000	0.000	1.000	1.000
FLUIDITY	3.957	1.784	1.884	2.603	3.768	5.118	6.165
SMTH	0.101	0.543	−0.639	−0.354	0.082	0.600	0.834
HHI	0.538	0.315	0.180	0.245	0.402	0.906	1.000
DIFF	1.074	0.057	1.015	1.043	1.069	1.104	1.136
MKTSIZE	8.186	1.494	6.200	7.133	8.130	9.552	9.881
ENTCOST	0.380	0.453	0.060	0.078	0.215	0.501	0.895
SIZE	6.833	1.550	4.283	5.980	7.007	7.939	8.790
VOL	10.316	1.949	7.454	9.087	10.648	11.742	12.512
BM	0.785	0.678	0.190	0.325	0.624	1.007	1.585
RET	0.026	0.138	−0.126	−0.033	0.019	0.083	0.174
ROA	0.004	0.029	−0.015	−0.001	0.008	0.016	0.024

This table reports descriptive statistics for the variables used in the regression analysis. Mean and SD denote the sample mean and standard deviation, respectively. P10, P25, P50, P75, and P90 represent the 10th, 25th, 50th (median), 75th, and 90th percentiles, respectively. All variables are defined in Appendix A.

Table 3 reports the correlation results. Notably, *FLUIDITY* exhibits a significant positive correlation with *DRV* ($\rho = 0.157$), indicating that heightened product market competition is positively associated with firms' propensity to engage in commodity derivatives hedging. However, *SMTH* is not significantly correlated with *DRV* ($\rho < 0.001$). Among the industry characteristics, *HHI* and *DIFF* are negatively correlated with *DRV*, whereas *MKTSIZE* and *ENTCOST* are positively correlated with *DRV*.

Table 3. Correlation Matrix.

	<i>DRV</i>	<i>FLUIDITY</i>	<i>SMTH</i>	<i>HHI</i>	<i>DIFF</i>	<i>MKTSIZE</i>	<i>ENTCOST</i>	<i>SIZE</i>	<i>VOL</i>	<i>BM</i>	<i>RET</i>
<i>FLUIDITY</i>	0.157										
<i>SMTH</i>	0.000	−0.045									
<i>HHI</i>	−0.724	−0.111	0.034								
<i>DIFF</i>	−0.048	−0.039	0.089	0.147							
<i>MKTSIZE</i>	0.727	0.171	−0.074	−0.658	0.111						
<i>ENTCOST</i>	0.099	0.160	−0.040	−0.340	−0.073	0.238					
<i>SIZE</i>	0.500	0.075	−0.047	−0.222	0.191	0.737	−0.333				
<i>VOL</i>	0.417	0.206	−0.046	−0.121	0.192	0.596	−0.218	0.795			
<i>BM</i>	−0.196	−0.006	0.025	−0.009	−0.239	−0.221	0.262	−0.364	−0.355		
<i>RET</i>	0.110	−0.005	−0.009	−0.090	−0.045	0.117	0.007	0.137	0.136	−0.088	
<i>ROA</i>	0.009	−0.083	0.025	0.030	0.345	0.017	−0.167	0.043	0.001	−0.262	0.026

This table reports Pearson correlation coefficients for the regression variables. All variables are defined in Appendix A. Statistical significance at the 5% level or less is indicated in bold.

4.2. Regression Results

To examine how product market competition and income smoothing influence firms' propensity to engage in commodity hedging, we estimate the regression models in Equations (1) and (2). Table 4 presents the regression coefficients and their z-statistics adjusted for standard errors clustered at the firm level. In column (1), we include the main effects of product market competition (*FLUIDITY*) and income smoothing (*SMTH*) (i.e., estimating Equation (1)); in column (2), we include both main effects and their interaction term (*FLUIDITY*SMTH*) (i.e., estimating Equation (2)) to examine whether the association between income smoothing and commodity hedging varies with the level of product market competition.

Table 4. Logistic Regression of Commodity Derivatives Hedging on Product Market Competition and Income Smoothing.

VARIABLES	(1) DRV	(2) DRV
FLUIDITY	0.418 (1.45)	0.945 *** (3.41)
SMTH	2.576 *** (2.87)	10.687 *** (4.85)
FLUIDITYxSMTH		−1.716 *** (−5.11)
HHI	−8.541 ** (−2.43)	−11.457 *** (−3.19)
DIFF	−6.552 ** (−2.24)	−7.597 ** (−2.55)
MKTSIZE	−0.926 (−0.65)	−0.721 (−0.48)
ENTCOST	−6.590 ** (−2.24)	−9.331 *** (−2.95)
SIZE	2.273 ** (2.27)	3.427 *** (2.90)
VOL	−0.918 ** (−2.29)	−1.301 *** (−3.03)
BM	−0.573 (−1.20)	−0.913 *** (−2.71)
RET	4.332 ** (1.98)	5.372 *** (4.14)
ROA	5.021 (1.16)	4.249 (1.17)
Constant	12.417 (1.15)	6.842 (0.65)
Year-fixed effects	Yes	Yes
Industry-fixed effects	Yes	Yes
Pseudo R-squared	0.761	0.793
Observations	1779	1779

This table reports the results of logistic regressions of commodity derivatives hedging on product market competition and income smoothing. In each column, we present regression coefficients with their z-statistics in parentheses. **, and *** denote statistical significance at the 5%, and 1% levels, respectively. Standard errors are clustered at the firm level. Detailed variable definitions are provided in Appendix A.

While *FLUIDITY* has a positive but insignificant coefficient in column (1), it is positive and significant in column (2). Overall, the evidence provides partial support for H1, suggesting that product market competition may be associated with greater use of commodity derivatives. Among industry characteristics, *HHI*, *DIFF*, and *ENTCOST* have negative and significant coefficients across both columns, whereas *MKTSIZE* has insignificant coefficients in both columns. Given that higher values of *HHI*, *DIFF*, and *ENTCOST* indicate lower levels of industry-level competition, the results suggest that firms facing lower levels of competition are less likely to use commodity derivatives. This finding is consistent with the notion that competitive pressures may increase firms' incentives to manage risks arising from product-market conditions. Therefore, these results provide additional support for H1.

To assess economic significance, we convert the coefficient on *FLUIDITY* into odds ratios. The estimated coefficient of 0.945 implies that a one-unit increase in *FLUIDITY* is associated with a 157% increase in the odds of commodity hedging. Moreover, a one-standard-deviation increase in *FLUIDITY* (1.784) corresponds to approximately a 5.4-fold increase in the odds of hedging. These results suggest that the documented association is economically meaningful in addition to being statistically significant. Collectively, the results provide evidence that greater product market competition, as measured by both

firm- and industry-level measures, is positively associated with firms' engagement in commodity hedging activities.⁷

Moreover, *SMTH* exhibits a positive and significant coefficient in both columns (coefficient = 2.576 and 10.687, both p -values < 0.01). This finding is consistent with H2b, indicating that firms that engage in greater income smoothing are more likely to use commodity derivatives at a given level of product market competition. Again, to check the economic significance of income smoothing, we convert the coefficient on *SMTH* into odds ratios. The estimated coefficient of 10.687 implies that a one-unit increase in *SMTH* is associated with substantially higher odds of commodity hedging. Since a one-unit change in *SMTH* is relatively large in economic terms, we focus on a one-standard-deviation increase. Using the sample standard deviation of 0.543, a one-standard-deviation increase in *SMTH* corresponds to approximately a 331-fold increase in the odds of hedging. These results suggest that the documented association between income smoothing and commodity hedging is economically meaningful in addition to being statistically significant.

This evidence also suggests that firms appear to use commodity hedging and accrual-based income smoothing as complements to reduce performance volatility. The complementary relation between commodity derivatives and income smoothing contrasts with the findings of Barton (2001) and Pincus and Rajgopal (2002). This difference may reflect the focus on commodity hedging rather than financial derivatives more broadly, which those studies find to have a substitutive relation with income smoothing.

Furthermore, the interaction term *FLUIDITY*×*SMTH* in column (2) has a negative and significant coefficient, suggesting that the positive association between commodity derivatives use and income smoothing weakens as competition intensifies. Using the estimated coefficients, the odds ratio associated with a one-unit increase in income smoothing decreases from approximately 503 at the 25th percentile of *FLUIDITY* to approximately 6.7 at the 75th percentile. This evidence indicates that greater product market competition substantially weakens the complementary relation between income smoothing and commodity hedging.⁸ At first glance, this finding may appear counterintuitive because greater product market competition can increase pressure on managers to deliver stable performance. However, commodity hedging and discretionary income smoothing may serve as alternative mechanisms for reducing earnings volatility. In highly competitive environments, firms face stronger incentives to manage risks arising from commodity price fluctuations and may therefore rely more heavily on commodity hedging as a risk-management tool. Because hedging itself can stabilize earnings by reducing exposure to commodity price risk, managers may have less need to engage in discretionary accrual-based income smoothing. Consequently, while competition may increase firms' overall demand for earnings stability, it can weaken the positive association between commodity hedging and income smoothing by shifting firms toward a market-based risk-management mechanism rather than accounting-based smoothing.

This interpretation complements the view that heightened competition enhances financial transparency and market monitoring (e.g., Bushman & Smith, 2001), thereby limiting managerial discretion in financial reporting. Taken together, these mechanisms help explain why the positive association between commodity derivatives use and income smoothing becomes less pronounced as competition intensifies.

This result may also explain why the coefficient on *FLUIDITY* in column (1) is statistically insignificant. By excluding the interaction term, Equation (1) does not account for the moderating role of income smoothing in the relation between product market competition and commodity derivatives use. Once this interaction is incorporated in Equation (2), the underlying relation becomes more apparent. Overall, the results in column (2) are consistent with Hypotheses H1 and H2b.

5. Sensitivity Analysis

5.1. Simultaneous Equation System

In this section, we extend our analysis to address the possibility that our three key variables (*DRV*, *FLUIDITY*, and *SMTH*) may be jointly determined. The preceding analyses based on Equations (1) and (2) implicitly assume that product market competition (*FLUIDITY*) and income smoothing (*SMTH*) affect managers' decisions to engage in commodity hedging (*DRV*). However, they do not account for the possibility that the three variables—*DRV*, *FLUIDITY*, and *SMTH*—are simultaneously determined. To address this concern, we employ a simultaneous equation system consisting of three regressions, with *DRV*, *FLUIDITY*, and *SMTH* as dependent variables.

Table 5 presents the results of the seemingly unrelated regressions (SUR).⁹ Column (1) shows a positive association between the use of commodity derivatives and product market competition (coefficient on *FLUIDITY* = 0.018, *p*-value < 0.01), consistent with H1 that product market competition is positively associated with firms' use of commodity derivatives. Moreover, column (1) shows a positive association between commodity hedging and income smoothing (coefficient on *SMTH* = 0.180, *p*-value < 0.01), consistent with a complementary relation between income smoothing and commodity hedging.

Table 5. Seemingly Unrelated Regression (SUR) Estimation.

VARIABLES	(1) DRV Eq.	(2) FLUIDITY Eq.	(3) SMTH Eq.
DRV		0.619 *** (4.41)	0.794 *** (16.55)
FLUIDITY	0.018 *** (4.41)		−0.046 *** (−5.52)
SMTH	0.180 *** (16.55)	−0.367 *** (−5.52)	
HHI	−0.316 *** (−6.69)	1.067 *** (3.78)	0.506 *** (5.06)
DIFF	−0.211 * (−1.66)	−1.085 (−1.44)	0.312 (1.16)
MKTSIZE	0.010 (0.60)	−0.209 *** (−2.08)	−0.019 (−0.53)
ENTCOST	−0.129 *** (−5.69)	0.799 *** (5.94)	0.062 (1.30)
SIZE	0.055 *** (4.00)	−0.201 ** (−2.48)	−0.106 *** (−3.68)
VOL	−0.028 *** (−4.49)	0.246 *** (6.74)	0.063 *** (4.81)
BM	−0.030 *** (−2.86)	−0.196 *** (−3.21)	0.019 (0.85)
RET	−0.028 (−0.62)	−0.802 *** (−3.02)	−0.170 * (−1.80)
ROA	−0.314 (−1.48)	−2.304 * (−1.83)	0.187 (0.42)
Constant	0.213 (1.18)	7.026 *** (6.62)	0.101 (0.27)
Year-fixed effects	Yes	Yes	Yes
Industry-fixed effects	Yes	Yes	Yes
R-squared	0.786	0.430	0.201
Observations	1779	1779	1779

This table reports the results of the SUR estimation of a system of simultaneous equations examining the relations between commodity derivatives hedging, product market competition, and income smoothing. The system consists of three equations with *DRV*, *FLUIDITY*, and *SMTH* as dependent variables. In each column, we present regression coefficients with their *z*-statistics in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Detailed variable definitions are provided in Appendix A.

Columns (2) and (3) similarly provide evidence suggesting that commodity hedging is positively associated with product market competition and income smoothing. In both the *FLUIDITY* and *SMTH* equations, the coefficients on *DRV* are positive and statistically significant. Moreover, the two columns consistently show that product market competition is negatively associated with income smoothing. In the *FLUIDITY* (*SMTH*) equation, the coefficient on *SMTH* (*FLUIDITY*) is negative and significant. This negative association is consistent with prior studies suggesting that greater product market competition is associated with lower levels of discretionary reporting behavior.

Although the SUR results provide additional evidence consistent with H1 and H2b, the documented associations may still be influenced by reverse causality or unobserved factors that jointly affect *DRV*, *FLUIDITY*, and *SMTH*. Accordingly, we conduct additional analyses in the next subsection to further examine potential endogeneity concerns.

5.2. Instrumental Variable Regressions

In Equations (1) and (2), *FLUIDITY* and *SMTH* may be endogenous explanatory variables. Although the SUR analysis in Table 5 helps account for the potential simultaneity between commodity hedging and income smoothing, it does not fully address endogeneity concerns. To further mitigate this issue, we estimate a two-stage residual inclusion (2SRI) model. In the first stage, the potentially endogenous variables (*FLUIDITY* and *SMTH*) are regressed on instrumental variables and control variables, and the resulting residuals are included in the second-stage nonlinear model. This approach yields consistent estimates in probit and logit models with endogenous regressors (Terza et al., 2008).

We use the industry means of *FLUIDITY* (*IV_FLUIDITY*) and *SMTH* (*IV_SMTH*) as instrumental variables. Industry-level competition and income-smoothing tendencies are expected to be associated with their firm-level counterparts and therefore provide variation useful for identification. As with any instrumental-variable approach, however, the exclusion restriction cannot be tested directly, and the results should be interpreted with appropriate caution. Table 6 reports the 2SRI results. In Panel A, the first-stage regressions show positive and significant associations between *FLUIDITY* and *IV_FLUIDITY* (coefficient = 0.855, p -value < 0.01) and between *SMTH* and *IV_SMTH* (coefficient = 0.893, p -value < 0.01), indicating strong first-stage relevance.

Panel B presents the second-stage results. The findings are qualitatively consistent with those reported in Tables 4 and 5. *FLUIDITY* remains positively associated with firms' propensity to engage in commodity hedging, providing additional support for H1. Likewise, *SMTH* remains positively associated with commodity hedging, consistent with a complementary relation between income smoothing and commodity hedging. The interaction term *FLUIDITY***SMTH* remains negative and significant, indicating that the positive association between income smoothing and commodity hedging weakens as product market competition increases.

The coefficients on the first-stage residuals suggest the presence of endogeneity for *SMTH* but not for *FLUIDITY*, supporting the use of an estimation approach that accounts for potentially endogenous regressors. Overall, the 2SRI results are qualitatively similar to the main findings reported in Tables 4 and 5. The consistency of the results across alternative specifications provides additional confidence that the documented associations are not solely driven by simultaneity or endogeneity concerns. Nevertheless, as with any instrumental-variable approach, the validity of the exclusion restriction cannot be tested directly, and therefore the results should be interpreted with appropriate caution.

Table 6. Two-Stage Residual Inclusion (2SRI) Estimation.

Panel A: First-Stage Regressions		
VARIABLES	(1) FLUIDITY	(2) SMTH
IV_FLUIDITY	0.855 *** (11.17)	−0.001 (−0.04)
IV_SMTH	−0.022 (−0.22)	0.893 *** (12.85)
HHI	−0.015 (−0.02)	0.058 (0.23)
DIFF	−0.342 (−0.42)	0.071 (0.35)
MKTSIZE	0.007 (0.03)	0.065 (0.78)
ENTCOST	0.525 (1.36)	−0.153 (−1.42)
SIZE	−0.192 (−0.75)	−0.094 (−1.56)
VOL	0.125 (1.43)	0.036 (1.31)
BM	−0.300 ** (−2.25)	0.006 (0.10)
RET	−0.283 (−0.76)	−0.033 (−0.20)
ROA	−1.698 (−1.22)	−0.662 (−1.28)
Constant	1.654 (1.21)	−0.263 (−0.43)
Year-fixed effects	Yes	Yes
Industry-fixed effects	Yes	Yes
R-squared	0.612	0.469
Observations	1779	1779
Panel B: Second-Stage Regressions		
VARIABLES	(1) DRV	(2) DRV
FLUIDITY	0.660 * (1.75)	0.902 *** (3.51)
SMTH	0.951 * (1.72)	8.745 *** (4.70)
FLUIDITY*SMTH		−1.807 *** (−4.78)
HHI	−7.123 ** (−2.26)	−9.242 *** (−2.60)
DIFF	−7.896 ** (−2.55)	−9.772 *** (−3.53)
MKTSIZE	−0.919 (−0.65)	−0.672 (−0.42)
ENTCOST	−7.168 ** (−2.34)	−9.959 *** (−3.04)
SIZE	2.210 ** (2.23)	3.331 *** (2.83)
VOL	−0.919 ** (−2.34)	−1.302 *** (−3.07)
BM	−0.465 (−0.89)	−0.938 ** (−2.42)

Table 6. Cont.

Panel B: Second-Stage Regressions		
VARIABLES	(1) DRV	(2) DRV
RET	4.166 *	4.799 ***
	(1.76)	(3.28)
ROA	4.413	3.104
	(1.03)	(0.84)
RSD_FLUIDITY	−0.271	0.090
	(−0.57)	(0.16)
RSD_SMTH	1.917 **	2.697 ***
	(2.11)	(2.90)
Constant	13.390	8.410
	(1.18)	(0.79)
Year-fixed effects	Yes	Yes
Industry-fixed effects	Yes	Yes
Pseudo R-squared	0.765	0.799
Observations	1779	1779

This table reports the results of the 2SRI estimation of logistic regressions of commodity derivatives hedging on product market competition and income smoothing. Panel A provides the results of the first-stage OLS regressions using the instrumental variables *IV_FLUIDITY* and *IV_SMTH* in columns (1) and (2), respectively. Panel B presents the results of the second-stage logistic regressions, including the residual values from the first-stage regressions (*RSD_FLUIDITY* and *RSD_SMTH*). In each column, we present regression coefficients with their z-statistics in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level. Detailed variable definitions are provided in Appendix A.

6. Conclusions

This study investigates whether and how product market competition influences firms' commodity hedging and income smoothing decisions in the metals industry. Using product market fluidity as a text-based measure of competition intensity, we find that firms operating in more competitive product markets tend to be more likely to hedge commodity price risk. This finding is consistent with the argument that firms facing greater competitive pressure may have stronger incentives to stabilize cash flows and manage exposure to input price volatility.

We further find that income smoothing through discretionary accruals is positively associated with hedging activity, suggesting that commodity hedging and accrual-based income smoothing are positively associated with one another. Moreover, we find that the interaction between competition and income smoothing is negative and statistically significant. This result implies that while both competition and smoothing are positively associated with commodity hedging, their marginal effects diminish when both mechanisms are jointly employed. Thus, firms appear to balance financial and accounting risk management strategies rather than relying on them in a purely additive manner. Our results remain qualitatively similar in additional analyses designed to address potential simultaneity and endogeneity concerns.

Our findings should be interpreted in light of several limitations. Although we employ firm-level controls, industry controls, and additional analyses to mitigate endogeneity concerns, we cannot fully eliminate the possibility that unobservable firm characteristics jointly affect product market competition, income smoothing, and commodity hedging activities. Consequently, the results should be interpreted primarily as evidence of association rather than definitive causal effects. Future research may further investigate the causal mechanisms underlying these relations using alternative research designs and identification strategies.

Overall, our findings contribute to the literature on risk management, product market competition, and financial reporting by highlighting how competitive forces shape firms' joint use of commodity derivatives and accounting discretion. By focusing on the metals industry—where commodity price exposure is economically significant—we provide evidence that firms respond to competitive uncertainty through coordinated financial and reporting strategies. These results enhance our understanding of how external competitive pressures influence internal risk management choices and offer implications for regulators and investors interpreting firms' hedging and reporting behavior.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Variable Definitions

Variables	Definitions
DRV	An indicator variable equal to 1 if the firm uses commodity derivatives for hedging purposes during the fiscal year, and 0 otherwise. Commodity hedging activity is identified from disclosures in the firm's annual report.
FLUIDITY	A continuous measure of product market fluidity, capturing the extent to which a firm faces dynamic and evolving competitive threats from rival firms. The measure is constructed following Hoberg et al. (2014) using text-based analysis of firms' product descriptions.
SMTH	Income smoothing, measured following Tucker and Zarowin (2006) as the Spearman correlation between changes in discretionary accruals and pre-managed income. Pre-managed income is defined as net income minus discretionary accruals. Discretionary accruals are estimated as the residuals from the performance-adjusted modified Jones model of Kothari et al. (2005) , estimated by industry-year (2-digit SIC). Following Tucker and Zarowin (2006) , we transform the Spearman correlation into a reversed fractional ranking within each industry-year.
HHI	The Herfindahl–Hirschman Index, measuring industry concentration. It is calculated as the sum of squared market shares of firms within an industry using the 4-digit SIC code.
DIFF	Product differentiation, measured as sales relative to operating costs at the industry-segment level, following Karuna (2007) .
MKTSIZE	The size of the firm's product market, measured as the natural logarithm of total industry sales within the firm's primary product market.
ENTCOST	Entry costs, measured as the natural logarithm of the weighted average gross value of industry PPE, following Karuna (2007) .
SIZE	Firm size, measured as the natural logarithm of total assets at the end of the fiscal year.
VOL	Trading volume, measured as the firm's average daily stock trading volume during the fiscal year.
BM	The book-to-market ratio, defined as the book value of equity divided by the market value of equity at the end of the fiscal year.
RET	Annual stock returns, measured as the firm's buy-and-hold returns over the fiscal year.
ROA	Return on assets, measured as net income divided by total assets at the end of the fiscal year.

Appendix B. Examples of Commodity Risk Disclosures

This appendix provides illustrative examples of firms' disclosures related to commodity price risk management. The first case presents a firm that actively hedges commodity risk and discloses the notional amounts of its derivatives. The second and third cases present firms that do not rely primarily on derivatives, due instead to operational flexibility arising from supplier diversification or the ability to pass costs through to customers. As described in Table 1, we exclude the second and third cases from the final sample to focus on firms with salient incentives to hedge commodity price risk. The excerpts below are reproduced from the firms' 10-K filings.

Case 1: Disclosure of Active Commodity Hedging

Ball Corp., Broomfield, CO, USA—Form 10-K (2019)

Item 7A. Quantitative and Qualitative Disclosures About Market Risk

Commodity Price Risk—Aluminum

"The company manages commodity price risk in connection with market price fluctuations of aluminum ingot through two different methods. First, the company enters into container sales contracts that include aluminum ingot-based pricing terms that generally reflect the same price fluctuations under commercial purchase contracts for aluminum sheet. The terms include fixed, floating or pass-through aluminum ingot component pricing. Second, the company uses certain derivative instruments such as option and forward contracts as economic and cash flow hedges of commodity price risk where there are material differences between sales and purchase contracted pricing and volume.

At 31 December 2019, the company had aluminum contracts limiting its aluminum exposure with notional amounts of approximately \$1.7 billion, of which approximately \$1.6 billion received hedge accounting treatment. Cash flow hedges relate to forecasted sales and purchase transactions and expire within the next two years. Included in shareholders' equity at 31 December 2019, within accumulated other comprehensive earnings (loss), is a net after-tax loss of \$15 million associated with these contracts. A net loss of \$13 million is expected to be recognized in the consolidated statement of earnings during the next 12 months, the majority of which will be offset by pricing changes in sales and purchase contracts, thus resulting in little or no earnings impact to Ball."

This disclosure illustrates a firm that meets our classification criteria for active commodity hedging. The firm explicitly reports the notional amounts of derivatives, hedge accounting treatment, and expected earnings impact, indicating formal risk management through derivative contracts.

Case 2: Non-Hedging: Commodity Risk Management Through Supplier Flexibility

Northwest Pipe Company, Vancouver, WA, USA—Form 10-K (Fiscal Year 2021)

Precast Infrastructure and Engineered Systems

"The main raw components in our precast and reinforced concrete products are cement, steel, and aggregate, which are widely available commodities. When possible, we source these raw materials from suppliers near our facilities. We also rely on certain suppliers of valves, pumps, piping, and certain custom fabricated items."

This disclosure highlights that the firm relies on widely available commodity inputs and maintains flexibility to source from multiple suppliers, particularly those located near its facilities. Such operational flexibility mitigates exposure to commodity price risk and reduces the need for formal hedging through derivatives.

Case 3: Non-Hedging: Commodity Risk Management Through Cost Pass-Through

Watts Water Technologies, Inc., North Andover, MA, USA—Form 10-K (2020)

Item 7A. Quantitative and Qualitative Disclosures About Market Risk

“We use derivative financial instruments primarily to reduce exposure to adverse fluctuations in foreign exchange rates, interest rates and costs of certain raw materials used in the manufacturing process. We do not enter into derivative financial instruments for trading purposes. As a matter of policy, all derivative positions are used to reduce risk by hedging underlying economic exposure. The derivatives we use are instruments with liquid markets. See Note 16 of Notes to the Consolidated Financial Statements for further details.

We purchase significant amounts of bronze ingot, brass rod, cast iron, stainless steel, steel, plastic and other materials, which are utilized in manufacturing our many product lines. Our operating results can be adversely affected by changes in commodity prices if we are unable to pass on related price increases to our customers. We manage this risk by monitoring related market prices, working with our suppliers to achieve the maximum level of stability in their costs and related pricing, seeking alternative supply sources when necessary and passing increases in commodity costs to our customers, to the maximum extent possible, when they occur.”

This disclosure illustrates a firm that manages commodity price risk partly through cost pass-through mechanisms. The ability to transfer input price increases to customers reduces net exposure to commodity price fluctuations and weakens incentives to use derivative-based hedging.

Notes

- ¹ Haushalter et al. (2007) examine how rival-induced growth opportunities shape firms’ cash-holding policies and currency-derivative strategies, highlighting predatory threats as a key determinant of internal financial policy. They interpret the positive relation between industry concentration and currency hedging as suggesting that firms in concentrated industries (e.g., oligopolistic industries) share a larger proportion of their growth opportunities with rivals. Consequently, these firms face stronger incentives to use currency derivatives to mitigate potential predation risk because financing constraints may prevent them from fully investing in their growth opportunities, thereby increasing the likelihood of market-share losses (i.e., demand-side or sales-side exposures).
- ² The accounting and disclosure landscape for derivatives is principally governed by ASC 815 (Accounting Standards Codification), as promulgated by the Financial Accounting Standards Board (FASB, 2024). Over the past two decades, the FASB has issued a series of amendments—including Statements 80, 105, 107, 119, 126, 133, 137, 138, 149, and 161—each designed to enhance the transparency, consistency, and utility of derivatives-related disclosures. These regulatory updates reflect the increasing complexity of derivative instruments, the transition from historical cost to fair value measurement, and the ongoing refinement of recognition versus disclosure requirements. The implementation of SFAS 133 represented a fundamental shift by mandating the recognition of derivative fair values on the balance sheet. Studies by Ahmed et al. (2006a, 2011) indicate that this enhanced the relevance of derivative exposure metrics, particularly for bond investors. Furthermore, Zhang (2009) provides evidence that, following the adoption of SFAS 133, firms with ineffective hedging practices became more prudent in their use of derivatives.
- ³ The complete list of firm-year observations included in the final sample is available from the authors upon request.
- ⁴ Hoberg et al. (2014) provide several validation tests supporting *FLUIDITY* as a measure of product market competition. In particular, they show that *FLUIDITY* captures competitive threats arising from competitors’ product changes rather than a firm’s own product changes. They further demonstrate that firms with higher *FLUIDITY* exhibit greater product similarity to venture-capital-backed firms and newly public firms, providing direct evidence that *FLUIDITY* reflects exposure to emerging competitors. Moreover, *FLUIDITY* remains distinct from conventional firm risk measures, indicating that it captures unique information about the firm’s competitive environment.
- ⁵ Our measure captures firms’ participation in commodity hedging rather than the intensity of derivative use. Although this approach is appropriate for examining firms’ hedging decisions, it does not capture cross-sectional variation in the extent of hedging among derivative users. Future research could extend our analysis by developing more refined measures of hedging intensity as more comprehensive and comparable derivatives data become available. Such measures may provide additional insights into how product market competition influences not only firms’ decisions to hedge but also the magnitude of their hedging activities.
- ⁶ Following Tucker and Zarowin (2006), we measure income smoothing as the negative correlation between changes in discretionary accruals and changes in pre-managed earnings. This measure is particularly appropriate because it captures managers’ deliberate use of discretionary accruals to offset fluctuations in underlying earnings rather than simply the magnitude of discretionary

accruals. Unlike conventional earnings management proxies, such as the absolute value of discretionary accruals, which capture the overall extent of managerial reporting discretion, the Tucker and Zarowin (2006) measure specifically identifies smoothing behavior by examining whether discretionary accruals systematically offset variations in pre-managed earnings. Accordingly, this measure aligns more closely with our objective of examining the relation between commodity hedging and income smoothing.

As described in Table 1, we exclude firms with substantial bargaining power over either suppliers or customers from the final sample. As a placebo test, we re-estimate the regressions in Table 4 using the excluded sample, which consists of 3080 observations (4859–1779), as reported in Table 1. The coefficients on *FLUIDITY*, *SMTH*, and *FLUIDITY*×*SMTH* are not statistically significant, supporting the importance of accounting for firms' risk-management incentives in the sample-selection process.

At low levels of competition (25th percentile of *FLUIDITY*), a one-unit increase in income smoothing is associated with roughly 503 times higher odds of commodity hedging. At high levels of competition (75th percentile of *FLUIDITY*), the corresponding odds ratio falls to approximately 6.7. This pattern is consistent with the negative interaction coefficient and suggests that competition attenuates the complementary relation between income smoothing and commodity hedging.

We do not include the interaction term *FLUIDITY*×*SMTH* in the *DRV* equation in column (1) because the *FLUIDITY* and *SMTH* equations in columns (2) and (3) would indirectly capture an interaction effect of the two variables.

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