Ratting out the cartel:
Do firms compete more operationally with leniency laws?

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Abstract

The growing popularity of leniency laws to cope with collusions, a toxic by-product of capitalism, warrants empirical investigations on its effectiveness. Has it achieved its goal in enhancing competitions among businesses around the world? Operationally, we show that leniency laws significantly drive firms in 64 countries worldwide toward more vigorous competition as evidenced by their strategic responses. In the short run, operational efficiency of firms in countries that started introducing leniency laws (in comparison to comparable matched firms in countries that did not) suffers. Specifically, they were driven to extend their credit terms, an effective combating move that while presenting short-term penalties to total asset turnover, signifies an immediate response to anticipated level of stronger competition. For long-term vision, firms also adjust themselves by optimizing fixed asset utilization, indicating a sustainable approach in maintaining their competitive edge in the market where benefits of once being in a cartel were lifted. These findings are more pronounced among larger and more profitable firms. Empirically, as leniency laws implementations in sample countries are staggered in their occurrences, we employ the recently moderated Difference-in-Differences (DID) imputation estimator to minimize biases from 'negative weighting' inherent in standard DID approaches.

Keywords: operational efficiency, anti-collusion, leniency programs, difference-in-differences, staggered implementation, domestic competition.

JEL: L41, K21, M21

I. Introduction

In capitalist economies, the principle of competition serves as the keystone in fostering innovation, enhancing efficiency, and stimulating economic growth (Teece, 1992; Carlin, 2001). Nonetheless, the lack of robust regulatory oversight can inadvertently lead this cornerstone to cause market disruptions. Specifically, the inherent over-drive for profit maximization among businesses may incline towards anti-competitive behaviors, such as collusion (Bourveau, 2020). Collusion occurs when firms work together to form a cartel for their advantage influencing markets and prices, significantly undermine economic well-being and consumer interests (Amthauer, 2023). A notable example is the European truck cartel, which resulted in a substantial welfare loss estimated at up to €15.5 billion for the European economy, illustrating the profound economic detriment caused by such practices (Beyer et al., 2020). Anti-collusion laws investigate and break cartels to protect consumers from high price fixing practices and ensure fair competition (Marslev & Staritz, 2023; Saggi, 2006).

Among these anti-collusion regulatory frameworks, leniency policies represent a special case and have emerged as a sophisticated mechanism, designed to offer a less costly and strategically effective approach for dismantling cartels (Charistos & Papadopoulos, 2022; Haucap & Heldman, 2023). By allowing market regulators to grant full or partial amnesty to firms that are part of a collusive agreement but cooperate by divulging information about it, these policies introduce a potent disincentive against collusion. This 'ratting out' dynamic, where firms within a cartel face the threat of internal betrayal in exchange for leniency, underpins the efficacy of such laws (Immordino et al., 2020; Marshall, 2017). The prospect that any member of the cartel can unilaterally decide to cooperate with regulators, thereby receiving automatic amnesty as stipulated by leniency laws, serves as a strategic tool for antitrust authorities. It essentially leverages the potential for distrust within cartels, compelling them to disband or refrain from forming in the first place, thus restoring competitive market conditions. By granting a pathway to legal pardon to a colluded business that come forward and tell all first (e.g. ratting), leniency laws poses a strategic 'threat' to the stability of collusive agreements. Supposedly, this should allow regulators

to enhance their leverage in restoring fair competition and protecting the market from anti-competitive practices.

But do firms really compete as a result of leniency laws? Existing literature offers limited answers to this important question. This is surprising as governments around the globe have enacted leniency provisions to strengthen antitrust laws and address growing concerns about cartels. Among very limited studies, Dong et al (2019) documented a contraction of gross margins among businesses after the introduction of leniency laws. Dasgupta & Žaldokas (2019) examine the strategic responses by firms under leniency laws and conclude that they adapt to higher competition by increasing their assets funded through pro-active equity issuances. Adding to this limited empirical evidence in the literature, we turn to the unstudied critical aspect that attributes to a firm's profitability – the operational efficiency. In the spirit of the DuPont model, a crucial tool in financial analysis, one can disentangle the various factors that contribute to a firm's return on equity (ROE) into three main components: profit margin (Dong et al, 2019), equity multiplier (financing – e.g., Dasgupta et al 2019), and total asset turnover (operational efficiency). From the above, the existing literature has largely overlooked how operational efficiency (and its finer and practical details), a critical determinant of shareholders' wealth (Aktas et al., 2015), is affected when cartels are dismantled. We intend to fill this gap.

If a firm needs to step up its competition quickly, what would be the most optimal way to do so operationally? Prior research has indicated that firms can leverage trade credit as a subtle, yet effective competitive tool. This not only acts as a form of price discrimination, but also offers firms the capacity to circumvent legal constraints on explicit price changes (Brennan et al., 1988; Mian & Smith, Jr., 1992). Moreover, extending trade credit serves multiple operational goals including boosting sales, bolstering the seller-buyer relationship, advertising, and certifying product quality (Deloof & Jegers, 1996; Kim & Atkins, 1978; Martínez-Sola et al., 2014). As competition intensifies, particularly in consumer credit markets, firms are more likely to offer credit to riskier clientele (Gissler et al., 2020). Thus, our study seeks to explore

these complex dimensions focusing on the strategic role of trade credit extension in the wake of leniency laws.

We adopt a novel design in a Difference-in-Differences (DiD) setting informed by the staggered implementation of laws across 64 countries from 1990-2020. This methodological approach extends beyond traditional two-way fixed-effect regression models commonly used in the prior literature. The recently developed DiD imputation estimator we utilize is specifically tailored and thus more suitable for studies involved with staggered law implementations, as established by Borusyak et al. (2024). In this context, "staggered law implementation" refers to the varying timelines across countries in which leniency laws were enacted and enforced at different points in time allowing us to observe and analyze their differential impacts over time. This enables us to provide a more unbiased and finite-sample efficient estimation. Our approach is aligned with emerging methodologies that are robust to heterogeneous treatment effects as demonstrated in works by Callaway and Sant'Anna (2020) and de Chaisemartin and D'Haultfœuille (2020). More specifically, unlike the extant literature, which commonly utilizes a DiD approach to measure the average treatment effect after policy changes (Bertrand & Mullainathan, 2003; Howell, 2016; Yang et al., 2012), our study effectively employs a detailed longitudinal analysis. In other words, this approach allows us to less biasedly capture the effects of leniency programs on firms' operational performance by examining the average outcomes for each year after the laws' implementation. Our detailed longitudinal analysis allows us to observe firms' adaptations, understand the timing of their strategic adjustments, and isolate the effects of leniency programs from external variables.

Our findings reveal the detailed effects of leniency laws on firms' asset management strategies revealing a complex interplay of short-term and long-term adaptations. First and foremost, we show that firms around the globe do adjust themselves to compete more fiercely in the presence of leniency laws. Initially, firms in countries that adapted leniency laws (in comparison to comparable matched firms but operated in the country in the absence of the same laws) extend their credit terms to enhance market share, yet this moves risks slightly diluting asset turnover. Concurrently, firms concentrate on optimizing fixed

asset utilization, a long-term effort aimed at sustainable growth and operational efficiency. This dual strategy creates an indeterminate net impact on total asset turnover highlighting the intricate balance firms maintain between immediate gains and long-term sustainability. Over time, we observe a dynamic shift. Firms adapt their credit policies to sustain customer relationships, uphold competitiveness, and optimize product management. These strategic adjustments point to an evolving landscape where firms recalibrate their asset management strategies in response to the changing regulatory environment. Regarding firm-level variations, our data indicates that larger and more profitable firms are more likely to offer a more attractive payment terms following the introduction of leniency laws, a behavior we attribute to strategic motives.

The recent emergence and growing popularity of leniency laws, particularly notable in the international business regulatory landscape, underscore a pivotal shift in how competitive practices are managed globally. Originating in the early 1990s[1], these laws have seen a staggered, yet strategic adoption across various nations with a notable absence in key emerging markets. This study reveals that while these laws have been effective in stimulating competition, their slow global dissemination points to a cautious approach by nations in reforming anti-competitive practices. The effectiveness of leniency laws, as demonstrated in our findings, suggests that they could serve as a vital policy tool in emerging economies offering a robust mechanism to enhance market competition. The adoption of these laws in these markets could be especially impactful considering our findings that emphasize their significant role in enhancing operational efficiency and encouraging competitive behavior in a diverse range of economic and cultural contexts.

The structure of the paper is outlined as follows. Section 2 reviews the relevant literature providing the background to our study. In Section 3, we propose our research hypotheses. Section 4 delineates our

[1] It is an interesting coincidence that leniency laws entered the anti-collusion laws scene in the early 1990's. In the Goodfellas film (1990), it is made popular how the Lucchese crime family was brought down by just one member, Henry Hill Jr. who ratted out his own mafia gang for amnesty.

data sources and describes the methodology. Section 5 presents our empirical results.. Finally, Section 6 concludes the paper.

II. Literature review

1. Impact of leniency laws on firms' behavior and performance

The strategic interplay behind leniency policies can be effectively analyzed through the framework of game theory, which explains the complex decision-making processes among firms engaged in collusion. Game theory posits that within the context of a cartel, each firm acts as a rational agent, aiming to maximize its utility under the uncertainty regarding the actions of its counterparts (Philips, 1995; Dixit & Nalebuff, 1991). The introduction of leniency laws transforms the traditional payoff matrix of participating in a cartel, introducing a divergent strategy that potentially offers a higher utility—cooperation with regulators in exchange for leniency. This dynamic introduces a 'prisoner's dilemma' scenario (Tucker, 1950), where firms are incentivized to defect from the cartel agreement to avoid punitive consequences, given the uncertainty of whether other firms will maintain their collusion or defect first (Kreps & Wilson, 1982).

The effectiveness of leniency policies in encouraging cartel members to 'rat out' each other depends on changing their expected benefits from staying loyal to the cartel versus defecting. By strategically adjusting the incentives for defection through the promise of amnesty or reduced penalties, regulators effectively decrease the equilibrium point at which collusion is the dominant strategy (Kobayashi, 2001). This adjustment not only disrupts existing cartels but also deters the formation of new collusive agreements, as the perceived risk and uncertainty of defection among potential cartel members outweigh the benefits of collusion. These leniency passages introduce a climate of strategic uncertainty among firms within a cartel by creating a pervasive fear of betrayal ('other firms may rat out at any time'), which directly undermines the economic rents[2] previously derived from collusive agreements. Such uncertainty not only threatens the fabric of anti-competitive behaviors but also signals a shift towards a more dynamic environment, as firms

[2] Economic rent refers to the excess payment made to a factor of production over and above what is needed to keep it in its current use, highlighting income derived from ownership or control of a scarce resource (Wessel, 1967).

adjust their strategies in anticipation of increased market competition. The erosion of guaranteed collusion profits compels firms to reconsider their positions, recognizing that the competitive landscape could escalate unpredictably as the security offered by collusion diminishes (Golombek et al., 1998; Peinert, 2021; Wie, 2002). Foremost, disrupting these collusive practices revitalizes market competition, thereby driving down prices and improving the quality of goods and services for consumers (Golodner, 2001).

In theory, Landeo and Spier (2020) prove that the ordered-leniency passage can efficiently detect and prevent harmful short-term activities conducted by a group of two or more injurers. In practice, the leniency passage is earliest implemented in 1993 in the United States (U.S.), effectively destabilized existing cartels and dissuaded the emergence of new ones (Miller, 2009) inspiring other countries to pass similar laws (Hammond, 2005). The total antitrust fines increased around 30 times after a decade from $107 million in 2003 to $3.6 billion in 2015 (Antitrust Division, 2023), while total sentence fines surged from 3,313 days in the 1990s to 23,398 days in 2012 (Dasgupta & Žaldokas, 2019). Overall, the worldwide adoption of leniency laws has significantly undermined collusion (Dong et al., 2019).

Over the past few decades, countries around the world have taken remarkable strides to strengthen anti-monopoly and anti-collusion laws. Following the 1993 revision in U.S., the program witnessed a significant increase of applications. Scott Hammond, Deputy Assistant Attorney General, observed in 2005 that the updated Corporate Leniency Program led to an increase in amnesty applications, with the rate escalating to approximately two per month (Hammond, 2005). Similarly, after implementing its leniency program in 2004, South Africa saw applications coming in at about three per month, surpassing the application rate in the United States. In Germany, the success of the initial leniency program is evident from the significant number of leniency applications received, with a total of 122 filings between 2000 and 2005, according to the cartel office's observations. (Bundeskartellamt, 2016). Notably, in 2003, the German Federal Cartel Office fined six major cement producers a total of 661 million Euros for forming a quota-cartel. The cartel was disrupted in 2002 when Readymix (now Cemex), aiming to optimize its production and distribution, inadvertently initiated competition that led to a sharp decrease in cement prices. As

investigations began, Readymix turned to the FCO as the main informant, benefiting from reduced fines through the federal leniency program, highlighting the program's role in dismantling cartels and encouraging self-reporting (Blum, 2008). Just before Spain introduced its leniency program in June 2008, cartel members were reportedly queuing up at the National Competition Commission's offices, eager to be the earliest from their cartel to seek leniency (Harrington, 2015).

To combat the above, the sweeping efforts to combat anti-competitive practices, as demonstrated through the widespread adoption of leniency programs, are further complemented by high-profile antitrust actions against global tech giants, illustrating the depth and breadth of global regulatory commitment to preserving market competition. For instance, in 2012, the U.S. Department of Justice accused Apple and five major book publishers of colluding to increase e-book prices from $9.99 to $14.99. This trend gained further momentum with China's 2021 imposition of a $2.8 billion fine on Alibaba for anti-monopoly violations. This comes alongside the United States' intensified focus on antitrust enforcement aimed at “Big Tech” companies including Amazon, Apple, Facebook, and Google. These instances underscore a universal commitment to dismantling monopolistic and collusive structures for the economic good. Within this expansive regulatory landscape, the crucial role of leniency in anti-collusion laws gains prominence, bridging the gap between voluntary compliance through self-reporting and the rigorous enforcement actions against those undermining competitive markets.

The scholarly interest in leniency policies and their impact on corporate behavior and financial outcomes has surged in recent years. Amthauer (2023) conducted a systematic review of case studies and noted a sparse publication record before 2010, with a significant uptick in research interest from 2018 onwards, peaking in 2019. This increase reflects a growing academic focus on understanding how leniency policies influence corporate strategies. Prior studies suggest that firms adapt their financing strategies and experience reductions in gross margins following the disruption of cartels (Dasgupta & Žaldokas, 2019; Dong et al., 2019). Additionally, some firms attempt to re-establish collusion through conference calls (Bourveau et al., 2020) or engage in strategic mergers to regain market power (Dong et al., 2019). However,

the current body of literature has not yet explored the impact of these leniency policies on firms' operational efficiency in a more competitive market environment after the laws take effect.

2. Firms' asset utilization after leniency passages

Dasgupta et al. (2018) finds that when the U.S. market becomes more competitive, better CEOs are hired and boards no longer tolerate slack and inefficiency leading to less organizational slack. In principle, organizational capabilities can be a competitive advantage and are immune to the market threats of imitation, substitution, dissipation, and appropriation (Collis, 1994). Progressive companies tend to build organizational capacity by which managers empower all employees to think and act as leaders in their domain in an increased competitive market (Ulrich & Lake, 2011). These studies imply that the organizational capacity of firms is improved due to more rigid boards and employers' encouragement policies as a reaction to enhanced market competition.

In addition to enhancing organizational capabilities, firms may also need to modify their financial and operational strategies to navigate a more competitive landscape. While existing research demonstrates that firms tend to bolster their cash holdings through an increase in cash and cash equivalents (Dasgupta & Žaldokas, 2019), it is crucial to also distinguish these short-term liquidity measures from more cyclical and sustainable aspects of financial management, including the Operating Cycle (OC). Cash and cash equivalents are one-time, short-term assets that can be quickly converted to cash within three months. In contrast, OC represent recurring and sustainable processes where cash is continually reinvested to generate more cash in subsequent cycles. As a result, this cyclical process, over the long term, should theoretically produce more cash than one-time sales or liquidations. These repeatable returns from operations are vital for a firm's long-term sustainability and are more indicative of a company's health than a mere stockpile of cash (Groth, 1992).

Following Hill et al. (2010) and Boisjoly et al. (2020), we study the working capital requirement in combination. Operating Cycle has long been presented for working capital in the extant literature. This

measure equals the total of account inventory days and receivables days, where these are the number of days that firms need to sell the products and collect the receivables. This proxy is commonly used to measure working capital management (Jalal & Khaksari, 2020) and cash-holding strategies (Wang et al., 2014). Operating Cycle provides further insight into the operating efficiency of firms, with a shorter cycle being preferred by most companies as it indicates a more efficient business progression (Groth, 1992). For example, the operating cycle, which indicates the speed and turnover of corporate cash flow, also influences the corporate cash-holding strategy (Wang et al. 2014).

3. Short-term strategies in response to antitrust enhancement

In the wake of antitrust enforcement actions, especially following the introduction of leniency programs, firms should be forced to make strategic adjustments to their capital structures to survive in an increasingly scrutinized competitive environment. Consistent with this conjecture, Dasgupta & Žaldokas (2019) have empirically demonstrated that these affected firms tend to increase their equity issuance resulting in a decrease in their debt-to-equity ratios. This shift toward a more equity-heavy capital structure is not merely a reactive measure, but a strategic move aimed at enhancing financial flexibility. With fewer burden of debt obligations, firms gain the flexibility to be more agile and adaptive in their market strategies, following the introduction of leniency laws in their countries.

Banner (1958) documented that the "ability to provide credit is a more effective competitive weapon than an attractive product price." Since then, a body of empirical and theoretical models has been studied further by linking trade credit to price discrimination and implicit warranties. Regarding price discrimination, Brennan et al. (1988) theoretically proves that the highest price that credit customers are willing to pay is lower than that of cash customers, suggesting that firms might lower prices to appeal to both groups. However, across various regions worldwide, firms encounter legal and practical challenges to price discrimination (Mian & Smith Jr, 1992). This is where Resale Price Maintenance (RPM) becomes a critical factor. RPM limits the ability of firms to adjust prices freely to restore competitive advantage (European Comission, 2022; Niels, 2011), a restriction that is enforced stringently in many

regions. Faced with these limitations and the widespread prohibition of price discrimination under anti-collusion laws, businesses around the globe would be prone to extend trade credit at subsidized rates. Therefore, the strategic use of trade credit stands out as a viable approach for firms aiming to enhance their competitive edge while complying with the complex legal frameworks that govern market practices.

From a theoretical standpoint, works by Kim and Atkins (1978), Copeland and Khoury (1980), and Martínez-Sola et al. (2014) suggest a strong link between trade credit policies and firm performance. Specifically, these studies demonstrate that the extent of trade credit granted to customers serves as a strategic mechanism to boost sales and profitability. In periods of fluctuating demand, Abuhommous (2017) notes that trade credit can affect operational efficiency by decoupling the delivery of goods from the receipt of payment from customers. Firms also achieve operational efficiencies by separating the delivery of goods from the collection of payment at predetermined dates, particularly when multiple sales to the same customer occur in a short timeframe, thereby reducing collection costs, a practice supported by Cheng and Pike (2003) as a motivation for extending trade credit. Furthermore, Nadiri (1969) posits that trade credit serves as an advertising tool to boost sales and this policy often aligns with industry norms. In other words, to remain competitive, firms must match the trade credit policies of their peers. Diverging from these norms could lead to decreased sales, a point underscored by Paul and Boden (2008).

In practice, sellers can also use trade credit to certify product quality (Deloof & Jegers, 1996; Lee & Stowe, 1993; Long et al., 1993; Ng et al., 1999; Pike et al., 2005; Smith, 1987). To the extent that consumers cannot observe product quality at the time of purchase, the trade credit allows them time to verify the quality before making the full payment. In particular, when the product quality falls short of expectations, buyers can withhold payment and return the product to the seller. Sellers can alternatively certify product quality through money-back guarantees and product warranties. However, these mechanisms are often seen as imperfect substitutes for trade credit from the consumers' perspective. These approaches are only effective if the sellers remain viable, and their reliability becomes questionable in highly competitive markets (El Ghoul & Zheng, 2016). Gissler et al. (2020) also finds that due to increased competition in consumer credit

markets because of regulatory changes, nonbanks expand credit to riskier and marginalized borrowers at extensive margins.

4. Long-term strategies in response to antitrust enhancement

While immediate responses to the implementation of laws often focus on short-term measures or reaction adjustments (Dasgupta et al., 2018; Dasgupta & Žaldokas, 2019), long-term competitiveness demands a broader perspective. In this context, the Fixed Asset Turnover (FAT) ratio plays a crucial role. Despite the extensive research on operational metrics, the FAT, a key measure of how efficiently a firm turns its fixed assets into revenue, has been notably overlooked. Serving as more than just a snapshot, the FAT ratio dynamically captures the firm's ability to convert fixed assets efficiently, including property, plant, and equipment, into revenue within a year (Bauman, 2013). High FAT ratios (and their dynamics) signal effective use of capital investments and a readiness to compete in an increasingly competitive market. In contrast, a lower FAT ratio can signal that a firm is not operating efficiently, making it more vulnerable to aggressive competitors (Miller, 1986).

In a business landscape increasingly influenced by rigorous anti-collusion regulations and leniency programs, the FAT ratio evolves from being merely an operational metric to a strategic cornerstone that informs an array of managerial decisions. Its robustness offers multiple financial benefits, notably in enhanced liquidity and improved credit ratings, which, in turn, significantly shape the firm's strategic planning from capital allocation to long-term market positioning (Chauhan, 2023; Lee, 2023). An increase in the FAT ratio not only signals operational efficiency, but also serves as an indicator of the firm's long-term viability and growth potential (Dvouletý et al., 2021). This can attract favorable credit terms and equity investments, boosting confidence among investors and creditors. Moreover, a strong FAT ratio indicates less dependency on external financing (Zambrano et al., 2022) making the firm less risky to lend to and thereby enhancing its creditworthiness (Lee, 2023). Such solid financial footing offers firms the flexibility and resilience needed to navigate the complexities of highly regulated and competitive markets.

III. Hypothesis development

1. Total assets utilization after amnesty policy

The significance of total asset turnover in determining future profitability is not only empirically well-established (Copeland & Khoury, 1980; Fairfield & Yohn, 2001; Nissim & Penman, 2001), but it also serves versatile roles in financial analysis. For instance, it is used as a diagnostic indicator for assessing bankruptcy risk (Eisdorfer & Hsu, 2011), thereby aiding stakeholders in making informed investment decisions. Furthermore, total asset turnover could also shed light on corporate overinvestment behavior that can have critical consequences for shareholder value and long-term firm sustainability (Aktas et al., 2015; Chhaochharia et al., 2017). In this broad context, total asset turnover emerges not merely as an isolated metric, but as an integrated component within a broader financial performance evaluation framework. Speficially, based on the Dupont Model, higher total asset turnover (the overall operational efficiency) provides a boost to a firm's Return on Equity (ROE).

In response to the competitive pressures intensified by the enactment of leniency laws, firms should be prompted to strategically realign both their immediate and future priorities. Initially, in the short run, to safeguard or expand their market presence, companies might adopt more favorable credit terms, using these adjusted credit policies as a strategic tool to attract and retain customers in lieu of engaging in price wars. This shift towards leniency in credit terms represents a tactical short-term adaptation to the competitive landscape reshaped by leniency laws. On the other hand, looking towards the longer horizon, for enduring growth and viability, these organizations increasingly prioritize the enhancement of fixed asset efficiency. By improving the utilization of fixed assets, firms aim to counterbalance any potential negative effects on asset turnover that may arise from the adoption of more lenient credit terms. This strategic focus on asset efficiency is crucial for sustaining competitive advantage and shareholder value in the long term. Therefore, to the extent that corporations compete more as a result of leniency laws, we posit the following hypothesis:

H1: There is a dynamic association between leniency passages and total assets turnover of firms in response to the introduction of laws

2. Long-term assets operational efficiency after leniency laws

After investigating overall shifts in total asset management efficiency following the introduction of leniency programs, our study aims to disentangle whether short-term or long-term asset management, stands as the critical driver behind these dynamic changes. Fixed assets represent a cornerstone for long-term growth in firms (Birhanu et al., 2016) and changes in this category often signal strategic capital budgeting decisions (Groth, 1992). Despite its significant role as a measure of long-term operational efficiency in corporate finance, as acknowledged in numerous textbooks, empirical research exploring fixed asset turnover remains conspicuously sparse. This is surprising as a strong Fixed Assets Turnover (FAT) ratio brings several financial benefits, such as improved liquidity and better credit ratings (Chauhan, 2023; Lee, 2023), especially important in a competitive market. A higher FAT ratio shows that a firm is operating efficiently and can sustain its operations in the long term (Dvouletý et al., 2021). It also helps firms attract investments and secure good financial terms, crucial in a market affected by leniency laws and increased competition (Dasgupta & Žaldokas, 2019). Therefore, we present our hypothesis:

H2: Fixed assets turnover increases after leniency laws.

3. Short-term assets operational efficiency after leniency laws

Seminal works by Deakin (1976) and So (1994) have underscored the utility of working capital ratios as predictive models for various financial outcomes, such as bankruptcy risk, bond ratings, and credit scores, as well as payment rates for progress collections. Both scholars and practitioners concur on the pivotal role of efficient working capital management, not only during periods of economic expansion, but also in

volatile economic climates (Abuzayed, 2012). This short-term financial management is viewed as a strategic lever for enhancing both competitive positioning and profitability.

3.1. Operating Cycle after leniency laws:

Operating Cycle serves as vital indicators of a firm's short-term operational efficiency. In a regulatory landscape reshaped by the introduction of antitrust leniency programs, this measure should particularly take on increased importance. One plausible strategy a firm might employ to stay competitive in this setting is to extend its credit sales. As discussed in Section II, this is particularly relevant in highly competitive markets where customers have a plethora of options and financial flexibility can be a decisive factor. While this approach could broaden a firm's customer base, it has the consequential effect of potentially lengthening the operating cycle as accounts receivable would take more time to convert into cash. This strategic choice comes with its own set of trade-offs. While it might attract more customers, it could also tie up working capital for extended periods, thereby affecting short-term liquidity metrics. Therefore, we posit the third hypothesis:

H3: Operating Cycle increases after leniency laws.

3.2. Receivables operational efficiency after leniency laws

In the wake of leniency programs, as firms navigate the constricted avenues for price competition due to stringent legal constraints, extending trade credit emerges as a strategic pivot to maintain competitiveness. This shift, as documented by Banner (1958), capitalizes on the superior competitive leverage of credit offerings over price reductions. As discussed in finer details in Section II, Theoretical and empirical works, including Brennan et al. (1988), have articulated how trade credit can circumvent the challenges of price discrimination, effectively serving as a tool for firms to attract a broader customer base without infringing on Resale Price Maintenance (RPM) policies or anti-collusion laws that restrict price flexibility (European Commission, 2022; Niels, 2011). Furthermore, trade credit also acts as an implicit

quality assurance mechanism, as outlined by Deloof & Jegers (1996) and Lee & Stowe (1993), offering buyers the opportunity to assess product quality post-purchase. This feature is particularly valuable in more competitive markets, where buyers have a plethora of options in the wake of less collusions brought upon by leniency laws. Therefore, we have the next hypothesis:

H4: Receivable operational efficiency of firms decreases after the leniency program.

4. Heterogeneous impacts across firm types

4.1. Additional effect of leniency passages on large firms:

Existing literature suggests that large firms are better positioned to adapt their operational strategies in response to regulatory changes, owing to their abundant resources and capabilities for strategic maneuvering (Mittelstaedt et al., 2003). As these firms often wield considerable bargaining power in their respective markets, their strategic responses to adapt to higher competition introduced by leniency laws might differ from those of smaller counterparts.

Acknowledging their substantial resources and influence, large firms may strategically choose to extend more lenient credit terms. This decision, while potentially introducing short-term operational inefficiencies, is underpinned by a broader vision. For these firms, the extension of lenient credit terms is not merely a reactionary measure but a deliberate strategy. By leveraging their bargaining power, they aim to solidify long-term market positioning, viewing any immediate inefficiencies (and yet relatively more affordable) as acceptable trade-offs for future strategic advantages. This approach reflects an understanding of the competitive dynamics at play, where large firms preemptively adjust their policies in anticipation of, or in response to, the heightened competition catalyzed by leniency laws better. Therefore, we propose the following hypothesis:

H5a: The pressing influence of leniency laws on operational efficiency is more pronounced in large firms.

4.2. Additional effect of leniency passages on high profitability firms:

In light of the institution of leniency programs, firms across the profitability spectrum are forced to reassess their operational strategies to adapt to more intense competition due to a new regulatory landscape. Among these, high-profitability firms may stand out as particularly responsive in this transition. At this juncture, the theory of competitive advantage (Porter, 1985) indicates that sustaining an edge necessitates ongoing strategic innovation. High-profitability firms, underpinned by their financial resilience, may find it strategic to relax credit policies. This strategic choice is consistent with the Dorfman-Steiner model as applied by Nadiri (1969), which considers trade credit as an investment in long-term customer relationships (Dorfman & Steiner, 1954). Abuhommous (2017) also empirically suggests that greater investments in accounts receivable could correlate with higher future profitability. Therefore, high-profitability firms may be more inclined to relax their credit policies post-leniency programs as part of a broader strategy to sustain and potentially extend their competitive advantage. This leads us to propose Hypothesis 12:

H5b: The pressing influence of leniency laws on operational efficiency is more pronounced in high profitability firms.

IV. Data and methodology:

1. Methodology

We investigate the repercussions of enacting leniency laws on operational efficiency at the firm level, using a comprehensive dataset that spans 64 countries from 1990 to 2020. This research employs a Difference-in-Differences (DiD) estimator, specifically adapted for staggered law implementations, in line with the methodology advanced by Borusyak et al. (2024). We justify this approach in Appendix A1. Conducting the study within an international framework, wherein regulatory changes manifest across multiple countries at diverse time intervals, minimizes the risk of confounding influences from unrelated economic shocks. This is consistent with the argument made by Leuz & Wysocki (2016), who contend that any extraneous shocks would have to correlate with the dates of regulation implementation across these multiple jurisdictions to bias the study's findings.

The imputation estimation process is constructed based on three steps. i) unit (firms) and period (year) effects are fitted by regression on never-treated and not-yet-treated observations only, ii) firms and years effects are used to impute the untreated potential outcomes and retrieve estimated treatment effects, and iii) a weighted average of these treatment effect estimates is taken with average weights.

In specific, firstly, we estimate a model for untreated (i.e., never-treated and not-yet-treated) potential outcomes using untreated observations only in a two-way fixed effects regression:

$$Y_{it} = X_{i,c} + \gamma_i + \tau_t + \epsilon_{i,t} \quad (1)$$

where *i, c,* and *t* index firms, countries, and years, respectively. The dependent variables Y_{it} correspond to total asset turnover, fixed assets turnover, operating cycle[3], and receivables turnover[4]. $X_{i,c}$ is a vector of the different firm and country-level controls, while γ and τ are firm and year fixed effects, respectively. In Equation (1), $X_{i,c}$ contains firm-level and country-level covariates standing for firm size, sales growth, leverage, tangibility, free cash flow, GDP, unemployment, and imports as a percentage of GDP following Cheng, Goh, & Kim (2018) and Dasgupta & Žaldokas (2019). In addition, when examining the regulatory effects on proxied by Operating Cycle and receivable operational management, we also control for capital intensity, real interest rate, profit, leverage, investment, dividend following Gaur, Fisher, & Raman (2005) and Jalal & Khaksari (2020). We describe the graph of dependent variable in Figure 1. The description and calculation of all variables in this study is in Appendix Table A1.

[3] We also conduct all the tests for the Cash Conversion Cycle, and the results support those obtained with the Operating Cycle

[4] We also conduct all the test for the Account Receibale Days, and the results also supports those obtained with receivable turnover

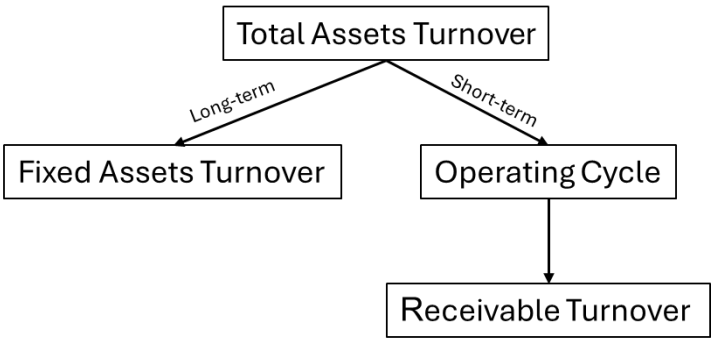


Figure 1: Three tiers of dependent variables

Note: This figure describes the three layers of dependent variables in this study representing the operational efficiency of firms.

In the generalized difference-in-differences setting with the staggered implementation of laws following Giroud & Mueller (2010), Borusyak et al. (2024) and Wing, Simon, & Bello-Gomez (2018), the *treated* group comprises all firms headquartered in countries that have passed a leniency law by year *t*. The *control* group is not restricted to all firms in countries that never pass a law, but even the countries will pass one later on. The standard error is clustered at the country-industry level following Dasgupta (2019).

Next, we extrapolate the equation (1) to treated observations, imputing untreated potential outcomes $Y_{it}(0)$[5], and calculate treatment effects τ_{it} .

$$\tau_{it} = Y_{it} - Y_{it}(0) \qquad (2)$$

Finally, we take the averages of these individually imputation-based treatment effects, called τ_w, which shows how the operational efficiency change after leniency passages. Herein, τ_w is our variable of interest. To bolster the robustness of our findings, we first undertake a parallel trend assumption test, as proposed by Borusyak et al. (2024), specific to the Difference-in-Differences framework. This preliminary step allows us

[5] The period-t potential outcome of unit i if it is never treated.

to verify the insignificance of any pre-existing differences between the treatment and control groups prior to the event dates, thereby strengthening the validity of subsequent DiD analyses. Additionally, we carry out sensitivity tests to examine the temporal effects of legal changes. Specifically, we assess the average impact on firms' operational efficiency at intervals of one, two, three, and four years following the enforcement year of the respective laws.

2. Data

In our study, we collect data from Datastream to analyze firms across 64 countries from 1990-2020. Guided by the caveats from Ince and Porter (2006), we adhere to a rigorous data filtering process outlined in Appendix Table A2. Specifically, our sample excludes non-common equity firms, as well as financial and utility companies and we only consider stocks listed on major exchanges. We also eliminate non-local firms and those whose stocks are not listed in the currency of the country in which they operate. Firms with specific cross-country names or negative metrics, such as stock price, sales, book values, and total assets are likewise removed. Further refining our dataset, we exclude firms with operating cycles (OC) exceeding 365 days and firms with market-to-book ratios outside the range of 0.01- to 3. Companies classified under "unspecified" or "other" industry categories are also omitted to enhance analytical precision. Post-filtering, we winsorize all firm-level variables at the 1% level except for firm age. Descriptive statistics for the refined sample are presented in Table 1 and the correlation matrix is presented in Appendix Figure A1.

Table 1: Summary statistics

Variables	Obs	Mean	Std. dev.	Median	Min	Max
Total Assets Turnover	310,737	1.106	0.702	0.955	0.113	4.074
Fixed Assets Turnover	310,434	10.304	22.949	3.577	0.211	171.593
Operating Cycle	310,737	150.184	82.597	139	4.000	556.000
Receivable Turnover	310,341	9.830	16.504	5.448	1.367	121.667
Firm size	310,737	19.286	1.942	19.045	14.525	24.270
Ln (GDP)	310,737	28.191	1.535	28.339	23.284	30.538
Unemployment	310,737	0.057	0.035	0.047	0.002	0.333
Tangibility	310,737	0.320	0.217	0.29	0.006	0.887
Lag (sale growth)	310,737	0.139	0.440	0.066	-0.553	2.958
Free cash flow	310,737	0.615	0.487	1	0.000	1.000
Capital Intensity	290,851	0.776	0.196	0.824	0.137	0.999
Real Interest rate	252,530	0.034	0.039	0.032	-0.353	0.776
Profit	310,250	0.037	0.117	0.049	-0.640	0.290
Leverage	305,283	1.390	0.472	1.262	1.000	3.826
Investment	310,654	0.058	0.070	0.0369	0.000	0.463
Dividend	310,736	0.013	0.021	0.007	0.000	0.122
Import (%GDP)	310,737	0.390	0.418	0.249	0.046	2.210

Note: This table demonstrates the statistics for the main variables. All firm-level variables are winsorized at 1%.

We conduct an in-depth comparison of our data summary statistics with those found in key existing studies, such as Dasgupta and Žaldokas (2019), Dong et al. (2019), and Ma et al. (2019). Remarkably, our statistical indicators closely align with those in the aforementioned literature attesting to the robustness and comparability of our dataset. Our statistical indicators closely align with those in the aforementioned literature attesting to the robustness and comparability of our dataset. For instance, the mean total assets in our sample are commensurate with the mean total assets reported in Dong et al. (2019) and Dasgupta and Žaldokas (2019). The slight divergence can be attributed to differences in data sources and screening methodologies. While we utilize Datastream, these studies rely on Compustat Global and North America

Compustat. Further corroborating the consistency across studies, we note that the statistical measures of tangibility are also remarkably similar. Specifically, our mean tangibility measure is 0.32, almost identical to the 0.316 reported in Dasgupta and Žaldokas (2019), presented in Table A2.1. Such parallels lend credence to the reliability of our empirical approach and the generalizability of our findings.

We conduct an in-depth comparison of our data summary statistics with those found in key existing studies including Dasgupta and Žaldokas (2019), Dong et al. (2019), and Ma et al. (2019). We extend our comparative analysis to evaluate the number of unique stocks and firm-year observations in our study relative to those in Ma et al. (2019) and Dong et al. (2019). The outcomes, detailed in Appendix Tables A4 and A5, affirm the consistent statistical characteristics of our filtered dataset in comparison to existing studies. Table A2.2, in particular, shows a high degree of similarity in the number of unique firms, as well as firm-year observations across countries between our sample and that of Dong et al. (2019). Notable exceptions are observed for specific countries including Bulgaria, Canada, Croatia, Hong Kong, Romania, Russia, Turkey, Ukraine, and the United States. These discrepancies are documented separately to maintain clarity.

Moving to Table A2.3, the differential counts of unique stocks and firm-year observations between our study and Dong et al. (2019) can be largely attributed to the divergent data sources employed. For instance, while Dong et al. (2019) reports 22,498 unique firms in the United States our dataset contains 7,365 unique firms, a count that interestingly exceeds the 4,067 unique U.S. firms reported by Ma et al. (2019) who also rely on Datastream for cross-country analyses. Similarly, our dataset includes 141 unique stocks in Bulgaria, a figure nearly nine times larger than the 17 reported by Dong et al. (2019). In conclusion, the consistency in key statistical characteristics between our dataset and those of existing studies lends considerable credibility to our empirical approach and findings. Given the minor variations that do exist, our data remain broadly aligned with the extant literature underscoring its reliability and robustness.

We have collected data pertaining to the passage of leniency laws across 64 countries. This information is primarily sourced from Dasgupta and Žaldokas (2019), "Getting the Deal Through," and corroborated with official local documents. Details concerning the years of leniency law passages are systematically presented in Table 2 and pictorially represented in Figure 2 for an intuitive understanding. Table 2 extends the work of Dasgupta and Žaldokas (2019), which originally documented leniency passages by countries based on Cartel Regulation 2013. Our contribution uniquely updates and enriches this dataset by incorporating the most recent information from Cartel Regulation 2018, published in "Getting the Deal Through," as well as from local official laws.

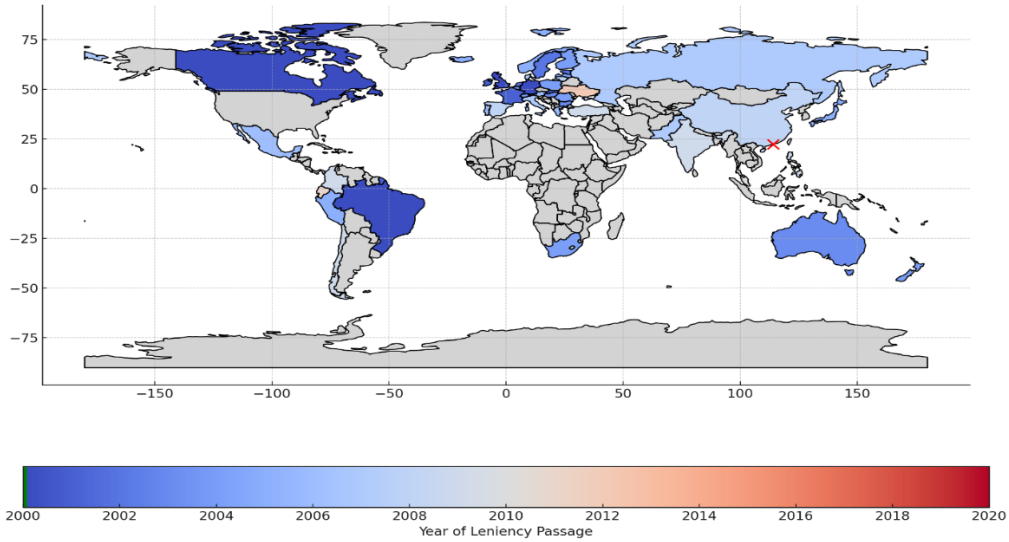


Figure 2: Leniency passage globally

Note: This figure presents a world map illustrating the years in which various countries have implemented leniency laws. The color scheme ranges from blue to red with blue representing earlier implementations and red denoting more recent ones. The data ranges from the year 1993-2017.

Table 2: Leniency passages

Country	Year	Country	Year
Argentina	None	Lithuania	2008
Australia	2003	Luxembourg	2004
Austria	2006	Malaysia	2010
Belgium	2004	Mexico	2006
Brazil	2000	Netherlands	2002
Bulgaria	2003	New Zealand	2004
Canada	2000	Nigeria	None
Chile	2009	Norway	2005
China	2008	Oman	None
Colombia	2009	Pakistan	2007
Croatia	2010	Peru	2005
Cyprus	2011	Philippines	2009
Czech Republic	2001	Poland	2004
Denmark	2007	Portugal	2006
Ecuador	2011	Romania	2004
Estonia	2002	Russia	2007
Finland	2004	Singapore	2006
France	2001	Slovakia	2001
Germany	2000	Slovenia	2010
Greece	2006	South Africa	2004
Hong Kong	2015	Spain	2008
Hungary	2003	Sweden	2002
Iceland	2005	Switzerland	2004
India	2009	Thailand	None
Indonesia	None	Turkey	2009
Ireland	2001	Ukraine	2012
Israel	2005	United Kingdom	1998
Italy	2007	U.S.	1993
Japan	2005	Venezuela	None
Jordan	None	Zambia	None
Korea	1997	Kenya	2017
Latvia	2004	Viet Nam	None

Note: This table builds upon the leniency passages by countries as presented by Dasgupta and Žaldokas (2019) that drew from Cartel Regulation 2013. Our analysis augments this foundational data with the latest updates from Cartel Regulation 2018, published by Getting the Deal Through, as well as from local official statutes. Notably, we furnish revised years for the implementation of leniency laws in Hong Kong, Indonesia, and Kenya.

V. Results

1. Parallel trend test

The DiD imputation estimator developed by Borusyak et al. (2024) offers an unbiased and efficient estimator of the estimand of interest. In addition, the parallel trend test based on such a method is more advanced than the current existing parallel trend testing approaches. The traditionally joint test of coefficients on leads in OLS is contaminated by treatment effect heterogeneity, which is proved by Sun and Abraham (2020). Moreover, the recently proposed placebo test based on robust estimators does not distinguish between estimation and testing. The approach proposed by Borusyak et al. (2024)regarding parallel assumption testing outperforms these two approaches as it only deals with the pre-treatment observation. By leveraging this method, our analysis isolates parallel trend tests to focus solely on pre-treatment and never-treated observations, thereby separating them from treated observations and sidestepping the biases inherent in traditional joint tests of coefficients during lead periods.

We run the regression below on untreated sample to falsify the parallel trend violation:

$$Y_{it} = X_{i,c} + \gamma_i + \tau_t + D_{it} * \mu + \varepsilon_{it} \quad (3)$$

where D_{it} is the set of indicators for observations during many periods before treatment ($t < 0$) with the periods before t serving as the reference group. For example, observations at t^{th} periods before the treatment date will receive the value of $D_{it} = 0$ and 1 otherwise. $X_{i,c}$ is a vector of the different firm and country controls as in the main specification, while γ and τ are firm and year fixed effects, respectively, clustering at country-industry level following Dasgupta et al. (2018). In particular, similar to the baseline regression model, $X_{i,c}$ contains firm-level and country-level covariates representing firm size, sales growth, leverage, tangibility, free cash flow, GDP, unemployment, and imports as a percentage of GDP following Cheng et al. (2018) and Dasgupta and Žaldokas (2019). In addition, when examining the regulatory effects on working capital management (proxied by Operating Cycle) and their components, we also control for

capital intensity, real interest rate, profit, leverage, investment, and dividends following Gaur et al. (2005) and Jalal and Khaksari (2020).

We estimate μ by using OLS on untreated observations only, followed by a joint null test that $\mu = 0$ by using the Chi-squared test. That the Prob > chi2 of the joint null test is higher than 0.05 supports that the parallel trend assumption is not violated at the 5% significant level. In other words, there is an insignificant difference between the treatment and control groups before the event date at the associated significance level. Although there is no universal optimal choice of t (Borusyak et al., 2024), we follow Dasgupta and Žaldokas (2019) and Nguyen et al. (2022) to choose $k = 2$. Apart from that, we also go further to test the parallel trend assumption at $k = 3$ to solidify our results. Based on the findings presented in Appendix Table A3, we find that the parallel trend assumption holds true in all variables.

2. Leniency laws and operational efficiency

In this section, we investigate the empirical impact of the enactment of leniency laws on corporate operational efficiency. Initially, we shed light on the general trends indicating whether firms experience a decline in operational efficiency following the introduction of amnesty policies. Subsequently, we disaggregate this effect to ascertain whether it emanates from long-term or short-term asset management efficiency. Finally, we explore how firms adjust their credit sales policy after leniency passages.

2.1. Impact of leniency passages on total assets turnover

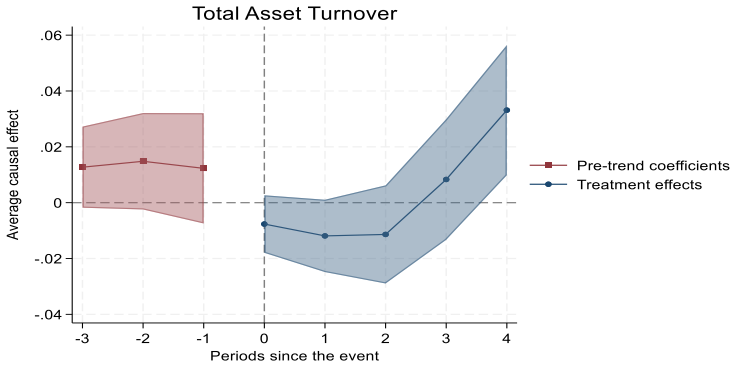


Figure 3: The effects of leniency passages on total assets turnover

Note: The graph utilizes dots to represent the disparity in total asset turnover between the treatment and control groups. Red dots illustrate the trend prior to the implementation of the leniency laws serving as a visual representation of our parallel trend assumptions. Post-event, the blue dots capture the shifts in total asset turnover disparities between the two groups attributed to the enactment of the leniency policies. In essence, the red dots set the baseline for parallel trends, while the blue dots reveal the treatment effect on asset turnover after the introduction of leniency laws.

Table 3: The effects of leniency passages on total assets turnover

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
τ_w	-0.009*	-0.01	-0.006	0.0014
	(0.085)	(0.110)	(0.391)	(0.855)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	109,781	120,739	132,688	146,216

Note: The dependent variable is total asset turnover. We control for firm and year fixed effects and clustering by country-industry following Dasgupta & Žaldokas (2019). *The firm-level and country-level covariates standing for firm size, sales growth, leverage, tangibility, free cash flow, GDP, unemployment, and imports as a percentage of GDP following* Cheng et al. (2018) and Dasgupta & Žaldokas (2019). *The coefficient of interest here is τ_w, which denotes the impact of leniency programs on firms' total assets turnover. Significance levels are denoted as follows: *** signifies 1%, ** indicates 5%, and * represents 10%.*

In line with our first hypothesis (H1), the empirical evidence presented in Table 3 and visually illustrated in Figure 3 corroborates the indeterminate net impact of leniency laws on total asset turnover. Our data supports the conceptual framework that contends for offsetting dynamics in firms' operational behavior following the enactment of leniency policies. Specifically, firms appear to engage in a complex interplay of short-term and long-term strategic adjustments. The extended credit terms, a short-term strategy to

maintain or capture market share, have the potential to prolong the operating cycle, thereby diluting asset turnover. Alternatively, firms seem to invest concurrently when optimizing their fixed asset utilization, a long-term strategy aimed at sustainable growth. This increased efficiency in fixed assets utilization acts as a countervailing force mitigating the dilutive impact of more lenient credit policies on asset turnover. The duality of these effects, clearly highlighted through our empirical findings, makes it challenging to identify a uniform directionality for the impact of leniency laws on asset turnover. Thus, the results substantiate our initial hypothesis that the net impact on total asset turnover is indeed indeterminate due to these offsetting operational adjustments.

2.2. Impact of leniency passages on long-term and short-term asset management efficiency

Table 4: The effects of leniency passages on long-term and short-term asset management efficiency

Panel A: The effects of leniency passages on fixed assets turnover

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
τ_w	0.26**	0.227*	0.292**	0.373**
	(0.04)	(0.096)	(0.044)	(0.02)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	109,732	120,684	132,626	146,145

Panel B.1: The effects of leniency passages on Operating Cycle

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
τ_w	1.669**	1.875**	1.75*	1.25
	(0.044)	(0.038)	(0.067)	(0.202)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	85,030	93,691	103,391	114,584

Note: The dependent variables are fixed assets turnover and Operating Cycle. We control for firm and year fixed effects and clustering by country-industry following Dasgupta (2019). The firm-level and country-level covariates standing for firm size, sales growth, leverage, tangibility, free cash flow, GDP, unemployment, and imports as a percentage of GDP follow Cheng et al. (2018) and Dasgupta & Žaldokas (2019). *In addition, when examining the regulatory effects on Operating Cycle and receivables management, we also control for capital intensity, real interest rate, profit, investment, and dividends following* Gaur et al. (2005) and Jalal & Khaksari (2020). *The coefficient of interest here is τ_w, which denotes the impact of leniency programs on firms' long-term and short-term asset management efficiency. Significance levels are denoted as follows: *** signifies 1%, ** indicates 5%, and * represents 10%.*

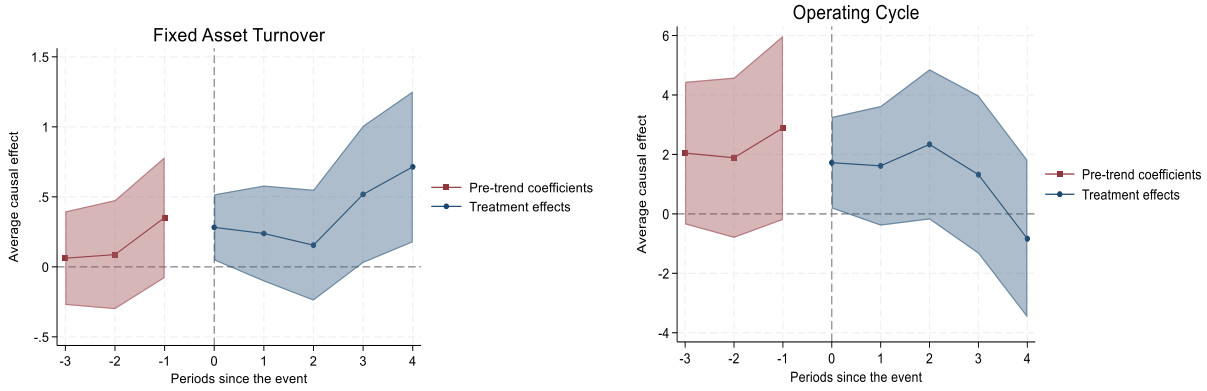


Figure 4: The effects of leniency passages on long-term and short-term asset management efficiency

Note: The graph utilizes dots to represent the disparity in long-term and short-term asset management efficiency between the treatment and control groups. Red dots illustrate the trend prior to the implementation of the leniency laws serving as a visual representation of our parallel trend assumptions. Post-event, the blue dots capture the shifts in long-term and short-term asset management efficiency disparities between the two-group attributed to the enactment of the leniency policies. In essence, the red dots set the baseline for parallel trends, while the blue dots reveal the treatment effect on long-term and short-term asset management efficiency after the introduction of leniency laws.

The empirical results shown in Panel A of Table 4 and graphically represented in Figure 4 offer a strong validation of our second hypothesis (H2), positing an increase in Fixed Asset Turnover (FAT) following the enactment of leniency laws. The data reveals a noticeable rise in FAT ratios for firms in areas with these leniency policies. Our findings can be viewed as a strategic response by firms to the challenging regulatory landscape shaped by anti-collusion measures. As theorized, firms appear to adapt by improving how they use their fixed assets, a move that yields multiple financial benefits. Elevated FAT ratios not only improve firms' liquidity and credit ratings, consistent with research by Chauhan (2023) and Lee (2023), but also serve as a robust indicator of long-term sustainability (Dvouletý et al., 2021).

In essence, the rise in FAT ratios can be construed as a tactical adaptation enabling firms to mitigate some of the adverse consequences of a more stringent regulatory environment. This operational shift translates into firmer financial footing endowing firms with the resilience and flexibility needed to compete effectively in markets now characterized by stringent compliance requirements. Furthermore, the sustained improvement in Fixed Asset Turnover (FAT) for a four-year period following the implementation of leniency laws underscores the enduring nature of this strategic shift and its long-term implications for operational efficiency.

Regarding the movement of short-term asset management can be seen in Panel B of Table 4 and Figure 3. The data validates our third hypothesis (H3) pointing to an extended Operating Cycle following the adoption of leniency laws. This suggests a decline in short-term operational efficiency. In consonance with our theoretical framework, this observed shift in short-term asset management can be interpreted as a strategic adjustment made by firms in response to a challenging regulatory environment. Notably, the lengthening of these cycles is suggestive of firms possibly extending credit sales terms as a tactic to either preserve or gain market share. Such an approach brings its own set of trade-offs. It may effectively expand the customer base, but at the expense of tying up working capital for more extended periods, thereby negatively affecting short-term liquidity metrics. However, the phenomenon decreases over time in both magnitude and significance levels indicating that the initial adverse effects on short-term operational

efficiency may be mitigated as firms adapt to the new regulatory landscape. This diminishing impact suggests that firms could be fine-tuning their credit policies, collection efforts, and inventory management over time to regain some of the efficiency lost due to the initial shift in strategic focus. The lengthening of the Operating Cycle reflects traditional financial principles and supports findings in established literature, which highlight the importance of managing working capital to balance profitability and liquidity risks (Abuzayed, 2012; Deakin, 1976; So, 1994).

2.3. Impact of leniency passages on receivables operational efficiency

Table 5: Impact of leniency passages on receivables operational efficiency around leniency passages

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
τ_w	-0.247**	-0.302**	-0.2961**	-0.229
	(0.033)	(0.016)	(0.032)	(0.129)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	84,903	93,537	103,211	114,375

*Note: The dependent variable is Receivable turnover. We control for firm and year fixed effects and clustering by country-industry following Dasgupta (2019). The firm-level and country-level covariates standing for firm size, sales growth, leverage, tangibility, free cash flow, GDP, unemployment, and imports as a percentage of GDP follow Cheng et al. (2018) and Dasgupta & Žaldokas (2019). In addition, when examining the regulatory effects on receivables management, we also control for capital intensity, real interest rate, profit, investment, and dividends following Gaur et al. (2005) and Jalal & Khaksari (2020). The coefficient of interest here is τ_w, which denotes the impact of leniency programs on firms' long-term and short-term asset management efficiency. Significance levels are denoted as follows: *** signifies 1%, ** indicates 5%, and * represents 10%.*

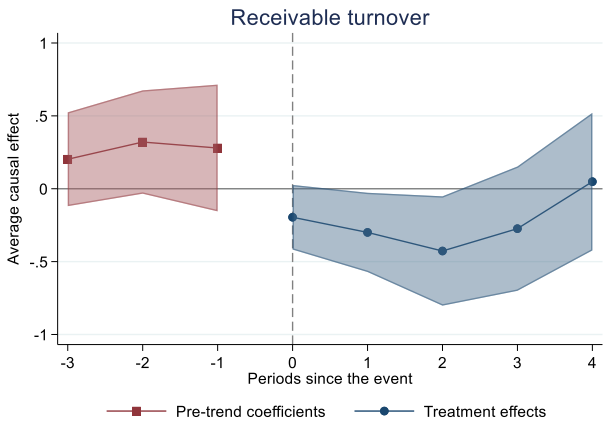


Figure 5: Impact of leniency passages on inventory and receivables management efficiency around leniency passages

Note: The graph utilizes dots to represent the disparity in inventory and receivables management efficiency between the treatment and control groups. Red dots illustrate the trend prior to the implementation of the leniency laws, serving as a visual representation of our parallel trend assumptions. Post-event, the blue dots capture the shifts in inventory and receivables management efficiency disparities between the two groups attributed to the enactment of the leniency policies. In essence, the red dots set the baseline for parallel trends, while the blue dots reveal the treatment effect in inventory and receivables management efficiency after the introduction of leniency laws.

Building upon our empirical findings presented in Table 5 and the graphical representations showcased in Figure 5, we ascertain that Hypothesis 4 that in the aftermath of leniency programs, the operational efficiency of firms' receivables would witness a decline. Additionally, the results shows a diminishing trend in both the magnitude and statistical significance of this impact over time implying a possible mitigation of the initial detrimental effects on receivable operational efficiency as firms acclimatize to the altered regulatory milieu. Such temporal changes may be indicative of firms gradually optimizing their credit extension strategies, thereby recovering some of the operational efficiency initially compromised by the regulatory shift.

The complex relationship between leniency programs and operational efficiency is substantiated in the corpus of the financial literature. Our study's results echo the theoretical frameworks laid out by El Ghoul and Zheng (2016), which indicated a surge in credit risk upon the extension of trade credit, particularly under intensified competitive conditions. Similarly, our results also resonate with Gissler et al. (2020) who demonstrated that due to increased competition in consumer credit markets following regulatory changes, firms expand credit to a riskier clientele exacerbating the already intricate dynamics of receivables management.

Our findings, therefore, present a critical extension to the literature concerning the unintended consequences of antitrust regulations on firms' short-term financial policies. The observed decline in receivable operational efficiency can be viewed as a result of the legal constraints that prevent firms from utilizing price discrimination as a competitive tool. To circumvent this, firms resort to extending trade credit which, while effective in attracting a broader customer base, hampers the efficient management of receivables. This finding is particularly significant given that trade credit is often used as an implicit quality assurance mechanism adding a further layer of complexity to its management in a post-leniency landscape. In addition, payment terms relaxation offers firms the capacity to circumvent legal constraints on explicit price changes (Brennan et al., 1988; Mian & Smith, Jr., 1992). Moreover, extending trade credit serves multiple operational goals, such as boosting sales, bolstering seller-buyer relationships, advertising, and certifying product quality (Deloof & Jegers, 1996; Kim & Atkins, 1978; Martínez-Sola et al., 2014).

Overall, our empirical findings underscore a complex impact of leniency laws on firms' asset management strategies. It is evident that firms demonstrate a sustained increase in FAT for the entire four-year period following the enactment of leniency laws. This could be perceived as a long-term strategic adaptation aimed at enhancing operational efficiency and financial stability, particularly in a regulatory environment that has grown increasingly stringent. Conversely, the immediate effects of leniency law introduction witnesses an extension of the Operating Cycle driven mainly by the extension of credit sales terms. While this has the downside of tying up working capital and reducing short-term liquidity, the magnitude and significance of

this impact attenuate over time. This suggests that firms are likely adjusting their credit policies to mitigate the initial effects on short-term operational efficiency. Therefore, while leniency passages initially appear to tax short-term efficiency, firms adapt over time to minimize this impact even as they continue to realize gains in long-term asset utilization.

2.4. Results on other determinant

Table 6: Coefficients of control variables in regressions

	(1)	*(2)*	*(3)*	*(4)*
	Total Assets Turnover	*Fixed Assets Turnover*	*Operating Cycle*	*Receivables Turnover*
Firm size	-0.1817***	-2.328***	7.85***	-0.827***
	(0.000)	(0.000)	(0.000)	(0.000)
Ln(GDP)	0.2887***	1.25	-9.6	1.471
	(0.000)	(0.289)	(0.373)	(0.126)
Unemployment	-0.219	-5.89	-3.71	6.685*
	(0.232)	(0.112)	(0.916)	(0.074)
Import (%GDP)	-0.175***	2.91***	8.657	0.6202
	(0.000)	(0.006)	(0.119)	(0.229)
Tangibility	-0.1917***	-24.73***	-7.505	5.845***
	(0.000)	(0.000)	(0.187)	(0.000)
Lag(sale growth)	0.094***	0.898***	-7.825***	0.3264***
	(0.000)	(0.000)	(0.000)	(0.001)
Free cash flow	0.059***	0.5449***	-6.35***	0.1914**
	(0.000)	(0.000)	(0.000)	(0.022)
Leverage	-0.0818***	-0.0729	4.946***	-0.426**
	(0.000)	(0.794)	(0.000)	(0.012)
Capital Intensity			-109.04***	-2.817***
			(0.000)	(0.001)

Table 6: Coefficients of control variables in regressions (continued)

	(1)	*(2)*	*(3)*	*(4)*
	Total Assets Turnover	*Fixed Assets Turnover*	*Operating Cycle*	*Receivables Turnover*
Real Interest rate			23.79***	-2.278***
			(0.013)	(0.034)
Profit			-118.267***	9.374***
			(0.000)	(0.000)
Investment			-40.58***	0.012
			(0.000)	(0.227)
Dividend			-51.75***	8.879***
			(0.004)	(0.001)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	141,142	142,652	110,660	110,468
adj. R-sq	0.87	0.75	0.8	0.85

Note: The dependent variables are all variables standing for operational efficiency in our study. We control for firm and year fixed effects and clustering by country-industry following Dasgupta (2019). The firm-level and country-level covariates standing for firm size, sales growth, leverage, tangibility, free cash flow, GDP, unemployment, and imports as a percentage of GDP follow Cheng et al. (2018) and Dasgupta & Žaldokas (2019). *In addition, when examining the regulatory effects on Operating Cycle and receivables management, we also control for capital intensity, real interest rate, profit, investment, and dividends following* Gaur et al. (2005) and Jalal & Khaksari (2020). *Significance levels are denoted as follows: *** signifies 1%, ** indicates 5%, and * represents 10%.*

In Table 6, we present the regression coefficients table that clarifies the impact of independent variables on the dependent variables in question. This multivariate regression table offers a comprehensive view of the

relationships providing coefficients, standard errors, and other pertinent statistics. Given the incorporation of both firm and country-level variables in our analysis, we will initially direct our attention to the firm-level variables to isolate their specific impact on the dependent variables.

The negative association between firm size and operational efficiency may stem from a complex interplay of factors. Larger firms often experience bureaucratic inertia (Acs et al., 1997) resulting in slower decision-making processes and may reach a point where the complexity of management leads to diseconomies of scale (Zhang et al., 2023). Additionally, the heterogeneity in business operations and monitoring difficulties can also impede efficiency improvements (Akın Ateş et al., 2022). High tangibility, representing substantial investments in physical assets like machinery and equipment, might hinder efficiency in revenue generation leading to lower total and fixed asset turnover. Additionally, the tangible nature of these assets can sometimes expedite the collection process positively affecting receivable turnover (Lee, 2023).

Sales growth, an essential gauge of market achievement, is intrinsically linked to a firm's operational efficiency. Increasing sales often catalyze economies of scale (Fetz & Filippini, 2010) diminishing the per-unit production cost. Such growth paves the way for strategic resource optimization, enhancing supply chain systems efficiency (Kuei et al., 2001) which, in turn, boosts total asset turnover. Additionally, a rise in sales often triggers investment in new technologies and systems that uplift both short-term and long-term asset management elevating fixed asset turnover (Coad et al., 2021). This harmonious relationship between sales growth and operational efficacy underscores a firm's adeptness in balancing resource allocation and strategy to meet rising market demand. Moreover, substantial free cash flow offers firms the flexibility to pursue strategic initiatives aimed at enhancing operational efficiency (Jeffrey et al., 2010; Xin et al., 2019). This financial cushion enables targeted investments in areas like cutting-edge technology, equipment modernization, or R&D projects that align with long-term goals for growth and efficiency (Li & Zhan, 2019). A robust free cash flow is also indicative of well-managed accounts for receivables, signaling an efficiently run operating cycle that bolsters overall productivity. In summary, free cash flow serves as a

driving force that enables firms to focus on optimizing both long-term assets and short-term operational effectiveness contributing to a competitive advantage and stronger financial outcomes.

While leverage can provide the necessary capital for growth and investment, it also brings about obligations for interest payments and principal repayments. These financial commitments can constrain a firm's operational flexibility and ability to invest in areas that may enhance efficiency, such as technology upgrades and process improvements (Bancel & Mittoo, 2011). Firms with high leverage may find themselves prioritizing debt servicing over operational optimization leading to potential inefficiencies in accounts receivable management or overall asset utilization (Shi et al., 2020; Xie et al., 2023). Moreover, higher leverage can signal financial risk that might restrict a firm's access to further credit and, thus, limit its agility in responding to market opportunities or challenges (Beltrame et al., 2018).

When it comes to the determinants for short-term operational efficiency, capital intensity can foster an improvement in short-term operational efficiency as demonstrated by its positive association with OC. Capital-intensive firms, by virtue of their significant investment in production and automation technologies, may have more streamlined processes (Lu et al., 2023). This could lead to a quicker conversion of inventory into sales and, subsequently, into cash thereby enhancing short-term operational efficiency. In firms with a high degree of capital intensity, the extension of payment terms to customers becomes a particularly detailed strategic decision. One contributing factor is the high fixed cost structure common to capital-intensive firms that creates a critical need for consistent and predictable revenue streams. Offering longer credit terms can serve as a customer retention strategy, thereby ensuring a more stable revenue base over time (Vittas & Cho, 1995).

Profitable firms often demonstrate robust managerial practices that are conducive to efficient operations, especially in the short term (Jin et al., 2021; Narayan, 2018). High profits endow these firms with the liquidity and capital necessary for various types of investments, be it in capacity expansion, technology upgrades, or market diversification. Such investments, while primarily growth-oriented, have a collateral

positive impact on operational efficiency. They provide the financial flexibility to optimize accounts receivable practices. As a result, firms are better positioned to optimize key efficiency indicators, thereby converting assets into revenue with heightened efficiency. Furthermore, the profits themselves are an indication of successful strategic decisions and market positioning that often naturally align with more efficient production, sales, and collection processes (Buzzell et al., 1975; Jackson, 2007). Therefore, both profitability and targeted investments contribute to a virtuous cycle that reinforces the firm's operational efficiency, while also promoting strategic alignment and effective resource utilization in the short term. Firms that regularly pay dividends are often viewed as financially stable and disciplined, a perception that can extend to supplier relationships and result in more favorable terms for raw material acquisition (Partington, 1989). In addition, the commitment to regular dividend payouts necessitates careful cash flow management. This heightened focus on cash flow often translates into stricter credit policies and more proactive collection efforts, thereby enhancing accounts receivable turnover and optimizing short-term operational efficiency.

A rising GDP often signals a robust economy marked by elevated consumer spending, greater business investment, and increased government outlays. This environment not only boosts demand for goods and services, but also encourages firms to optimize operations, scale up production, and tap into economies of scale (Almfraji & Almsafir, 2014). Concurrently, a strong economy frequently spurs technological innovation further amplifying operational efficiencies (Sweet & Eterovic Maggio, 2015). Conversely, a high imports-to-GDP ratio suggests significant reliance on foreign products that may reveal deficiencies in domestic operational efficiency. This dependency can shift the focus away from improving domestic production as importing often becomes a more convenient and cost-effective option. Moreover, increased import reliance may point to intense competition from abroad potentially limiting domestic firms' market share and, by extension, their capacity to achieve economies of scale or invest in efficiency-enhancing technologies.

In light of the other macroeconomic variables discussed, it is worth noting that elevated real interest rates present their own set of challenges for firms. This hesitancy to invest in technological and procedural improvements can detract from the firm's ability to manage short-term operations efficiently. The impact is often observed in compromised responsiveness to market fluctuations and suboptimal performance in key metric like the Operating Cycle (OC).

2.5. Robust to industry concentration

Furthermore, we test whether the results are still robust when adding the HHI Index. Inclusion of the Herfindahl-Hirschman Index (HHI) adds another layer of robustness to our examination of the leniency program's impact on operational efficiency across countries. HHI is a well-established metric used to assess market concentration calculated by squaring the market share of each firm in the industry and then summing the resulting numbers. Specifically, HHI=$\sum_{i=1}^{N} s_i^2$, where s_i represents the market share of firm i in the industry and N is the number of firms (Dasgupta & Žaldokas, 2019). A higher HHI value generally indicates less competition and greater market power for existing firms, while a lower value suggests a more competitive market landscape.

Control for market concentration via the HHI is crucial for several reasons. First, it accounts for the influence of market structure on operational efficiency that can otherwise confound the observed effects of the leniency program. Firms operating in concentrated markets may react differently to leniency programs compared to those in more competitive settings. Additionally, the HHI serves to control for variations in market dynamics that could be country-specific or sector-specific, thereby isolating the impact of the leniency program itself. By introducing the HHI into our analyses, we sharpen the focus on the role of leniency programs while accounting for potentially confounding market factors thus enriching the validity and reliability of our findings. In general, the outcomes after accounting for the HHI remain consistent with our primary findings. Although the introduction of leniency programs initially imposes a strain on short-term operational efficiency, firms demonstrate adaptability by mitigating these effects over time.

Simultaneously, they sustain improvements in the utilization of long-term assets. The inclusion of the HHI control substantiates the robustness of these conclusions reaffirming that the observed impacts are principally attributed to the leniency programs rather than market concentration factors.

Table 7: The impact of leniency programs after controlling further for HHI

Panel A: The effects of leniency passages on total assets turnover with HHI

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
τ_w	-0.0096*	-0.0101	-0.006	0.0015
	(0.087)	(0.112)	(0.395)	(0.843)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	106,264	114,359	121,852	129,892

Panel B: The effects of leniency passages on fixed assets turnover with HHI

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
τ_w	0.2609**	0.229*	0.293**	0.375**
	(0.038)	(0.093)	(0.042)	(0.019)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	106,223	114,316	121,805	129,842

Table 7: The impact of leniency programs after controlling further for HHI (continued)

Panel C: The effects of leniency passages on OC with HHI

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
τ_w	1.673**	1.878**	1.753*	1.25
	(0.044)	(0.038)	(0.066)	(0.202)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	82,307	88,948	95,128	101,798

Panel D: The effects of leniency passages on Receivable Turnover with HHI

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
τ_w	-0.247**	-0.3029**	-0.296**	-0.229
	(0.033)	(0.016)	(0.032)	(0.13)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	82,180	88,796	94,953	101,598

Note: The dependent variable are firms' operational efficiency. We control for firm and year fixed effects and clustering by country-industry following Dasgupta (2019). The firm-level and country-level covariates standing for firm size, sales growth, leverage, tangibility, free cash flow, GDP, unemployment, and imports as a percentage of GDP follow Cheng et al. (2018) and Dasgupta & Žaldokas (2019). *In addition, we also control for the HHI index in this case. Moreover, when examining the regulatory effects on Operating Cycle and receivable turnover, we also control for capital intensity, real interest rate, profit, investment, and dividends following* Gaur et al. (2005) and Jalal & Khaksari (2020). *The coefficient of interest here is* τ_w,

*which denotes the impact of leniency programs on firms' operational efficiency. Significance levels are denoted as follows: *** signifies 1%, ** indicates 5%, and * represents 10%.*

2.6. Heterogeneous impacts of leniency passages

For triple differences following Borusyak et al. (2024), we group the firm identifier with a firm-level dimension. After that, we measure the τ_w for the specific new identifier and not for the firm only as the baseline Model (1). The desired results are called $\mu_{i,g}$ following Borusyak et al. (2024). Essentially, $\mu_{i,g}$ show the additional effect of leniency programs on specific group of firms based on chosen dimensions. For example, if the chosen dimension is comparing the impact of a leniency program on large firms compared to other firms, $\mu_{i,g}$stands for the additional impact of the leniency program on large firms compared to other firms. We also follow Dasgupta and Žaldokas (2019) in examining the additional effects to control for firm and year fixed effects while still clustering by country-industry.

2.6.1. Large firms

Table 8: Interaction test to assess leniency programs' additional effects on operational efficiency in large firms.

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
$\mu_{i,g}$ (TAT)	0.008 (0.198)	0.005 (0.329)	0.008 (0.2000	0.012* (0.062)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	110,192	121,309	133,471	147,198
$\mu_{i,g}$ (FAT)	0.002 (0.991)	-0.128 (0.415)	-0.180 (0.245)	-0.283* (0.068)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	110,143	121,254	133,407	147,125

Table 8: Interaction test to assess leniency programs' additional effects on operational efficiency in large firms (continued)

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
$\mu_{i,g}$ (OC)	1.339 (0.145)	1.080 (0.235)	0.327 (0.719)	0.134 (0.888)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	85,380	94,174	104,076	115,450
$\mu_{i,g}$ (RT)	-0.332*** (0.007)	-0.327** (0.016)	-0.311** (0.031)	-0.330** (0.025)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	85,255	94,023	103,900	115,246

*Note: The dependent variables are variables standing for operational efficiency in this study. We control for firm and year fixed effects and clustering by country-industry following Dasgupta (2019). The firm-level and country-level covariates standing for firm size, sales growth, leverage, tangibility, free cash flow, GDP, unemployment, and imports as a percentage of GDP follow Cheng et al. (2018) and Dasgupta & Žaldokas (2019). In addition, when examining the regulatory effects on Operating Cycle and receivable turnover, we also control for capital intensity, real interest rate, profit, investment, and dividends following Gaur et al. (2005) and Jalal & Khaksari (2020). Following Borusyak (2024), we group the firm's identifier and the identifier of the chosen dimension and test the additional effect of leniency programs on firms in a chosen dimension. The coefficient of interest is $\mu_{i,g}$, which denotes the additional impact of leniency programs on large firms. Significance levels are denoted as follows: *** signifies 1%, ** indicates 5%, and * represents 10%.*

Table 8 reveals that large firms consistently underperform in Receivable Turnover over a four-year period suggesting an extension of more generous credit terms to clients, confirming our Hypothesis 5a. Given their substantial resources and bargaining power, large firms are well-positioned to offer more lenient credit terms (Rajan & Petersen, 1997). Research indicates that large firms, with their extensive resources and strategic agility, are well-equipped to adjust their operations given the regulatory shifts (Mittelstaedt et al., 2003). Recognizing their significant influence, such firms may opt to offer more flexible credit terms strategically. This choice, despite potentially reducing operational efficiency in the short term, is driven by a long-term perspective. Through this strategic decision, they utilize their market power to ensure a durable competitive position, considering any immediate operational drawbacks as investments for future advantages, especially in response to the competitive pressures brought about by leniency laws.

2.6.2. Highly profitable firms

Table 9: Interaction test to assess leniency programs' additional effects on operational efficiency in highly profitable firms

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
$\mu_{i,g}$ (TAT)	0.0103* (0.066)	0.007 (0.244)	0.006 (0.264)	0.004 (0.474)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	109,781	120,739	132,688	146,216
$\mu_{i,g}$ (FAT)	0.039 (0.772)	-0.090 (0.535)	-0.104 (0.479)	-0.178 (0.267)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	109,732	120,684	132,626	146,145
$\mu_{i,g}$ (OC)	0.831 (0.296)	0.955 (0.239)	1.019 (0.195)	1.193 (0.153)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y

Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	85,030	93,691	103,391	114,584

Table 14: Interaction test to assess leniency programs' additional effects on operational efficiency in highly profitable firm (continued)

	(1) 1 year	(2) 2 years	(3) 3 years	(4) 4 years
$\mu_{i,g}$ (RT)	-0.352** (0.018)	-0.378** (0.022)	-0.382** (0.026)	-0.371** (0.040)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Cluster by country-industry	Y	Y	Y	Y
Controls	Y	Y	Y	Y
N	84,903	93,537	103,211	114,375

*Note: The dependent variables are variables standing for operational efficiency in this study. We control for firm and year fixed effect and clustering by country-industry following Dasgupta (2019). The firm-level and country-level covariates standing for firm size, sales growth, leverage, tangibility, free cash flow, GDP, unemployment, and imports as a percentage of GDP follow Cheng et al. (2018) and Dasgupta & Žaldokas (2019). In addition, when examining the regulatory effects on Operating Cycle and receivable turnover, we also control for capital intensity, real interest rate, profit, investment, and dividends following Gaur et al. (2005) and Jalal & Khaksari (2020). Following Borusyak (2024), we group the firm's identifier and the identifier of the chosen dimension and test the additional effect of leniency programs on firms in a chosen dimension. The coefficient of interest is $\mu_{i,g}$, which denotes the additional impact of leniency programs on highly profitable firms. Significance levels are denoted as follows: *** signifies 1%, ** indicates 5%, and * represents 10%.*

Table 9 further reveals that these high-profitability firms exhibit a trend of relaxed credit policies over the study period. This pattern aligns with the strategic investment perspective on trade credit as posited by

Abuhommous (2017). Given their financial robustness, these firms are better positioned to implement a more accommodating credit policy as a calculated strategic initiative. This is further underscored by Nadiri's (1969) application of the Dorfman–Steiner model, where trade credit functions as an investment geared toward fostering long-term customer relations (Dorfman & Steiner, 1954; Nadiri, 1969). The intent here is multi-dimensional—consolidating current client relationships, carving out a competitive niche, and potentially leveraging their financial potency to tap into new markets. This is corroborated by Abuhommous (2017) who found that greater investments in accounts receivable are linked to higher future profitability. In general, the results confirm our Hypothesis 5b that highly profitable firms relax their credit policy more than their counterparts after leniency programs.

VI. Discussion/Conclusion

When businesses collude, lack of competition leads to suboptimal allocation of scarce resources in a given economy. Unfortunately, such is a common backlash from capitalism without a check, leading to increasing wealth gap and resentment against capitalism around the world. But what would be an effective tool to keep healthy competition among firms intact? Even in the presence of traditional anti-trust laws such as Sherman Antitrust Act (1891) and Clayton Antitrust Act (1914), the United States introduced the new breed of anti-collusion laws that is less based on 'catch me if you can' approach. Instead, by granting pardon to business that comes forward with collusion information to the authorities first, such leniency laws are designed to dismantle collusions among the cartels. With 'rats will always rat' concern, businesses should be aware that they can rely less on collusion and prepare to compete more so. After leniency laws was first introduced in the US in 1993, it has become popular worldwide. More than 50 countries around the world have adapted this concept by 2020. But does it work? Do leniency laws really promote competition among businesses worldwide?

The empirical studies on the effectiveness of leniency laws are still very limited in the literature. Complimentary to studies that warrant its meaningful impact by Dong et al (2019) and Dasgupta et al

(2019), we provide the first evidence from the operational side of businesses that firms do adapt to compete more so after the passage of this unconventional and yet popular laws. Specifically, our findings reveal that firms (relative to comparable matched firms in countries without leniency laws) initially extend their credit terms to customers, a short-term approach that risks reducing asset turnover. At the same time, they simultaneously further optimize fixed asset utilization, a long-term tactic aimed at sustainable growth. The net impact of these forces on total asset turnover remains indeterminate indicating an intricate interplay between short-term and long-term strategies. In other words, firms in our sample appear to adapt their credit policies strategically over time to sustain consumer relationships, remain competitive, and manage product quantities (Deloof & Jegers, 1996; Nadiri, 1969; Pike et al., 2005) while improving themselves to achieve long-term efficiency gains at the same time. Thus, while leniency laws initially strain short-term operational efficiency, firms appear to recalibrate their healthy strategies for a more sustainable long-term performance. These findings remain robust even after accounting for industry-level market concentration. Additionally, our findings reveal that larger and more profitable firms extend more advantageous payment terms in the wake of leniency laws suggesting the influence of 'because I can afford it' effect. This finding provides an insight for policy makers to consider when implementing such laws.

On the empirical note, our identification relies on the generalized difference-in-differences estimation based on a staggered passage of leniency laws in 64 countries around the world from 1990-2020. While previous work by Dasgupta and Žaldokas (2019) relied on Cartel Regulation 2013 for their temporal mapping, our study further enriches this dataset with more recent updates by using Cartel Regulation 2018 and local official statutes. Our methodology also differs, with improvements of an advanced Difference-in-Differences (DiD) estimator recently developed by Borusyak et al. (2024) to address the limitations of traditional two-way fixed-effect models. Unlike prior studies, our research employs a comprehensive, year-by-year longitudinal analysis to uncover the impact of leniency laws on firms' operational performance, with less biases.

Lastly, our findings can be generalized. While increasingly popular, there are still more than half of economies around the world that have not adopted leniency laws. Its less costly approach should be particularly attractive to governments in emerging economies. Yet, many are still doing without, including Thailand, Vietnam, Indonesia, Nigeria, and others. The gradual global spread of leniency laws, as evidenced in our comprehensive dataset (Table 2), indicates a growing but still rather cautious recognition of their effectiveness. Our findings, which endorse that these laws can actually enhance competition, especially from the operational side of businesses, present a strong case for their adoption as a competitive policy tool in these economies. The effectiveness of leniency laws in stimulating competitive practices suggests that policymakers in these markets could potentially benefit from their implementation. The threat of Henry Hill Jr. always exists in human mind, after all.

Appendix:

Table A1: Description and calculation of variables used in the study

Variables	References	Calculation	Sources
Total Asset Turnover		Net Sales or Revenues/Total Assets	Datastream
Fixed Assets Turnover		Net Sales or Revenues/Fixed Assets	Datastream
Cash Conversion Cycle	(Wang, 2019)	CCC = Days of Inventory Outstanding + Days of Receivable Oustanding – Days of Payables Outstanding	Datastream
Firm size	(Dasgupta & Žaldokas, 2019)	Ln(Total Assets)	Datastream
LnGDP	(Dasgupta & Žaldokas, 2019)	Ln(GDP)	World Bank national accounts data and OECD National Accounts data files
Unemployment			International Labour Organization, ILOSTAT database.
Import(%GDP)	(Dasgupta & Žaldokas, 2019)		World Bank national accounts data and OECD National Accounts data files
Tangibility	(Jalal & Khaksari, 2020)	Net property, plant, and equipment/Total assets	Datastream
Sale growth	(Dasgupta & Žaldokas, 2019; Rajan & Petersen, 1997)		Datastream

Table A1: Description and calculation of variables used in the study (continued)

FCF	(Cheng et al., 2018; Gao et al., 2021)	A dummy variable that is equal to one if a firm's free cash flow is not negative and zero otherwise.	Datastream
Capital Intensity	(Gaur et al., 2005)	Gross Fixed Assets/(Gross Fixed Assets + Inventories)	Datastream
Real Interest Rate	(Jalal & Khaksari, 2020)	Lending interest rate adjusted for inflation as measured by the GDP deflator.	International Monetary Fund, International Financial Statistics and data files.
Profit	(Jalal & Khaksari, 2020)	Operating profit before taxes and depreciation/Total assets	Datastream
Leverage	(Giroud & Mueller, 2010; Jalal & Khaksari, 2020)	Total assets/(Total assets – Total debts)	Datastream
Investment	(Jalal & Khaksari, 2020)	Capital expenditures/Total assets	Datastream
Dividend	(Jalal & Khaksari, 2020)	Cash dividends/Total assets	Datastream

Table A2: Filtering screens

Screen	Content	Reference
Screen 1: Keeping only equity, delete all other types of companies.	Because the other types are non-common stock and may behave irregularly. Ince and Porter (2006) also argues that eliminating non-common equity securities and correcting errors in the data significantly improve the time-series properties of market-wide returns	(Ince & Porter, 2006)
Screen 2: Dropping all Financial and Utility, real estate firms.	Dissimilarities in their financial characteristics and regulated nature as compared to other industries	(Fama & French, 1992; Karolyi & Wu, 2018)
Screen 3: Deleting stock not listed on a major exchange.	+Major exchanges have standardized listing requirements, which facilitates comparability across different countries and markets. +Stocks listed on major exchanges are subject to stricter regulatory requirements, ensuring more reliable and transparent financial reporting	(Ince & Porter, 2006)
Screen 4: Removing all nonlocal firms.	Nonlocal firms may operate under different legal and regulatory frameworks, which could skew the results or complicate the analysis by introducing additional variables.	(Ince & Porter, 2006)
Screen 5: Dropping stocks with specific characteristics consisting of "income trust," "preferred stocks," "partner," etc., in the company name in ALL country.	Their behavior is different from common stocks due to their special features (not common stocks). For example, REITs are the real estate composite index. Quite like a fund, people just put money into it and invest in property, so those subjects don't have corporations leading to a lack of operational efficiency ratios.	(Griffin et al., 2010)

Table A2: Filtering screens (continued)

Screen 6: Dropping stocks with specific characteristics consisting of "income trust," "preferred stocks," "partner," etc., in the company name in specific countries.	Their behavior is different from common stocks.	(Griffin et al., 2010)
Screen 7: Delete all stocks listed that are not in the currency of the country in which the market is located.	Eliminating foreign factors, especially when examining a cross-country study.	(Ince & Porter, 2006)
Screen 8: Excluding firms with negative sales.	Firms with negative sales may not be operating under normal business conditions, making them less relevant	(Griffin et al., 2010)
Screen 9: Excluding firms with negative book values and prices.	+ Negative book values are not typical for most businesses, can disrtort the results. +Negative stock prices are not a standard occurrence in financial markets and typically represent severe financial issues or errors in data reporting	(Easley et al., 2002; Griffin et al., 2010)
Screen 10: Excluding firms with a range of market-to-book value.	Excluding firms with a market-to-book value higher than three or less than 0.01	(Barlev et al., 2007)
Screen 11: Excluding firms with negative total assets.	Negative total assets often signal severe financial distress or bankruptcy, conditions that are not typical of standard business operations	(Barlev, 2007; Dasgupta, 2019)
Screen 12: Excluding companies with a CCC higher than 365.	Such extreme values could be outliers that skew the overall analysis and might not accurately reflect the impact of laws	(Jalal, 2020)

Table A3: Parallel trend assumption test

Dependent variables	p-value of joint null test	p-value of joint null test
	Two years before leniency passages	Three years before leniency passages
Total Assets Turnover	0.1899	0.2939
Fixed Assets Turnover	0.0502	0.0617
Operating Cycle	0.1699	0.2152
Receivable Turnover	0.1755	0.2957

Notes: In this table, three years and two years are the number of periods before the event date used for the parallel trend test. The number in each column is Prob>chi2, which is the p-value of the associated joint null test where $\mu = 0$. *That Prob>chi2 is higher than 0.05 supports the parallel trend assumption. The results show that parallel is satisfied in all cases.*

Table A3: Relevant summary statistics from extant cross-countries studies

Panel A: Relevant summary statistics from Dasgupta & Žaldokas', 2019 paper

Variables	N	Mean	Median	SD
Assets ($millions)	633,400	3,692.295	100.353	892,415.2
Tangibility	462,654	0.316	0.270	0.242

Note: In this table, data is collected from Compustat Global and North America Compustat and winsorized at 1%.

Panel B: Relevant summary statistics from Dong et al.'s, 2019 paper

Variables	N	Mean	Median	SD
Assets ($ million)	507,354	2,886.19	130.75	37,700.46

Note: Data is collected from Compustat Global and North America Compustat filtered and winsorized at 1%.

Table A4: Number of unique stocks and firm-year observation comparison across studies

Our sample			(Dong et al., 2019)		(Ma et al., 2019)
Datasource	**Datastream**		**Compustat Global & North America**		**Datastream**
Country	Unique stock	Firm - year Obs.	Unique stock	Firm - year Obs.	Unique stock
Argentina	86	895	73	925	
Australia	1,363	7,316	2,075	20,082	2,799
Austria	125	1,030	132	1,472	197
Belgium	152	1,343	162	1,843	256
Brazil	166	1,438	384	4,492	
Bulgaria	141	758	17	126	108
Canada	1,544	9,397	3,701	28,176	2,435
Chile	160	1,417	164	2,124	
China	2,497	10,634	2,478	27,416	
Colombia	61	451	38	349	
Croatia	101	614	30	255	122
Cyprus	66	382	34	275	146
Czech	49	206	34	274	
Denmark	187	1,604	196	2,335	385
Ecuador	2	10	2	17	
Estonia	13	123	17	181	
Finland	188	1,745	158	2,060	223
France	1,132	8,969	1,026	11,219	1,621
Germany	1,108	9,271	1,012	11,508	1,306
Greece	288	2,384	234	2,223	412
Hong Kong	1,314	11,254	364	3,654	1,664
Hungary	47	389	32	306	87
Iceland	19	112	10	80	
India	2,491	12,756	2,113	24,173	2,955
Indonesia	486	4,198	338	3,775	485
Ireland	85	618	108	1,209	67
Israel	333	2,396	285	2,601	786
Italy	325	2,239	340	3,643	584
Japan	4,473	54,999	3,877	53,694	3,584
Jordan	96	712	103	828	
Kenya	33	235			61
Latvia	27	218	28	270	
Lithuania	27	151	34	305	31
Luxembourg	24	122	44	416	17
Malaysia	1,011	8,713	1,035	12,848	1,087
Mexico	167	1,573	146	1,681	242

Table A4: Number of unique stocks and firm-year observation comparison across studies (continued)

Our sample			(Dong et al., 2019)		(Ma et al.,2019)
Datasource	**Datastream**		**Compustat Global & North America**		**Datastream**
Country	Unique stock	Firm - year Obs.	Unique stock	Firm - year Obs.	Unique stock
Netherlands	216	2,039	244	2,884	281
New Zealand	151	1,011	157	1,623	263
Nigeria	71	387	55	500	
Norway	284	1,778	340	3,063	583
Oman	77	703	58	604	
Pakistan	221	1,514	205	2,232	374
Peru	119	955	77	931	178
Philippines	151	1,265	174	2,154	321
Poland	483	3,162	402	3,454	951
Portugal	93	838	80	838	177
Romania	125	769	47	357	176
Russian	419	1,929	191	1,647	
Singapore	827	7,267	738	8,066	735
Slovakia	21	105	10	75	
Slovenia	42	270	23	253	96
South Africa	418	2,994	370	3,857	878
South Korea	2,264	20,631	1,475	8,701	2,594
Spain	187	1,575	188	2,293	273
Sweden	638	4,109	554	5,694	1,087
Switzerland	251	2,468	270	3,596	480
Thailand	638	6,835	496	5,723	785
Turkey	328	2,679	157	1,538	422

Table A4: Number of unique stocks and firm-year observation comparison across studies (continued)

Our sample			(Dong et al., 2019)		(Ma et al.,2019)
Datasource	**Datastream**		**Compustat Global & North America**		**Datastream**
Country	Unique stock	Firm - year Obs.	Unique stock	Firm - year Obs.	Unique stock
Ukraine	77	432	6	38	
United Kingdom	2,207	12,430	2,832	28,168	3,924
United States	7,365	52,310	22,498	213,914	4,067
Venezuela	25	257	21	222	21
Vietnam	955	5,592			
Zambia	9	39	9	81	

Note: In this table, "Unique stock" stands for the number of unique stocks, and "Firm-year obs." stands for the number of firm-year observations.

Table A5: Number of unique stocks and firm-year observation comparison across studies

My sample			(Dong et al., 2019)		(Ma et al.,2019)
Datasource	**Datastream**		**Compustat Global & North America**		**Datastream**
Country	Unique Stock	Firm - year Obs.	Unique Stock	Firm - year Obs.	Unique Stock
Bulgaria	141	758	17	126	108
Canada	1,544	9,397	3,701	28,176	2,435
Croatia	101	614	30	255	122
Hong Kong	1,314	11,254	364	3,654	1,664
Romania	125	769	47	357	176
Russian	419	1,929	191	1,647	
Turkey	328	2,679	157	1,538	422
United States	7,365	52,310	22,498	213,914	4,067

Note: In this table, "Unique stock" stands for the number of unique stocks, and "Firm-year obs." stands for the number of firm-year observations.

Appendix A1: Difference-in-Differences imputation estimator (Staggered DID): Justification

The notion of breaking down the Average Treatment Effects (ATE) in a Difference-in-Differences (DiD) framework into weighted averages has a long history in econometrics, as initially proposed by Imbens & Angrist (1994). Their use of monotonicity conditions (either non-increasing or non-decreasing) ensures only positive weights in the ATE calculation but localizes their estimated effects. Vytlacil (2002) later showed this monotonicity could be equated to a selection model, paving the way for a richer exploration of treatment effect heterogeneity, as evidenced in work by Heckman et al. (2005). More recently, however, an emerging line of research has questioned the validity of the traditional two-way fixed effect DiD approach. These studies demonstrate that this conventional DID method assumes linear additive effects, an assumption that does not hold in cases of staggered law implementations (see (Baker et al., 2022; Callaway & Sant'Anna, 2020; de Chaisemartin & D'Haultfœuille, 2020; Goodman-Bacon, 2021; Imai & Kim, 2021; Sun & Abraham, 2020)).

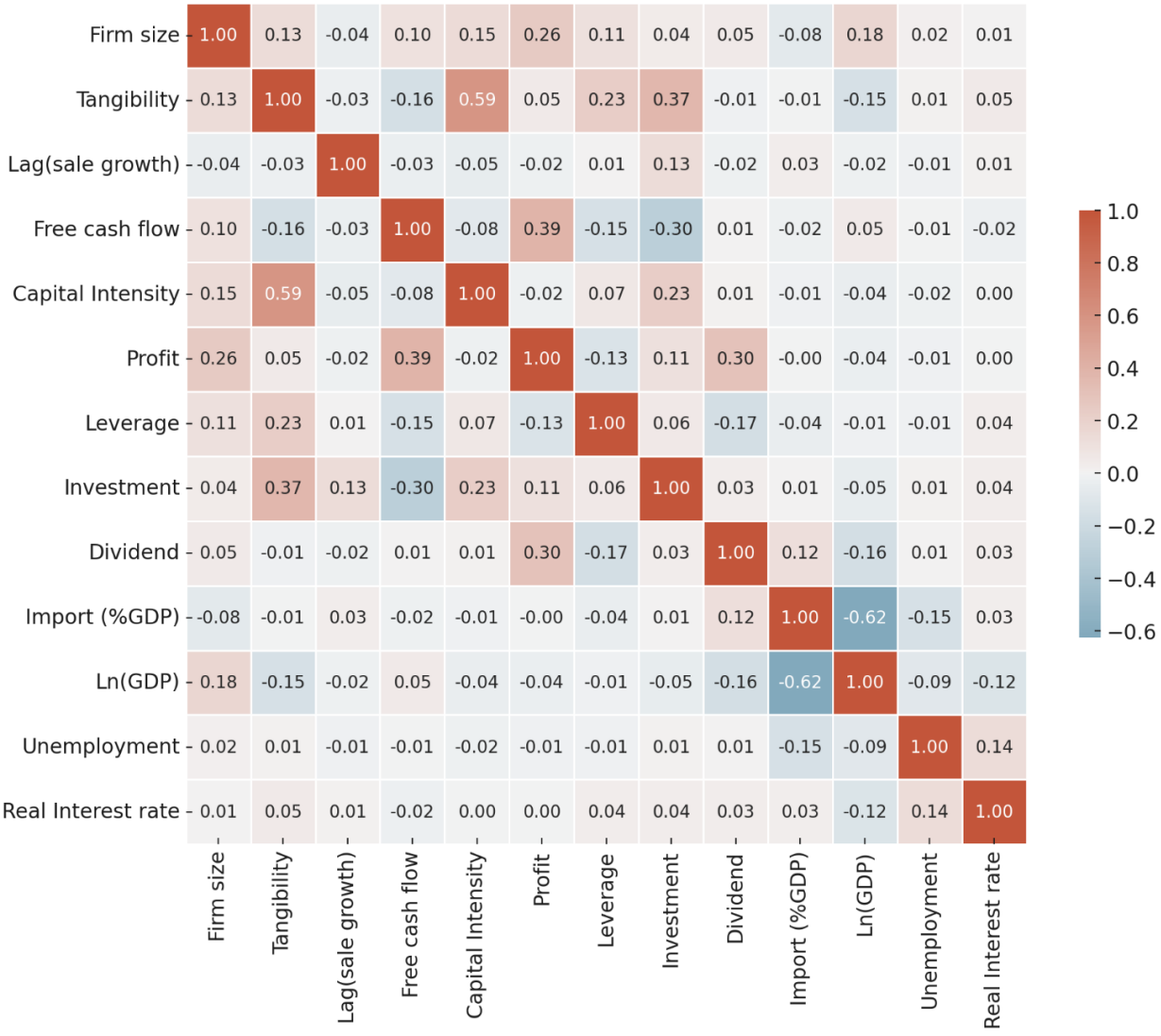
Specifically, 'negative weights' in the DiD estimation can arise when already-treated units serve as controls and their changing treatment effects over time are subtracted from the estimation (Goodman-Bacon, 2021). This negative weighting phenomenon emerges when treatment effects fluctuate over time, generally biasing regression DiD estimates away from the true treatment effect's sign. If one group receives treatment across multiple periods while another remains untreated, the treated group may enter as a control. This introduces treatment effect heterogeneity and consequently biases the results significantly (Cunningham, 2021; Goodman-Bacon, 2021)

As noted by Goodman-Bacon (2021), the presence of heterogeneous treatment effects, particularly when units in the panel are exposed to treatments at different times, poses a limitation for event studies using traditional two-way fixed-effect regression (Goodman-Bacon, 2021). The imputation estimator proposed by Borusyak et al. (2024) addresses this limitation and stands as a finite-sample efficient and unbiased estimator.

This is also in line with a growing body of DiD estimators that are robust to unrestricted heterogeneous treatment effects (Callaway & Sant'Anna, 2020; de Chaisemartin & D'Haultfœuille, 2020).

In general, the recently modified DiD imputation estimator as outlined by Borusyak et al. (2024) is more suitable for analyses involving staggered timing of implementation compared to the traditional two-way fixed-effect Difference-in-Differences approach. Additionally, it proves to be more robust and efficient than other recently adopted DiD estimators, such as those proposed by de Chaisemartin & D'Haultfœuille (2020) and Sun & Abraham (2020). This methodology has gained traction in recent academic literature, evidenced by its application in studies such as Alvarez et al. (2022), Biasi & Sarsons (2021), and Von Bismarck-Osten et al. (2022). Notably, Alvarez et al. (2022) confirms the robustness of the Borusyak et al. (2024) estimator against that of de Chaisemartin and D'Haultfœuille (2020). Given its simplicity and distinct advantages, Cunningham (2021) suggests that this estimator offers a promising and popular future solution for addressing the issues of 'negative weighting' inherent in standard DiD approaches.

Figure A1: Correlation matrix of key independent variables utilized in the empirical analysis.



Note: This is the correlation matrix of all independent variables in this study.

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