

Anticollusion Enforcement: Justice for Consumers and Equity for Firms

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We consider the case of changing competition that comes from stronger antitrust enforcement around the world to show that, as the equilibrium switches from collusion to oligopolistic competition, firms step up investment and increase equity issuance. As a result, debt ratios fall. These results imply the importance of financial flexibility in surviving competitive threats. Our identification relies on a difference-in-differences estimation based on the staggered passage of leniency programs in 63 countries around the world from 1990 to 2012. (*JEL* D22, D43, G32, G38, L44)

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Price-fixing cartels are pervasive. John Connor's data set of Private International Cartels, comprising 1,014 suspected cartels that were either convicted of price fixing or under investigation from 1990 to 2013, reveals the total affected sales of these cartels to be around \$1.5 trillion. In recent years, the number of new identified cartels has been averaging over 70 per year, suggesting that the share of industrial output that is cartelized, even for developed economies, is substantial.¹

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¹ Some countries (e.g., Austria, Germany, Switzerland, the Netherlands, the Nordic countries, the United Kingdom, and Australia) had cartel registries at the time when cartels were not illegal in those countries. Hyytinen, Steen, and Toivanen (2018) report that in 105 of 193 Finnish manufacturing industries at least one cartel of national scope was registered between 1950 and 1990. Their estimates based on the hidden Markov model suggest that, by the end of 1990, almost all industries were cartelized.

However, as recent trends in the number of detected collusion suggest, cartels are also crumbling rapidly. Antitrust enforcement around the world has been steadily picking up speed. Total criminal antitrust fines increased from \$107 million in 2003 to \$1.1 billion in 2012, and total prison sentences increased from an annual average of 3,313 days in the 1990s to 23,398 days by the end of 2012. Higher fines and new tools such as leniency programs for cartel whistleblowers have led to unprecedented enforcement action not only in the United States and the European Union (EU) but also in the rest of the world.

The breakdown of collusive activities that involve higher prices and restricted output is likely to result in the expansion of production. It might also lead to technological change: colluding firms have fewer incentives to innovate, especially when they face little threat of external competition (Vives 2008). We predict that such expansion in production capacity and investment in technological change when moving from the collusive to the oligopolistic equilibria will cause the financing deficits of firms to increase. That might trigger a change in the means of financing and a likely change in the leverage.

In this paper, we study how firms adjust their financing strategies when the cost of collusion become higher and cartels break up. On the one hand, such increased competition in the product market could make firms raise debt that provides convex incentives to managers (Brander and Lewis 1986; Maksimovic 1988). On the other hand, the firms might be rebalancing their capital structure due to the trade-off considerations as lower profitability and higher ex ante probability of default make debt less appealing.

Yet these direct capital structure considerations of pure debt-equity rebalancing and the strategic use of debt are unlikely to be the only relevant factors in the environment when firms are moving between different competitive equilibria. The firms are likely to adjust their product market strategies and such readjustment would lead to a different asset mix which would mean indirect implications to the capital structure choices. In particular, firms might be increasing financing to sustain financial flexibility (Fresard 2010; Hoberg, Phillips, and Prabhala 2014). While both debt and equity can provide such financial flexibility, the exact mix of debt and equity is likely to be a function of the type of investment that the firm is trying to raise. Indeed, expansion of the physical factories might be easier to finance with debt suited to fund collateralizable assets while intangible investment might be better suited to fund with the equity (Kerr and Nanda 2015). Firms might also raise money to keep as excess funds that can be held in cash balance as a competitive threat to rivals. In that case, equity might also be preferable as debt limits firm's ability to respond to product market threats by removing excess funds (Phillips 1995; Kovenock and Phillips 1995; Kovenock and Phillips 1997).

Since theory does not provide clear predictions about how firms' financing behavior responds to such a change in the competitive regime, in this paper we take advantage of the variation in the cost of collusion coming from the staggered passage of leniency legislation in 63 countries from 1993 to

2011 to study how more aggressive cartel enforcement affects firms' debt-equity choices and financial leverage. Leniency programs have been one of the most important developments for cartel detection and deterrence (Chen and Rey 2013). By allowing reduced fines or even providing immunity to cartel members that collaborate in conviction cases, leniency laws are expected to have increased the costs of forming cartels and the benefits of breaking them up.² Such strengthening of antitrust policy has changed the competitive landscape and thus provides an opportunity to identify the effect of changes in the strategic interactions between firms on their financing choices and capital structure.

Importantly, countries passed the leniency programs at different points in time between 1993 and 2011. Based on this staggered nature of the law passage, we attempt to identify the effect of a less collusive product market environment on firms' financing decisions by following a difference-in-differences strategy. In other words, controlling for firm and time fixed effects, we compare the change in financing choices of firms that were affected by the law to the contemporaneous change in choices of the control group of firms that were headquartered in the countries that have not yet passed such a law.

We find that following the adoption of a leniency law, firms expand by increasing asset growth, coming from higher cash holdings, capital expenditures, and investment in intangible assets, and they fund this expansion by issuing more equity. In some of our specifications, debt issuance activity also increases, though much more modestly. Consistent with more aggressive equity issuance, with some exceptions, we also find that leverage declines following the adoption of a leniency law.

Our results are robust when we control for industry*year, region*year, and industry*region*year fixed effects to filter out regional or industry-specific trends that could simultaneously affect financing choices of firms and competition policy. We also control for observable variables capturing macroeconomic conditions. To mitigate the concern that the adoption of these laws signaled other events that could affect capital structure through alternative channels, we control for import penetration to capture the effect of trade agreements; industry's Herfindahl-Hirschman index (HHI); country's capital account openness; adoption of competition law and other anticartel legislation; corporate governance reforms; stock and credit market development; country's rule of law, governance, and regulatory quality; and corporate tax changes.

While existing evidence suggests that cartels are quite pervasive, the above results do not distinguish between firms that are members of cartels, and those that are not. We expect our results to be stronger for the former. Using a database on actual cartel convictions, we predict the propensity for a firm to

² Dong, Massa, and Žaldokas (2018) show that, after the passage of leniency laws, the gross margin of affected firms decreases by 14.8%. A recent case in which four European truck manufacturers (Daimler, Iveco, DAF, and Volvo) were awarded a combined EUR 2.93 billion of total penalties, whereas MAN, another company that participated in the collusion, received full immunity for revealing the existence of the 14-year long cartel is a good example of the application of a leniency law.

be a member of a convicted cartel based on its industry and country, and other firm characteristics. We find that our results are significantly stronger for firms with higher predicted probability of being part of a cartel. We also explore cross-industry heterogeneity and find that our results are stronger in the cases where collusion is more stable according to the theory predictions: for firms in the more concentrated industries, firms in the industries that use less patent protection, and firms in low-growth industries.

As an additional source of variation, we look at how the financing choices of firms in a country respond not only to that country's adoption of leniency laws but also to the adoptions in other countries where these firms are likely to experience product market interactions. In particular, we look at how a firm is affected by the passage of leniency laws in countries that are major export destinations of the firm's industry and in countries where the firm's subsidiaries are located. An appealing feature of this setting is that the passage of a leniency law in another country is likely to be even more exogenous to any other factors in the home country that might simultaneously affect financing decisions of firms and antitrust policy. Indeed, we find consistent results that asset growth and equity issuance also increases for firms in an industry when other countries that are important export destinations for that industry adopt a leniency law, or when the laws are adopted in countries where the firms' subsidiaries are located.

Finally, we look at another case of strengthening anticartel legislation, the enactment of Antitrust Criminal Penalty Enhancement and Reform Act (ACPERA) in the United States in 2004. The act increased the fines and provided more incentives for leniency law applicants, and thus has been lauded as one of the most significant revisions in the history of the U.S. antitrust system. We again predict the propensity for a firm to be a member of a convicted cartel based on its industry and firm characteristics. We find that U.S. firms with higher predicted probability of being part of a cartel increased asset growth, financing deficit, and equity issuance.

What we demonstrate in this paper is consistent with the interpretation that when the nature of equilibrium in the product market changes from collusion to oligopolistic competition, firms increase asset growth, by raising cash holdings and investment, and finance such investment with equity to retain financial flexibility. Given that all former cartel members are expected to expand investment in production capacity and increase output, financing the expansion with debt would make firms vulnerable to rival firms changing their strategies and expanding production capacity even more aggressively with equity financing.³

³ For example, while immediately issuing equity might involve some wealth transfer to debtholders, equity issuers would be unencumbered by the debt overhang problem and even greater wealth transfer when pursuing future expansion. Zingales (1998) finds that, after the Carter deregulation of the trucking industry, firms with higher pre-deregulation debt levels invested less, and this affected adversely their survival likelihood.

At first glance, our results are also consistent with the trade-off theory, which suggests that, when profits are expected to fall, firms will reduce leverage. Indeed, Xu (2012) examines the effect of higher import penetration (instrumented by tariff cuts and exchange rate changes) on leverage, and finds that leverage drops even controlling for current profitability. She attributes this to expected lower future profitability following a reduction of barriers to entry into the industry. An important difference between Xu's (2012) setting and ours is that unlike firms exposed to greater import competition who experience decrease in asset growth, firms newly exposed to leniency law increase asset growth. Byoun (2008) finds that firms with above-target debt ratios are much slower to adjust capital structure toward the target when they have a financing deficit, as opposed to when they have a financing surplus.⁴ Therefore, since firms newly exposed to a leniency law increase their asset growth and financing deficits as they expand output and capacity, it is unlikely that the significant increase in equity issuance activity is purely driven by debt-ratio rebalancing motives. For these firms, equity issuance serves the dual roles of maintaining financial flexibility in the face of competition and financing asset growth.

Finally, a contemporaneous paper by Ferrés, Ormazabal, and Sertsios (2016) examines capital structure choices of U.S firms that were discovered to have participated in a cartel. They find that these firms reduce leverage during the collusion period, which is seemingly at odds with our findings. A few differences in setup might explain this. First, Ferrés, Ormazabal, and Sertsios (2016) only consider U.S. firms that have been convicted, while we examine all U.S. and international firms that have been exposed to leniency law. Second, the behavior of firms that recognize that collusion is no longer feasible could be dissimilar from that of firms prior to entering a period of collusion. Interestingly, the results on equity issuance and repurchase activities are quite symmetric, – while we find that firms step up equity issuance after the introduction of leniency law, Ferrés, Ormazabal, and Sertsios (2016) discover that firms repurchase equity during collusion period (but presumably also reduce debt as they become more profitable).

1. Relation to Literature

We first provide a brief background of the theoretical literature on product market collusion that motivates our empirical enquiry. Two parts of this literature are relevant for our study. The first concerns the implications of a change in the nature of competition from collusion to oligopolistic competition on firms' investment behavior. The second studies the implications of such a

⁴ Hovakimian (2004) also finds that offsetting the accumulated deviation from the target is not the primary reason for issuing or repurchasing equity. Only debt reductions by above target firms are used to adjust back to the target, with debt issuances generally causing high debt firms to further deviate from target.

change (and the associated investment behavior) on firms' financing choices, especially, the choice between debt and equity.

1.1 Collusion versus oligopolistic competition

Firms collude to maximize joint profits. They do so by restricting output and charging higher prices than what would prevail if they did not coordinate their output and pricing decisions.

Collusion is typically distinguished by being explicit or being tacit. Explicit collusion occurs when participating firms communicate with each other and fix prices, production capacities, or input costs such as wages. Colluding firms might also divide geographic or product markets. In most jurisdictions, such cartels which result in lower consumer welfare are illegal and are subject to the antitrust enforcement. When a cartel arrangement is no longer sustainable (e.g., because of more stringent antitrust enforcement), the participating firms become competitors, and the market structure becomes an oligopoly. Regardless of whether the strategic variables chosen by the firms are prices or quantities (and the resultant competition is characterized by Cournot or Bertrand competition), prices are lower and qualities are higher compared to the collusive outcome.

Collusion also can be a tacit when it involves no direct communication between firms. Even such collusion can be stable if it involves a repeated interaction between firms over many periods. Firms coordinate their prices to levels that are above those that would prevail if they were interacting only once. This is possible under the threat of "retaliation" should any firm deviate and undercut the rivals. To be effective, the retaliation must imply sufficient loss of long-term profits so that the loss outweighs the gain from a one-time deviation, and it must also be in the best interests of the retaliating firms to continue with the retaliation. In a repeated game setting, a multiplicity of equilibria are possible under collusion, but all of them result in higher joint profits, higher prices, and more restrictive output compared to the absence of collusion.

Unlike explicit collusion, tacit collusion is difficult to prosecute.⁵ However, because of the absence of direct communication, it may be difficult for firms to coordinate their prices, especially when firms are asymmetric because of the multiplicity of equilibria. Many collusive arrangements will have both tacit and explicit components. Grout and Sonderegger (2005) argue that "parties might be more likely to engage in overtly collusive practices specifically in those circumstances that are predicted by the theory as being adverse to collusion" because "the need for cartel members to communicate intensifies precisely when collusion is harder to sustain." More stringent antitrust enforcement

⁵ For instance, in the decision *Text Messaging Antitrust Litigation* (no. 14-2301, April 9, 2015), Judge Richard Posner stated that it is "difficult to prove illegal collusion without witnesses to an agreement" and that circumstantial evidence "consistent with an inference of collusion, but [...] equally consistent with independent parallel behavior" is not sufficient.

targeting explicit collusion may therefore cause even tacit collusion more difficult to sustain.

When collusion (either explicit or tacit) breaks down and firms have to compete with each other for market share, new investment may be necessary. One simple reason for this is that each firm will produce more in the new equilibrium, and this might require investment in additional production capacity. Firms may also have to step up investment in research and development (R&D), accelerate new product development, and hold more cash to finance such expenditures in the future and deal with predatory tactics by rivals. All this is likely to generate a demand for financing. We next discuss the financing choices firms face.

1.2 Implications for financing

In contrast to the implications for investment and R&D spending when the equilibrium switches from collusion to oligopolistic competition, the financing choices that firms will make are far from clear.

Debt financing makes equityholders' payoff convex in cash flows. The literature on the strategic role of debt (Brander and Lewis 1986; Maksimovic 1988; Dasgupta and Titman 1998) is based on the premise that limited liability could affect the product market choices of firms. Brander and Lewis (1986) show that firms in an oligopoly have an incentive to choose debt in equilibrium. This is the case regardless of whether firms compete in prices or quantities. However, there is no role for debt when firms are colluding and maximizing shareholder value, regardless of whether firms are colluding tacitly in a repeated game setting (Maksimovic 1988) or whether they are colluding explicitly and setting prices to maximize joint profit each period (Brander and Lewis 1986).⁶ That said, it is difficult to infer directly from these models what one should expect regarding financing or capital structure choice if, for exogenous reasons, the nature of competition changes from collusion to oligopolistic competition. One reason for this is that investment decisions are typically not considered in these models, and as noted, the transition to a new product market equilibrium may well entail new investment in tangible and intangible assets, which in turn might affect financing choice and affect subsequent capital structure.

Another line of research emphasizes the need to maintain financial flexibility under competitive pressure. Kovenock and Phillips (1995, 1997) explicitly consider the role of capital structure in financing investment in oligopolistic product markets. The authors argue that firms will be constrained in expanding production capacity once internal funds are exhausted. Given rival firms' choices, this will happen at lower levels of production capacity when the debt ratio is higher. When firms compete in prices, higher debt ratios can increase

⁶ In fact, Maksimovic (1988) shows that, once the coupon payment on a perpetual bond exceeds the profit in the retaliation phase following deviation, higher debt makes collusion more difficult to sustain.

both own and rival firms' prices and profits.⁷ This reasoning suggests that when collusion gives way to oligopolistic competition and firms need to expand investment, they would prefer to maintain lower debt ratios and preserve internal financing.

Fairly robust empirical support has been provided for such a "financial flexibility" argument. Zingales (1998) examines the effect of deregulation in the trucking industry. He finds that, consistent with Kovenock and Phillips (1995, 1997), debt overhang model (Myers 1977), and models of "deep pockets" and predatory behavior (Telser 1966; Benoit 1984; Bolton and Scharfstein 1990), firms with high leverage prior to deregulation are more likely to exit the industry, due to their inability to compete effectively by increasing investment and charging lower prices.⁸ Subsequent empirical research has also found the importance of financial flexibility in competitive environments.⁹ In our context, this line of research would imply that as collusion ends, firms need to be poised to increase investment and compete aggressively. This requires less reliance on debt as opposed to equity, and building up internal liquidity.

Mainstream theories of capital structure provide additional perspectives on this issue. Firms—especially larger firms that are more likely to be cartel members—generally finance their capital expenditures with debt, rather than equity. When collusion ends, they are in a situation where they need to step up their investment, but at the same time, they experience decrease in their profitability. In this situation, the pecking order hypothesis suggests that the reliance on debt financing would increase. On the other hand, the trade-off theory of capital structure calls for lower optimal leverage as expected bankruptcy costs increase. Firms are therefore expected to rebalance to a lower leverage ratio.¹⁰ However, the literature also finds that trade-off-type rebalancing mostly occurs when firms have a financing surplus, that is, when their growth opportunities slow down and internal funds are used to reduce debt. There is little evidence that highly levered firms rebalance via equity issuance, presumably because such rebalancing entails wealth transfer to bondholders.

⁷ Kovenock and Phillips (1995, 1997) find evidence that after leveraged recapitalizations, firms reduce investment, whereas rivals do the opposite. This evidence is consistent with their theory, but they point out that the evidence is also consistent with Jensen's (1986) free cash flow hypothesis. Jensen's (1986) argument also predicts lower leverage when collusion breaks down, as the free cash flow problem is likely to be less important.

⁸ Chevalier (1995) finds that supermarket chains that underwent leveraged buyouts (LBOs) in the 1980s were more likely to close stores in local areas that competed with low-debt major rivals. Prices tended to drop in these markets after the LBO, suggesting predation by rival non-LBO firms.

⁹ Fresard (2010) finds that larger cash holdings allow market share gains at the expense of rivals, especially when product market competition is intense, and also deters entry. Hoberg, Phillips, and Prabhala (2014) document that firms build up cash by cutting dividends when competition becomes more intense.

¹⁰ Indeed, Ovtchinnikov (2010) and Xu (2012) find that leverage goes down when competition intensifies, consistent with trade-off theory. The other recent consistent findings include those of Valta (2012), who finds that the threat of import competition is associated with higher cost of debt, and Klasa et al. (2018), who find that the risk of losing trade secrets causes firms to maintain lower leverage.

Finally, the type of financing that firms seek in the new equilibrium is likely to be sensitive to the type of assets they acquire. Fixed assets that can be collateralized are typically financed with debt, whereas riskier R&D investment, advertising, employee training are easier to finance with equity. Moreover, if firms want to carry a liquidity buffer either to fend off predatory threats or to finance future investment by adding to their cash holdings, equity is likely to be the preferred financing choice.¹¹

The change from a collusive regime to an oligopolistic one thus is very likely to be associated with additional external financing, with both debt and equity being issued, but their relative importance is ultimately an empirical question.

2. Empirical Strategy and Data

2.1 Background on leniency laws

Given the importance of the antiwelfare implications of product market collusion, governments have devoted considerable resources in tackling it. One of the most effective tools has been the introduction of leniency programs (or leniency laws). Leniency laws allow market regulators or the courts to grant full or partial amnesty to those firms that, despite being a part of a collusive agreement, cooperate in providing information about it. In particular, a typical leniency program stipulates that the first firm that provides substantial evidence to the government (if the latter does not yet have sufficient evidence to prosecute the cartel) gets automatic amnesty. In countries where the firm's managers, employees and directors may face criminal liability for participating in a collusive agreement, as is the case in the United States, amnesty also extends to waiving such criminal liability. As suggested by Hammond (2005), U.S. leniency law, which was strengthened in 1993, proved successful in destabilizing existing cartels and deterring the formation of new cartels and has thus inspired other countries to pass similar laws. Dong, Massa, and Žaldokas (2018) show that the passage of leniency laws significantly harms collusion. In particular, they find that the passage of leniency laws increases conviction rates and generally lowers gross margins of firms, thus also capturing the effect of leniency laws on the unobservable break-ups of cartels. Table 1 reports the list of leniency law passage years around the world.

Although the laws are not passed in a vacuum and are arguably influenced by economic and political conditions in the respective countries, countries do not seem to have followed one particular trend and reason for such law passage. Some countries passed the law after prominent collusion cases. For instance, Hungary did so after it faced significant criticism

¹¹ A simultaneous increase in cash holding and debt protects the firm against defaulting on existing debt, but creates a new liability, so the firm is still vulnerable to predation. Moreover, if predatory strategies by rivals—especially those who raise financing via equity issuance—cause the cash raised to become depleted, an overhang problem is created (Myers 1977) that will confer considerable strategic advantage to rivals.

concerning its competition investigation against mobile telephone operators, while Switzerland strengthened its competition law in 2003, including the passage of leniency laws, after it failed to prosecute firms involved in the vitamin cartel. Taiwan passed the law as a response to general concerns about rising consumer prices.

Other countries passed leniency laws after significant pressures from the United States, the EU, or supranational organizations (Lipsky 2009). For instance, Mexico passed the law in 2006 following general recommendations of an OECD Peers Review in 2004 on Competition Law and Policy in Mexico which reported that its antitrust authority needs better investigative tools, including the ability to give leniency to a whistleblower revealing secret cartel conduct. Similarly, the United States had bargained for strengthening of Singapore's antitrust law in its negotiations for a bilateral free trade agreement.¹² Moreover, the EU has fostered the adoption of leniency laws by its member states and often seeks similar provisions in its bilateral association and trade agreements. The IMF and the World Bank ask for the overhaul of antitrust laws as a condition for loans and other funding (Bradford 2012).

In some cases, the passage of leniency laws was contentious. For instance, the leniency law met significant opposition in the Swiss Parliament as the law relies on denunciations that run contrary to Swiss legal tradition. Japanese Business Federation (Nippon Keidanren), the most influential industrial organization in Japan, extensively argued against such a law in Japan, claiming that cooperating and informing on fellow participants in exchange for a lower sanction is an affront to Japanese culture, and should only be considered as part of the wider review of the entire criminal law system. In Table IA1, we report the table from Dong, Massa, and Žaldokas (2018) that estimates the Cox proportional hazard model predicting the passage of leniency law in the country. The most consistent predictor is the economic development of the country as proxied by the log gross domestic product (GDP). Right-wing affiliation of the chief executive has a negative effect, as compared to center- or left-wing orientation.

2.2 Identification

Against this background, we posit that no single particular trend has led to leniency law passages. We thus employ a difference-in-differences identification strategy to estimate the effect of competition on financing strategies of firms.

Our main estimates are then based on the following regression specification:

$$Y_{it} = \alpha + \beta(\text{Leniency Law})_{kt} + \delta X_{ikt} + \tau_t + \gamma_i + \epsilon_{it}, \quad (1)$$

¹² One may argue that free trade agreements might affect market structure in a way similar to cartel busting. Mindful of Singapore's case, we carefully control for country's levels of trade and this does not affect our results. Moreover, we are not aware of any other case apart from Singapore, where a leniency law was passed as an outcome of a trade deal. Finally, most trade agreements are regional. Controlling for region*year fixed effects or industry*region*year fixed effects does not affect our results.

where i, k , and t index firms, countries, and years, respectively. The dependent variables Y_{it} correspond to the asset growth, total net external financing (financing deficit), change in common equity over the lagged book value of assets (equity issuance), the change in debt over the lagged book value of assets (debt issuance), or the debt-to-equity ratio, defined as the book value of debt over shareholder equity.

$(\text{Leniency Law})_{kt}$ equals 0 before the passage of the leniency law in country k , and 1 afterward. X_{ikt} is a vector of the different firm, country and industry controls, while γ and τ are firm and year fixed effects, respectively. In our baseline specification, our control variables X_{ikt} include firm size and profitability, the country's GDP and unemployment rate, imports as a percentage of GDP, and the exchange rate. In a standard difference-in-differences setting with staggered implementation of laws (Bertrand and Mullainathan 2003; Giroud and Mueller 2010), the *treated* group comprises all firms that are headquartered in countries that have passed a leniency law by year t . The *control* group comprises firms in countries that never adopted a leniency law in our sample period and firms headquartered in countries that adopted a leniency law at some later point of time.

In addition to using the passage of leniency laws in a firm's headquarter country, we implement an alternative identification strategy. We create a treatment variable based on a firm's exposure to the passage of leniency laws in those countries to which the firm's industry sends a significant fraction of its exports. By making it more difficult to form international cartels with industry peers in the countries that are likely to be firm's sales markets, the passage of leniency law in another country also increases the costs of collusion.

This continuous variable that we call "*Export market leniency laws*" is even more exogenous to political and economic conditions in a firm's country. It is estimated as the weighted average of the passage of laws in all other countries, excluding the country of the firm's headquarters:

$$(\text{Export Market Leniency Law})_{jkt} = \sum_{\hat{k}} w_{\hat{k}j} L_{\hat{k}t},$$

where \hat{k} denotes any country other than country k , j denotes a three-digit SIC industry, t denotes year. $w_{\hat{k}j}$ is the share of three-digit SIC industry j 's exports from country k to any other country \hat{k} out of all exports from industry j in country k in 1990. $L_{\hat{k}t}$ is an indicator variable that equals 1 if country \hat{k} has passed a leniency law by year t and 0 otherwise. To avoid endogeneity of industry structures, we remove the time variation and base the weights on the data in year 1990. The variable ranges from 0 when leniency laws are not passed in any country with any market share in the firm's industry to 1 when all foreign countries with any share in the firm's industry have passed the leniency law.

Our alternative specification is then as follows:

$$Y_{it} = \alpha + \beta(\text{Export Market Leniency Law})_{jkt} + \delta X_{ikt} + \tau_t + \gamma_i + \epsilon_{it}. \quad (2)$$

Table 1
Summary statistics

		Mean	Median	SD
Asset growth	569,403	0.246	0.052	0.936
Financing deficit	530,550	0.285	0.021	1.168
Net equity issuance	536,239	0.238	0.004	1.041
Net debt issuance	560,697	0.037	0.000	0.212
Assets (\$millions)	633,400	3,692.295	100.353	892,415.2
ROA	565,328	0.016	0.077	0.389
Debt/equity	559,797	0.978	0.439	1.475
Tangibility	462,654	0.316	0.270	0.242
Sales growth	362,751	1.242	1.076	0.915

This table reports summary statistics for the main variables used in the subsequent analysis. Asset growth, financing deficit, net equity issuance, net debt issuance, ROA, and sales growth are winsorized at 1%. The debt-to-equity ratio is limited to between 0 and 9.

Unlike Equation (1), in Equation (2), unless no country to which a firm's industry is exporting has passed a leniency law, a firm is considered as *treated*, and the intensity of treatment changes as more of the countries to which this industry exports adopt leniency law.

Finally, our third identification strategy relies even more directly on the international nature of firm operations. In the specifications above, we assign our treatment of leniency law passage based on the firm's headquarter country, where presumably most firms have most of their sales. *Export market leniency laws* measure already considers that firms also sell to other countries and are exposed to the other countries' antitrust codes. However, for a subset of firms we go further and have collected data on their actual international operations. We can thus test whether the passage of laws in other countries where they operate, also has a significant effect. More specifically, we measure a firm's exposure to leniency laws by looking at the distribution of the firm's operations around the world in terms of sales as recorded in Lexis-Nexis Corporate Affiliations database. So, we construct a measure of exposure to leniency law changes based on the proportion of firm activity that takes place in the country that experiences the law change. To illustrate, consider two firms, A and B, both headquartered in Germany. Firm A has 75% of its operations in Germany, and 25% in France; firm B has 25% of its operations in Germany and 75% in France. So, when Germany introduced the leniency law in 2000, firm A should have been affected more than firm B.

2.3 Data

In our analysis, we consider all nonfinancial firms in Worldscope, Compustat Global, and Compustat North America data sets from 1990 to 2012. We start with Compustat Global and Compustat North America samples and following the techniques described in Karolyi and Wu (2018) we augment this data set with Worldscope data as this allows us expand the sample of international firms we cover in our analysis and provides additional variables we can use in the analysis. Our initial sample covers 633,400 firm-years. We report some descriptive statistics in Table 1.

Table 2
Leniency laws

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	None	Spain	2008
Hungary	2003	Sweden	2002
Iceland	2005	Switzerland	2004
India	2009	Taiwan	2012
Indonesia	None	Thailand	None
Ireland	2001	Turkey	2009
Israel	2005	Ukraine	2012
Italy	2007	United Kingdom	1998
Japan	2005	US	1993
Jordan	None	Venezuela	None
Korea	1997	Zambia	None
Latvia	2004		

This table reports leniency law passage by country. Our primary source of information is the Cartel Regulation 2013, published by Getting the Deal Through. We complement this data set using press releases and news articles.

We collect information on the passage of leniency laws in 63 large countries from the Cartel Regulation 2013, published by Getting the Deal Through. We manually double check this information and complement it using press releases and news articles in Factiva database. We report the years when leniency laws were passed in Table 2.

Export data used to construct *Export market leniency laws* measure comes from CEPII TradeProd Database that has bilateral trade flows for more than 200 countries at ISIC industry level over 1980-2006. We match them to the three-digit SIC and average over the respective values within the three-digit SIC in case multiple three-digit ISIC codes match to three-digit SIC codes. The data on firm operations around the world come from the subsidiary data in Lexis Nexis Corporate Affiliations database.

3. Main Results

3.1 Univariate results

We start by plotting asset growth and financing deficit for the affected firms. Figure 1 plots the mean of the mean change in asset growth of treated firms

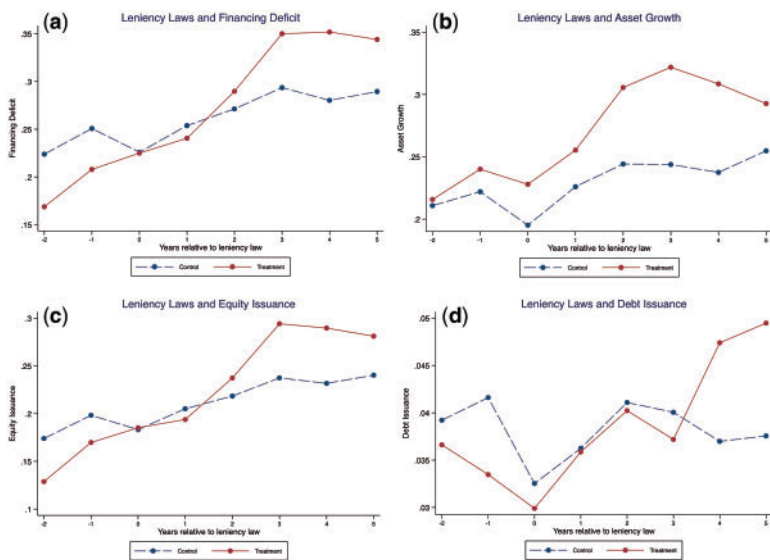


Figure 1
Trends

We plot mean change in (a) asset growth, winsorized at 1%, (b) net equity issuance and net debt issuance, winsorized at 1%, (c) net equity issuance (common stock over lagged assets), winsorized at 1%, and (d) net debt issuance (financial debt over lagged assets), winsorized at 1%. As a control sample, we consider firms that were not affected by a leniency law over the same period as the treated firm but were in the same SIC3 industry; that is, control firms did not have a leniency law introduced over 2 years before to 5 years after the introduction of the leniency law for the treated firm.

and control firms in the same industry, 2 years before and 5 years after the adoption of a leniency law in a country. Thus, the control firms are all firms in the same industry in countries that had not passed a leniency law in the 7 years surrounding the event date.

While we see that the treated and the control firms start from the same level, asset growth starts shooting up for the treated firms in the year after the passage of leniency laws but later trends level off. Similarly, for the financing deficit, we see rather parallel trends 2 years before the law passage and then diverging trends 1 year after the law passage. These results suggest that asset growth and financing deficit increase after the passage of leniency laws. We also report corresponding graphs for equity and debt issuance. Later, we further study these trends in a regression setting.

3.2 Leniency laws and asset growth

In this section, we present regression results to examine the effect of leniency law adoption by a country on the asset growth of firms in that country. We first provide general results on whether firms increase their asset size, and we later deconstruct whether such increase comes from the capital expenditures in expanding capacity, the investment into intangible assets, or the increase in

Table 3
Asset growth

A. Leniency law

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Leniency law	0.057*** 3.275	0.073*** 3.954	0.066*** 5.108	0.053*** 4.964	0.033** 2.044	0.024 1.432	0.050** 2.488
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.118	0.237	0.179	0.253	0.247	0.232	0.237
N	553,861	454,037	231,444	453,957	454,035	333,743	454,037

B. Export market laws (in other countries)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Export market leniency laws	0.080*** 5.193	0.123*** 6.011	0.103*** 4.485	0.104*** 6.540	0.063*** 4.038	0.051*** 3.276	
Subsidiary-based leniency laws							0.046** 2.226
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.094	0.198	0.168	0.204	0.208	0.164	0.237
N	274,616	216,677	115,703	216,518	216,677	161,329	30,077

We consider all nonfinancial Worldscope, Compustat Global, and Compustat North America firms from 1990 to 2012. This table reports ordinary least squares (OLS) regressions, where the dependent variable is annual asset growth, winsorized at 1%. All regressions, except where it is stated otherwise, include firm fixed effects and time fixed effects. Standard errors are clustered at the country-SIC3 industry level.

In panel A, our main variable of interest is the Leniency law dummy. In Column 1, we test its effect without any additional controls. In Column 2, we control for firm and country characteristics. In Column 3, we control for additional firm and industry characteristics. Column 4 includes SIC3 industry*year fixed effects. Column 5 includes geographic region*year fixed effects. Column 6 restricts the sample to non-U.S. firms. Column 7 treats the EU as one country and for EU member countries assumes the passage of leniency law to be the later of 2002 and the year when the country joined the EU. In panel B, our main variable of interest is a continuous variable of country-SIC3 export-weighted laws passed in other countries. In Column 1, we test its effect without any additional controls. In Column 2, we control for firm and country characteristics. In Column 3, we control for additional firm and industry characteristics. Column 4 includes SIC3 industry*year fixed effects. Column 5 includes geographic region*year fixed effects. Column 6 restricts the sample to non-U.S. firms. In Column 7 the main variable of interest is instead a continuous variable of firm subsidiary location-weighted laws passed in other countries.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

the cash buffer. We report the specifications where we use the passage of the leniency law as our treatment variable in Table 3, panel A, and the results where we study export market leniency law in Table 3, panel B.

3.2.1 Baseline regressions. Panel A of Table 3 presents results on our baseline specifications in the difference-in-differences setting, which incorporates firm and year fixed effects. The dependent variable is the annual asset growth. In Column 1, we only consider the effect of a leniency law without any additional controls, and, in Column 2, we add firm-specific variables and several other

variables to capture macroeconomic conditions and import competition. We see that leniency law passage is associated with higher asset growth. We choose the latter specification to be our baseline, and we find that the asset growth increases by as much as 7% in our specification, which corresponds to one-third of the unconditional mean in the sample.

In Column 3, we add the additional control variables: tangibility, sales growth, lagged by 2 years, and industry market-to-book ratio.¹³ Tangibility, estimated as the proportion of fixed assets over total assets, should capture firm's collateralizable assets while the lagged sales growth should capture growth opportunities. While our data limitations do not allow us to control for individual market-to-book ratios for international firms going back to 1990s, we control for industry market-to-book ratio to capture industry growth opportunities. We calculate the latter based on Compustat North America data as the three-digit SIC industry median, and we control for it for all—even non-North American—countries. These additional controls come at the expense of substantially reducing our sample but we still find that the passage of a leniency law has a significant positive effect on the asset growth.

In Column 4, we control for industry*year fixed effects. This means that we are comparing treated and control firms in the same year in the same industry. As a result, the specification controls for any common industry trends that could be correlated with leniency law adoption. The coefficient of leniency law remains positive and significant. Column 5 includes region*year fixed effects to absorb factors at the regional level, such as those related to multilateral or regional trade agreements, or any regional economic trends that could affect the capital structure and the propensity of leniency law adoption in these regions.¹⁴ The specification thus explores variation within adopting and nonadopting countries within each region and year to examine whether there is any effect of leniency law adoption on asset growth. The coefficient of leniency law adoption is positive and significant.

Finally, in Columns 6 and 7, we perform two important robustness checks that relate to two particular geographic areas. Since the United States adopted a leniency law very early in our sample period, and at the same time U.S. firm-years constitute one-fourth of the regression sample in Column 2, it is possible that our results are driven by a time-trend affecting U.S. firms only. In Column 6, only non-U.S. firm-years are retained, and both the magnitude of the effect decreases but also the significance of the effect of leniency law drops.¹⁵ Finally, in Column 7, we address a possible concern with the determination of the year

¹³ For the primary dependent variables of interest, our regression specifications maintain the same set of control variables. Tangibility, sales growth, and market-to-book ratio are common control variables in the capital structure literature. We include these control variables separately as their availability shrinks the sample size. We report the estimates for the control variables of Tables 3–8 in Tables IA2–IA7.

¹⁴ We allocate countries into seven geographic regions: North America, Latin America, Western Europe, Central and Eastern Europe, Asia, Africa, and Oceania.

¹⁵ We report all our results when we exclude U.S. firms from our sample. These results are available in Table IA8.

when a leniency law becomes relevant for firms in the EU. While the EU adopted a leniency law that would become applicable to all EU member countries in 2002, individual countries passed a leniency law that would apply to all firms doing business with these countries in a staggered manner. In Column 7, we assume that the effective date for leniency for an EU member is the later of 2002 and the year the country joined the EU. Our results remain unchanged.

3.2.2 Export market leniency laws. In this section, we repeat the same tests used in Table 3, panel A, but replace the leniency law adoption indicator variable with the *Export market leniency laws* measure that looks at the leniency law adoption in the countries other than the firm headquarter country. In addition, we study the subsidiary-sales-weighted measure of leniency law adoption in other countries.

Table 3, panel B, reports the results. The coefficient of the *Export market leniency laws* variable is positive and significant in all specifications. The results suggest that as the exposure of domestic firms to markets under leniency law increases, suggesting greater exposure to markets characterized by noncollusive behavior, asset growth rises. Results for subsidiary exposure to leniency laws reported in Column 7 are similar.

We perform similar sets of robustness tests as before. Columns 2 and 3 control for additional firm variables. Column 4 includes three-digit SIC industry*year fixed effects. Column 5 includes geographic region*year fixed effects. Column 6 restricts the sample to non-U.S. firms. Our results are robust to these specifications.

Using both identification strategies, we find that stronger actions against collusion have led to a faster growth in assets, that is, larger investment. We note that such increase in asset growth and investment comes despite the drop in profitability (see Dong, Massa, and Žaldokas 2018 for this result).

3.2.3 Deconstructing asset growth. As we argue in Section 1, the actual use of funds is likely to determine the type of financing. The expansion of the physical factories might be easier to finance with debt suited to fund collateralizable assets while intangible investment might be better suited to fund with the equity. Firms might also raise money, raised from equity issuances, to keep as excess funds that can be kept as a competitive threat to rivals. We thus next check where the growth in the assets is coming from. We group the change in assets into three categories: (a) capital expenditures; (b) investment in intangible assets; (c) and the change in cash holdings.

We then estimate our specifications like in Table 3, panel A, Column 2, and in Table 3, panel B, Column 2, on these three different components.¹⁶ In Columns

¹⁶ Here, we only rely on Compustat North America and Worldscope data sets because Compustat Global does not provide the detailed decomposition of different asset categories.

Table 4
Deconstructing asset growth

	(1)	(2)	(3)	(4)	(5)	(6)
Leniency law	0.012*** 3.866		0.008*** 8.350		0.040*** 4.474	
Export market leniency laws		0.020*** 4.262		0.012*** 8.511		0.055*** 4.180
Controls	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	Y	Y	Y
R-squared	0.143	0.089	0.134	0.098	0.232	0.218
N	281,790	131,923	208,727	97,321	356,624	160,392

We consider all nonfinancial Worldscope and Compustat North America firms from 1990 to 2012. This table reports OLS regressions, where in Columns 1 and 2 the dependent variable is capital expenditures, scaled by lagged assets; in Columns 3 and 4, the dependent variable is change in intangible assets, scaled by lagged assets; in Columns 5 and 6, the dependent variable is change in the cash and cash equivalents, scaled by lagged assets. All regressions include firm fixed effects and time fixed effects. Standard errors are clustered at the country-SIC3 industry level.

Our main variable of interest is the Leniency law dummy in Columns 1, 3, and 5, and a continuous variable of country-SIC3 export-weighted laws passed in other countries in Columns 2, 4, and 6. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

1 and 2 of Table 4, we report the results for capital expenditures, defined as the change in tangible assets, adjusted for depreciation and scaled by lagged assets. In Columns 3 and 4, we report the results for change in intangible assets, adjusted for amortization and scaled by lagged assets. In Columns 5 and 6, we report the results for change in cash and short-term investments, scaled by lagged assets. These results show that leniency laws have led to the increase in investment into both tangible and intangible assets and most notably in increased holdings of cash. The increase in cash holdings could be a consequence of fixed costs of issuance, because of which firms raise more than they plan to invest immediately and hold cash for future investment, or because of a need to maintain financial flexibility to fend off predatory threats by rival firms.

3.3 Financing deficit and issuance activity

Further, we look at financing deficit. Following Chang and Dasgupta (2009), the financing deficit is defined as the difference between a firm's requirement for funds (due to investment and dividend payments) and internally generated funds, and is identically equal to the sum of net issue of debt plus net issue of equity. Our results, based on the same specifications as for the asset growth, are reported in Table 5. We find that leniency laws are associated with a higher financing deficit, that is, larger issuance activity.

We further study the sources of financing. Table 6 presents the results for the net equity issuance, and Table 7 presents the results for the net debt issuance. Overall, we find strong effects for equity issuance and weaker effects for the debt issuance. That both debt and equity issuances increase is consistent with the finding that the financing deficit increases after the passage of leniency laws as firms step up investment and experience decrease in profits. However, most

Table 5
Financing deficit

A. Leniency law

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Leniency law	0.084*** 4.185	0.081*** 4.951	0.067*** 5.420	0.062*** 6.413	0.033** 2.338	0.045*** 3.140	0.055*** 2.963
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.266	0.460	0.389	0.468	0.465	0.413	0.460
N	516,999	428,853	229,477	428,784	428,851	311,676	428,853

B. Export market laws in other countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Export market leniency laws	0.079*** 5.091	0.115*** 6.077	0.101*** 4.477	0.104*** 6.793	0.053*** 3.544	0.058*** 4.099	
Subsidiary-based leniency laws							0.057*** 2.907
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.274	0.460	0.415	0.462	0.465	0.333	0.369
N	257,480	205,991	115,199	205,833	205,991	151,434	29,965

We consider all nonfinancial Worldscope, Compustat Global, and Compustat North America firms from 1990 to 2012. This table reports OLS regressions, where the dependent variable is the financing deficit defined as the difference between a firm's requirement for funds (due to investment and dividend payments) and internally generated funds, and is identically equal to the sum of net issue of debt plus net issue of equity, winsorized at 1%. All regressions, except where it is stated otherwise, include firm fixed effects and time fixed effects. Standard errors are clustered at the country-SIC3 industry level. In panel A, our main variable of interest is the Leniency law dummy. Except for a different dependent variable, we perform the same set of specifications used in Table 3, panel A, and in the interest of space we refer to the description in the caption of Table 3, panel A. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

In panel B, our main variable of interest is a continuous variable of country-SIC3 export-weighted laws passed in other countries. Except for a different dependent variable, we perform the same set of specifications used in Table 3, panel B, and in the interest of space we refer to the description in the caption of Table 3, panel B. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

of the effect comes from the equity issuance. The economic magnitude of the effect of a leniency law, though positive and often statistically significant, for debt issuance is about one-tenth of that for equity issuance.

Among firm-level control variables in panels A and B, we find that asset size is associated with higher issuance activity while profitability is associated with the lower issuance activity. Tangibility has contrasting effects for equity and debt issuance, – while higher tangibility of assets correlates with lower equity issuance, it is associated with higher debt issuance, consistent with the previous literature.

These varying results on debt and equity also mean that it is unlikely that the result is driven by lower collusion in the supply of capital. If leniency laws

Table 6
Net equity issuance

A. Leniency law

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Leniency law	0.074*** 3.901	0.071*** 4.450	0.064*** 5.502	0.054*** 6.054	0.032** 2.545	0.043*** 3.459	0.048*** 2.609
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.276	0.468	0.393	0.476	0.473	0.438	0.468
N	522,581	432,711	229,888	432,646	432,709	315,016	432,711

B. Export market laws in other countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Export market leniency laws	0.065*** 4.623	0.095*** 5.378	0.098*** 4.799	0.085*** 6.042	0.043*** 3.566	0.047*** 4.027	
Subsidiary-based leniency laws							0.048*** 3.126
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.280	0.460	0.417	0.463	0.466	0.352	0.409
N	259,326	207,280	115,359	207,122	207,280	152,558	29,985

We consider all nonfinancial Worldscope, Compustat Global, and Compustat North America firms from 1990 to 2012. This table reports OLS regressions, where the dependent variable is change in common stock over lagged assets, winsorized at 1%. All regressions, except where it is stated otherwise, include firm fixed effects and time fixed effects. Standard errors are clustered at the country-SIC3 industry level. In panel A, our main variable of interest is the Leniency law dummy. Except for a different dependent variable, we perform the same set of specifications used in Table 3, panel A, and in the interest of space we refer to the description in the caption of Table 3, panel A.

In panel B, our main variable of interest is a continuous variable of country-SIC3 export-weighted laws passed in other countries. Except for a different dependent variable, we perform the same set of specifications used in Table 3, panel B, and in the interest of space we refer to the description in the caption of Table 3, panel B.

*, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

affected the collusion between financial institutions, it is more likely that the supply of debt capital, such as bank lending, would have been affected, as opposed to the supply of equity capital. In such case, debt should have become cheaper and thus firms should have expanded their borrowing.¹⁷

3.4 Debt-to-equity ratio

Finally, we present the results of the regressions that examine the effect of leniency law adoption on the book debt-to-equity ratio. The effect of leniency law on the book debt-to-equity ratio reflects the type and size of issuance activity

¹⁷ That said, supply-side considerations could mean that we are underestimating the effect of equity issuances. Local equity markets in smaller countries might not be able to absorb large equity issuances coming from the top players in one particular industry at the same time.

Table 7
Net debt issuance

A. Leniency law

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Leniency law	0.005*** 3.038	0.005*** 2.738	0.001 0.583	0.004** 2.254	0.000 0.043	0.001 0.403	0.004** 2.179
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.065	0.088	0.089	0.092	0.090	0.086	0.088
N	545,275	448,583	230,890	448,500	448,581	328,856	448,583

B. Export market laws (in other countries)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Export market leniency laws	0.009*** 3.011	0.010*** 3.498	0.001 0.273	0.010*** 3.554	0.006 1.497	0.004 1.063	
Subsidiary-based leniency laws							-0.001 -0.149
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.059	0.079	0.087	0.080	0.082	0.092	0.083
N	271,648	214,792	115,545	214,633	214,792	159,617	30,053

We consider all nonfinancial Worldscope, Compustat Global, and Compustat North America firms from 1990 to 2012. This table reports OLS regressions, where the dependent variable is change in financial debt over lagged assets, winsorized at 1%. All regressions, except where it is stated otherwise, include firm fixed effects and time fixed effects. Standard errors are clustered at the country-SIC3 industry level. In panel A, our main variable of interest is the Leniency law dummy. Except for a different dependent variable, we perform the same set of specifications used in Table 3, panel A, and in the interest of space we refer to the description in the caption of Table 3, panel A.

In panel B, our main variable of interest is a continuous variable of country-SIC3 export-weighted laws passed in other countries. Except for a different dependent variable, we perform the same set of specifications used in Table 3, panel B, and in the interest of space we refer to the description in the caption of Table 3, panel B.

*, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

and the firm's retention policy (which, in turn, depends on profitability). While the tilt toward equity issuance is likely to lower the debt-to-equity ratio, lower profitability is likely to raise it.

To avoid outliers and negative values, we limit the book debt-to-equity ratio between 0 and 9 (which corresponds to the debt-asset ratio of 0 to 0.9).¹⁸ Table 8 presents the results, where we follow the same sequence of specifications as for the asset growth and the issuance activities. We find that the passage of a leniency law has a significant negative effect on the debt-to-equity ratio. The

¹⁸ Our results hold when we change the dependent variable to be the debt to debt plus equity ratio, which is a monotone transformation of the debt-to-equity ratio. We only consider book debt ratios because of missing data required to calculate the market value of equity for most of the international firms. Our results also hold when we limit the debt-to-equity ratio to between 0 and 8 (instead of between 0 and 9) or when we exclude negative values and winsorize the book debt-to-equity ratio at 1%, 5%, or 0.5%.

Table 8
Debt-to-equity ratio

A. Leniency law

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Leniency law	-0.012 -0.985	-0.025* -1.875	-0.052*** -3.338	-0.023* -1.739	-0.045*** -3.221	-0.011 -0.789	-0.009 -0.601
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.590	0.618	0.579	0.620	0.620	0.639	0.618
N	546,937	409,725	217,938	409,651	409,723	305,758	409,725

B. Export market laws (in other countries)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Export market leniency laws	-0.033 -1.359	-0.046* -1.651	-0.111*** -3.762	-0.046* -1.693	-0.053* -1.703	-0.005 -0.159	
Subsidiary-based leniency laws							-0.014 -0.336
Controls	N	Y	Y	Y	Y	Y	Y
Additional controls	N	N	Y	N	N	N	N
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	N	Y	Y
Industry*year fixed effects	N	N	N	Y	N	N	N
Region*year fixed effects	N	N	N	N	Y	N	N
R-squared	0.602	0.623	0.568	0.625	0.625	0.642	0.616
N	272,658	197,781	109,900	197,614	197,781	149,677	29,253

We consider all nonfinancial Worldscope, Compustat Global, and Compustat North America firms from 1990 to 2012. This table reports OLS regressions, where the dependent variable is book debt to book equity ratio, limited to between 0 and 9. All regressions, except where it is stated otherwise, include firm fixed effects and time fixed effects. Standard errors are clustered at the country-SIC3 industry level. In panel A, our main variable of interest is the leniency law dummy. Except for a different dependent variable, we perform the same set of specifications used in Table 3, panel A, and in the interest of space we refer to the description in the caption of Table 3, panel A.

In panel B, our main variable of interest is a continuous variable of country-SIC3 export-weighted laws passed in other countries. Except for a different dependent variable, we perform the same set of specifications used in Table 3, panel B, and, in the interest of space, we refer to the description in the caption of Table 3, panel B.

*, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

economic magnitude of the impact is large: in the baseline specification of Column 2 of panel A, the treated firms reduce the debt ratio by 0.025 relative to control firms, which is 2.5% (5.7%) of the sample mean (median) debt ratio. Among the control variables, leverage is positively related to firm size (log book value of assets) and negatively related to firm profitability (return on assets (ROA)), which are well-documented results in the literature (see Frank and Goyal 2009). Leverage is positively related to the country's GDP, and negatively related to changes in the exchange rate, which is likely to reflect competitive pressure and may be capturing an expected decline in future profits. While tangibility has a significant positive effect on the debt-to-equity ratio (consistent with the literature), lagged sales growth and industry market-to-book ratio has a negative effect.

Panel B reports the results, where we instead use *Export market leniency laws* for identification. The coefficient of the *Export market leniency laws* variable is negative but statistically significant in only some of the specifications.

Overall, these results do not find much support for theories that argue that debt has strategic value in oligopolistic industries (e.g., Maksimovic 1988). If firms communicate during the collusive arrangements (and such communication is not considered as cheap talk), debt has no strategic value. However, when the collusion breaks down, debt might start having a strategic use. Our evidence does not suggest that the debt ratio goes up after the passage of leniency law. On the contrary, debt ratios fall and firms increase equity issuance.

The results in this section also suggest that the channel through which competition affects leverage is different from the one in Xu (2012). Xu (2012) finds that leverage drops when there is greater import penetration in an industry (e.g., caused by tariff cuts or currency depreciation), and suggests that this could be because firms anticipate lower future profits and face higher probability of default. She further finds that her results are stronger for financially weaker (low z-score) firms, which is consistent with trade-off theory. In contrast, our results are stronger for more profitable firms within the industry, which is what one would expect if more profitable firms are the ones that are ex ante more likely to be in collusion.¹⁹ Further, while asset growth falls following tariff cuts in Xu's (2012) setting, we find that firms expand by increasing the capital expenditure, investment in intangible assets, and adding to cash holdings. The shift to a new equilibrium potentially creates a situation in which financing growth with debt could leave these firms vulnerable to aggressive strategies by their rivals. Financing asset growth with debt could also mean that the firm is unable to respond to future expansion by more conservatively financed rivals due to the debt overhang problem – in fact, debt financed firms might invite even more aggressive predatory reactions from rival firms that are unencumbered by debt.

4. Targeted Treatment, Robustness Tests, and Other Supportive Evidence

4.1 Targeted treatment

Not all industries are cartelized. Leniency law is likely to affect mostly those firms that are engaged in collusion, or have the potential to form cartels in the future. The latter firms are also relevant for our study because, if the expected cost of cartel formation increases, firms might change their behavior, including their financing choices. For example, firms might be more willing to take on more debt if, under adverse industry conditions, cartelization becomes more

¹⁹ In Table IA9, we show that the effects of the leniency law on asset growth, financing deficit, and equity issuance are stronger for firms that are more profitable within their industries.

feasible. If the cost of cartel formation increases, these firms may want to reduce debt even though they are not currently engaged in collusion.²⁰

We conduct four sets of tests and report them in Table 9. We primarily rely on differences across industries. First, we estimate the propensity of a firm to be convicted in a cartel case. We use a prediction model based on time-varying firm characteristics (asset size, leverage, and ROA), country characteristics (GDP and unemployment), and country fixed effects and three-digit SIC fixed effects. Industry characteristics are an important determinant of the potential for cartelization since cartels are known to proliferate in certain industries (see, for instance, a survey by Levenstein and Suslow (2006), who discuss a number of historical examples of industries in which there are repeated episodes of collusion).²¹ Country-specific institutional features are also likely to be important determinants. We fit the prediction model by only using pre-leniency observations and predict the probability that the firm will be convicted in the cartel case after the passage of a leniency law.

Panel A reports results for the asset growth (Columns 1 and 2), financing deficit (Columns 3 and 4), equity issuance (Columns 5 and 6), debt issuance (Columns 7 and 8), and debt-to-equity ratio (Columns 9 and 10) as the dependent variable for both the leniency law dummy and the export market based measure. Both measures are interacted with the predicted probability of conviction. Firms that are more likely to be convicted invest more and have a higher financing deficit that they cover by issuing more equity. This results in lower leverage after the passage of leniency law in the home country. Meanwhile, the effect of the *Export market leniency laws* measure on equity (debt) issuances is more positive (negative) for firms with higher predicted probability of conviction.

Second, in panel B, we sort the firms according to the Herfindahl-Hirschman index of the firm's three-digit SIC industry in a particular year. The firms in the concentrated industries with fewer symmetric players find it easier to collude (see, e.g., the discussion in Motta 2004; on this being the most important cross-sectional factor empirically predicting collusion as well the experimental evidence in Huck, Normann, and Oechssler 2004). We then interact leniency law passages with HHI. Panel B reports the results on asset growth (Columns 1 and 2), financing deficit (Columns 3 and 4), and net issuances (Columns 5 and 6). We find that our results on asset growth, financing deficit, and net equity issuances are stronger for more concentrated industries. We also report results

²⁰ An additional reason our results may not be limited to existing cartels could be that the breakdown of collusion in the segment of the market dominated by larger firms is likely to result in these firms expanding output and lowering prices, and so it might lead to lower profitability for smaller firms in the rest of the industry even though they are not cartelized.

²¹ Admittedly, a three-digit SIC classification is a coarse partitioning of industry for our purposes, since many of the cartels have been known to proliferate for specific products, such as potash, particular vitamins, or airline routes.

Table 9
Heterogeneity

A. Predicted convictions

	Asset growth		Financing deficit		Equity issuance		Debt issuance		Debt-to-equity ratio	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Leniency law	-0.044***		-0.018		-0.017		-0.002		-0.023*	
	-3.176		-1.587		-1.629		-1.022		-1.911	
Export market leniency laws		-0.021		-0.012		-0.016		0.001		-0.027
		-1.558		-0.856		-1.191		0.410		-1.044
Leniency law*Predicted conviction	0.802***		0.633***		0.666***		-0.029		-1.434*	
	3.331		3.144		3.796		-0.661		-1.733	
Export market leniency laws*Predicted conviction		0.933***		0.959***		1.035***		-0.089*		-1.513
		3.193		3.489		4.005		-1.805		-1.269
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.148	0.135	0.328	0.335	0.344	0.356	0.061	0.046	0.591	0.590
N	242,093	118,855	235,038	115,939	236,084	116,286	240,611	118,305	231,828	114,449

B. HHI

Leniency law	0.046**		0.060***		0.050***		0.005***		-0.019	
	2.512		3.806		3.485		2.602		-1.091	
Export market leniency laws		0.097***		0.092***		0.072***		0.010***		-0.027
		5.403		5.357		4.483		3.149		-0.804
Leniency law*HHI	0.173***		0.137**		0.137**		-0.002		-0.037	
	2.735		2.280		2.430		-0.311		-0.591	
Export market leniency laws* HHI		0.189**		0.165**		0.166***		0.000		-0.119
		2.338		2.018		2.124		-0.020		-1.073
HHI	0.066	0.068	0.084	0.071	0.078	0.067	0.006	0.002	0.020	-0.027
	0.960	0.549	1.254	0.585	1.208	0.556	0.741	0.262	0.323	-0.306
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.239	0.199	0.463	0.464	0.470	0.463	0.087	0.078	0.620	0.624
N	444,779	212,808	419,717	202,165	423,563	203,452	439,348	210,928	400,727	193,987

C. Patent protection

Leniency law	0.209***		0.185***		0.174***		0.006		-0.025	
	5.869		5.727		5.551		1.592		-0.977	
Export market leniency laws		0.316***		0.276***		0.248***		0.014**		-0.048
		4.496		4.108		3.837		2.460		-0.919
Leniency law*Industry patents	-0.029***		-0.022***		-0.022**		0.000		0.001	
	-4.290		-3.824		-3.956		-0.369		0.120	
Export market leniency laws* Industry patents		-0.039***		-0.032***		-0.030***		-0.001		0.000
		-3.378		-2.834		-2.758		-0.697		0.044
Industry patents	-0.013	-0.006	-0.014*	-0.006	-0.016**	-0.007	0.002	0.001	-0.004	-0.009
	-1.534	-0.665	-1.895	-0.773	-2.319	-0.964	1.536	0.621	-0.540	-0.833

Table 9
Continued

	Asset growth		Financing deficit		Equity issuance		Debt issuance		Debt-to-equity ratio	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.243	0.203	0.468	0.470	0.471	0.469	0.085	0.075	0.619	0.629
N	356,309	192,197	337,639	182,743	340,542	183,882	352,253	190,532	321,783	175,160
<i>D. Industry growth</i>										
Leniency law	0.546***		0.506***		0.484***		-0.007		-0.116	
	3.899		3.580		3.716		-0.396		-1.506	
Export market leniency laws		0.549***		0.482**		0.417**		0.009		0.027
		2.791		2.403		2.164		0.366		0.180
Leniency law*Industry growth	-0.429***		-0.384***		-0.371***		0.009		0.080	
	-3.233		-2.931		-3.056		0.585		1.195	
Export market leniency laws* Industry growth		-0.384**		-0.327*		-0.282*		-0.002		-0.068
		-2.277		-1.860		-1.671		-0.088		-0.517
Industry growth	0.713***	0.608***	0.593***	0.577***	0.519***	0.513***	0.038***	0.026*	-0.256***	-0.294***
	6.057	3.971	5.648	3.644	5.291	3.496	3.126	1.751	-3.894	-2.796
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.238	0.200	0.461	0.465	0.468	0.465	0.089	0.077	0.617	0.622
N	430,143	207,708	407,496	197,703	410,937	198,870	425,235	205,973	388,743	189,689

We consider all nonfinancial Worldscope, Compustat Global, and Compustat North America firms from 1990 to 2012. This table reports OLS regressions. Columns 1 and 2 report the results where the dependent variable is annual asset growth, winsorized at 1%; Columns 3 and 4 report the results where the dependent variable is net issue of debt plus net issue of equity, winsorized at 1%; Columns 5 and 6 report the results, where the dependent variable is change in common stock over lagged assets, winsorized at 1%; Columns 7 and 8 report the results where the dependent variable is change in financial debt over lagged assets, winsorized at 1%; Columns 9 and 10 report the results where the dependent variable is book debt to book equity ratio, limited to between 0 and 9. All regressions include firm fixed effects and time fixed effects, and controls such as log assets, ROA, log GDP, unemployment rate, country imports as the percentage of GDP, and exchange rate change. Standard errors are clustered at the country-SIC3 industry level.

In panel A, our main variable of interest is the interaction between the passage of the leniency laws and the likelihood that the market is cartelized. We use a prediction model based on time-varying firm characteristics (asset size, leverage and ROA), country characteristics (GDP and unemployment), as well country fixed effects and SIC3 fixed effects. We fit the prediction model only by using pre-leniency observations and predict the probability that the firm will be convicted in the cartel case in the year after the passage of the leniency law. In Columns 1, 3, 5, 7, and 9, our main variable of interest is the interaction term between the passage of the leniency law and the predicted conviction probability. In Columns 2, 4, 6, 8, and 10, our main variable of interest is the interaction term between a continuous variable of country-SIC3 export-weighted laws passed in other countries and the predicted conviction probability.

In panel B, our main variable of interest is the interaction between the passage of the leniency laws and Herfindahl-Hirschman index of the firm's industry in a specific year. In Columns 1, 3, 5, 7, and 9, our main variable of interest is the interaction term between the passage of the leniency law and the Herfindahl-Hirschman index. In Columns 2, 4, 6, 8, and 10, our main variable of interest is the interaction term between a continuous variable of country-SIC3 export-weighted laws passed in other countries and the Herfindahl-Hirschman index.

In panel C, our main variable of interest is the interaction between the passage of the leniency laws and the number of patents filed with the USPTO by the firms in the firm's industry in a specific year. In Columns 1, 3, 5, 7, and 9, our main variable of interest is the interaction term between the passage of the leniency law and the number of patents. In Columns 2, 4, 6, 8, and 10, our main variable of interest is the interaction term between a continuous variable of country-SIC3 export-weighted laws passed in other countries and the number of patents.

In panel D, our main variable of interest is the interaction between the passage of the leniency laws and the median lagged 2-year sales growth in the firm's industry. In Columns 1, 3, 5, 7, and 9, our main variable of interest is the interaction term between the passage of the leniency law and the industry growth. In Columns 2, 4, 6, 8, and 10, our main variable of interest is the interaction term between a continuous variable of country-SIC3 export-weighted laws passed in other countries and the industry growth.

*, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

for net debt issuances (Columns 7 and 8) and leverage (Columns 9 and 10), where we do not find a statistically significant interaction effect.

Next, we look at the opposite prediction. Industries that can protect their profits in other ways and are thus effectively monopolized would need to rely less on the collusion and are thus less likely to be affected by the passage of leniency law. Moreover, collusion is also more fragile in innovative industries (Rey 2004). We sort the firms according to the number of patents filed by the U.S. firms at the USPTO in a firm's three-digit SIC industry in a particular year. While we do not have data on patents filed by international firms, we argue that the industry-level prevalence of patent protection would be highly correlated across different countries (see, e.g., Bena et al. 2017 on the use of USPTO patents in the international sample of firms). We then interact leniency law passages with the log number of patents in firm's industry. As reported in panel C, we find a weaker effect on asset growth (Columns 1 and 2), financing deficit (Columns 3 and 4), and net issuances (Columns 5 and 6) for the industries that protect themselves with patents and need to rely less on the collusive activities. We do not find statistically significant differences in terms net debt issuances (Columns 7 and 8) and leverage (Columns 9 and 10).

Finally, in panel D, we look at recent industry growth. High growth industry can be associated with less collusion under two sets of assumptions (Ivaldi et al. 2003). The first occurs when high growth encourages new entry, and the industry is expected to become less profitable in the future. In this scenario, the loss of future profits from being punished by rival firms if cooperation breaks down would lower compared with the gain from cheating today. The second scenario occurs when recent high growth implies a (temporary) upturn in a cyclical industry; in this case, the gain from deviation today would outweigh the loss from punishment in the future, and collusion could be more difficult to sustain (Rotemberg and Saloner 1986). We use the three-digit SIC industry median of sales growth as the proxy for maturity of an industry. As before, we find that asset growth, financing deficit, and equity issuances are moderated by this cross-sectional characteristic while debt issuances and leverage are not affected differentially affected by the leniency laws for high-growth and low-growth industries.

4.2 Dynamics

One concern with our study is that leniency laws might have been anticipated and the adjustment might have started before the actual adoption of laws. In addition, if stronger laws are anticipated and weaker laws are passed, focusing on the actual adoption year might even reverse the sign of the estimates (Hennessy and Strebulaev 2015). The binary treatment such as the one adopted in our case mitigates the latter concern but we take it seriously. For each country, we collect the data on when the first discussion on leniency laws has been started by policy makers. To collect this information, we use Factiva News Database and search for the news in local language about the leniency program

adoption in competition law.²² Out of 54 countries that have passed leniency laws as reported in Table 1, we have found leniency programs discussed in the media of 35 countries. Some smaller, especially Central and Eastern European, countries are not covered by Factiva and for a handful of those that are even covered we were not able to find that media discussed leniency laws before their passage. Out of these 35 countries, we found that 26 had discussion about leniency laws at least 1 year before the law passage. We call this year the “anticipation year.” If the program was not discussed in the media, we assume that there was no additional anticipation, and we consider the actual year of adoption as anticipation year.

In Table 10, we use this anticipation year as our treatment year. We find significant economic effects for asset growth (Column 1), financing deficit (Column 3), equity issuance (Column 5), and debt issuance (Column 7). We do not find a statistically significant effect for debt-to-equity ratio (Column 9).

Using this definition of treatment year, we further explore the dynamics of the treatment effect, in particular, whether it shows up within a relatively short period after the law is discussed for the first time, and whether we can find any pre-trends in the data. To explore the dynamics of the issuance activities and leverage change, we create dummy variables corresponding to the following windows around the treatment year: from 1 to 4 years before the treatment; the treatment year and the 2 years after treatment; the next 3 years; and the years beyond. We find that firms first start growing and issuing equity over the first two sub-periods after the discussion about the leniency law passage started and there is no pre-trend once anticipation effect is taken into account. We do not find that the effect is long-lasting and it disappears in the period that starts at 6 years after the anticipation of the law.

4.3 Robustness tests

In Table 11, we report further robustness tests. We only report the coefficients on the leniency law (panel A) or export-market leniency law measure (panel B) for the respective regressions where the outcome variable is reported in the column. The full set of coefficients for these regressions are reported in Tables IA10 and IA11.

4.3.1 Control for the acquisitions, the degree of competition, other laws, and clustering. We start our robustness tests by examining whether our results hold when we control for industry*region*year fixed effects. That is, in these tests we would be comparing German car manufacturers to French car manufacturers when the leniency law was passed in Germany, but not in

²² The terms differ across countries, even when they use the same language. For instance, in Chile, the earliest mentioned term used “delación compensada,” in Mexico “programa de indulgencia,” and in Spain “Clemencia.” As every local competition authority discusses leniency programs on their websites, we primarily use the official wording that they adopt there but we also experiment with similar terms using Google Translate.

Table 10
Anticipation, placebo tests, and dynamics

	Asset growth		Financing deficit		Equity issuance		Debt issuance		Debt-to-equity ratio	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Anticipated leniency law	0.094**		0.097***		0.086***		0.006*		-0.020	
	2.234		2.884		2.975		1.818		-0.430	
Anticipated leniency law (-4, -1)		0.099		0.082		0.082		0.001		0.014
		1.491		1.452		1.589		0.170		0.250
Anticipated leniency law (0, 2)		0.139**		0.129**		0.122**		0.005		-0.002
		2.046		2.367		2.353		0.888		-0.027
Anticipated leniency law (3, 5)		0.151*		0.137**		0.129**		0.010		-0.031
		1.831		2.191		2.360		1.139		-0.306
Anticipated leniency law (6+)		0.025		0.016		0.027		0.004		-0.018
		0.255		0.197		0.364		0.416		-0.151
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.239	0.241	0.462	0.464	0.468	0.469	0.088	0.088	0.619	0.619
N	455,003	455,003	429,793	429,793	433,662	433,662	449,534	449,534	409,908	409,908

We consider all nonfinancial Worldscope, Compustat Global, and Compustat North America firms from 1990 to 2012. This table reports OLS regressions. Columns 1 and 2 report the results where the dependent variable is annual asset growth, winsorized at 1%; Columns 3 and 4 report the results where the dependent variable is net issue of debt plus net issue of equity, winsorized at 1%; Columns 5 and 6 report the results where the dependent variable is change in common stock over lagged assets, winsorized at 1%; Columns 7 and 8 report the results where the dependent variable is change in financial debt over lagged assets, winsorized at 1%; and Columns 9 and 10 report the results where the dependent variable is book debt to book equity ratio, limited to between 0 and 9. All regressions include firm fixed effects and time fixed effects and controls such as log assets, ROA, log GDP, unemployment rate, country imports as % of GDP, and exchange rate change. Standard errors are clustered at the country-SIC3 industry level.

In Columns 1, 3, 5, 7, and 9, our main variable of interest is leniency law passage, when anticipation effect is taken into account. We define the anticipated leniency law based on when the law was first discussed in the local media of the respective country. In Columns 2, 4, 6, 8, and 10, our main variables of interest are the dummy variables of from 1 to 4 years before the anticipated leniency law; the year of the anticipated leniency law and the 2 years after it; the next 3 years; and the years beyond *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

France. This test controls for industry trends within each region. As reported in panel A, row 1, our estimates are lower but they are statistically significant at similar levels.

We further control for the fact that leniency laws induced firms to engage in more merger and acquisition (M&A) activities (Dong, Massa, and Žaldokas, 2018) and the increase in equity might correspond to firms paying target shareholders in stock. We control for this in two ways. First, in row 2, we exclude firm-years with the acquisitions as reported in Thomson Reuters SDC Platinum database. Second, in row 3, we exclude those firms that engaged in M&A activity within 3 years after the passage of leniency law in their country. Our sample drops by 17%, but we find consistent results both in terms of economic and statistical significance.

Further, we control for general trends in changing concentration and competitive environment. In row 4, we show that controlling for the Herfindahl-Hirschman index has no effect on the coefficient of leniency law. As shown in row 5, the volume of imports to the firm’s industry also does not affect the effect of leniency law on issuance activity, suggesting that we are capturing

Table 11
Robustness tests

A. Leniency laws

	Asset growth	Financing deficit	Equity issuance	Debt issuance	Debt-to-equity ratio
(1) Control for industry*region*year FEs	0.055*** 7.578	0.057*** 8.325	0.050*** 8.539	0.005*** 3.469	0.057** 2.476
(2) Exclude firm-years with acquisitions	0.061*** 3.522	0.068*** 4.726	0.062*** 4.446	0.002 1.111	-0.020 -1.430
(3) Exclude firms that engaged in M&A within 3 years after leniency law	0.076*** 3.812	0.083*** 4.649	0.075*** 4.305	0.002 0.859	-0.011 -0.715
(4) Control for HHI	0.073*** 3.967	0.081*** 4.962	0.071*** 4.455	0.005*** 2.763	-0.025* -1.836
(5) Control for imports	0.066*** 4.468	0.060*** 4.461	0.056*** 4.460	0.002 0.987	-0.049*** -2.654
(6) Lagged control variables	0.077*** 4.326	0.082*** 5.000	0.072*** 4.481	0.005*** 2.618	-0.025* -1.801
(7) Cluster at the country level	0.073* 1.829	0.079** 2.466	0.072** 2.624	0.005 1.165	-0.027 -0.580
(8) Double cluster at the country and the year level	0.073* 1.835	0.079** 2.488	0.072** 2.522	0.005 1.096	-0.027 -0.555
(9) Double cluster at the industry and the year level	0.073** 2.533	0.079*** 3.320	0.072*** 3.125	0.005 1.085	-0.027 -1.108
(10) Double cluster at the country and the industry level	0.073* 1.954	0.079*** 2.828	0.072*** 3.109	0.005 1.145	-0.027 -0.621
(11) Control for financial development	0.050*** 3.017	0.061*** 4.126	0.055*** 3.852	0.003* 1.733	-0.008 -0.585
(12) Control for rule of law	0.065*** 3.271	0.076*** 4.620	0.073*** 4.681	0.000 0.066	-0.004 -0.268
(13) Focus on high regulator quality countries	0.047** 2.530	0.056*** 3.414	0.050*** 3.173	0.003* 1.746	-0.033** -2.328
(14) Control for other cartel legislation	0.083*** 3.977	0.087*** 4.728	0.074*** 4.072	0.006*** 2.781	-0.027* -1.836
(15) Control for other law changes	0.056*** 3.750	0.058*** 4.005	0.058*** 3.993	-0.001 -0.376	-0.062*** -4.477

Table 11
Continued

B. Export market laws (in other countries)

	Asset growth	Financing deficit	Equity issuanc	Debt issuanc	Debt-to-equity ratio
(1) Control for industry*region*year FEs	0.054*** 4.921	0.066*** 6.261	0.058*** 7.052	0.002 0.746	0.095** 1.985
(2) Exclude firm-years with acquisitions	0.111*** 5.610	0.101*** 5.611	0.087*** 5.147	0.006** 2.142	-0.041 -1.421
(3) Control for HHI	0.124*** 6.063	0.115*** 6.110	0.095*** 5.400	0.010*** 3.556	-0.044 -1.577
(4) Control for imports	0.128*** 5.668	0.121*** 5.736	0.103*** 5.150	0.007** 2.546	-0.065** -2.256
(5) Lagged control variables	0.129*** 5.989	0.117*** 5.952	0.098*** 5.306	0.009*** 3.226	-0.042 -1.501
(6) Cluster at the country level	0.124** 2.280	0.115** 2.381	0.096** 2.345	0.010* 1.793	-0.044 -0.597
(7) Double cluster at the country and the year level	0.124* 2.039	0.115** 2.102	0.096* 1.921	0.010 1.619	-0.044 -0.582
(8) Double cluster at the industry and the year level	0.124** 2.767	0.115** 2.755	0.096** 2.273	0.010 1.554	-0.044 -1.133
(9) Double cluster at the country and the industry level	0.124** 2.429	0.115** 2.510	0.096** 2.450	0.010* 1.830	-0.044 -0.641
(10) Control for financial development	0.070*** 4.795	0.066*** 4.648	0.055*** 4.208	0.006** 1.979	0.005 0.195
(11) Control for rule of law	0.117*** 4.542	0.111*** 4.784	0.103*** 4.691	0.000 0.085	-0.004 -0.132
(12) Control for other cartel legislation	0.116*** 5.256	0.110*** 5.419	0.092*** 4.837	0.010*** 2.937	-0.044 -1.452
(13) Control for other law changes	0.097*** 3.415	0.106*** 3.610	0.105*** 3.973	-0.001 -0.327	-0.107*** -3.804

We consider all nonfinancial Worldscope, Compustat Global, and Compustat North America firms from 1990 to 2012. This table reports OLS regressions, where the dependent variables are listed in the columns. All regressions are estimated independently. All regressions include firm fixed effects and time fixed effects. Standard errors are clustered at the country-SIC3 industry level.

In panel A, for each specification, indicated by the row number, we report the coefficient on our main variable of interest, the Leniency law dummy, and the respective *t*-statistic. Row 1 controls for industry*region*year fixed effects. Row 2 excludes firm-years where firms have performed acquisitions as reported in the SDC Platinum database. Row 3 excludes the firms that performed acquisitions within the first 3 years after the passage of leniency laws in their country. Row 4 controls for HHI in firm's SIC3 industry in its country. Row 5 controls for log imports to a firm's SIC3 industry in its country. Row 6 lags control variables. Row 7 clusters standard errors at the country level. Row 8 double clusters standard errors at the country and the year level. Row 9 double clusters standard errors at the industry and the year level. Row 10 double clusters standard errors at the country and the industry level. Row 11 controls for the financial development in the country. Row 12 controls for the country's government effectiveness, regulator quality, and rule of law. Row 13 focuses on leniency law passages only in the countries with high regulator quality. Row 14 controls for other forms of strengthening anticartel legislation. Row 15 controls for other law changes such as the introduction of competition law, the change in corporate governance law, and Chinn-Ito index of degree of capital account openness, and corporate tax rate.

In panel B, for each specification, indicated by the row number, we report the coefficient on our main variable of interest, a continuous variable of country-SIC3 export-weighted laws passed in other countries, and the respective *t*-statistic. Row 1 controls for industry*region*year fixed effects. Row 2 excludes firm-years where firms have performed acquisitions as reported in the SDC Platinum database. Row 3 controls for HHI in firm's SIC3 industry in its country. Row 4 controls for log imports to a firm's SIC3 industry in its country. Row 5 lags control variables. Row 6 clusters standard errors at the country level. Row 7 double clusters standard errors at the country and the year level. Row 8 double clusters standard errors at the industry and the year level. Row 9 double clusters standard errors at the country and the industry level. Row 10 controls for the financial development in the country. Row 11 controls for the country's government effectiveness, regulator quality, and rule of law. Row 12 controls for other forms of strengthening anticartel legislation. Row 13 controls for other law changes such as the introduction of competition law, the change in corporate governance law and Chinn-Ito index of degree of capital account openness, and corporate tax rate.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

a distinct effect of changing international trade activity that the firm faces. In row 6, we lag our control variables rather than control for the contemporaneous variables, which does not affect our results. Further, in rows 7–10, we explore the sensitivity of our estimates' statistical significance when we cluster our standard errors in a different way. While in our baseline specifications we cluster them at the industry*country level, here we report that the statistical significance is consistent when we cluster them by country (row 7), double cluster by country and year (row 8), double cluster by industry and year (row 9), or double cluster by country and industry (row 10).

We further control for the economic conditions and contemporaneous changes in other legislation. First, in row 11, we control for the conditions in the capital and credit markets. In particular, we add the controls of time-varying stock market capitalization to GDP and private credit to GDP. The inclusion of these control variables addresses the concern that firms may be timing the market when issuing equity.

Second, by adopting policies (e.g., leniency laws) that promote fair competition in an economy, the country also strengthens its rule of law, which makes the country more attractive for investment and innovation. In row 12, we control for the measures of the rule of law, regulatory quality, and the quality of judicial system based on WorldBank Worldwide Governance Indicators. We do not find that this affects our estimates.

Moreover, the enforcement of leniency laws can differ across countries. While we are not able to measure which leniency laws would be more successful *ex ante* at the time of their implementation, we can focus solely on the countries with high regulatory quality based on WorldBank Worldwide Governance Indicators. In row 13, we redefine the leniency law variable to be one only for the countries that have regulatory quality higher than the median regulatory quality around the world at the time of the implementation of the leniency law.

We further recognize that there were additional changes in antitrust law during our period of study. In particular, there has been a significant increase in penalties, changes in what constitutes cartel conduct and new violation provisions, and investigative powers of antitrust authorities. Throughout this paper we focus on leniency law as the passage of leniency law is a clearly identifiable and measurable event while other provisions might have occurred at multiple times in each country (e.g., change in penalties) or might have had unclear effects on the cartel conduct (e.g., changes in violation provisions). If anything, even if there were correlated changes in anticartel provisions, our identification using leniency law should then proxy for a general strengthening of the anticartel provisions and are informative of a general enforcement effect. That said, our estimates might be biased if we misattribute the gradual strengthening of anticartel provisions to a particular year (i.e., when leniency law was passed). For some countries, we were able to collect data on other provisions from International Competition Network and control for them explicitly by adding dummies when, for example, the first penalty was increased

in our sample period or the first time when the definition of what constitutes cartel conduct has been changed. As can be seen in row 14, such controls do not significantly alter our estimates, giving confidence that the passage of leniency laws has been a crucial legislative policy.

Finally, in row 15, we control for other types of policy changes that could have overlapped with leniency law adoption, such as the general competition law, corporate governance law, corporate taxes, and Chinn-Ito index of capital market openness. We do not find that any of these laws affect our estimates. This is comforting as, for instance, capital market openness arguably correlates with the country's integration into the global economy, so our leniency law variable is not simply proxying for that.

We report corresponding tests for export market leniency laws in Table 11, panel B. Because of a different construction of the variable, we exclude the test in which we exclude firms that engaged in M&A within 3 years after the leniency law and the test in which we focus on high regulatory quality countries.

For debt-to-equity ratio, we provide a few additional robustness checks. In particular, our results are robust if we add lagged leverage as an additional control, in the spirit of target adjustment models and also to capture that leverage is highly persistent. The inclusion of lagged leverage allows us to interpret the coefficients of the other right-hand-side variables as their effects on the change in the debt-to-equity ratio. The effect of leniency law on the change in leverage is also significantly negative, and the estimated magnitude of the effect increases three-fold when firm fixed effects are dropped.²³ We report these results in Table IA10, panel J, Columns 6 and 7, for leniency law and Table IA11, panel J, columns 5 and 6, for export market leniency laws.

4.3.2 Large issuances. In Table IA12, panels A and B, we estimate probit models for large equity (debt) issuances and repurchases. A large equity or debt issuance is defined as a net increase in excess of 5% of book value of assets, while a large repurchase (debt retirement) is defined as a net decrease of more than -1.25% (-5%) of assets.²⁴ The tables report probit marginal effects. The results suggest that passage of a leniency law is associated with a 9% increase in the likelihood of a large equity issuance, compared to a 5.5% increase in the probability of a large debt issuance.

4.3.3 Non-U.S. firms. Finally, almost of our results hold if we limit the sample to non-U.S. firms. In Table IA8, we replicate Tables 3–5 that provide the main

²³ Note that the specifications in Table IA10, panel J, Column 6, and Table IA11, panel J, Column 5, which include firm fixed effects, are known to produce biased coefficient estimates because of the presence of the lagged dependent variable (Nickell 1981).

²⁴ We follow Hovakimian, Opler, and Titman (2001), Leary and Roberts (2005), and Xu (2012) in defining these cutoffs.

results of the paper. Panels A–E report results for leniency law, and panels F–J report results for export-based leniency law measure. Panels A and F show the results for asset growth, corresponding to Table 3; panels B and G show results for financing deficit, corresponding to Table 5; panels C and H show results for net equity issuances, corresponding to Table 6; panels D and I show results for net debt issuances, corresponding to Table 7; and panels E and J the results for leverage specifications, corresponding to Table 8. We find that most of the results consistently show that, following leniency law passages, the asset growth, the financing deficit, and the equity issuances increased for firms outside of the United States.

5. Additional Supporting Evidence: ACPERA

To provide additional supportive evidence for our international leniency law-based tests, we look for other cases of strengthening of anticartel legislation. In particular, we study the enactment of Antitrust Criminal Penalty Enhancement and Reform Act (ACPERA) in the United States in 2004, which has been one of the most significant revisions in the history of the U.S. antitrust enforcement system. The act increased the corporate fines for firms in price-fixing conspiracies, allowing up to \$100 million corporate fines, up to \$1 million individual fines, and up to a 10-year prison term. Moreover, the ACPERA provided more incentives for firms applying for leniency. In particular, the ACPERA stipulated that in civil actions alleging violations of the Sherman Act, such as price fixing, leniency applicants are only liable for actual damages caused by their conduct, as opposed to treble damages.

We thus look at the passage of ACPERA as our alternative identification strategy. We only focus on the U.S. firms and argue that firms that are more likely to be cartelized will be affected by ACPERA more. We use a prediction model, similar to the one in Section 4.1, and we fit it to the data of the U.S. firms that were convicted of being part of a cartel up to year 2003. We then use firm observables in 2004 to predict the likelihood of being convicted in a collusion case. As before, our prediction model is based on time-varying firm characteristics (asset size, leverage, and ROA) and three-digit SIC fixed effects. Compared to the prediction model in Section 4.1, we exclude country fixed effects and country characteristics as we only focus on the U.S. cases.

We report the results in Table 12. We find larger asset growth, an increase in financing deficit, and an increase in equity issuance for firms with higher predicted conviction after ACPERA was passed. Interestingly, we find a drop in debt issuances. We do not find a statistically significant effect on leverage.

These out-of-sample tests provide comforting evidence that anticartel enforcement has significant effects on the firm growth and their financing behavior.

Table 12
Alternative test: ACPERA

	Asset growth	Financing deficit	Equity issuance	Debt issuance	Debt-to-equity ratio
ACPERA*Predicted conviction	0.674*	0.639*	0.839***	-0.145***	-0.439
	1.888	1.905	2.847	-2.644	-1.107
Log assets	0.253***	0.192***	0.158***	0.025***	0.076***
	25.121	18.571	16.759	12.384	8.198
ROA	-1.026***	-2.024***	-1.789***	-0.075***	-0.052***
	-28.737	-51.703	-49.178	-11.028	-3.479
Firm fixed effects	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	Y	Y
R-squared	0.204	0.469	0.464	0.044	0.471
N	75,327	73,685	73,927	75,071	70,805

We consider all nonfinancial US-headquartered Compustat North America firms from 1990 to 2012. This table reports OLS regressions. Column 1 reports the results where the dependent variable is annual asset growth, winsorized at 1%; Column 2 reports the results where the dependent variable is net issue of debt plus net issue of equity, winsorized at 1%; Column 3 reports the results, where the dependent variable is change in common stock over lagged assets, winsorized at 1%; Column 4 reports the results where the dependent variable is change in financial debt over lagged assets, winsorized at 1%; and Column 5 reports the results where the dependent variable is book debt-to-book-equity ratio, limited to between 0 and 9. All regressions include firm fixed effects and time fixed effects. Standard errors are clustered at the firm level.

Our main variable of interest is the interaction between the passage of ACPERA in 2004 and the likelihood that the market is cartelized. We use a prediction model for U.S. firms based on time-varying firm characteristics (asset size, leverage, and ROA) as well SIC3 fixed effects. We fit the prediction model only by using pre-ACPERA observations and predict the probability that the firm will be convicted in the cartel case in the year after the passage of ACPERA, that is, 2004. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

6. Conclusion

We consider the case of a change in competition that comes from stronger antitrust enforcement around the world to show that more intense strategic competition and expanding output is associated with significantly more equity issuance, a slight increase in debt issuance, and lower leverage ratio.

Our identification relies on the difference-in-differences estimation based on a staggered passage of leniency laws in 63 countries around the world from 1990 to 2012. In addition to exploiting a leniency law passage in the firm's country, we look at the leniency law passages in the main export markets of the firm's industry, and leniency law passages in the firm's subsidiary locations, and find consistent results.

We argue that as collusion becomes more difficult to sustain, the nature of equilibrium switches from collusion to oligopolistic competition. Firms have to expand investment to compete for market share, but prefer to do so with equity rather than debt to maintain financial flexibility and avoid debt overhang.

Importantly, countries passed the leniency programs at different points in time between 1993 and 2011. Our purpose is to take advantage of the staggered nature of the law passage to identify the effect of a less collusive product market environment on firms' financing decisions by following a difference-in-differences strategy. In other words, controlling for firm and time fixed effects, we attempt to compare the (change in) financing choices of firms that were affected by the law with those of the control group of firms that were headquartered in the countries that have not yet passed such a law. We

note, however, that it is possible that other policy changes or other economic shocks occurring simultaneously with the passage of leniency laws in different countries at different points of time could affect capital structure choices in the same direction. We collect information on an exhaustive set of law changes in different countries and control for the passage of these laws. In addition, our own reading of the background of leniency law adoption in different countries suggests that these laws were not adopted for one specific reason. Nonetheless, the leniency law passage was arguably not random and thus it is difficult to claim that we undoubtedly identify the causal effect. Further research could analyze the political economy of stronger anticartel enforcement and reveal whether our analysis is subject to any particular concerns.

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