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Inflation, Procurement Costs, and Working Capital: An Integrated Framework for Supply Chain Financial Planning, a Decision Model Connecting Purchasing Policies, Inventory Exposure, and Cash Requirements

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Abstract

The inflation episode of 2022 exposed a gap between how firms buy materials and how they plan cash. Purchasing teams responded to rising input prices by ordering earlier and in larger lots, while treasury teams faced sharply higher short-term borrowing costs and growing nominal working capital needs. Purchasing quantities, inventory value and cash needs were therefore moving together, yet they were often planned separately. Using a model-based research design that combines an integrative synthesis of 200 sources, analytical optimisation and scenario-based numerical experiments, this paper develops an integrated decision model that links three elements in a single framework: the purchasing policy (order quantity, forward buying in response to announced price increases, and payment timing), the resulting inventory exposure (the value of stock held and the price risk it carries), and the cash requirement (average and peak working capital financed through a credit facility). The central construct is an effective carrying rate equal to physical holding cost plus the financing rate minus expected input price inflation. We show that the optimal order quantity rises with inflation and falls with the financing rate, that the borrowing limit acts as a binding ceiling on forward buying with a measurable shadow price of cash, and that nominal working capital drifts upward at the rate of inflation even when physical volumes are constant. A numerical illustration calibrated to four 2022-style macroeconomic regimes shows that an inflation-aware policy lowers total relevant cost by up to 24 percent relative to a static policy, and that the cash constraint, not the cost trade-off, is what limits the value of forward buying. The paper closes with a five-step planning procedure that purchasing and finance functions can operate jointly.

Keywords: inflation; procurement; economic order quantity; working capital; forward buying; trade credit; cash-to-cash cycle; supply chain finance

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Introduction

For most of the period from the global financial crisis to 2020, manufacturers and distributors operated in an environment of low and stable inflation and near-zero policy interest rates. Under those conditions the cost of holding inventory was dominated by physical costs such as storage, handling, insurance and obsolescence, and the financial component of carrying cost was small. Purchasing decisions and cash planning could be made largely in separate departments without much loss.

That environment ended abruptly. In the United States, annual consumer price inflation reached 9.1 percent in June 2022, the highest reading in four decades (Bureau of Labor Statistics, 2022), and producer prices for many industrial inputs rose faster still. Energy, metals, chemicals, packaging and freight costs moved by double digits within months. The policy response followed with a lag: the Federal Reserve raised its target range for the federal funds rate from near zero in March

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2022 to 4.25 to 4.50 percent by December 2022 (Federal Reserve Board, 2022), and comparable tightening occurred in the United Kingdom, the euro area and many emerging markets. For firms in economies such as Nigeria, Ghana or Egypt, the combination of high domestic inflation, currency depreciation and rising lending rates was even more acute, compounding existing constraints on access to finance (Michael & Ogunsola, 2019a) and on port and logistics costs (Okonkwo, Agbabiaka, Ogunwole, Mayo, & Okeke, 2020).

Research published during 2022 traced much of this surge to the supply side. The Global Supply Chain Pressure Index developed by Benigno, di Giovanni, Groen and Noble (2022) reached record highs during the pandemic and helped forecast producer and consumer price inflation, while di Giovanni, Kalemli-Özcan, Silva and Yildirim (2022) and Santacreu and LaBelle (2022) linked bottlenecks in global supply chains to higher producer prices, especially in industries that rely heavily on imported inputs. Shapiro (2022) estimated that supply factors accounted for about half of the rise in inflation above pre-pandemic levels, and Ball, Leigh and Mishra (2022) attributed the rise in core inflation partly to the pass-through of energy and supply chain shocks. Rees and Rungcharoenkitkul (2021) showed that precautionary inventory building in lean supply chains amplified these bottlenecks, and both the International Monetary Fund [IMF] (2022) and the Bank for International Settlements [BIS] (2022) warned that relative price shocks of this kind could become entrenched. Because cost shocks pass through to selling prices only partially and with variable markups (Amiti, Itskhoki, & Konings, 2019), procurement cost increases fall at least in part on the buyer's margin and working capital.

The year therefore presented firms with two forces pulling in opposite directions. Rising input prices rewarded buying early and holding more stock, because each unit purchased today avoids a higher price tomorrow. Rising interest rates penalised the same behaviour, because every unit held must be financed. At the same time, the nominal value of receivables, payables and inventory grew mechanically with prices, so that firms needed more cash simply to run the same physical volume of business. Studies of procurement in capital-intensive sectors had already shown that sourcing strategy and inventory availability drive both operating cost and uptime (Okonkwo, Ogunwole, & Okeke, 2018a, 2018b); in 2022 many firms discovered that their purchasing policy had quietly become a financing policy, and that their credit facilities, sized for a low inflation world, had become the real constraint on operations.

This paper addresses a practical question: how should a firm set its purchasing policy when input prices are rising, financing is costly and cash is limited, and what cash requirement does that policy create? To answer it, we combine the inflation-adjusted lot-sizing logic of Buzacott (1975) with the working capital accounting used in cash-to-cash analysis (Farris and Hutchison, 2002; Hofmann and Kotzab, 2010), so that ordering cost, inventory carrying cost, price appreciation and the financing cost of receivables net of payables appear in one total relevant cost function. A credit facility limit on peak working capital is then imposed, which yields an order quantity ceiling and a shadow price of cash and ties the procurement decision directly to treasury planning. To our knowledge, this joint treatment of inflation, financing cost and a binding liquidity limit within a single purchasing model has received little attention, and a calibrated illustration across four 2022-type macroeconomic regimes shows when larger lots pay off, when forward buying ahead of an announced price increase is worthwhile, and how much of that value the cash constraint removes.

The paper proceeds as follows. Section 2 sets out the methodology. Section 3 synthesises the relevant literature, and Section 4 presents the conceptual model and its formal development. Section 5 reports the numerical analysis and Section 6 discusses the findings. Sections 7, 8 and 9 address implications, limitations and directions for future research, and Section 10 concludes.

Methodology

Research design

The study follows a model-based quantitative design

Table 1: Thematic structure of the literature synthesis

Theme	*Focus*	*Model element informed*
Inventory decisions under inflation	Lot sizing with inflation, discounting, announced price changes and supplier credit	Effective carrying rate H; forward-buying rule
Trade credit, supply chain finance and working capital	Payment terms, financing constraints, cash conversion cycle and firm performance	Working capital terms AR and AP; credit ceiling L; payment timing
Procurement practice, supply risk and resilience	Sourcing, negotiation, supplier relationships, forecasting, disruption and resilience	Price and demand inputs; safety stock SS; contract levers
Financial governance and information systems	Controls, reporting, treasury analytics and data integration	Conditions for implementing the planning routine

in three stages. First, an integrative literature synthesis identifies the mechanisms that connect input price inflation, purchasing decisions, inventory and the financing of working capital. Second, these mechanisms are formalised in an analytical decision model whose structure follows from the synthesis. Third, the model is exercised in a calibrated numerical experiment that compares policies across macroeconomic regimes representative of 2021 and 2022. This design suits the research question because the relationships of interest are causal and structural, while firm-level data that isolate procurement responses to the 2022 shock were not yet available when the study was conducted.

Literature identification and synthesis

Sources were identified through two complementary streams. The first was a structured search of Google Scholar, publisher platforms (INFORMS, Elsevier, Wiley, Springer, Emerald and Oxford University Press), RePEc/IDEAS and the publications of central banks and international organisations. Search strings combined terms such as inventory, economic order quantity, inflation, time value of money, announced price increase, forward buying, trade credit, supply chain finance, reverse factoring, working capital, cash conversion cycle, supply chain disruption, resilience and 2022 inflation. The second stream drew on a curated corpus of applied research on procurement, operations, finance, governance and information systems, much of it from emerging-market settings, which was screened for relevance to procurement cost, inventory, financing or planning systems.

Three inclusion criteria were applied to both streams: publication between 1913 and 2022, bibliographic details that could be verified, and a substantive connection to at least one link in the chain from purchasing policy to inventory exposure to cash requirement. Sources that did not meet these criteria, or whose details could not be confirmed, were excluded. The final set comprises 200 sources, 100 from each stream. The sources were then coded thematically and organised into four themes, shown in Table 1, each of which informs a specific element of the conceptual model.

Analytical modelling

The decision model extends the deterministic economic order quantity framework in three ways: an inflation-adjusted carrying rate, explicit working capital accounting for inventory, receivables and payables, and a liquidity constraint representing a revolving credit facility. The resulting problem is convex in the order quantity, so optimal policies and the shadow price of the liquidity constraint are obtained analytically from the Kuhn–Tucker conditions. Formal results are stated as propositions in Section 4 and derived in the Appendix.

Numerical experiment

The numerical stage uses parameters representative of a mid-sized manufacturer purchasing a key raw material. Four regimes are specified to reflect the combinations of input inflation and financing cost observed around 2021 and 2022, informed by published price and policy rate data. For each regime the optimal policy, total relevant cost, average and peak working capital and nominal working capital drift are computed and compared with a static benchmark policy that ignores inflation. A forward-buying case, a payment-terms analysis and a sensitivity analysis across inflation rates from 0 to 16 percent and three financing rates complete the experiment. All calculations were carried out in Python and can be reproduced from the parameters reported in Section 5.

Literature Synthesis

Inventory decisions under inflation

The economic order quantity of Harris (1913) assumes a constant unit price and a constant carrying rate.

Buzacott (1975) was among the first to show that when all prices and costs inflate at a common rate, the optimal order quantity can be approximated by replacing the carrying rate with the carrying rate net of the inflation rate, so that inflation enlarges the optimal lot. Misra (1979) extended the analysis using discounted cash flows over an infinite horizon, and Sarker and Pan (1994) incorporated shortages and the time value of money. A related stream treats a single, announced price increase as a special purchasing opportunity; textbook treatments such as Tersine (1994) derive the optimal special order that a buyer should place immediately before a known increase. These models establish the core intuition used here, but they are typically silent on how the resulting inventory is financed and whether the firm has the cash to execute the policy.

A large body of work extends these foundations. Chandra and Bahner (1985), Datta and Pal (1991) and Hariga (1995) built present-value cost models under inflation for constant, linearly trending and general time-varying demand, while Ray and Chaudhuri (1997), Moon and Lee (2000) and Wee and Law (2001) added stock-dependent demand, uncertain product life cycles and joint pricing. Aggarwal (1981) offered purchasing managers practical models for buying ahead of a single price jump and under continuing inflation.

The response to announced price increases has been analysed by Lev, Weiss and Soyster (1981), Taylor and Bradley (1985), Lev and Weiss (1990), Goyal, Srinivasan and Arcelus (1991) and Huang, Kulkarni and Swaminathan (2003), who show that the optimal special order can be substantial when the increase is near, and Grubbström and Kingsman (2004) derived exact discounted cash flow policies for step changes in unit cost. Tersine and Barman (1995) treated the mirror case of temporary price discounts.

A further strand combines inflation with supplier credit: Aggarwal and Jaggi (1995), Liao, Tsai and Su (2000), Sarker, Jamal and Wang (2000) and Chang (2004) showed that the credit period and the gap between inflation and the discount rate jointly determine the optimal replenishment cycle. Our effective carrying rate condenses these results into a single parameter that planners can update as conditions change.

Trade credit, supply chain finance and working capital

A second stream examines how payment terms change inventory decisions. Goyal (1985) showed that a permissible delay in payment lowers the effective cost of holding stock and enlarges the optimal order. Gupta and Wang (2009) extended this to stochastic demand and showed that trade credit is equivalent to a reduction in the effective purchase cost. Buzacott and Zhang (2004) linked inventory decisions to asset-based borrowing limits, demonstrating that the amount a firm can borrow against its inventory and receivables shapes its production decisions. Kouvelis and Zhao (2012) compared supplier financing with bank financing for capital-constrained retailers.

Petersen and Rajan (1997) showed that firms rely more on supplier credit when bank credit is rationed, and theoretical work by Burkart and Ellingsen (2004) and Cuñat (2007) explains why suppliers can lend when banks will not. Contract-level evidence shows that large, creditworthy buyers obtain longer terms (Klapper, Laeven, & Rajan, 2012), that long terms imposed on small suppliers reduce their investment (Murfin & Njoroge, 2015), and that trade credit can also soften competition among suppliers (Peura, Yang, & Lai, 2017); Seifert, Seifert and Protopappa-Sieke (2013) review this literature from an operations perspective.

Supply chain finance extends these ideas: Pfohl and Gomm (2009) and Gelsomino, Mangiaracina, Perego and Tumino (2016) frame it as optimising financial flows across partners, Caniato, Gelsomino, Perego and Ronchi (2016) document the drivers of adoption, and Lekkakos and Serrano (2016), Wuttke, Blome, Heese and Protopappa-Sieke (2016) and Tunca and Zhu (2018) analyse reverse factoring and buyer intermediation.

At the operations and finance interface, Birge (2015) and Babich and Kouvelis (2018) argue that capital market frictions break the separation of operating and financing decisions; Dada and Hu (2008) and Kouvelis and Zhao (2016) show that financing constraints reduce order quantities; Alan and Gaur (2018) model inventory as collateral under asset-based lending; Chod (2017) and Yang and Birge (2018) show how trade credit corrects inventory distortions and shares risk; and Chen and Cai (2011) examine logistics providers that also finance their customers. This literature highlights that inventory and financing are jointly determined, which motivates the cash constraint in our model.

In emerging markets the supply of such financing is shaped by how banks design distributorship and trade finance products (Agboada, Ezeako, Okoli, & Ibeh, 2018), by fintech-enabled transaction banking and digital lending to small firms (Okafor, Osuji, & Dako, 2021), and by the risk evaluation models lenders use to price credit (Akomolafe & Agu, 2019b). On the payment side,

the adoption of web-based payment portals (Agyei, Izuchukwu, Feboh, & Idowu, 2019) and smart-contract automation of supplier payments (Akomolafe, Olaogun, Adesuyi, Ndukwe, & Sakyi, 2022) make it increasingly practical to manage payment timing as a deliberate decision variable rather than an administrative outcome.

The corporate finance literature measures working capital efficiency through days inventory outstanding, days sales outstanding and days payables outstanding, which together form the cash conversion or cash-to-cash cycle. Deloof (2003) found that shorter receivable and inventory periods are associated with higher profitability. Farris and Hutchison (2002) introduced the cash-to-cash cycle as a supply chain metric, and Hofmann and Kotzab (2010) argued that working capital should be managed across the supply chain rather than firm by firm. Protopappa-Sieke and Seifert (2010) were among the few to connect operational inventory policy with financial performance measures in a single model, and Wuttke, Blome and Henke (2013) documented the growth of financial supply chain management in practice.

More recent work has turned to analytics: Tonoyan, Dada and Ayivi-Donkor (2021b) reviewed predictive cash flow modelling and working capital optimisation in retail, and Dada, Isiekwu and Oluwo (2021a) described tiered treasury architectures for consolidating cash flows and controlling foreign exchange risk in multinational groups. A parallel stream develops data-driven decision systems for strategic financial planning (Lawal & Oduleye, 2019b, 2021b), capital allocation (Lawal & Oduleye, 2021a), cost management (Oduleye & Medon, 2021) and predictive budgeting from operational and market signals (Adesuyi, Walawalkar, & Kalu, 2022), and examines the role of the chief financial officer in coordinating finance across partnerships (Isiekwu, Oluwo, & Dada, 2021). The empirical finance literature reinforces this view.

Richards and Laughlin (1980) introduced the cash conversion cycle as a dynamic liquidity measure, and studies of corporate liquidity show that firms hold more liquid assets when external finance is costly and cash flows are volatile (Kim, Mauer, & Sherman, 1998; Opler, Pinkowitz, Stulz, & Williamson, 1999; Bates, Kahle, & Stulz, 2009). Shorter cash conversion cycles are associated with higher profitability among small firms (García-Teruel & Martínez-Solano, 2007; Baños-Caballero, García-Teruel, & Martínez-Solano, 2010), although the relation is concave, so that an optimal working capital level exists (Baños-Caballero et al., 2012; Afrifa & Padachi, 2016) and is lower for financially constrained firms (Baños-Caballero et al., 2014).

Moving toward that optimum improves operating and stock performance (Aktas, Croci, & Petmezas, 2015), excess working capital is valued below cash by shareholders (Kieschnick, Laplante, & Moussawi, 2013), and differences in cash conversion cycles predict stock returns (Wang, 2019; Zeidan & Shapir, 2017). Working capital policy responds to sales volatility and financing costs (Hill, Kelly, & Highfield, 2010), can buffer fixed investment against cash flow shocks (Ding, Guariglia, & Knight, 2013), and matters more in downturns and crises (Enqvist, Graham, & Nikkinen, 2014; Tsuruta, 2019). Global and emerging-market evidence, including manufacturers in Egypt, Kenya, Nigeria and South Africa, confirms the negative link between the cycle and profitability (Raheman & Nasr, 2007; Ukaegbu, 2014; Chang, 2018).

Table 2: Decision levers, exposures and cash effects

Purchasing lever	*Inventory exposure*	*Cash effect*	*Direction under rising inflation*
Order quantity (lot size)	Average cycle stock p·Q/2	Raises average and peak working capital	Larger lots become cheaper in real terms
Forward buying before announced increases	Temporary stock above cycle needs	Large one-off cash outflow	Value rises with size of increase
Safety stock	Permanent buffer p·SS	Raises base working capital	Supply risk often raises it further
Supplier payment terms (DPO)	None directly	Each extra day frees p·D/365	More valuable when rates are high
Early-payment discounts	None directly	Uses cash to earn implied return	Compare implied rate with financing rate
Supplier and contract choice	Indexation, price locks	Shifts price risk and cash timing	Fixed-price contracts gain value

Note: p is unit purchase price, Q order quantity, SS safety stock, D annual demand, DPO days payables outstanding.

On the inventory component specifically, Chen, Frank and Wu (2005) found that firms with abnormally high inventories earned poor subsequent returns, and Gaur, Fisher and Raman (2005) explained inventory turnover by margins, capital intensity and sales surprises. These studies strengthen the case for treating working capital as a planned quantity, but they generally take procurement policy as an input rather than a decision.

Procurement practice, supply risk and resilience

A growing body of applied work from emerging-market settings links procurement design to cost and resilience. Okonkwo, Ogunwole and Okeke (2018a) proposed a framework for strategic procurement optimisation in oil and gas operations, and Okonkwo, Ogunwole, Okeke and Mayo (2019) showed how contract negotiation and vendor governance can reduce total procurement cost, a mechanism directly relevant to price-locking and indexation under inflation. Agbabiaka, Okonkwo, Ogunwole, Mayo and Okeke (2019) and Ogunwole, Okonkwo, Agbabiaka, Mayo and Okeke (2021) developed risk management and resilience frameworks for gas processing and critical infrastructure supply chains, while Okonkwo, Agbabiaka, Ogunwole, Mayo and Okeke (2021) connected materials readiness to supply chain performance.

On the systems side, Ahiaeke Patrick, Okonkwo, Mayo and Okeke (2020, 2021) examined data-driven ERP procurement processes and vendor evaluation, and Mbonu, Iwuanyanwu, Aliliele and Uzoka (2020a) set out a framework for agile supply chain digital transformation with embedded IT risk controls. Further work has addressed regulatory-compliant procurement in high-risk environments (Okonkwo, Ogunwole, Mayo, & Okeke, 2021), process automation for procurement efficiency and transparency (Akinleye & Adeyoyin, 2021), negotiation optimisation to reduce procurement costs in manufacturing (Akinleye & Adeyoyin, 2022a), supplier relationship management for strategic procurement objectives (Akinleye & Adeyoyin, 2022b; Ike et al., 2021), profitability analysis of retail procurement (Akin-Oluyomi, Atima, Akinleye, & Akokodaripon, 2020) and sustainable, ESG-integrated procurement in African manufacturing (Efobi, Akinleye, & Fasawe, 2022a; Okojie, Filani, Ihwughwavwe, & Sakyi, 2020). These contributions establish that procurement decisions carry cost, risk and governance consequences, but they do not formalise the link between purchasing quantities, inflation and the cash a firm must finance.

The disruptions of 2020 to 2022 also stimulated work on the information and risk side of supply chains. Predictive analytics has been shown to improve demand forecasting accuracy and reduce inventory inefficiencies (Aifuwa et al., 2020), and machine learning forecasts can be linked directly to revenue projection and financial planning (Tonoyan, Dada, & Ayivi-Donkor, 2021a). End-to-end visibility frameworks (Nnabueze et al., 2021) and real-time risk dashboards (Filani, Nnabueze, Ike, & Wedraogo, 2022) give planners earlier warning of supply and price changes.

Resilience studies covering global distribution networks (Anene, 2021), humanitarian logistics (Anene & Clement, 2022) and pharmaceutical supply (Awulu, Obukadata, & Williams, 2022b) emphasise buffers and alternative sourcing, while legal and governance research examines force majeure and contractual resilience in energy supply chains (Uchechi, Ominyi, Anichukwueze, & Jones, 2020) and shared responsibility in multi-jurisdictional supply chain governance (Ominyi, Uchechi, Anichukwueze, & Jones, 2021; Akin-Oluyomi & Akhigbe, 2022). The international literature on disruption is extensive.

Tang (2006), Kleindorfer and Saad (2005) and Craighead, Blackhurst, Rungtusanatham and Handfield (2007) set out frameworks for disruption risk and its severity, Zsidisin (2003) defined supply risk from the buyer's perspective, and Hosseini, Ivanov and Dolgui (2019) reviewed quantitative resilience methods. The pandemic prompted simulation studies (Ivanov, 2020), the concept of supply network viability (Ivanov & Dolgui, 2020), digital supply chain twins (Ivanov & Dolgui, 2021) and systematic reviews (Chowdhury, Paul, Kaisar, & Moktadir, 2021; Queiroz, Ivanov, Dolgui, & Fosso Wamba, 2022).

Order variability itself is shaped by the bullwhip effect, to which price variations and order batching contribute (Lee, Padmanabhan, & Whang, 1997), although its empirical incidence varies across industries (Cachon, Randall, & Schmidt, 2007). For commodity inputs, Gaudenzi, Zsidisin, Hartley and Kaufmann (2018) examined how purchasing firms choose between financial hedging, contractual pass-through and supplier arrangements to mitigate price risk.

In regulated sectors such as pharmaceuticals, drug shortage early warning models (Eze, Anene, & Akinleye, 2022a), traceability frameworks (Aneke & Adesemoye, 2019), operational performance metrics (Awulu, Obukadata, & Williams, 2022a), digital process analytics (Obukadata, Awulu, & Williams, 2021a) and

Lean Six Sigma in distribution (Obukadata et al., 2021b) show how supply risk translates into inventory policy.

Cross-border sourcing adds legal and trade frictions, including import-export barriers for Nigerian firms (Jones & Ominyi, 2020), uneven market access under free trade agreements (Jones & Ominyi, 2022a) and import compliance requirements (Aneke & Adesemoye, 2021), while contract design and review practices influence how price and delivery risks are shared (Uchechi & Ominyi, 2019; Uchechi et al., 2021). This work supplies the forecasts and risk signals on which our model depends, notably the expected inflation rate and the safety stock requirement.

Financial governance and information systems

An integrated purchasing and cash policy can only be executed if the data, controls and systems behind it are reliable. Work on internal audit and control highlights technology-enabled risk assessment (Akomolafe & Agu, 2018), risk-based internal control models (Akomolafe & Agu, 2019a), integrated governance for financial resilience (Akomolafe & Agu, 2019c) and AI-enabled IT general controls (Mbonu, Aliliele, Iwuanyanwu, & Uzoka, 2022).

Strategic accounting systems (Bola-Sadipe, Aliliele, & Eboh, 2019), comprehensive financial reporting models (Medon & Oduleye, 2022), data-driven tax compliance (Bola-Sadipe, Eboh, & Odihi, 2022) and fraud and anti-money laundering analytics (Atakpa, 2021; Atakpa & Abetoh, 2022) protect the integrity of payables, receivables and inventory records on which working capital calculations rest.

Within the finance function, analytics for enterprise value creation (Lawal & Oduleye, 2018a), tax governance (Lawal & Oduleye, 2018b), transfer pricing of intra-group inputs (Lawal & Oduleye, 2019a), risk-based business intelligence (Mbonu, Aliliele, Iwuanyanwu, & Uzoka, 2021a) and forecasting models in lending institutions (Dada, Isiekwu, & Oluwo, 2021b) extend the decision support available to treasury teams.

Fiscal and legal exposure also matters: finance bills alter sectoral cost structures (Akinola, Farounbi, Onyelucheya, & Okafor, 2020), stamp duty and litigation policies affect enterprise financial exposure (Uchechi, 2018), and automated compliance pipelines and regulatory risk assessment reduce the cost of meeting obligations (Uchechi & Ominyi, 2020; Uchechi, Ominyi, Anichukwueze, & Jones, 2022). On the banking side, partnership ecosystems (Agboada, Anene, Ezeako, & Okoli, 2020), relationship banking (Ezeako, Okoli, Uzondu, & Ibeh, 2019) and digital collections platforms (Osuji, Okafor, & Dako, 2021) shape both the availability of credit and the speed at which receivables convert to cash.

Finally, integration technology, including ETL design (Badmus, Dosunmu, & Ozowara, 2019a), enterprise service bus patterns (Badmus, Jooda, Ozowara, & Anunagba, 2022b), cloud migration (Ladapo, Jooda, Dosunmu, & Abolaji, 2022), predictive capacity planning (Edivri & Oteri, 2022) and business intelligence for resource allocation (Owoade, Moneke, & Anioke, 2022), determines whether procurement, inventory and treasury data can be combined in the way our model requires.

Synthesis

Existing work tends to fall on one side of a divide. Inflation-adjusted inventory models optimise cost but ignore liquidity, while working capital studies describe cash outcomes but take inventory policy as given. Few models capture the 2022 situation in which inflation and the cost of funds rose together and the borrowing limit became binding. The conceptual model in Section 4 links these strands with a formulation simple enough to be operated in a spreadsheet by purchasing and treasury staff, while preserving the main economic trade-offs.

Conceptual Model and Decision Formulation

Conceptual structure

The framework rests on a chain of three links. Purchasing policies determine inventory exposure; inventory exposure, together with receivables and payables, determines cash requirements; and cash requirements, through the cost and availability of financing, feed back into the best purchasing policy. Inflation enters at two points: it raises the value of avoiding future purchases (a benefit of holding stock) and it raises the nominal value of every working capital account (a cost in cash terms). Interest rates enter through the financing cost of every unit of working capital. This view is consistent with standard supply chain planning texts, which treat inventory as both an operational buffer and a capital investment (Chopra & Meindl, 2016).

Two features of the framework deserve emphasis. First, the relevant cost of holding inventory is not the accounting carrying rate but an effective rate that nets out the price appreciation the stock avoids. Second, the cash constraint applies to the peak of working capital,

Table 3: Notation

Symbol	*Definition*
D	Annual demand (units per year)
S	Fixed cost per order (administration, receiving, freight set-up)
p	Current unit purchase price
h	Physical holding cost rate (storage, insurance, obsolescence) per year
r	Financing rate on short-term funds per year
π	Expected input price inflation per year
H	Effective carrying rate, H = h + r – π
SS	Safety stock (units)
m	Selling price as a multiple of purchase price
DSO, DPO	Days sales outstanding and days payables outstanding
L	Credit facility limit available for working capital
Q	Order quantity (decision variable)
δ	Size of an announced one-time price increase (fraction)

not its average, because the credit line must cover the day on which a large order is paid but has not yet been sold. Purchasing decisions that look attractive on average cost can therefore be infeasible from a liquidity standpoint. Making this visible requires that procurement, inventory and treasury data be reported through common, standardised decision workflows (Alieme, Sule, & Obukadata, 2022) supported by integrated operational analytics (Agboada, Ezeako, Okoli, & Uzondu, 2018).

Setting, notation and assumptions

Consider a firm that buys a single input (or a homogeneous category of inputs) and sells finished output. Demand is deterministic at D units per year. The firm orders a quantity Q each cycle, holds a safety stock SS, and finances working capital through a revolving credit facility with limit L at annual rate r. Input prices are expected to rise at rate π per year. Table 3 summarises the notation.

The model rests on the following assumptions

- Demand is constant and known over the planning horizon; uncertainty is absorbed by the safety stock.
- Input prices rise smoothly at rate π, and the firm can buy in advance at today's price. Inflation is small enough within a cycle that first-order approximations are adequate.
- Receivables and payables are proportional to sales and purchases through fixed DSO and DPO.
- All working capital is financed at the marginal rate r, either from the credit facility or at the opportunity cost of cash.
- Storage capacity and shelf life are not binding unless stated; where they bind they enter as an additional upper limit on Q.

Inventory exposure, cash requirement and cost

Each unit held for one year incurs a physical cost h·p and a financing cost r·p, but it also avoids a price rise worth approximately π·p. The net economic cost of holding one unit for a year is therefore p(h + r – π). Following Buzacott (1975), we define the effective carrying rate

$$H = h + r - \pi \quad (1)$$

The inventory exposure of the firm is the value of stock held, p(Q/2 + SS) on average. It carries a financing cost and a price risk: if inflation turns out lower than expected, or prices fall, the exposure becomes a loss rather than a gain. This asymmetry is discussed in Section 6

Receivables equal AR = m·p·D·DSO/365 and payables equal AP = p·D·DPO/365. Average working capital need is

$$WCN(Q) = p(Q/2 + SS) + AR - AP \quad (2)$$

The peak requirement occurs immediately after an order has been received and paid, when the full lot is in stock

$$PWC(Q) = p(Q + SS) + AR - AP \leq L \quad (3)$$

Constraint (3) implies an upper bound on the order quantity that the firm can finance

$$Q_L = (L - AR + AP)/p - SS \quad (4)$$

The total relevant annual cost combines ordering cost, the effective carrying cost of inventory and the financing cost of the net trade credit position

$$TC(Q) = S·D/Q + H·p(Q/2 + SS) + r(AR - AP) \quad (5)$$

The firm chooses Q to minimise (5) subject to (3). The last term does not depend on Q but matters for the

comparison of regimes and for decisions on payment terms.

Analytical properties

Proposition 1 (Inflation-adjusted order quantity)

If $H > 0$, the optimal order quantity is

$$Q^* = \min\{\sqrt{(2SD/(pH))}, Q_L\} \quad (6)$$

and it is increasing in π and decreasing in r and h. If $H \leq 0$, holding stock is profitable at the margin and the optimal quantity is set by the tightest of the cash ceiling Q_L, storage capacity and shelf-life limits. The proof follows from the convexity of (5) in Q and the Kuhn–Tucker conditions.

Proposition 2 (Shadow price of cash)

When the cash constraint binds, the Lagrange multiplier on (3), expressed as a rate per unit of inventory value, is $\lambda = 2SD/(pQ_L^2) - H$. It measures the reduction in annual cost the firm would achieve from one more unit of credit, and equals the rate the firm should be willing to pay for additional facility capacity or for extended supplier terms.

Proposition 3 (Nominal working capital drift)

With constant physical volume and a stable policy, all components of (2) scale with p, so working capital need grows at rate π:

$$dWCN/dt = \pi \cdot WCN \quad (7)$$

This drift is a pure funding requirement. It does not represent a change in efficiency, but it absorbs credit capacity and must be planned for in the treasury budget even when sales volumes are flat.

Proposition 4 (Forward buying before an announced increase)

If the supplier announces a price rise of δ, the cost-minimising special order placed at the old price is

$$Q_s = \delta D/(h + r) + (1 + \delta) \cdot Q_new \quad (8)$$

where Q_new is the regular order quantity at the new price (Tersine, 1994). The feasible special order is $\min\{Q_s, Q_L\}$. Because Q_s grows linearly with δ while the cash ceiling is fixed, the cash constraint becomes more likely to bind as price shocks become larger, which is precisely the pattern observed in 2022.

Proposition 5 (Payment timing)

An early-payment discount of d for payment within t_d days instead of the net term N carries an implied annual return of $d/(1 - d) \times 365/(N - t_d)$. The firm should take the discount when this return exceeds r plus the shadow price λ. Each additional day of payables outstanding releases $p \cdot D/365$ of cash, worth $r \cdot p \cdot D/365$ per year in financing cost and, when the constraint binds, additional forward-buying capacity.

Numerical Analysis

Calibration

Following the simulation-based approach to cost and financial impact assessment reviewed by Tonoyan, Dada and Ayivi-Donkor (2022b, 2022c), we illustrate the model with a mid-sized manufacturer buying a key raw material. Annual demand is D = 120,000 units at a current price of p = $50, giving annual purchases of $6.0 million. The fixed order cost is S = $1,500, the physical holding rate h = 10 percent, safety stock SS = 2,000 units, and the selling price is 1.4 times the purchase price. Receivables are collected in 45 days and payables settled in 30 days, giving AR = $1,035,616 and AP = $493,151. The firm holds a revolving credit facility of L = $3.0 million, so the cash-feasible order ceiling from (4) is Q_L = 47,151 units, or about 4.7 months of demand.

Four regimes capture the conditions firms faced around 2022. Regime A is a pre-shock baseline with 2 percent inflation and a 3.5 percent financing rate. Regime B reflects the first half of 2022, when input inflation reached 8.5 percent while financing rates had only begun to rise. Regime C reflects the second half of 2022, when inflation eased to 6.5 percent but financing rates climbed to 8 percent. Regime D represents a

Table 4: Optimal purchasing policy and cash requirement by regime

Regime	*π*	*r*	*H*	*Q* (units)*	*Cover(months)*	*Orders / yr*	*Avg. WCN ($)*	*Peak WC ($)*
A. 2021 baseline	2.0%	3.5%	11.5%	7,913	0.8	15.2	840,280	1,038,094
B. H1 2022 inflation surge	8.5%	4.5%	6.0%	10,954	1.1	11.0	916,327	1,190,188
C. H2 2022 monetary tightening	6.5%	8.0%	11.5%	7,913	0.8	15.2	840,280	1,038,094
D. Commodity input shock	14.0%	5.0%	1.0%	26,833	2.7	4.5	1,313,286	1,984,107

Note: $H = h + r - \pi$ with h = 10%. Avg. WCN from equation (2); peak working capital from equation (3). Credit facility L = $3,000,000.

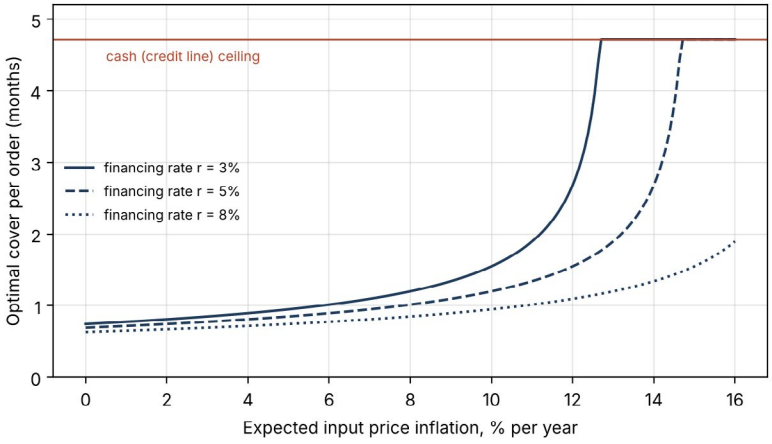


Figure 1: Optimal cover per order as a function of expected inflation for three financing rates
Note: The curves rise steeply as π approaches h + r, where the effective carrying rate approaches zero, and are truncated by the cash ceiling Q_L.

commodity input under acute price pressure, with 14 percent expected inflation and a 5 percent financing rate.

Optimal policy across regimes

Three patterns stand out. First, the optimal lot responds strongly to the gap between inflation and the cost of funds. In Regime B the effective carrying rate falls from 11.5% to 6.0%, and the optimal order rises by 38.4% to 10,954 units. In Regime D, where inflation exceeds the financing rate by nine percentage points, H falls to 1.0% and the optimal lot more than triples, to roughly 2.7 months of cover. Second, Regime C shows that tighter money can fully offset higher inflation: with r rising to 8 percent, H returns to its baseline value and the optimal policy is identical to Regime A, even though inflation is more than three times higher. Third, larger lots carry a real cash cost: peak working capital in Regime D is $1,984,107, nearly double the baseline, and closes much of the gap to the credit limit.

Cost of a static policy

Table 5 compares the cost of the optimal policy in each regime with the cost of continuing to use the 2021 order quantity, computed with a 3.5 percent financing rate and no inflation adjustment. The static policy is the one many enterprise resource planning systems would continue to apply if carrying-cost parameters were not updated.

The saving from updating the policy is small when inflation and rates move together (Regimes A and C) and becomes material when they diverge: 4.1% in Regime B and 23.9% in Regime D. The final column shows the nominal working capital drift predicted by Proposition 3. In Regime D the firm needs about $183,860 of additional funding over a year simply because prices have risen, a sum larger than the entire annual ordering and carrying cost. In practice this drift, rather than the lot-size decision, is often what surprised treasury teams in 2022.

Forward buying and payment terms

Suppose that in Regime B the supplier announces an 8

Table 5: Cost of a static policy versus the inflation-aware policy

Regime	*TC, static Q ($/yr)*	*TC, optimal Q* ($/yr)*	*Saving ($/yr)*	*Saving (%)*	*WC drift π·WCN ($/yr)*
A. 2021 baseline	76,130	75,984	146	0.2%	16,806
B. H1 2022 inflation surge	66,013	63,274	2,739	4.1%	77,888
C. H2 2022 monetary tightening	100,541	100,395	146	0.1%	54,618
D. Commodity input shock	54,597	41,540	13,057	23.9%	183,860

Note: Static Q = 7,303 units, the classical EOQ with h + r = 13.5% and no inflation term. Total relevant cost includes the financing of net receivables.

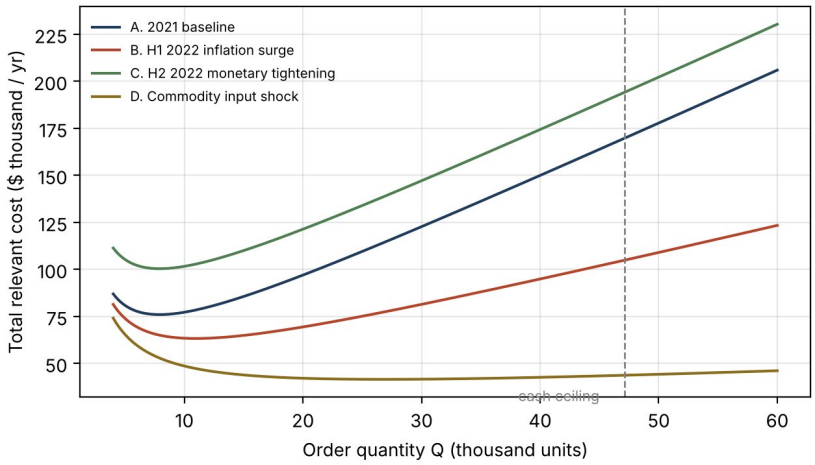


Figure 2: Total relevant cost as a function of order quantity in the four regimes
Note: The cost curve flattens as inflation rises relative to the financing rate, so the penalty for ordering too much shrinks while the cash requirement grows.

percent price increase effective next month. Equation (8) gives an unconstrained special order of 73,530 units, about 7.4 months of demand, which would save approximately $161,826 compared with buying at the new price. However, paying for that order would push peak working capital to roughly $4.3 million, well above the $3.0 million facility. The cash-feasible special order is therefore capped at Q_L = 47,151 units (4.7 months), which still saves about $140,805. The cash constraint costs the firm about $21,021, or 13.0% of the available benefit.

This result illustrates the central message of the paper. In periods of rapid price increases, the binding limit on procurement value is frequently liquidity rather than the cost trade-off itself. A firm that negotiates an additional $1.3 million of temporary credit, or extends payment terms on the special order, can capture the forgone saving. Conversely, a firm that executes the full forward buy without checking the facility may breach covenants or be forced to delay payments to other suppliers.

Two further calculations complete the picture. A conventional 2/10 net 30 discount carries an implied annual return of 37.2%, far above any financing rate observed in 2022, so the firm should continue to take such discounts whenever cash allows, but these discounts compete for the same scarce credit capacity as forward buying. Separately, each additional day of payables outstanding releases $16,438 of cash. Extending DPO from 30 to 45 days would free about $246,575, which at an 8 percent financing rate saves roughly $19,726 per year and expands the forward-buying ceiling by about 4,932 units. Supplier negotiations over terms are therefore a direct lever on procurement cost when cash is constrained.

Sensitivity

The policy is most sensitive to the inflation forecast when H is close to zero, as the steep portion of Figure 1 shows. If a firm sized its lots for 14 percent inflation and prices then stabilised, it would be left holding nearly three months of high-cost stock financed at a rising rate. Because the cost curve in Figure 2 is flat near the optimum, a prudent approach is to plan on a conservative inflation estimate, accept a small expected cost penalty, and avoid the larger downside of excess stock bought at peak prices.

Discussion

The results confirm, in a liquidity-constrained setting, the central intuition of inflation-adjusted inventory theory: when input prices rise faster than the cost of holding stock, larger lots and earlier purchases lower cost (Buzacott, 1975; Chandra & Bahner, 1985; Hariga, 1995). The regime comparison adds an important qualification. Because the financing rate enters the effective carrying rate with the opposite sign to inflation, the monetary tightening of late 2022 was enough to cancel the incentive to hold more stock, even though inflation remained high. Firms that had enlarged inventories in the first half of the year therefore found themselves holding stock that was no longer justified by the cost

trade-off, which is consistent with the precautionary inventory build-up and subsequent overstock described by Rees and Rungcharoenkitkul (2021).

The binding cash ceiling in the forward-buying case echoes the operations and finance literature, in which financing constraints reduce order quantities and change the structure of optimal policies (Buzacott & Zhang, 2004; Dada & Hu, 2008; Protopappa-Sieke & Seifert, 2010; Kouvelis & Zhao, 2016; Alan & Gaur, 2018). The present results show that, during a price shock, this constraint can absorb a material share of the value available from buying ahead. They also clarify why trade credit and buyer-led financing schemes are valuable at such times: by shifting the timing of payment, they relax the very constraint that limits procurement savings (Yang & Birge, 2018; Tunca & Zhu, 2018).

The nominal drift in working capital connects the model to empirical research on working capital management. Studies show that the optimal level of working capital is lower for financially constrained firms (Baños-Caballero et al., 2014), that working capital management matters more in downturns (Enqvist et al., 2014; Tsuruta, 2019), and that the cash conversion cycle is closely linked to profitability in African manufacturing (Ukaegbu, 2014). A cycle measured in days can remain stable while the cash needed to support it rises with prices, so day-based metrics alone may understate funding pressure during inflation. Finally, the planning routine depends on reliable forecasts, visibility and internal controls, which links the model to applied work on predictive forecasting (Aifuwa et al., 2020), end-to-end visibility (Nnabueze et al., 2021) and risk-based internal control (Akomolafe & Agu, 2019a).

Implications

Managerial implications

The model supports a joint planning procedure in which purchasing and finance share inputs and outputs rather than negotiating after the fact. We propose five steps, which can be run monthly or whenever inflation or rate expectations change materially.

Update the effective carrying rate

Replace static carrying-cost parameters in planning systems with $H = h + r - \pi$, using the current marginal borrowing rate and a category-specific input inflation forecast rather than headline consumer inflation. Modern ERP procurement modules can hold these parameters and refresh them automatically (Ahiaeke Patrick et al., 2020).

Compute the cash ceiling

Translate the available credit facility, after receivables and payables, into a maximum feasible order quantity Q_L for each major category, and allocate facility capacity across categories according to their shadow prices.

Set lot sizes and forward buys

Apply equation (6) for routine orders and equation (8) for announced increases, bounded by Q_L, storage and shelf life. Prioritise forward buys where the price increase is large relative to $h + r$.

Budget the nominal drift

Add $\pi \cdot WCN$ to the treasury forecast so that the credit line is sized for the inflation-driven increase in working capital, not only for volume growth. Predictive cash flow and budgeting tools (Tonoyan et al., 2021b; Adesuyi et al., 2022) can carry this drift forward automatically.

Use payment terms as a release valve

Rank early-payment discounts and payment-term extensions by their implied rate relative to $r + \lambda$, and negotiate terms before, not after, large forward buys.

Three broader implications follow. First, procurement performance measures that reward purchase price variance alone encourage forward buying without regard to cash; a balanced scorecard should include the financing cost of inventory and the use of facility capacity. Contract and vendor governance practices (Okonkwo et al., 2019) and data-driven vendor evaluation (Ahiaeke Patrick et al., 2021) offer practical routes to embed price and payment terms into supplier selection. Negotiation optimisation (Akinleye & Adeyoyin, 2022a) can be extended to treat price indexation, payment terms and delivery timing as joint bargaining variables rather than price alone. Second, the response to 2022 should have differed by category: commodity-linked inputs with high expected inflation justified larger lots, while stable-price components did not, so blanket inventory increases were rarely optimal. Third, the reversal risk is real. When inflation eases faster than interest rates, H rises sharply and large stocks bought at peak prices become a burden, which was the experience of many retailers and manufacturers in late 2022 who reported excess inventories and margin pressure.

Execution depends on organisation as much as on analysis. Standard operating procedures that embed the planning routine (Agboada, Ezeako, Okoli, & Uzondu, 2019; Eyetsemitan, Oyeleye, Ambali, & Fadayomi, 2022), cross-functional key performance indicators that hold

purchasing and finance to shared targets (Sakyi, Filani, Nnabueze, Okojie, & Ogedengbe, 2022b; Seyi-Lande, Arowogbadamu, & Oziri, 2022), governance alignment where operations are shared with partners (Eyetsemitan, Ambali, Oyeleye, & Fadayomi, 2020) and supply chain talent development (Falemi, Akhigbe, & Akin-Oluyomi, 2020) all help translate the model into practice.

Data-driven operations management frameworks (Efobi, Akinleye, & Fasawe, 2021) and customer service analytics (Sakyi, Nnabueze, Filani, Okojie, & Okereke, 2022a) can improve the demand signals that drive order quantities.

For firms holding maintenance spares, the shift from reactive to predictive and reliability-centred maintenance reduces the safety stock needed for a given uptime target (Sunday, Omoegun, Essien, & Oluokun, 2020; Obetta, 2020; Mayo, Ogbole, Okoruwa, & Babatope, 2021), freeing working capital that inflation would otherwise erode, and cost-continuity trade-offs of the kind studied by Anyanwu (2020) apply equally to support services that sit around the procurement function.

For firms in high-inflation emerging markets, where input inflation driven by currency depreciation can exceed local lending rates, H may be negative for imported inputs. In that case the cash ceiling, foreign exchange availability and storage capacity determine purchasing policy, and the model highlights the value of securing longer supplier credit or foreign currency facilities as a procurement strategy in its own right. For small and resource-constrained firms, lean process discipline can also reduce the safety stock and cycle stock needed to support a given service level, which lowers the working capital base on which inflation operates (Ambali, Eyetsemitan, Oyeleye, & Fadayomi, 2021; Ike et al., 2022; Efobi, Akinleye, & Fasawe, 2022b). For capital-intensive sectors, the same logic extends to aligning capital budgeting with execution schedules, so that large material commitments are timed against available funding (Nwangwu, Duvbiama-Owasanoye, & Akano, 2021).

Implications for lenders, suppliers and policymakers

For lenders, the model implies that borrowing bases and covenants calibrated in nominal terms tighten automatically as prices rise, so working capital facilities should be reviewed against expected inflation rather than only against sales volume; trade finance and digital lending products designed for this purpose can ease the constraint for smaller firms (Agboada, Ezeako, Okoli, & Ibeh, 2018; Okafor et al., 2021). For large buyers and suppliers, supply chain finance programmes that lengthen effective payment terms without weakening suppliers are a direct lever on procurement cost under inflation (Lekkakos & Serrano, 2016; Wuttke et al., 2016). For policymakers, the analysis shows that monetary tightening reaches firms not only through demand but also through the carrying cost of inventory, and in economies where imported inputs depend on access to foreign exchange, treasury and currency arrangements become part of procurement capacity (Dada et al., 2021a).

Limitations

The model is deliberately parsimonious, and its results should be read with several limitations in mind. Demand is deterministic and inflation is treated as a known rate, whereas in 2022 both were highly uncertain. The analysis covers a single purchased category with a dedicated credit limit, while most firms allocate one facility across many categories. Supplier behaviour is taken as given, yet suppliers facing the same pressures may shorten terms or require prepayment, tightening the cash constraint precisely when forward buying is most valuable. The numerical analysis is illustrative and calibrated rather than estimated from firm data, so the magnitudes reported depend on the chosen parameters. Finally, the analysis abstracts from taxes and inventory accounting methods such as LIFO and FIFO, which affect reported profit and cash taxes under inflation and whose implementation in operating workflows is itself demanding for smaller firms (Eyetsemitan, Ambali, Oyeleye, & Fadayomi, 2021).

Future Research

Several extensions follow directly. A stochastic version in which the inflation path follows a regime-switching process would allow the value of waiting to be quantified alongside the value of buying ahead. A multi-item formulation with a shared credit facility would allocate scarce cash across categories using the shadow prices derived in Proposition 2. Making supplier payment terms endogenous, for example through a game between buyer and supplier, would capture how inflation changes the bargaining over trade credit. Disruption risk, which raises safety stock requirements independently of inflation, could be integrated using the risk and resilience frameworks of Agbabiaka et al. (2019) and Ogunwole et al. (2021), and contractual remedies for

supplier price changes could be modelled drawing on work on contract and dispute process standardisation (Uchechi, Ominyi, & Jones, 2018). Empirically, firm-level panel data linking changes in inventory and working capital during 2021 and 2022 to category price inflation and borrowing costs would provide a direct test of the model's predictions.

Conclusion

The inflation of 2022 showed that purchasing policy and cash planning cannot be managed separately. This paper has developed an integrated decision model that links order quantities and forward buying to inventory exposure and to the cash a firm must finance. The effective carrying rate $h + r - \pi$ summarises how inflation and interest rates jointly shape the best lot size, the credit facility imposes a ceiling that often binds before the cost trade-off does, and nominal working capital drifts upward at the rate of inflation even when volumes are flat. A calibrated illustration shows that updating purchasing policy for inflation can reduce relevant costs substantially when inflation and rates diverge, and that liquidity is the main limit on the value of forward buying. A joint planning routine built on these relationships allows procurement and finance to make consistent decisions in volatile price environments.

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Appendix: Derivation of Proposition 1

Differentiating (5) with respect to Q gives $dTC/dQ = -SD/Q^2 + Hp/2$, and $d^2TC/dQ^2 = 2SD/Q^3 > 0$, so TC is strictly convex for $Q > 0$ whenever $H \geq 0$. Setting the first derivative to zero yields the unconstrained optimum $\sqrt{(2SD/(pH))}$. Forming the Lagrangian with multiplier $\mu \geq 0$ on constraint (3), the first-order condition becomes $-SD/Q^2 + Hp/2 + \mu p = 0$. If the unconstrained optimum satisfies (3), $\mu = 0$; otherwise $Q^* = Q_L$ and $\mu = SD/Q_L^2 - Hp/2$. Expressing μ per unit of inventory value at the margin, $\lambda = 2\mu/p = 2SD/(pQ_L^2) - H$, which is Proposition 2. When $H < 0$ the derivative is negative for all Q, so cost decreases without bound until a capacity, shelf-life or cash limit binds.