The Anticompetitive Effect of Minority Share Acquisitions: Evidence from the Introduction of National Leniency Programs*

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Abstract

We address the growing concern that minority shareholding (MS) in rival firms may lessen competition, using the introduction of national leniency programs (LPs) as a shock that destabilizes collusive agreements and study their effect on MS acquisitions. Based on data from 63 countries, we find a large and significant increase in domestic horizontal MS acquisitions in the year in which an LP is introduced, but only in countries with effective antitrust enforcement, where collusion is subject to criminal sanctions, and the level of corruption is low. We do not find an effect on non-horizontal or cross-border MS acquisitions. Our findings suggest that firms may use MS acquisitions to either stabilize collusive agreements or soften competition in the event that collusion breaks down.

JEL Classification: G34, K21, L41
Keywords: Minority Shareholdings, Collusion, Leniency Programs, Cartel Stability

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1 Introduction

There is a growing concern in recent years about the potential anticompetitive effects of partial cross ownership among rival firms, that is, cases in which firms acquire minority shares (MS) in actual or potential rivals.[1] For instance, a 2014 European Commission white paper argues that "The Commission's experience, the experiences of Member States and third countries, but also economic research show that in some instances the acquisition of a noncontrolling minority stake, such as one firm acquiring a 25% stake in a competitor, can harm competition and consumers" (European Commission, 2014). A similar concern was voiced in a 2008 OECD policy roundtable: "Minority shareholdings and interlocking directorates can have negative effects on competition, either by reducing the minority shareholder's incentives to compete (unilateral effects), or by facilitating collusion (coordinated effects)" (OECD, 2008).

Despite this growing concern, merger regulations do not apply in many countries when the acquisition does not give the acquirer control over the target firm, and in fact, competition authorities often are not even aware of such acquisitions.[2] Moreover, even in countries where competition authorities have the competence to review acquisitions of minority shareholding (e.g., Austria, Canada, Germany, Japan, the U.S., and the UK, see European Commission, 2014), acquisitions, especially those deemed to be "passive", are either granted a de facto exemption from antitrust liability or have gone unchallenged (Gilo, 2000).[3] A case in point is the U.S., where the Federal Trade Commission and the Department of Justice have the competence to review MS acquisitions, but despite that, less than 1% of all MS transactions are challenged and even fewer are blocked (see Nain and Wang, 2018).

The Industrial Organization literature has shown that horizontal MS acquisitions may raise competitive concerns due to unilateral and coordinated effects.[4] Reynolds and Snapp (1986), Bresnahan and Salop (1986), Farrell and Shapiro (1990), and Shelegia and Spiegel (2012) show that following an MS acquisition in a rival, the acquirer softens its competitive behavior, because

[1]There is also a growing concern about common ownership: cases where the same set of shareholders own several competing firms. Recent papers by Azar, Schmalz, and Tecu (2018), and Azar, Raina, and Schmalz (2016) show that airline ticket prices and bank fees are significantly higher when competing firms are held by the same institutional investors, such as Berkshire Hathaway, BlackRock, and Vanguard. Panayides and Thomas (2017) study data from 119 U.S. industries over the period 1997-2014 and find that common ownership by institutional investors (blockholders) is associated with higher industry profitability, due to reduced expenditures. By contrast, Backus, Conlon, and Sinkinson (2018) find no common ownership effect on prices in the U.S. ready to eat cereal industry.

[2]For a comprehensive review of antitrust policies concerning MS acquisitions, see Fotis and Zevgolis (2016).

[3]Gilo (2000) argues that the lenient approach towards passive investments in rivals in the U.S. stems from the courts' interpretation of the exemption for stock acquisitions "solely for investment" included in Section 7 of the Clayton Act.

[4]See European Commission (2013) and O'Brien and Waehrer (2017) for recent literature surveys.

it internalizes some of the competitive externality it imposes on the target.[5] The anticompetitive effects of horizontal MS acquisitions could be even larger if the acquisition gives the acquirer some degree of control over the target firm, because then the acquirer can also soften the target's behavior in addition to its own behavior. In fact, Salop and O'Brien (2000) argue that horizontal MS acquisitions could lead to even less competitive outcomes than full horizontal mergers if the acquirer's control rights substantially exceed its cash flow rights.[6]

Malueg (1992), Dietzenbacher, Smid, and Volkerink (2000), and Gilo, Moshe, and Spiegel (2006) show that MS acquisitions can also facilitate tacit collusion. The reason is that when firms hold MS in rivals, they internalize part of the negative competitive externality that they impose on rivals when they deviate from a collusive agreement. Although MS may also soften competition once a collusive agreement breaks down and hence weaken the incentive to collude, the first effect typically dominates, so firms have a stronger incentive to collude.[7]

Despite the increasing concern about the competitive effects of MS acquisitions, empirical evidence on these effects is still scarce. Dietzenbacher, Smid, and Volkerink (2000) use cross ownership data from the Dutch financial sector to calibrate oligopoly models with constant marginal costs. They conclude that the price-cost margins in the Dutch financial sector are 8% higher in a Cournot model and 2% higher in a differentiated goods, price competition, model than they would be absent cross-ownership. Brito, Ribeiro, and Vasconcelos (2014) propose a methodology to evaluate the unilateral effects of partial cross ownership and apply it to several MS acquisitions in the wet shaving industry. Among other things, they estimate that Gillette's acquisition of a 22.9% nonvoting equity interest in Wilkinson Sword in 1990 had only a negligible negative effect on prices, but a counterfactual acquisition of a 22.9% voting equity would have led to a 2.1% – 2.7% increase in the price of Wilkinson Sword wet shaving

[5]Interestingly, Farrell and Shapiro (1990) show that in the context of a Cournot model, the acquirer's softer behavior induces rivals to expand their output; if rivals are more efficient than the acquirer, the output shift can actually enhance welfare. Brito, Cabral and Vasconcelos (2014) study the welfare effects of different forms of a divestiture of a firm's partial ownership in a rival.

[6]Foros, Kind, and Shaffer (2011) show that when the acquirer fully controls the target, a partial ownership stake may be more profitable than full ownership because the acquirer chooses a softer stragety for the target than under full ownership. If the two firms compete with a third firm and strategies are strategic complements, the third firm also softens its behavior in a way that may benefit the acquirer.

[7]Malueg (1992) shows in a symmetric Cournot duopoly, in which firms hold the same ownership stakes, v, in one another, that the second effect may dominate the first. But if this were the case, firms would not wish to increase v, so we should not observe such an outcome. While MS among rivals typically soften competition, they may also have a bright side. Lopez and Vives (2018) (general oligopoly model with symmetric cross or common ownership structure) and Shelegia and Spiegel (2016) (Bertrand duopoly with asymmetric cross-ownership structure) show that MS in rivals may encourage cost-reducing investments. Moreover, vertical MS acquisitions may be welfare-improving because they allow downstream and upstream firms to partially internalize various externalities that they impose on one another (see e.g., Spiegel, 2013).

razor blades. Nain and Wang (2018) study 774 horizontal MS acquisitions in U.S. manufacturing industries announced in 1980-2010 and find that the acquisitions raised prices by 2% and raised price-cost margins by 0.7%, even after controlling for other factors that may have accounted for these increases.

In this paper, we find indirect evidence for the anticompetitive effect of horizontal MS acquisitions. Our empirical strategy relies on the fact that it is generally accepted that leniency programs (LP), which allow firms and individuals who report their cartel activity and cooperate with the antitrust authority to avoid criminal sanctions and fines, can destabilize collusive agreements. Indeed, following the success of the U.S. revision of its LP in 1993, many countries have introduced LPs with similar designs in order to detect existing cartels and deter new ones from being formed.[8] Hence, once an LP is introduced, colluding firms may wish to acquire MS in rivals to either stabilize their collusive agreements or soften competition if a collapse of collusion is inevitable.[9] Firms that wish to start colluding after the LP is already in place may also wish to acquire MS in rivals to sustain their newly formed collusive agreements. Accordingly, we examine whether the introduction of an LP encourages MS acquisitions.

We construct a panel data set that covers 63 countries, of which 54 have introduced a national LP between 1990 and 2013. We find robust evidence that once an LP is introduced, there is a large and significant increase in the number and value of domestic horizontal MS acquisitions (the acquirer and target firms are located in the same country and are horizontally related). We do not find an effect in the case of non-horizontal acquisitions, or in the case of cross-border acquisitions. Moreover, the increase in domestic horizontal MS acquisitions is present only in the short-run – within a year or two after the LP is introduced – there is no permanent increase in MS acquisitions after the LP is already in place. These findings suggests that the increase in MS acquisitions is driven by colluding firms which react quickly to the introduction of the LP.

If MS acquisitions are indeed a reaction to the destabilizing effect of the LP on collusive agreements, we should expect to see an effect only when the LP has a deterrent effect. Consistent with this idea, we find that the introduction of an LP has a significant and large effect on domestic horizontal MS acquisitions only when (i) antitrust enforcement is effective, (ii) cartel infringement is subject to criminal sanctions, and (iii) the level of corruption is low. We also

[8]For a review of LPs in different countries, see OECD (2012) and UNCTAD (2010).

[9]In the latter case, firms play the Nash equilibrium once the LP is introduced. As mentioned above, Reynolds and Snapp (1986), Bresnahan and Salop (1986), Farrell and Shapiro (1990), and Shelegia and Spiegel (2012) show that MS acquisitions lead to less competitive outcomes.

find that the LP has a significant effect only on acquisitions of domestic horizontal MS stakes in large firms and when the acquired stake is in the range of $10\% - 25\%$. Such stakes are significant in size, but normally do not trigger merger notification.[10]

The idea of using the introduction of an LP as a negative shock to collusive agreements was first used by Sovinsky and Helland (2018). They argue that the 1993 revision of the U.S. LP and its adjustment in 1995 have reduced the gains from collusive relationships in the form of research joint ventures (RJV). They find a significant drop in the probability of joining an RJV after 1993. Bourveau, She, and Zaldokas (2018) show that following the introduction of an LP in a given country, U.S. firms, which trade with that country, start sharing more detailed information in their financial disclosure that may facilitate collusion and is associated with higher future profitability. Dong, Massa, and Zaldokas (2018) show that the introduction of LPs in 63 countries between 1990 and 2012 led to more cartel convictions and lower average gross margins of affected firms, and moreover, was followed by almost doubling of the expenditure of firms on mergers and acquisitions. Interestingly, the effect is much smaller when they restrict attention to horizontal mergers (Table IA3 in their Internet Appendix). In a similar vein, Marx and Zhou (2015) study mergers among cartel co-conspirators in the European Union and find that the European Commission's LP appears to have expediated mergers.[11]

The remainder of the paper is organized as follows. In Section 2 we discuss our empirical strategy and in Section 3 we present our data. The estimation results are in Section 4 and in Section 5 we show robustness checks. We conclude in Section 6. The Appendix includes a model that illustrates our empirical strategy, model fit tests for the choice of our empirical model, additional information on our data, and some additional robustness checks. An online Appendix includes additional material.[12]

2 Empirical Strategy

Following the pioneering papers of Motta and Polo (2003) and Spagnolo (2004), a large theoretical and experimental literature has emerged which examines the competitive implications of LPs. This literatures shows that by and large, LPs hinder collusion (see Marvao and Spagnolo

[10] In most countries, merger notification is required only when an MS acquisition results in joint control, i.e., the right to block major decisions within the target (see OECD, 2008).

[11] Davies, Ormosi, and Graffenberger (2015) also study mergers after cartel breakdowns and find that mergers are more frequent post-cartel breakdown, especially in less concentrated markets. This finding is consistent with the notion that mergers are a substitute for collusive behavior.

[12] The online Appendix is available at https://www.tau.ac.il/~spiegel/papers/MS-OnlineAppendix.pdf.

(2016a) for a recent literature review). The theory has received empirical support. For instance, Levenstein and Suslow (2011), Abrantes-Metz et al. (2013), De (2010), Zhou (2012, 2016), and Hellwig and Hüschelrath (2018), show that the introduction of an LP has a significantly negative effect on the duration of detected cartels, Miller (2009) finds that the LP introduced in the U.S. in August 1993 enhanced deterrence and detection capabilities, and Dong, Massa, and Zaldokas (2018) find that find that the introduction of LPs in a country more than doubles the number of detected cartels.

We will therefore use the introduction of a national LP in a given country as an exogenous shock, which destabilizes collusive agreements between firms located in that country. The idea, which we formalize in the Appendix, is that firms whose collusive agreements are destabilized may wish to react to the LP by acquiring MS in rivals. One reason for doing so is that once an LP is in place, a given firm i may be worried that rival j will apply for leniency, not necessarily because it prefers to apply, but rather because it fears that firm i will apply first.[13] By acquiring an MS stake in rival j, firm i may be able to reassure the rival that it is not going to apply for leniency, because it now shares j's loss when it applies for leniency. The acquisition then alleviates rival j's need to apply for leniency and therefore stabilizes the collusive agreement. Firms may in fact wish to acquire MS stakes in rivals even if collusion breaks down once an LP is introduced, if the acquisition softens the resulting non-collusive equilibrium as in Reynolds and Snapp (1986), Bresnahan and Salop (1986), Farrell and Shapiro (1990), or Shelegia and Spiegel (2012).

Although firms may use MS as a collusive device even before an LP is in place, acquiring an MS is typically costly.[14] Consequently, it is reasonable to expect that firms will be reluctant to acquire MS in rivals if they have other means to sustain collusion. But since the introduction of an LP destabilizes collusive agreements, firms may have to resort to acquisition of MS in rivals. This suggests in turn that the introduction of an LP may be followed by an increase in MS acquisitions in rival firms. The short-run effect though is likely to be larger than the long-run effect because once the LP is introduced, firms may need to react to it quickly to avoid intense competition. In the long run, firms may still wish to facilitate new collusive agreements

[13]This effect is reminiscent of the "race to the courthouse" effect in Harrington (2008). Harrington (2013) shows that a similar effect arises when cartel members are privately informed about the likelihood of conviction without a cooperating firm. Then, each firm may apply for amnesty, fearing that another firm may believe that the probability of detection is high, and will apply for amnesty first.

[14]In particular, if the shares are acquired from atomistic shareholders, the acquirer makes no money on the acquired shares due to Grossman and Hart's (1980) free-rider problem and only benefits from an increase in the value of its own firm.

by acquiring MS in rivals, but given the deterrent effect of LP on collusion, we may expect a decrease in the formation of new collusive agreements and hence in the need to facilitate them.

To study the effect of the introduction of an LP on MS acquisitions, we use a panel of 63 countries over the period 1990-2013, and estimate the following count data model:

$$\mathrm{MS_{it}} = \exp(LP_{it}\beta_1 + X_{it}\beta_2 + \xi_i + \xi_t + \varepsilon_{it}),$$

where $\mathrm{MS_{it}}$ is a measure of MS acquisitions of rivals in country i in year t (either the number of MS acquisitions or their aggregate deal value in dollars); LP_{it} is a vector of dummies for the year in which the LP was introduced in country i and several years before and after the LP introduction; X_{it} is a vector of macroeconomic and financial markets control variables; ξ_{i} and ξ_{t} are country and year fixed effects; and ε_{it} is the noise term. The vector X_{it} is included in the estimation because MS acquisitions may be driven by additional considerations beside their competitive effects.[15] We wish to control, at least partially, for these considerations and examine whether the introduction of a national LP has an effect on MS acquisitions even after the additional considerations are controlled for.

In our baseline specification, the vector LP_{it} includes dummies for the year in which the LP was introduced (*LP*), one year before the introduction (*LP − 1*), one year after it (*LP + 1*), and the period after the introduction, starting with the second year after the introduction (*After LP + 1*). The control group in the baseline specification includes the pre-LP period up to two years before the introduction. The dummies *LP − 1*, *LP* and *LP + 1* are intended to examine whether the LP had an effect shortly before, during, and after the LP was introduced, relative to the pre-LP period, while the *After LP + 1* dummy examines the long-run effect of the LP. In other specifications, we also include the *LP + 2* and *LP + 3* dummies to examine if the LP had a differential effect on MS acquisitions in the short run than in the long run; the long-run effect if now captured by an *After LP + 3* dummy that includes all post-LP years, starting with the fourth year after the LP introduction. We also examine if the LP had an effect prior to one year before the LP was introduced and include the dummies *LP − 2* and *LP − 3*. When the *After LP + 3* dummy is also included, the control group consists of four years and more before the LP was introduced. Naturally then, countries that introduced an LP later on are overrepresented

[15] See Meadowcroft and Thompson (1986), Allen and Phillips (2000), Fee, Hadlock, and Thomas (2006), and Parker Ouimet (2013) for papers that examine the driving forces behind MS acquisitions. Jovanovic and Wey (2014) study a model where an MS acquisition is a first step towards a full merger.

in the control group. We therefore also run an estimation without the *After LP + 3* dummy, in which case, the control group includes four and more years before and after the introduction of the LP. As we shall see, our results are robust to the choice of the control group.

In general, a count data model could be estimated with a (Quasi-Maximum Likelihood) Poisson model or with a Negative Binomial (NB) model. The Poisson model however is inappropriate for our data because we have significant Poisson overdispersion: when estimated by Poisson, the resulting conditional variance is approximately four times larger than the variance implied by a Poisson distribution. A potential source for the observed overdispersion is the fact that more than 30% of all observations in our data are zeros, i.e., country-year pairs without any MS acquisitions.[16] This fraction of zeros is higher than assumed by Poisson and even higher than that assumed by NB models. It is possible that at least some of the zeros in our data are false and due to imperfect data reporting, especially in smaller and developing countries. Moreover, it is also likely that data collection has improved over time, meaning that we may have more false zeros in earlier years.

We will therefore analyze our data with zero-inflated negative binomial (ZINB) model, which apart from the count component that estimates the full range of the counts, also includes a binary component that estimates the probability of excess zeros. The binary component, sometimes called the inflation equation, is conventionally computed using the following logit model:

$$\Pr(\mathrm{MS_{it}} = 0|Z_{it}) = \frac{\exp(Z_{it}\beta)}{1 + \exp(Z_{it}\beta)},$$

where Z_{it} is a vector of variables that do not necessarily coincide with the variables used in the count component,[17] In our case, Z_{it} includes time dummies for the periods 1990-1995, 1996-2000, and after 2000; real GDP; and the size of the stock market as well as the leniency policy variables.[18] The tests presented in Tables A1a and A1b in the Appendix indicate that the ZINB model fits the data best.

[16]The share of zeros is even larger for the aggregate deal value (43.52%) because we do not have information on the deal values for all acquisitions.

[17]E.g. Hilbe, 2007, p. 174.

[18]We also experimented with other variables and time periods, but the results did not change by much. We also included year fixed effects, but the estimation did not converge. We therefore decided to use three time periods instead.

3 The Data

3.1 Data Description

MS acquisitions We constructed our data set on MS acquisitions in several steps, outlined in Table A2 in the Appendix. First, we extracted from Thomson One Financial database information on all acquisitions for which the reported final stake is below 50% in 63 countries for the period 1990-2013.[19] Second, we eliminated share buybacks and self-tenders, where the acquirer and target are one and the same. Third, we eliminated acquisitions with a sought final stake above 50% since these acquisitions cannot be construed as genuine MS acquisitions. Fourth, we eliminated acquisitions for which the acquirer or target are investors and investment offices according to their primary business description, because these acquisitions are likely to be driven by investment considerations, which are unrelated to the issue that we focus on in this paper. We are then left with 47,675 MS acquisitions, of which 32,683 are domestic (the acquirer and target are from the same country) and 14,992 are cross-border acquisitions.

Since we are interested in the collusive effect of MS acquisitions, and use the introduction of a national LP as a shock to existing collusive agreements, we will mostly focus on domestic horizontal (DH) MS acquisitions. We classify MS acquisitions as horizontal if the listed activities of the acquirer (or its parent company) and the target overlap in at least one 4-digit SIC code.[20] With this classification in place, 12,934 domestic MS acquisitions in our data set are horizontal. Of these, 10,699 are new acquisitions, in the sense that the acquirer did not own a previous stake in the target, while 2,235 acquisitions are increases of an already existing MS.[21]

If indeed firms acquire MS in order to react to the destabilizing effect of the LP on collusion, the introduction of an LP should not affect on non-horizontal MS acquisitions. Moreover, we should see a much weaker effect, if any, in the case of cross-border MS acquisitions, because it is not clear which LP - the one in the acquirer's country or the one in the target's country - is relevant, and moreover, it is not obvious that a domestic competition authority can punish

[19] In some cases the data set does not report the final stake. We did not take these acquisitions into account to ensure that we only study MS acquisitions.

[20] In Tables E4 and E5 in the online Appendix we show that the results remain robust if we use 3-digit SIC codes instead.

[21] Unfortunately we do not have the initial ownership data and hence, when we observe firm i acquiring a stake in firm j, we cannot tell if firm j already holds a stake in firm i. However, out of the 12,934 domestic horizontal MS acquisitions in our data over the period 1990-2013, there are only 45 cases in which the target firm also acquired a stake in the acquirer during our observation period.

foreign firms.[22] To check whether this is the case, we will also examine domestic non-horizontal (DNH) MS acquisitions and cross-border horizontal (CBH) and cross-border non-horizontal (CBNH) MS acquisitions. Of the 32,683 domestic MS acquisitions in our data set, 19,749 acquisitions are non-horizontal and of the 14,992 cross-border MS acquisitions, 7,689 are horizontal and 7,303 are non-horizontal.

Given that the variation in the LP data is at the country and year level, we aggregate the data by country and year and create two measures of MS acquisitions: the number of MS acquisitions in country i and year t, and the aggregate deal value of MS acquisitions in country i and year t, measured in millions of constant 1990 dollars.[23] Figure 1 below shows the annual total number of transactions and aggregate value of MS acquisitions over all countries for the period 1990 and 2013.[24] It is worth noting that the number of MS acquisitions and their aggregate value have an increasing time trend with peaks in 2000 (the dotcom bubble) and in 2009 (the global financial crisis). We control for these trends using time fixed effects.

Of the 63 countries in our data set, the U.S. accounts for the largest aggregate value of transactions, with about 18% of the total (68,977 million dollars out of 380,874 million dollars), while Japan has the largest number of acquisitions, followed by the U.S. (1,839 acquisitions in Japan and 1,575 in the U.S. out of a total of 12,934 MS acquisitions). The distributions of the number and aggregate value of MS acquisitions across countries for the period 1990-2013 are presented in Figures A1 and A2 in the Appendix.

[22]Moreover, Choi and Gerlach (2012) show in a theoretical model that when antitrust authorities in two different countries do not share information, collusion is easier and LPs are less effective when firms operate in both countries than when they operate in only one country.

[23]The latter were computed using GDP deflator data for the US provided by the International Monetary Fund (IMF), with 1990 as the base year.

[24]With 63 countries and 24 years we should have 1,512 country-year pairs. However several countries in our data set did not exist in 1990. For that reason we have data on the Czech Republic and Slovakia only for 1993-2013; on Lithuania, Estonia, Latvia, and Russia only for 1991-2013; and on Croatia only for 1992-2013. All in all then we have 1,500 country-year pairs.

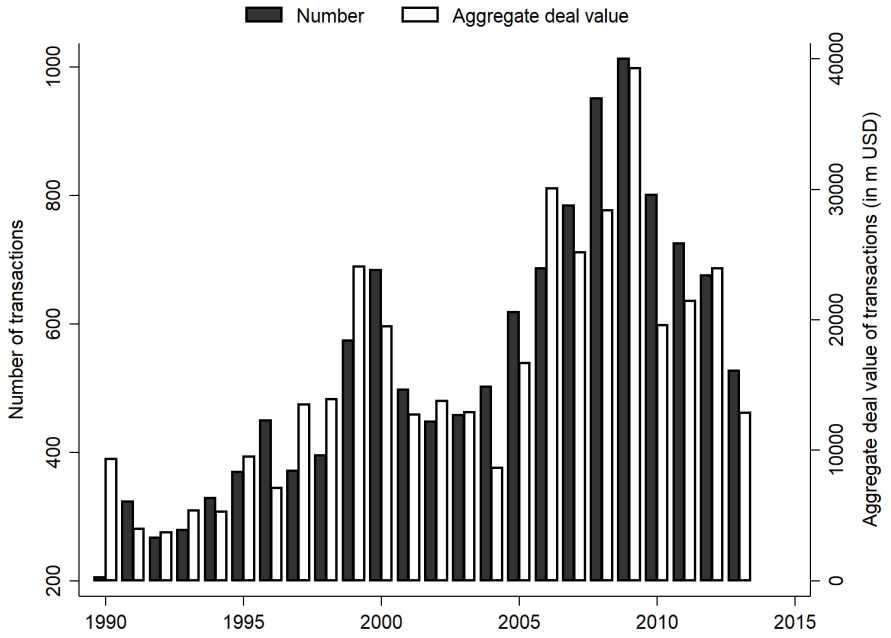

Figure 1: The number and aggregate deal value of MS acquisitions (in million USD, 1990-2013)

Leniency Programs (LPs) The U.S. had an LP in place since 1978, but the LP became a big success only after the DOJ revised it in 1993 and offered automatic amnesty to the first applicant conditional on full cooperation.[25] Following this success other countries adopted LPs with very similar designs, starting with South Korea in 1997 and the UK in 1998.[26] After 2000, at least three countries have introduced an LP each year, with a peak in 2004, when nine countries have introduced an LP. Table A3 in the Appendix lists for each country the year in which the LP was introduced. As the table shows, nine countries in our data (Argentina, Hong Kong, Indonesia, Jordan, Nigeria, Oman, Thailand, Venezuela, and Vietnam) did not introduce an LP at least until 2013 when our data ends. Figure 2 shows the distribution of years in which LPs were introduced.[27]

[25]The number of amnesty application jumped from roughly one per year before 1993 to more than one per month afterwards. For details, see https://www.justice.gov/atr/status-report-corporate-leniency-program

[26]Indeed, the DOJ has advised a number of foreign governments in drafting and implementing effective national LPs in their jurisdictions. The key feature of all LPs is that the first applicant may be granted amnesty, while subsequent cooperating cartel members may get a fine reduction of up to 50%. See `https://www.justice.gov/atr/speech/modern-leniency-program-after-ten-years-summary-overview-antitrust-divisions-criminal`

[27]The EU has introduced an LP in 1996 and revised it in 2002 and 2006. In this paper however we only focus on national LP's. In the robustness section we show that our findings also hold when we drop EU countries from the sample. Also, including the EU's LP and its revisions in the regressions does not change our results qualitatively (see Tables E11 and E12 in the online Appendix for details).

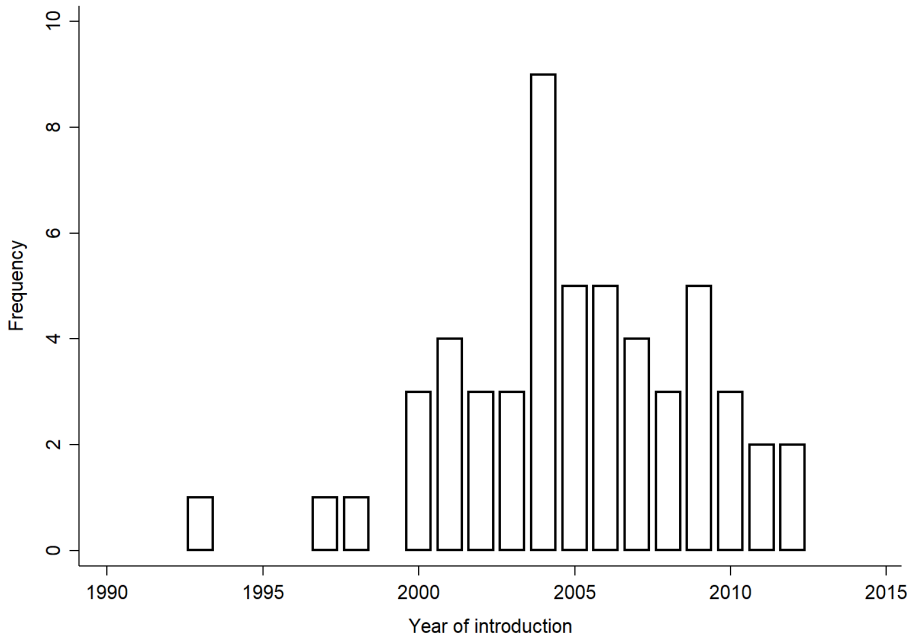

Figure 2: Frequency of the introduction of new national LP (by year)

Efficacy of LPs Although LPs in different jurisdictions have similar designs, the deterrent effect of an LP may depend on additional factors, such as how effective antitrust enforcement is, whether cartel infringement is subject to criminal sanctions, and whether the level of corruption is high. In particular, in countries where the LP is ineffective, we should not expect firms to respond to the introduction of an LP by acquiring MS stakes in rivals.

To control for the deterrent effect of LP, we will interact the LP dummy with country-specific indices reflecting the efficacy of antitrust enforcement, whether cartel infringement is subject to criminal sanctions, and the level of corruption. To capture the efficacy of antitrust enforcement, we use the Anti-Monopoly Policy Index (AMPI), provided by the World Economic Forum (WEF).[28] The AMPI is based on a survey of top business executives regarding their perception of the efficacy of antitrust enforcement in their country and varies from 1 (not effective at all) to 7 (extremely effective). Although the AMPI is based on a single survey question, we chose it over other popular measures, such as the Rating Enforcement (RE) measure published in the Global Competition Review, because of its wide coverage, which allows us to include it

[28]The AMPI is published annually in the Global Competition Review and is part of a much broader Global Competitiveness Index (GCI) which can be downloaded at `http://reports.weforum.org/global-competitiveness-report-2014-2015/rankings/` (last accessed on 24 June 2018). For the construction of AMPI, we use the variable "6.03 Effectiveness of anti-monopoly policy."

for 62 out of 63 countries in our data.[29] Despite its simplicity, the AMPI is highly correlated with the RE measure, with a correlation coefficient of 0.7. We therefore believe that the AMPI is a sensible measure of antitrust enforcement. Since the AMPI is only available from 2006 onwards, we divide countries into two groups, depending on whether their average AMPI's during the 2006-2013 period is above the median for all countries (countries with an effective antitrust enforcement), or below the median (countries with ineffective antitrust enforcement). This classification is justified by the fact that the AMPI scores are stable over time.

The efficacy of an LP may depend not only on how effective antitrust enforcement is in general, but also on whether cartel enforcement involves criminal sanctions (Marvao and Spagnolo, 2016b). We therefore use several sources, including Ginsburg and Wright (2010), Global Legal Group[30], Getting The Deal Through[31], and Thomson Reuters Practical Law[32] to construct a dummy "Criminal Sanctions" that takes the value 1 if cartel infringement in a given country is subject to criminal sanctions and 0 otherwise.

Finally, we control for corruption using the Control of Corruption Index (CCR) provided by the World Bank as part of the World Governance Indicator (WGI) data set. The CCR index is available from 1996 onwards and captures perceptions of the extent to which public power is exercised for private gain, as well as "capture" of the state by elites and private interests. It rates countries on a 100 points scale, with higher scores reflecting lower levels of corruption.[33] As with the AMPI, we also divide countries two groups depending on whether their average CCR is above the median for all countries (countries with low levels of corruption), or below the median (countries with high levels of corruption).

Table A3 in the Appendix shows for each country in our data the year in which an LP was introduced (if at all), the average AMPI and CCR values, and whether cartel infringement is subject to criminal sanctions. It should be noted that the AMPI and CCR indices are relatively highly, but imperfectly, correlated (the correlation coefficient between the two is 0.59). The correlation between the AMPI and CCR dummies and the "Criminal Sanctions" dummy is

[29]The RE measure is based on a detailed questionnaire filled by the competition authorities themselves and also considers how local competition counsels, antitrust lawyers and economists, academics, and local journalists evaluate an agency's performance. Unfortunately, the RE measure is only available for a fraction of the countries used in our analysis.

[30]https://iclg.com/practice-areas/cartels-and-leniency-laws-and-regulations.

[31]https://gettingthedealthrough.com/area/5/cartel-regulation/.

[32]https://uk.practicallaw.thomsonreuters.com/Browse/Home/International/CartelLeniencyGlobalGuide?transitionType=Default&contextData=(sc.Default).

[33]A description of the data and variables used to compute the CCR can be found at https://info.worldbank.org/governance/wgi/pdf/cc.pdf and also Kaufmann, Kraay, and Mastruzzi (2010).

very low (the respective correlation coefficients are merely 0.06 and 0.10).

Macroeconomic and Financial Controls To control for other potential determinants of MS acquisitions, we collected country-specific macroeconomic variables, including real GDP, unemployment rate, inflation rate (based on the GDP deflator index), and the purchasing-power-parity conversion rate (PPPEX). These variables were shown to be potential drivers of mergers and acquisitions (see, e.g., Rossi and Volpin (2003), Di Giovanni (2005) and Erel et al. (2012)). We also include the growth rate of the volume of import (IMP) and exports (EXP) of goods and services to reflect year-over-year changes in trade activity. All variables are taken from the World Economic Outlook Database (WEO) provided by the International Monetary Fund (IMF) and are available for all countries in our data except India and Oman.

In addition to the macroeconomic control variables, we also include in the analysis country-specific financial markets variables from the World Bank's World Development Indicators (WDI). These variables include the total market capitalization of listed firms as a share of GDP to control for the size of the stock market (STOCK); domestic credit to private sector as a share of GDP to control for the availability of credit (CREDIT); total imports and exports as a share of GDP to control for trade activity (TRADE); and the real interest rate to control for the cost of investment (INTEREST). Unfortunately, the financial markets variables (and especially CREDIT and INTEREST) are not available for all country-year pairs and hence when we use them, our sample is reduced from $1,368$ to $1,018$ country-year pairs.

3.2 Descriptive Statistics

Table 1 shows the descriptive statistics of our variables, reported on an annual basis. On average, there are 8.6 domestic horizontal MS acquisitions per country per year, of which 7.1 are new acquisitions. The average aggregate deal value is 144 million dollars per country per year for all acquisitions, and 112 million dollars for new acquisitions.[34] Both the number and value of MS acquisitions at the country year level have a large variance. In particular, in 30% of all country-year pairs in our data there are no MS acquisitions, while in other country-year pairs there is a large number and a large value of MS acquisitions. The table also shows a large

[34]We winsorized the deal values at 98.5% to eliminate extreme outliers. Without winsorizing the mean would be 244 millions USD for all acquisitions and 196 million USD for new acquisitions.

heterogeneity across countries in terms of the macroeconomic and financial market variables.[35]

At an individual level, the average value of a new domestic horizontal MS acquisition across all countries and years is 29.6 million dollars, though the distribution of deal values has a long right tail with a median value of merely 4.7 million dollars. In terms of industries, we have at least one MS acquisition in 647 4-digit SIC code industries. Of these, the industries with the largest number of new domestic horizontal MS acquisitions are information retrieval services (3.8% of the total), prepackaged software (3.7%), crude petroleum and natural gas (3.7%), and electric services (2.4%). Using the more general industry description of Thomson Reuter's, domestic horizontal MS occur most frequently in the sectors high technology (14.1%), energy and power (13.4%) and materials (13.4%).[36]

Table 1: Summary statistics

	Mean	S.D.	Min	Max	Obs.	Source
Deal characteristics						
Number of MS acquisitions	8.62	19.1	0	189	1,500	Thomson
Number of new MS acquisitions	7.13	15.4	0	151	1,500	Thomson
Aggregate value of MS acquisitions (in million USD)	144	380	0	4225	1,500	Thomson
Aggregate value of new MS acquisitions (in million USD)	112	309	0	3929	1,500	Thomson
Macro variables						
Real GDP	4.85	1.6	0.39	9.24	1.477	IMF
GDP growth	0.03	0.0	-0.23	0.24	1,468	IMF
Unemployment (% of Labor Force)	7.95	4.6	0.03	27.8	1,397	IMF
Inflation (%)	28.3	230	-25.70	5053	1,466	IMF
Purchasing-power-parity conversion rate (PPPEX)	115	530.9	0.00	7,311	1.472	IMF
Volume of exports of goods and services (EXP)	7.58	7.9	-26.6	77.5	1,451	IMF
Volume of imports of goods and services (IMP)	9.81	17.1	-41.6	507	1.453	IMF
Financial market variables						
Credit	73.5	50.9	1.12	311	1.373	WDI
Interest rate (%)	5.89	11.3	-91.7	93.9	1-190	WDI
Stock	59.5	64.9	0.00	606	1,375	WDI
Trade	85.5	65.6	13.8	450	1,437	WDI
Competition policy effectiveness variables						
Anti-Monopoly Policy Index (AMPI, 1-7)	4.52	0.79	2.32	6.19	495	TI
Control of Corruption (CCR, 0-100)	67.91	26.34	0.51	100	945	WGI

Notes: All variables reflecting a percentage are scaled to 100 for 100%; values of acquisitions and GDP are measured in constant 1990 million USD; GDP growth and imports and exports are measured in terms of year-over-year percentage changes.

Before moving to the estimation results, we first illustrate in Figure 3 the evolution of the number and aggregate value of domestic horizontal MS acquisitions from three years before

[35]Some values in Table 1 are extreme, like the -920.7 GDP growth in Bulgaria in 1991 (immediately after the fall of communism in Eastern Europe), the 27.8% average unemployment rate in South Africa in 2002, the 5,000% inflation rate in Peru in 1990, the 311% of GDP credit in Iceland in 2006, or the -92% real interest rate in Ukraine in 1993 and 94% in Bulgaria in 1996.

[36]Detailed information on the sector definition can be found at:
http://mergers.thomsonib.com/td/DealSearch/help/Macro-Mid.pdf.

the introduction of a national LP to three years after. To make the data comparable across countries, we normalize the data for each country to values between 0 and 1, as follows:

$$MS_{it}^{norm} = \frac{MS_{it} - \min(MS_i)}{\max(MS_i) - \min(MS_i)},$$

where $\min(MS_i)$ and $\max(MS_i)$ are the lowest and highest value of MS_{it} for country i over the sample period.[37] Figure 3 shows that the number of MS acquisitions, as well as their aggregate value, increase as we approach the year in which an LP is introduced (this year is different for different countries) and then decrease. This trend suggests that the introduction of an LP encourages MS acquisitions in rivals. In the next section, we show that this pattern persists even when we control for other factors that may affect MS acquisitions, and use year fixed effects.

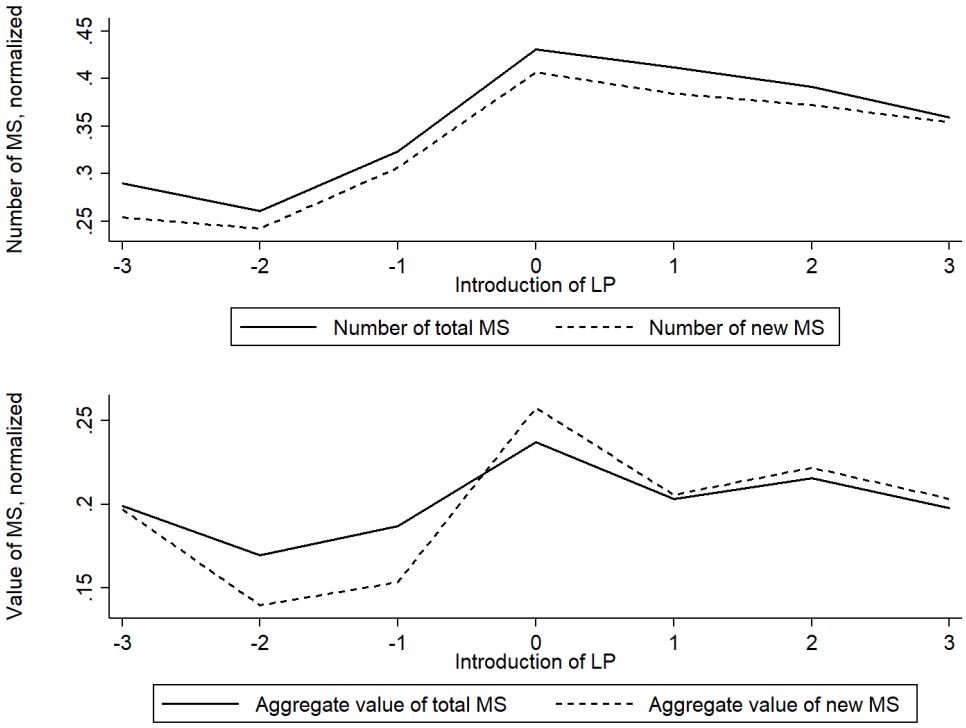

Figure 3: Evolution of domestic horizontal MS acquisitions in the three years before and after the introduction of national leniency programs (normalized by country, 0-1)

[37]Cyprus, Ecuador, Taiwan and Ukraine are not included in the figure since they introduced a national LP only in 2011 and 2012, so we do not observe these countries for three years after the LP was introduced (we have data only until 2013). In the online Appendix we also present the figure for a the five years before and after an LP was introduced (Figure E1). In this case we dropped thirteen countries that introduced an LP before 1995 or after 2008. The peak in the LP year remains even then.

4 Estimation results

We now turn to our estimation results. The results are obtained by ZINB estimation and all specifications include country and year fixed effects. In most of the paper, we focus on new MS acquisitions, where the acquirer did not hold an initial stake in the target. In the online Appendix we also consider increases of already existing MS in rivals and show our results remain very similar (Tables E1 and E2).

4.1 Domestic horizontal MS acquisitions

We begin by considering domestic horizontal MS acquisitions, which is the type of acquisitions that we expect to be affected by the introduction of a national LP. As mentioned earlier, we have observations on 10,699 new domestic MS horizontal acquisitions. The estimates of the effect of an LP on the number of new domestic horizontal MS acquisitions are shown in Table 2. In Columns (1) and (2), we include dummies for the year in which the LP was introduced (LP), one year after ($LP+1$), and the subsequent period ($After\ LP+1$). The difference between Columns (1) and (2) is that in Column (2) we also control for financial market variables. The results show that relative to the period that preceded the LP, the introduction of an LP has a significant effect on the number of MS, but only in the year of introduction and not in subsequent years. In Column (3), which we will use as our baseline specification throughout the paper, we also add a dummy for the year before the LP is introduced ($LP-1$). The results show that firms do not react to the LP before it was introduced, nor in the years after the introduction.

In Columns (4) and (5) we extend the pre- and post-LP dummies up to three years before and after the LP is introduced. Once again, the LP has a significant effect on the number of MS acquisitions only in the year in which the LP is introduced. A potential problem with the specifications in Columns (1)-(5) is that the control group consists of the pre-LP years and hence countries that have introduced an LP in later years are overrepresented in the control group.[38] In Column (6) we re-estimate the specification in Column (5), but now drop the $After\ LP+3$ dummy (which is not significant); consequently, the control group now includes the post-LP years and hence is more balanced. The results however remain robust.

[38]For instance, the specification in Column (5) has no control years for the U.S., only four years for South Korea, and only five years for the UK, versus fourteen control years for Lithuania, sixteen for Malaysia, and seventeen for Cyprus and Ecuador.

Table 2: ZINB estimations of the number of new domestic horizontal MS acquisitions

	(1)	(2)	(3)	(4)	(5)	(6)
LP-3					0.03	0.06
					(0.18)	(0.15)
LP-2					-0.01	0.02
					(0.16)	(0.12)
LP-1			0.09	0.08	0.07	0.11
			(0.13)	(0.13)	(0.17)	(0.11)
LP	0.22*	0.33***	0.34**	0.32**	0.30*	0.34***
	(0.12)	(0.12)	(0.14)	(0.14)	(0.18)	(0.12)
LP+1	0.06	0.13	0.13	0.11	0.09	0.14
	(0.15)	(0.16)	(0.17)	(0.17)	(0.23)	(0.13)
LP+2				0.14	0.13	0.17
				(0.21)	(0.27)	(0.14)
LP+3				0.02	0.00	0.06
				(0.21)	(0.28)	(0.13)
After LP+1	-0.04	0.06	0.05			
	(0.16)	(0.17)	(0.19)			
After LP+3				-0.02	-0.05	
				(0.19)	(0.26)	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes	Yes
Macroeconomic covariates	Yes	Yes	Yes	Yes	Yes	Yes
Financial covariates	No	Yes	Yes	Yes	Yes	Yes
F-test on joint significance of covariates	0.00	0.00	0.00	0.00	0.00	0.00
R^2	0.67	0.67	0.67	0.66	0.66	0.66
Observations	1368	1018	1018	1018	1018	1018

Notes: Standard errors clustered at the country level. Inflation equation is reported in the online Appendix. The macroeconomic covariates are GDP, GDP growth, Unemployment rate, Inflation, PPPEX, IMP and EXP. The financial covariates are CREDIT, INTEREST, STOCK and TRADE. All covariates are lagged by one year. The full estimation outputs are available in the online Appendix of the paper. The reported R^2 is the deviance based R^2 suggested by Cameron and Windmeijer (1996) for count data. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

In Table 3 we repeat the same analysis as before, but now with the aggregate deal value as the dependent variable. The results are qualitatively similar, although the coefficients of the LP dummy are much larger now, and the LP has a significant effect not only in the year in which the LP is introduced, but depending on the specification also in the next one or two years.

Table 3: ZINB estimations of the aggregate value of new domestic horizontal MS acquisitions

	(1)	(2)	(3)	(4)	(5)	(6)
LP-3					0.22	0.10
					(0.39)	(0.43)
LP-2					0.24	0.03
					(0.36)	(0.35)
LP-1			-0.14	-0.16	-0.07	-0.30
			(0.42)	(0.42)	(0.45)	(0.41)
LP	0.75**	0.95**	0.90**	0.88**	0.98**	0.72**
	(0.38)	(0.41)	(0.42)	(0.43)	(0.41)	(0.30)
LP+1	0.50	0.84***	0.80**	0.79**	0.90***	0.60***
	(0.34)	(0.29)	(0.33)	(0.34)	(0.33)	(0.23)
LP+2				0.75*	0.87*	0.50*
				(0.43)	(0.45)	(0.26)
LP+3				0.54	0.64	0.35
				(0.50)	(0.49)	(0.44)
After LP+1	0.44	0.61	0.57			
	(0.40)	(0.39)	(0.42)			
After LP+3				0.45	0.58	
				(0.49)	(0.48)	
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Macroeconomic covariates	Yes	Yes	Yes	Yes	Yes	Yes
Financial covariates	No	Yes	Yes	Yes	Yes	Yes
F-test	0.00	0.00	0.00	0.00	0.00	0.00
R^2	0.33	0.36	0.36	0.36	0.36	0.36
Observations	1368	1018	1018	1018	1018	1018

Notes: Standard errors clustered at the country level in parenthesis. Inflation equation is reported in the online Appendix. The macroeconomic and financial covariates are as in Table 2. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

To appreciate the magnitude of the LP coefficients and visualize them, we convert the coefficients of the LP dummies in Column (6) in Tables 2 and 3 to percentage point changes (using the transformation $100 \times (e^{\beta} - 1)$, where β is the value of the relevant coefficient) relative to the control group, which includes four years or more before and after the LP was introduced. The resulting percentage changes are shown in Figure 4 with a 90% confidence interval around each coefficient. The figure shows that in the year the LP is introduced, the number of new domestic horizontal MS acquisitions increases by 41%, and the aggregate deal value increases by 105%, relative to the control group.[39] The effect on the number of MS acquisitions is insignificant before or after the LP is introduced. By contrast, the effect on the deal value remains significant and high for two years after the introduction of the LP: 82% one year after and 65% two years after the introduction. This suggests that some large MS acquisitions (either

[39]These estimates probably understate the true effect because our LP dummies are for the calendar year in which the LP was introduced (unfortunately we do not have the exact month for the LP introduction for many countries in our dataset). Hence, if an LP was introduced towards the end of the year, most of the effect might be observed only in the next calendar year and would be captured by the $LP + 1$ dummy.

large stakes or stake in larger targets) take more time to complete.

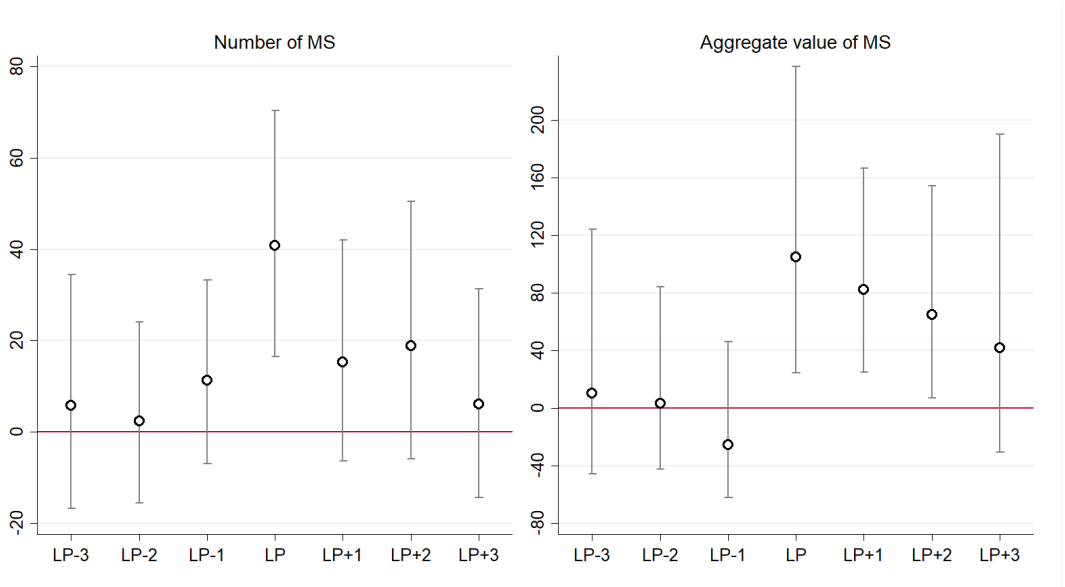

Figure 4: Percentage effect of the introduction of an LP on new domestic horizontal MS with 90% CIs

The fact that we do not see an effect before the LP is introduced should not come as a surprise given that typically, MS acquisitions can be completed quickly, so firms do not need to start acquiring MS stakes in rivals in advance.[40] Moreover, the fact that MS acquisitions can be completed quickly also suggests that in the post-LP years we should not observe the completion of acquisitions that started shortly after the LP was introduced. In addition, if LPs deter collusion, there are two countervailing effects in the post-LP years: on the one hand, fewer collusive agreements should be formed. On the other hand though, when these agreements form, there is more need for MS acquisitions to support them. The absence of an effect in the post-LP period could be due to the fact that the two effects may cancel each other out.

Apart from these considerations, the absence of a permanent effect of the LPs suggests that the observed increase in the number and aggregate value of MS acquisitions is not driven by pre-treatment trends or some unobserved country-specific change in the political or legal climate that drives both the introduction of the LP and the decisions of firms to acquire MS in rivals. We return to this issue in more detail in Section 5.

[40]Using the Zephyr database by Bureau van Dijk, we find that the median duration from the first rumour of an MS acquisition to its completion over the period 2005-2013 (a total of 60,427 MS acquisitions) was 0 days with an average duration of just 25 days. We use Zepher for the computation because the Thomson One Financial database that we use in this paper does not report the time needed to complete acquisitions. The reason we still use the Thomson One Financial database is that Zephyr only covers MS transactions from 2004 onward.

4.2 Non-Horizontal and Cross-border MS Acquisitions

So far we have shown that the number and aggregate deal value of new domestic horizontal (DH) MS acquisitions increase significantly in the year in which an LP is introduced. But, as already mentioned, if MS acquisitions are indeed a reaction to the negative shock of the LP on collusive agreements, the introduction of an LP should have no effect on non-horizontal MS acquisitions, and moreover, we should see a much weaker effect, if any, on cross-border MS acquisitions. To examine whether this is indeed the case, we re-estimate our baseline specification (Column (3) in Tables 2-3) for domestic non-horizontal MS acquisitions (DNH), cross-border horizontal MS acquisitions (CBH), and cross-border non-horizontal MS acquisitions (CBNH). The results for the number of MS acquisitions are reported in Table 4 below.[41]

Table 4: ZINB estimations for the number of new non-horizontal and cross-border MS acquisitions

	(1) DNH	(2) CBH LP in target country	(3) CBH LP in acquirer country	(4) CBNH LP in target country	(5) CBNH LP in acquirer country
LP-1	-0.04	-0.14	0.15	0.17	-0.05
	(0.15)	(0.19)	(0.11)	(0.14)	(0.14)
LP	-0.08	-0.03	0.07	0.21	-0.02
	(0.22)	(0.14)	(0.15)	(0.16)	(0.12)
LP+1	-0.06	-0.03	-0.02	0.08	-0.06
	(0.20)	(0.16)	(0.16)	(0.16)	(0.15)
After LP+1	-0.26	-0.02	0.08	0.08	-0.03
	(0.21)	(0.18)	(0.19)	(0.16)	(0.14)
Year FE	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Macro covariates	Yes	Yes	Yes	Yes	Yes
Financial covariates	Yes	Yes	Yes	Yes	Yes
F-test	0.00	0.00	0.00	0.00	0.00
R^2	0.68	0.62	0.65	0.64	0.65
Observations	1018	1018	1018	1018	1018

Notes: Standard errors clustered at the country level in parenthesis. Inflation equation appears in the online Appendix. The macroeconomic and financial covariates are as in Table 2. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

Column (1) shows the results for DNH MS acquisitions. Columns (2)-(3) show results for CBH MS acquisitions when an LP is introduced in the target's country (Columns (2)) and when it is introduced in the acquirer's country (Columns (3)). Columns (4)-(5) show analogous results for CBNH MS acquisitions. The results show that the introduction of an LP does not have a significant effect on either DNH, CBH, or CBNH MS acquisitions, which is consistent

[41]The results for the aggregate value of MS acquisitions are very similar and reported in Table E6 the online Appendix.

with the idea that firms acquire MS stakes in rivals in order to react to the destabilizing effect of the LP on collusive agreements.

4.3 The Deterrent Effect of the LP

As mentioned above, we expect firms to respond to the introduction of an LP only when the LP is effective in destabilizing collusive agreements. We examine this issue in Table 5 where we interact the LP and After LP dummies with dummies that control for the deterrent effect of the LP. In Column (1), we interact the LP and $After\,LP$ dummies with the AMPI dummy that reflects the efficacy of antitrust enforcement. In Column (2), we interact the LP and $After\,LP$ dummies with the "Criminal Sanctions" dummy that reflects whether cartels enforcement is subject to criminal sanctions. In Column (3), we interact the LP and $After\,LP$ dummies with the CCR dummy that reflects the level of corruption. The control group in Table 5 includes all pre-LP years.

The results in Table 5 show that, as expected, the introduction of an LP affects MS acquisitions only in countries with effective antitrust enforcement, where cartel enforcement is subject to criminal sanctions, and where the level of corruption is low.[42] Expressed in terms of percentage points increase (again using the transformation $100 \times (e^{\beta} - 1)$, where β is the value of the relevant coefficient) relative to the pre-LP years (the control group), the effects are now much larger than they are for the entire sample. In particular, the LP is associated with an increase of 57% in the number of new domestic horizontal MS acquisitions when antitrust enforcement is effective, 84% when cartels enforcement is subject to criminal sanctions, and 58% when the level of corruption is low.

[42]One might worry that the AMPI and CCR indices are correlated with the general development of a country. Although this correlation may not bias our estimations given that we use country fixed effects and given that our macroeconomic and financial variables control for the level of development, we also ran the estimations from Table 5 with a subsample of only developed countries, using the United Nations's Human Development Index (HDI) as a measure for a countries development status. The results, presented in Table E3 the online Appendix, remain fully robust. One may also wonder whether the effect of antitrust on MS acquisitions is nonlinear as there should be only a few collusive agreements when antitrust enforcement is very effective, and hence little need for MS acquisitions once an LP is introduced. In Table E7 in the online Appendix we examine this possibility by interacting the LP dummy with terciles of the AMPI values, but find a significant effect only for the top tercile.

Table 5: ZINB estimations of the number of new domestic horizontal MS acquisitions - LP effectiveness

	(1)	(2)	(3)
LP × Effective Enforcement	0.45***		
	(0.16)		
After LP × Effective Enforcement	0.10		
	(0.17)		
LP × Ineffective Enforcement	-0.01		
	(0.19)		
After LP × Ineffective Enforcement	-0.08		
	(0.30)		
LP × Criminal Sanctions		0.60***	
		(0.22)	
After LP × Criminal Sanctions		0.32	
		(0.25)	
LP × No Criminal Sanctions		0.12	
		(0.20)	
After LP × No Criminal Sanctions		-0.16	
		(0.21)	
LP × Low Corruption			0.46***
			(0.16)
After LP × Low Corruption			0.06
			(0.18)
LP × High Corruption			0.10
			(0.18)
After LP × High Corruption			0.07
			(0.31)
Year FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Macroeconomic covariates	Yes	Yes	Yes
Financial covariates	No	Yes	Yes
F-test	0.00	0.00	0.00
R^2	0.67	0.67	0.66
Observations	1008	1018	1018

Notes: Standard errors clustered at the country level in parenthesis. Inflation equation is reported in the online Appendix. The macroeconomic and financial covariates are as in Table 2. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

4.4 Stake Size

As the results in Section 4.1 show, the introduction of an LP has a much larger effect on the aggregate deal value of domestic horizontal MS acquisitions than on their sheer number. There are two potential reasons for this: (i) in the year in which an LP is introduced, firms acquire larger stakes in rivals than in other years, so the average deal value of MS acquisitions is also larger, and (ii) in the year in which an LP is introduced, firms acquire MS stakes in larger rivals, which are worth more money. In the next two subsections we explore these possibilities.

To examine the size of acquired MS stakes, we split the domestic horizontal MS acquisitions in our data into three groups. The first group includes acquisitions of small stakes of up to 10%; such acquisitions are typically viewed as passive and do not trigger merger notification.

The second group includes acquisitions of medium size stakes of 10% – 25%. Although such acquisitions have to be notified in some countries, in practice they are almost never subject to merger investigation (European Commission, 2016). The third group includes acquisitions of large stakes of 25% – 50%, which are typically no longer considered to be passive and hence attract antitrust scrutiny (European Commission, 2016).

Table 6 shows the distribution of new domestic horizontal MS acquisitions in terms of their number and aggregate deal value. For each size interval, the table also shows the average and the median size of the target firm in millions of dollars, where firm size is computed by dividing the dollar value of the acquisition by the size of the acquired stake.

Table 6: Size intervals of new domestic horizontal MS acquisitions by the stake size

Size interval	Number of acquisitions	%	Aggregate deal value in m USD	%	Average size of target in m USD	Median size of target in m USD
0 - 10%	2,217	20.7	35,684	21.1	401	65
10 - 25%	3,928	36.7	59,829	35.5	176	29
25 - 50%	4,554	42.6	73,205	43.4	97	17
Total	10,699	100	168,718	100	201	29

To interpret Table 6, note that if the number of MS acquisitions was uniformly distributed among all stake sizes from 0% to 50%, 20% of all new domestic horizontal MS acquisitions would be of 10% or less, 30% would be in the range of 10% – 25%, and 50% would be in the range of 25% – 50%. Table 6 shows that indeed, the distribution of the number of MS acquisitions is close to uniform.[43] The average stake which is being acquired is 23%. As for the size of targets, Table 6 shows that acquisitions of small stakes of up to 10% are in large firms that are worth on average 401 million dollars, acquisitions of medium size stakes of 10% – 25% are in targets that are worth on average 176 million dollars, and acquisitions of large stakes of 25% – 50% are in targets that are worth on average only 97 million dollars. In all three cases, the median is well below the average, implying that the distribution of target sizes is skewed to the right.

Table 7 shows results from separate estimation of our baseline model for each of the three size groups. Relative to two years and more before the introduction of the LP (the control group), there is now a significant increase in the number of new domestic horizontal MS

[43] If we consider increases of already existing MS stakes, then in 9% of all acquisitions, the acquirer's final stake is up to 10%, in 36% of all MS acquisitions it is 10% – 25%, and in 55% of all acquisitions the acquirer's final stake is 25% – 50%. The median size of the initial stake before the acquisition is around 15%.

acquisitions in the year of introduction, but only in the case of stakes of 10% – 25%. The effect on stakes below 10% is similar in size but not significant, and there seem to be no effect on stakes above 25%.[44] Expressed in terms of percentage points, the LP is associated with a 52% increase in the number of MS acquisitions of stakes of 10% – 25%, compared with only a 40% increase for the entire sample (based on the coefficient in Column (3) in Table 2).

The results in Table 7 are consistent with our earlier findings: to have an substantial competitive effect, the acquired stakes must be large, but at the same time, if firms are colluding, they prefer to stay "under the radar," and hence acquire stakes of no more than 25%, which typically do not attract antitrust scrutiny.

Table 7: ZINB estimations of the number of new domestic horizontal MS acquisitions by stake size

	(1) 0-10%	(2) 10-25%	(3) 25-50%
LP-1	0.09	0.29	0.01
	(0.20)	(0.18)	(0.14)
LP	0.38	0.42**	0.12
	(0.27)	(0.17)	(0.16)
LP+1	0.42	0.16	0.22
	(0.27)	(0.22)	(0.16)
After LP+1	0.35	0.12	0.10
	(0.29)	(0.25)	(0.19)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Macroeconomic covariates	Yes	Yes	Yes
Financial covariates	Yes	Yes	Yes
F-test	0.00	0.00	0.00
R^2	0.57	0.59	0.60
Observations	1018	1018	1018

Notes: Standard errors clustered at the country level in parenthesis. Inflation equation is reported in the online Appendix. The macroeconomic and financial covariates are as in Table 2. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

4.5 Target Size

We next turn to the possibility that in the year in which an LP is introduced, firms acquire stakes in larger rivals. As before we measure the size of targets by dividing the value of the acquisition by the size of the acquired stake. We then classify target firms as either small or large, depending on whether their size is below or above the median of all target firms in their country. The results are reported in Table 8, where the dependent variable is the number of

[44] If we split the MS acquisitions in our data into five groups instead of three: 0% – 10%, 10% – 20%, 20% – 30%, 30% – 40%, and 40% – 50%, we get a significant increase in the number of new domestic MS acquisitions only when the acquired stakes are in the range of 10% – 20%.

MS acquisitions in small rivals in Column (1) and in large rivals in Column (2).[45]

Table 8: ZINB estimations of the number of new domestic horizontal MS acquisitions by rival size (below or above median)

	(1) Small firms	(2) Large firms
LP-1	0.14	-0.15
	(0.19)	(0.17)
LP	0.02	0.45**
	(0.21)	(0.19)
LP+1	0.08	0.48*
	(0.19)	(0.25)
After LP+1	-0.04	0.16
	(0.24)	(0.27)
Country FE	Yes	Yes
Year FE	Yes	Yes
Macroeconomic covariates	Yes	Yes
Financial covariates	Yes	Yes
F-test	0.00	0.00
R^2	0.61	0.60
Observations	1018	1018

Notes: Standard errors clustered at the country level in parenthesis. Inflation equation is reported in the online Appendix. The macroeconomic and financial covariates are as in Table 2. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

Table 8 shows that in the year in which an LP is introduced, there is a significant increase in the number of MS acquisitions in large rivals, but not in small ones. Expressed in percentage points, the LP is associated with a 57% increase in the number of MS acquisitions of stakes in large firms, compared with a 40% increase for the entire sample (based on the coefficient in Column (3) in Table 2). This finding is consistent with Hellwig and Hüschelrath (2017) who find that large firms are often involved in cartel activity, and with Hoang et al. (2014) who find that large cartel members are most likely to become the chief witness under an LP.

4.6 Stake Size or Target Size?

Having shown that an LP is associated with a significant increase in the number of MS acquisitions which involve stakes of $10\% - 25\%$ is large firms, we now return to the question posed earlier: why does the introduction of an LP have a much bigger effect on the deal value of MS acquisitions than on their sheer number? Is it mainly because firms acquire larger stakes in rivals or because they acquire stakes in larger rivals?

As mentioned earlier, the average stake size of MS acquisitions over all years is 23%. It

[45]Unfortunately we cannot examine the effect of an LP on the size of the acquiring firm because the data set we use does not report this information.

therefore seems that firms do not buy larger MS stakes when an LP is introduced. To confirm this finding, we compute for each country the median stake size acquired in that country over all years, and then estimate our baseline specification separately for acquisitions of above median stakes and below median stakes. The results, presented in Table A4 in the Appendix, show that the introduction of an LP has a significant effect only on the acquisitions of below median stakes, but not of above median stakes.

5 Robustness

5.1 Outliers

One might be concerned that our results are driven, at least in part, by observations from some specific years or specific countries which are outliers and bias our results. We address this concern in Table A5 in the Appendix as follows. First, nine countries - Belgium, Finland, Latvia, Luxembourg, New Zealand, Poland, Romania, South Africa, and Switzerland - have introduced an LP in 2004. To check that our results are not affected by the large number of countries that introduced an LP in 2004, we re-estimate in Column (1) of Table A5 our baseline specification after dropping MS acquisitions from the nine countries that introduced an LP in 2004. Second, one might worry that our results are driven in part by the fact that many MS acquisitions in our data come from only three countries: the U.S., Japan, and Spain. In Column (2) of Table A5 we drop from the estimation MS acquisitions from the U.S., Japan, and Spain. Third, the EU has a supra-national LP program in addition to the national LPs in individual member states. In Column (3) of Table A5 we re-estimate our baseline specification without the EU countries.[46] Fourth, non-OECD countries may be structurally very different from OECD countries and hence not comparable. In Column (4) of Table A5 we drop non-OECD countries from the estimation.

Table A5 in the Appendix shows that as in our baseline specification, a national LP still has a positive effect on domestic horizontal MS acquisitions, but only in the year in which it is introduced. Moreover, the effect in Columns (1), (2), and (4), is similar in size to that in Table 2, albeit it is less significant which is not too surprising given that we have fewer observations. The effect in Column (3), which only applies to non-EU countries, is much larger than the

[46] In Tables E10 and E11 in the online Appendix we also present estimations where we control for the EU LP 1996 and it's revision in 2002. The results remain robust. We do not report results only for the subset of EU countries since most EU countries adopted an LP in 2002-2004 so there is not enough variation in the EU data.

effect in Table 2: expressing the effect as a percentage change relative to the control group, the increase in MS acquisitions in the year in which the LP is introduced is 73.3% for non-EU countries, compared with 35% – 40% for all countries (based on the LP coefficients in Columns (2)-(6) in Table 2). This could be due to the fact that the EU already had a supra-national LP program in place before most national LPs were introduced in the EU member states.

5.2 Reforms of Competition and Merger Law

It turns out that in fifteen countries in our data set, the LP was introduced along with competition law or merger law reforms.[47] These reforms are inconsequential for our analysis if they also destabilize collusive agreements, because we use the introduction of an LP only as a negative shock to collusive agreements. One might be still concerned however that some of these reforms may have affected the incentives of firms to engage in MS acquisitions for reasons that are unrelated to collusion. To address this concern, we will now control for various antitrust reforms, using four different country-specific dummies which we construct with data from Borell, Jimenez, and Garcia (2013) and Lel and Miller (2015).

In Column (1) of Table A6 reported in the Appendix we include in the estimation three dummies. The first two are "First Competition Law," which takes the value 1 for all years in which a country had a competition law in place and 0 beforehand,[48] and "Competition law reform 1," which takes the value 1 for all years after a country had reformed its competition law and 0 for all years prior to the reform. Four countries in our data set - Estonia, Lithuania, Netherlands, and Slovenia - had two competition law reforms during our sample period. The third dummy "Competition law reform 2," takes the value 1 in these countries for years after the second reform and 0 for years preceding the second reform.[49] In Column (2), we include in the estimation a dummy "Merger law reform," which takes the value 1 for all years after a

[47]Specifically, Austria, Brazil, Bulgaria, China, Czech Repulic, Finland, France, Iceland, Japan, Mexico, Luxembourg, Poland, Slovak Republic, and South Korea revised their competiton laws in the same year the LP was introduced, while Switzerland revised its merger law in the same year the LP was introduced. See Borell, Jimenez, and Garcia (2013) and Lel and Miller (2015).

[48]Before a competition law is enacted, competition policy is typically scattered in several different laws. See Medalla (2017) for a discussion about Philippenes which passed a competition law only in 2015.

[49]We do not have information on competition law reforms for eight countries in our data - Cyprus, Ecuador, Ireland, Latvia, Nigeria, Pakistan, Oman, Vietnam - and hence we drop them from the analysis. Of the 55 countries for which we have information, 36 had a reform before the LP was introduced, 15 had a reform at the same year that the LP was introduced, 7 had a reform after the LP was introduced, and 5 countries had a reform of their competition law but did not introduced an LP before 2013, which is the last year in our data.

country had reformed its merger law and 0 for all years prior to the reform.[50] In Column (3) we include in the estimation all four dummies. Finally, in Column (4) we exclude all countries that had any other reform in the year the LP was introduced.

The results in Table A6 in the Appendix show that neither of the four dummies is significant, and the results are by and large similar to those in Table 2 in all specifications. This suggests that the increase in MS acquisitions once an LP was introduced is driven by the LP itself rather than by other reforms that took place.

5.3 Endogeneity

Another potential concern about our results is that the introduction of an LP in a given country, as well as the increase in MS acquisitions in that country, may both be driven by some unobserved country-specific changes in the political or legal climate beside the antitrust reforms that we have considered in the previous section. To address this concern, we apply the identification strategy recently proposed by Lewbel (2012) for linear regression models containing an endogenous regressor, when no outside instruments is available. The method exploits model heteroskedasticity to construct instruments using the available regressors. As Lewbel (2012) shows, these instruments are particularly valid under assumptions that are satisfied when endogeneity is caused by an unobserved factor that affects both the dependent variable and an explanatory variable.[51] The results of the Lewbel IV estimations are reported in Table A7 in the Appendix.[52] The results do not suggest that endogeneity is a concern, and the effect of the LP variable remains significant.

5.4 Placebo

Finally, we run two types of placebo tests to exclude other possibilities that could drive our results. In this section we only report results for the number of new domestic horizontal MS acquisitions. Corresponding results for the aggregate deal value are similar and are reported in the online Appendix. First, an important assumption for our difference-in-differences estimation is that absent an LP, MS acquisitions in the treatment and in the control group would

[50] We exclude from the analysis in Column (2) seventeen countries for which we do not have information about merger law reforms. The seventeen countries are Bulgaria, Croatia, Cyprus, Ecuador, Estonia, Iceland, Jordan, Latvia, Lithuania, Nigeria, Oman, Romania, Russia, Slovak Republic, Slovenia, Ukraine, Vietnam.

[51] Lewbel (2018) shows that the assumptions required for the proposed estimator can also be satisfied when an endogenous regressor is binary as is the case with our LP dummy.

[52] A technical description of the required assumptions for the Lewbel IV estimation and a brief description on the procedure itself are provided on p.14 in the online Appendix.

have developed in parallel. Since in our case an LP has no permanent effect on MS acquisitions, the LP effect which we observe is unlikely to be driven by different trends. To add further confidence that the common trend assumption holds, we randomly assign to each country that has introduced an LP a placebo LP year which precedes the actual year of introduction. We then run the specification in Column (3) of our baseline specification in Table 2, using data on the number of new domestic horizontal MS acquisitions, and compare the resulting coefficient of the LP dummy with the true coefficient from Table 2. We repeat this procedure $1,000$ times. Figure 5 shows the distribution of the resulting placebo coefficients and their p-values. The vertical red line represents the value of the coefficient and the p-value of the LP coefficient of the actual sample. The placebo coefficients are centered around 0 (the mean is 0.055) and their p-values exceed 10% in 99% of the cases and always exceed the true p-value in Column (3) in Table 2, which is 0.019. This suggests that our results are not driven by differences in pre-treatment trends.

Another common concern in difference-in-difference estimation is that the standard errors may understate the standard deviation of the estimators due to serial correlation (Bertrand, Duflo and Mullainathan, 2004). Like the previous concern, this concern is also unlikely in our case, because we allow for arbitrary serial correlation by clustering standard errors at the country level. Nonetheless, we evaluate this concern by randomly assigning a placebo LP year to all countries in our data, including those that did not introduce an LP during our sample period. Moreover, we now allow the placebo LP year to be either before or after the actual year in which an LP was introduced. As before, we repeat the procedure $1,000$ times. The coefficients are again centered around 0 (the mean is now -0.014), and the p-values of the LP coefficient exceed 10% in 87% of the cases and exceeds the true p-values in 97.2% of the cases. As before, the placebo estimates are close to random chance, suggesting that our results are not caused by autocorrelation.

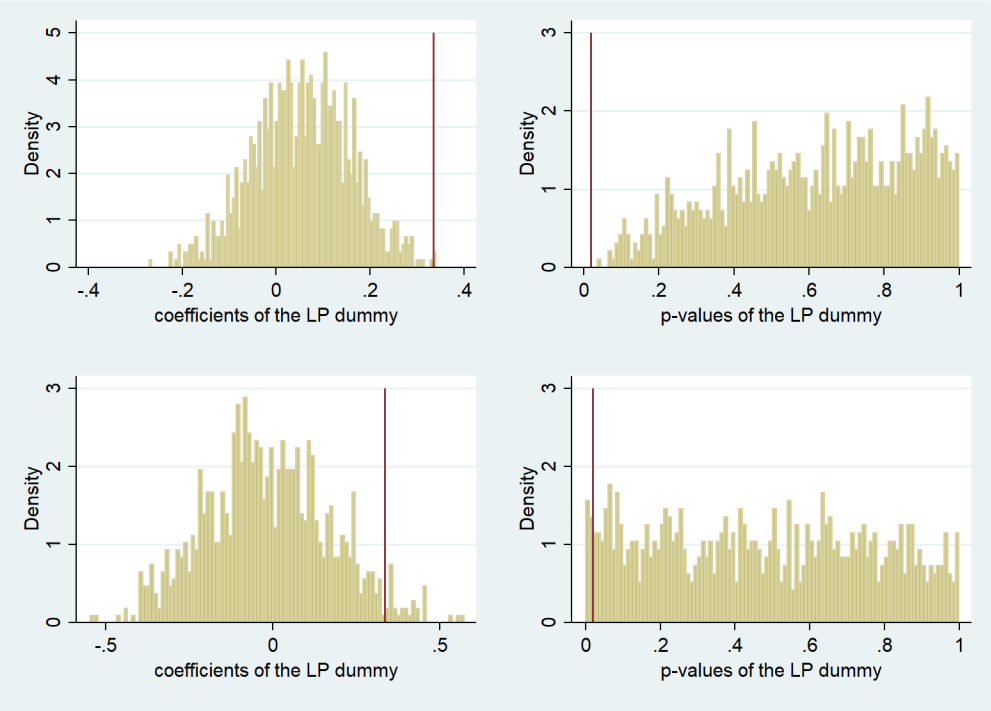

Figure 5: The LP coefficient and its p-value in the placebo tests for the number of new domestic horizontal MS acquisitions. Placebo LPs are either assigned only to pre-treatment years (the top panels) or to all years (the bottom panels)

6 Conclusion

We have addressed the growing concern that MS among rival firms may lessen competition. Our empirical strategy is based on the idea that LP's destabilize collusive agreements. Firms located in a country that has introduced an LP may then have an incentive to acquire MS stake in rivals to either stabilize their collusive agreements, or soften competition if collusion is going to break down anyway. Consistent with this idea, we find robust evidence that the introduction of a national LP is followed by a significant increase in the number of domestic horizontal MS acquisitions and in their aggregate value. The effect is large in magnitude: the number of domestic horizontal MS acquisitions increases by 41% in the year an LP is introduced, while the aggregate deal value increases by 105%. There is no similar effect on non-horizontal MS acquisitions or cross-border MS acquisitions, and moreover, no effect in countries with ineffective antitrust enforcement, where cartel infringement is not subject to criminal sanctions, and where the level of corruption is high; in such countries, the LP is unlikely to destabilize collusive agreements. Moreover, we observe a significant increase in MS acquisitions only in target firms with above-median market capitalization and only when the acquisition involves

stakes of 10% – 25%, which are large, but typically do not trigger merger investigation, and hence stay "under the radar."

Although the theoretical literature shows that by and large, MS acquisitions lessen competition, so far this possibility has received only little empirical support. Our paper provides evidence that MS acquisitions are used to lessen competition, especially when the acquisitions involve intermediate size MS stakes in large domestic rivals. Our results suggest that antitrust authorities should review such MS acquisitions, as is already done, to some extent, in some countries such as Austria, Germany, or the UK.

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A Appendix

The Appendix includes a model that motivates our empirical strategy; model fit tests for the choice of our empirical model; additional information on how we constructed our data set; data on the number and deal value of MS acquisitions; cross-country data on the year in which an LP was introduced in each country, the efficacy of antitrust enforcement, and the level of corruption in each country; and some additional robustness checks.

A.1 A Theoretical Model

The following simple model illustrates the logic of our empirical strategy; it shows that the introduction of an LP may destabilize collusive agreements, whereas the acquisition of MS in rivals may restore them. To this end, we build on the Aubert, Rey, and Kovacic (2006) model of leniency programs and consider an infinitely repeated duopoly, with an intertemporal discount factor $\delta \in (0,1)$. In each period, the two firms can collude, but if they do, they need to communicate with other. Communication is detected by the Competition Authority (CA) with probability ρ, in which case the two firms are convicted and pay a fine F. The gross profit of firm $i = 1,2$ is π_i^M under collusion, π_i^C under competition, π_i^D when firm i deviates unilaterally from a collusive agreement, and $\underline{\pi}_i$ if firm j deviates unilaterally from a collusive agreement, where $\pi_i^D > \pi_i^M > \pi_i^C \geq \underline{\pi}_i$ and $\pi_i^M + \pi_j^M > \max\left\{\pi_i^D + \underline{\pi}_j, \pi_j^D + \underline{\pi}_i\right\}$. That is, the two firms jointly benefit from collusion, but each firm benefits at the expense of the rival if it deviates from a collusive agreement. The expected fine ρF is not sufficiently large to deter collusion: $\pi_i^M - \pi_i^C > \rho F$ for $i = 1,2$.

Without an LP and MS, firm i has an incentive to collude only if the infinitely discounted sum of its collusive profits net of the expected cost of fines exceeds the one-time profit from deviation, net of the expected cost of fines, plus the infinitely discounted competitive profit, starting from the next period onward:

$$\frac{\pi_i^M - \rho F}{1-\delta} \geq \pi_i^D - \rho F + \frac{\delta \pi_i^C}{1-\delta}.$$

The incentive constraint reflects the idea that firms can continue to collude if they colluded in the past (even if collusion was detected they paid a fine) but once there is a deviation, they revert to the Nash equilibrium in all future periods. We can now rewrite the incentive constraint as

follows:

$$\delta \geq \delta_i \equiv \frac{\left(\pi_i^D - \rho F\right) - \left(\pi_i^M - \rho F\right)}{\left(\pi_i^D - f\right) - \pi_i^C} = \frac{\pi_i^D - \pi_i^M}{\left(\pi_i^D - \rho F\right) - \pi_i^C}. \tag{A-1}$$

As in the classic model of collusion, the right-hand side of (A-1) is the ratio between the gain from deviation, $\pi_i^D - \pi_i^M$, and the gap between the deviation profit, $\pi_i^D - \rho F$, and the competitive profit, π_i^C. Collusion can be sustained only if $\delta \geq \max\{\delta_1, \delta_2\}$, where the firm with the higher δ_i is the maverick firm, i.e., the firm with the more binding incentive constraint.

Under an LP, each firm enjoys a reduced fine f if it fully cooperates with the CA, where $f < \rho F$. Collusion then breaks down, so a firm which applies for leniency might as well deviate, since it will face competition afterwards anyway. The one-period payoff when deviating becomes $\pi_i^D - f$ instead of $\pi_i^D - \rho F$, so the condition for collusion becomes

$$\delta \geq \delta_i^{LP} \equiv \frac{\left(\pi_i^D - f\right) - \left(\pi_i^M - \rho F\right)}{\left(\pi_i^D - f\right) - \pi_i^C}, \qquad i = 1, 2. \tag{A-2}$$

Notice that an LP affects matters in this simple setup only by reducing the deviating firm's expected fine from ρF to f. Harrington (2008) refers to this effect as the "Deviator Amnesty Effect." It is easy to see that $\delta_i^{LP} > \delta_i$: an LP hinders collusion. Moreover, if $\delta_i^{LP} > \delta > \delta_i$ for at least one firm, collusion is feasible before an LP is introduced, but breaks down once an LP is in place. It should also be noted that δ_i^{LP} is increasing with ρF, implying that the LP is more effective in deterring collusion when the expected fine, ρF, is higher.

A.1.1 Collusion with Minority Shareholdings (MS)

Now, suppose that firm 1 holds a passive stake $\alpha_1 < 1/2$ in firm 2 and firm 2 holds a passive stake $\alpha_2 < 1/2$ in firm 1. These stakes give firms a share in their rival's profit, but no control over the rival's decisions. Using y_1 and y_2 to denote the stand-alone values of the two firms, their overall values, including their stakes in rivals, are defined by the following system:

$$V_1 = y_1 + \alpha_1 V_2, \qquad V_2 = y_2 + \alpha_2 V_1.$$

Solving the system, yields

$$V_1(\alpha_1, \alpha_2) = \frac{y_1 + \alpha_1 y_2}{1 - \alpha_1 \alpha_2}, \qquad V_2(\alpha_1, \alpha_2) = \frac{y_2 + \alpha_2 y_1}{1 - \alpha_1 \alpha_2}.$$

Note that each firm puts a larger weight on its own stand alone value than on the rival's stand alone value.[53]

Recalling that the gross profit of firm $i = 1, 2$ is π_i^M under collusion, π_i^C under competition, π_i^D when firm i deviates unilaterally from a collusive agreement, and $\underline{\pi}_i$ if firm j deviates unilaterally from a collusive agreement, the values of the two firms under collusion are

$$V_1^M(\alpha_1, \alpha_2) = \frac{\pi_1^M - \rho F + \alpha_1\left(\pi_2^M - \rho F\right)}{1 - \alpha_1\alpha_2}, \qquad V_2^M(\alpha_1, \alpha_2) = \frac{\pi_2^M - \rho F + \alpha_2\left(\pi_1^M - \rho F\right)}{1 - \alpha_1\alpha_2},$$

and their values under competition are

$$V_1^C(\alpha_1, \alpha_2) = \frac{\pi_1^C + \alpha_1\pi_2^C}{1 - \alpha_1\alpha_2}, \qquad V_2^M(\alpha_1, \alpha_2) = \frac{\pi_2^C + \alpha_2\pi_1^C}{1 - \alpha_1\alpha_2}.$$

When firm 1 deviates unilaterally from a collusive scheme, the values of the two firms are

$$V_1^D(\alpha_1, \alpha_2) = \frac{\pi_1^D - f + \alpha_1\left(\underline{\pi}_2 - F\right)}{1 - \alpha_1\alpha_2}, \qquad V_2^D(\alpha_1, \alpha_2) = \frac{\underline{\pi}_2 - F + \alpha_2\left(\pi_1^D - f\right)}{1 - \alpha_1\alpha_2},$$

and analogously when firm 2 deviates unilaterally. Notice that the deviating firm pays a reduced fine f, while the rival pays the full fine F.

With these values in place, the condition which ensures collusion becomes

$$\frac{\pi_i^M - \rho F + \alpha_i\left(\pi_j^M - \rho F\right)}{(1-\delta)\left(1 - \alpha_i\alpha_j\right)} \geq \frac{\pi_i^D - f + \alpha_i\left(\underline{\pi}_j - F\right)}{1 - \alpha_i\alpha_j} + \frac{\delta\left(\pi_i^C + \alpha_i\pi_j^C\right)}{(1-\delta)\left(1 - \alpha_i\alpha_j\right)}, \qquad i = 1, 2.$$

Using this inequality, the critical discount factor above which firm i is willing to collude is given by

$$\delta \geq \delta_i(\alpha_i) \equiv \frac{\left(\pi_i^D - f + \alpha_i\left(\underline{\pi}_j - F\right)\right) - \left(\pi_i^M - \rho F + \alpha_i\left(\pi_j^M - \rho F\right)\right)}{\left(\pi_i^D - f + \alpha_i\left(\underline{\pi}_j - F\right)\right) - \left(\pi_i^C + \alpha_i\pi_j^C\right)}. \tag{A-3}$$

As in the case of δ_i and δ_i^{LP}, the right-hand side of (A-3) is the ratio between the gain from deviation and the gap between the deviation profit and the competitive profit, but now the profits include firm i's share in firm j's profit.

In general, the profits, π_i^M, π_i^D, π_i^C, and $\underline{\pi}_j$ depend on α_i and on α_j because now firms internalize, at least partially, the competitive externality they impose on one another. Hence,

[53] Also note that while $V_1(\alpha_1, \alpha_2)$ and $V_2(\alpha_1, \alpha_2)$ sum up to more than $y_1 + y_2$, the share of "real" shareholders (not firms) in these profits is $(1 - \alpha_2) V_1(\alpha_1, \alpha_2) + (1 - \alpha_1) V_2(\alpha_1, \alpha_2) = y_1 + y_2$.

the right-hand side of (A-3) potentially depends on α_i in a complex way. To simplify matters, we will assume here that π_i^M, π_i^D, π_i^C, and $\underline{\pi}_j$ are independent of α_i. This holds for instance in the Bertrand model, where both firms have an identical per-unit cost c. Then, $\pi_i^M = \frac{\pi^m}{2}$, $\pi_i^D = \pi^m$ and $\pi_i^C = \underline{\pi}_j = 0$, where $\pi^m \equiv Q\left(p\right)\left(p-c\right)$ is the monopoly profit.

Now, straightforward differentiation establishes that

$$\begin{aligned}
\delta_i'\left(\alpha_i\right) \equiv & \frac{\left(\left(\underline{\pi}_j - F\right) - \left(\pi_j^M - \rho F\right)\right)\left[\left(\pi_i^D - f\right) - \pi_i^C - \alpha_i\left(\pi_j^C - \left(\underline{\pi}_j - \rho F\right)\right)\right]}{\left[\left(\pi_i^D - f + \alpha_i\left(\underline{\pi}_j - F\right)\right) - \left(\pi_i^C + \alpha_i \pi_j^C\right)\right]^2} \\
& - \frac{\left(\left(\underline{\pi}_j - F\right) - \pi_j^C\right)\left[\left(\pi_i^D - f + \alpha_i\left(\underline{\pi}_j - F\right)\right) - \left(\pi_i^M - \rho F + \alpha_i\left(\pi_j^M - \rho F\right)\right)\right]}{\left[\left(\pi_i^D - f + \alpha_i\left(\underline{\pi}_j - F\right)\right) - \left(\pi_i^C + \alpha_i \pi_j^C\right)\right]^2} \\
= & \frac{\left(\left(\underline{\pi}_j - F\right) - \left(\pi_j^M - \rho F\right)\right) - \delta_i\left(\alpha_i\right)\left(\left(\underline{\pi}_j - F\right) - \pi_j^C\right)}{\left(\pi_i^D - f + \alpha_i\left(\underline{\pi}_j - F\right)\right) - \left(\pi_i^C + \alpha_i \pi_j^C\right)} \\
< & \frac{-\pi_j^M + \rho F_j + \pi_j^C}{\left(\pi_i^D - f + \alpha_i\left(\underline{\pi}_j - F\right)\right) - \left(\pi_i^C + \alpha_i \pi_j^C\right)} < 0,
\end{aligned}$$

where the first inequality follows since $\delta_i\left(\alpha_i\right) \leq 1$ and since $\pi_j^C > \underline{\pi}_j - \rho F$, and the second inequality follows because $\pi_j^M - \pi_{ji}^C > \rho F$ for $j = 1, 2$. Hence, MS facilitate collusion by lowering the critical discount factor above which firm i is willing to collude. Intuitively, when firm i acquires an MS in firm j it internalizes the fact that a deviation from a collusive agreement lowers firm j's expected profit in the deviation period from $\pi_j^D - \rho F$ to π_j^C and lowers it in all subsequent periods from $\pi_j^M - \rho F$ to π_j^C.

A.1.2 The Reaction of Firms to the Introduction of an LP

Assuming that firms acquire MS stakes in rivals from atomistic shareholders, they gain from the acquisition only if their own value increases. The reason for this is Grossman and Hart's (1980) well-known free-rider problem: to induce atomistic shareholders to sell their shares, the acquirer must offer them the post-acquisition value of their shares. Hence, the acquirer breaks even on the acquisition. Assuming in addition that the acquisition entails some transaction costs, firms will acquire MS in rivals only if (i) the increase in their own value exceeds the transaction costs, and (ii) firms have no other way to boost their own value. In our simple setup, firms can boost their own values only by shifting the equilibrium from competition to collusion.

There are now few cases that can arise depending on the size of δ.

Case 1: If $\delta \geq \max\{\delta_1, \delta_2\}$, firms can collude before an LP is introduced without having to acquire MS in each other. If, after an LP is introduced, $\delta \geq \max\left\{\delta_1^{LP}, \delta_2^{LP}\right\}$, collusion is still feasible, so firms still do not need to acquire MS in each other. In this case, the introduction of an LP is not followed by MS acquisitions.

Case 2: If $\max\{\delta_1, \delta_2\} \leq \delta < \max\left\{\delta_1^{LP}, \delta_2^{LP}\right\}$, firms are able to collude before an LP is introduced, but not afterwards. Firms may now resort to MS acquisitions to restore their collusive agreements. Assuming without a loss of generality that $\delta_1^{LP} \geq \delta_2^{LP}$ (firm 1 is the industry maverick), there are two possible subcases:

(i) If $\delta < \delta_2^{LP}$, both firms need to acquire MS in each other to sustain collusion.

(ii) If $\delta_2^{LP} \leq \delta < \delta_1^{LP}$, only firm 1 needs to acquire an MS in firm 2 to sustain collusion.

In case (i), collusion can be sustained if there exist $\alpha_1 < 1/2$ and $\alpha_2 < 1/2$ such that $\delta \geq \max\{\delta_1(\alpha_1), \delta_2(\alpha_2)\}$. Since $\delta_1'(\alpha_1) < 0$ and $\delta_2'(\alpha_2) < 0$, the condition is satisfied if $\delta \geq \max\{\delta_1(1/2), \delta_2(1/2)\}$. Then, the introduction of an LP is followed by MS acquisitions by both firms, provided that the increase in firm value exceeds the transaction cost associated with MS acquisition.

In case (ii), collusion can be sustained if there exists $\alpha_1 < 1/2$ such that $\delta \geq \delta_1(\alpha_1)$, which is ensured if $\delta \geq \delta_1(1/2)$. When this condition holds, the introduction of an LP is followed by MS acquisitions by firm 1 in firm 2, again provided that the increase in firm 1's value exceeds the transaction cost associated with MS acquisition.

If there do not exist $\alpha_1 < 1/2$ and $\alpha_2 < 1/2$ such that $\delta \geq \max\{\delta_1(\alpha_1), \delta_2(\alpha_2)\}$, collusion cannot be sustained anymore when an LP is introduced even with MS. Given our assumption that π_1^C is independent of α_1 and π_2^C is independent of α_2, firms have no incentive to acquire MS in each other. However, if π_1^C increases with α_1 and π_2^C increases with α_2, the two firms may still wish to acquire MS in each other once an LP is introduced because these acquisitions soften competition once collusion breaks down.

Case 3: If $\delta < \max\{\delta_1, \delta_2\}$, collusion is not feasible before an LP is introduced without MS. Consequently, we may see MS stakes even before an LP is introduced if the acquisitions make collusion feasible and boost profits sufficiently or they make the non-collusive equilibrium less

competitive. The introduction of an LP may now be followed by an increase in the MS if this is necessary to keep collusion sustainable. However if there do not exist $\alpha_1 < 1/2$ and $\alpha_2 < 1/2$ such that $\delta \geq \max\{\delta_1(\alpha_1), \delta_2(\alpha_2)\}$, firms cannot collude once an LP is introduced and hence have no use for their MS stakes.

A.2 Tests and Statistics of the Model Fit

The following tables report results from model fit tests.[54] Specifically, we compare Poisson, Negative Binomial (NB), zero-inflated Poisson (ZIP) and zero-inflated Negative Binomial (ZINB) models for the number and the value of MS acquisitions. We use the Akaike Information Criteria (AIC) and the Bayesian Information Criteria (BIC), where a lower value means a better model fit. We also report the Likelihood-Ratio (LRχ^2) from boundary likelihood-ratio tests for nested models (Poisson vs NB and ZIP vs ZINB, respectively) and the Vuong test for non-nested models (Poisson vs ZIP and NB vs ZINB, respectively). The tests suggest that the ZINB models fit our data best.

Table A1a: Tests and statistics of the model fit for the number of new domestic horizontal MS acquisitions

	AIC	BIC	LRχ^2	Vuong
Poisson	6.20	-275		
NB	4.61	-1,881		
ZIP	6.04	-395		
ZINB	4.60	-1,852		
Preferred model	ZINB	NB		
Poisson vs. NB			1,613	
Preferred (p-val.)			NB (0.00)	
Poisson vs. ZIP				3.20
Preferred (p-val.)				ZIP (0.00)
NB vs ZINB				2.13
Preferred (p-val.)				ZINB (0.02)
ZIP vs ZINB			1,464	
Preferred (p-val.)			ZINB (0.00)	

[54]The program Countfit by Long and Freese (2014) is applied for the computation of tests and fit statistics.

Table A1b: Tests and statistics of the model fit for the number of new domestic horizontal MS acquisitions

	AIC	BIC	LRχ^2	Vuong
Poisson	119	114,829		
NB	7.83	1,396		
ZIP	93.45	88,591		
ZINB	7.68	1,279		
Preferred model	ZINB	ZINB		
Poisson vs. NB			113,000	
Preferred (p-val.)			NB (0.00)	
Poisson vs. ZIP				8.69
Preferred (p-val.)				ZIP (0.00)
NB vs ZINB				8.66
Preferred (p-val.)				ZINB (0.00)
ZIP vs ZINB			87,319	
Preferred (p-val.)			ZINB (0.00)	

A.3 Data Set Construction

The following table shows how we constructed the data set that we use in the paper and the number of observations that remained after each step.

Table A2: Construction of the data set on MS acquisitions

Step	Action	Remaining observations
1	All acquisitions in 63 countries during the period 1990-2013, where the final known stake remains below 50%	86,432
2	Eliminate share buybacks and self-tenders	78,897
3	Eliminate acquisitions with a sought final stake exceeding 50%	78,538
4	Eliminate acquisitions where the acquirer is an investor	49,253
5	Eliminate acquisitions where the target is an investor	47,675

	Breakdown of the MS acquisitions into types	Observations
	Domestic horizontal acquisitions	12,934
	Domestic non-horizontal acquisitions	19,749
	Cross-border horizontal acquisitions	7,689
	Cross-border non-horizontal acquisitions	7,303

A.4 Cross Country Data

This subsection contains data about the number and deal value of MS acquisitions and also information regarding the year in which an LP was introduced in each country and statistics about the efficacy of antitrust enforcement and the level of corruption. We begin with the following figures that show the distribution of the number of MS acquisitions and their aggregate deal value by country for the period 1990-2013.

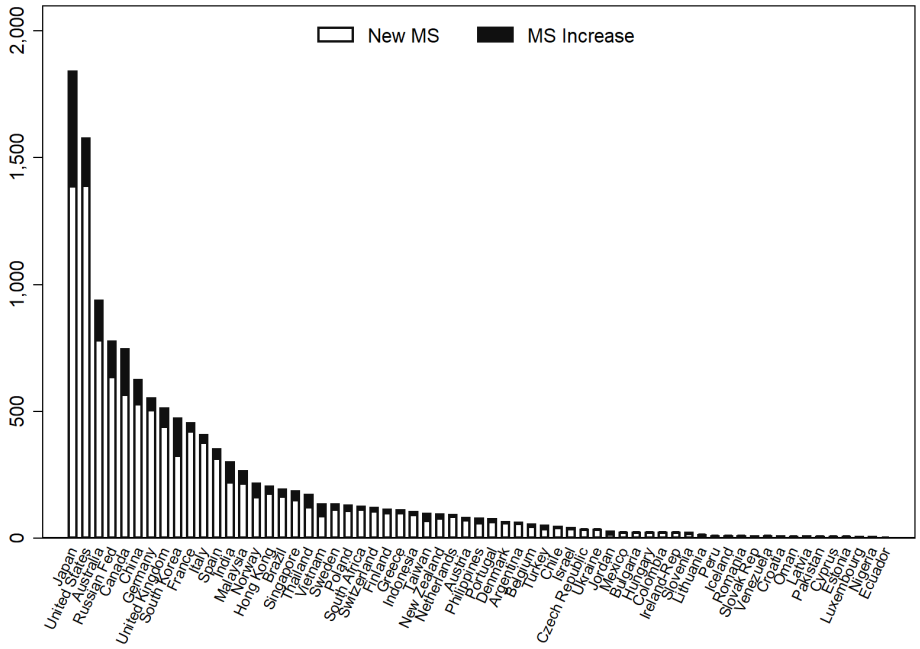

Figure A1: Number of MS acquisitions, new acquisitions and stake increases

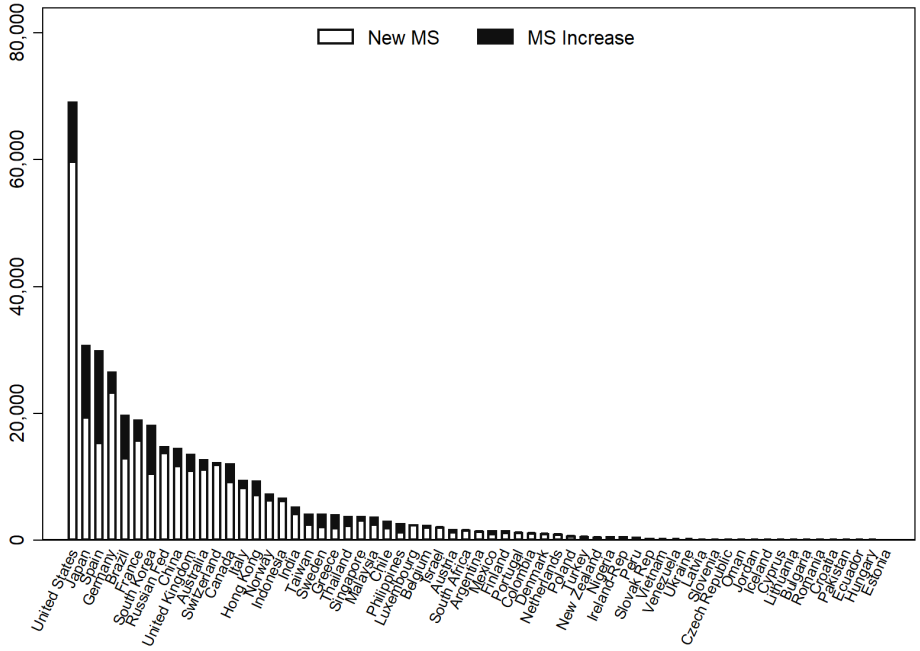

Figure A2: Value of MS acquisitions, in million USD, new acquisitions and share increases

The next table shows for each country that introduced an LP before 2013 the year of introduction. This information is largely taken from Dong et al. (2016). In addition, the table shows for each country the Anti-Monopoly Policy Index (AMPI) score provided by the World

Economic Forum (WEF), whether cartel infringements are subject to criminal sanctions, and the Control of Corruption (CCI) score computed by the World Bank. As mentioned earlier, the AMPI score is on a 1-7 scale, with 7 being the most effective enforcement and the CCI score is on a 0-100 scale, with 100 being the lowest level of corruption.

Table A3: Country-specific information on leniency programs and enforcement

Country	LP	AMPI	CCR	Criminal sanctions	Country	LP	AMPI	CCR	Criminal sanctions
Argentina	No LP	3.2	43.4	.	Luxembourg	2004	5.1	94.8	N
Australia	2003	5.3	94.6	Y	Malaysia	2010	4.7	63.1	N
Austria	2006	5.2	93.2	N	Mexico	2006	3.5	45.6	N
Belgium	2004	5.2	90.3	N	Netherlands	2002	5.8	96.7	N
Brazil	2000	4.5	57.9	Y	New Zealand	2004	5.5	98.9	N
Bulgaria	2003	3.3	52.8	N	Nigeria	No LP	3.9	10.5	.
Canada	2000	5.1	95.1	Y	Norway	2005	5.4	96.8	Y
Chile	2009	4.9	90.3	N	Oman	No LP	4.4	70.2	.
China	2008	4.1	39.5	N	Pakistan	2007	3.9	17.1	N
Colombia	2009	4.0	46.7	N	Peru	2005	4.0	47.6	Y
Croatia	2010	3.7	56.6	N	Philippines	2009	3.7	32.5	Y
Cyprus	2011	4.7	82.9	N	Poland	2004	4.2	70.3	N
Czech Republic	2001	4.5	69.2	N	Portugal	2006	4.5	83.6	N
Denmark	2007	5.4	99.8	Y	Romania	2004	3.7	47.0	Y
Ecuador	2011	3.0	26.2	N	Russia	2007	3.3	17.2	Y
Estonia	2002	4.6	79.8	Y	Singapore	2006	5.3	97.8	N
Finland	2004	5.7	99.3	N	Slovak Rep	2001	4.2	64.5	Y
France	2001	5.3	89.1	Y	Slovenia	2010	4.2	80.4	Y
Germany	2000	5.5	93.6	N	South Africa	2004	5.3	66.6	N
Greece	2006	4.0	64.9	Y	South Korea	1997	4.7	69.9	Y
Hong Kong	No LP	4.2	92.3	.	Spain	2008	4.5	85.4	N
Hungary	2003	4.1	72.4	N	Sweden	2002	5.7	98.4	N
Iceland	2005	4.8	96.6	Y	Switzerland	2004	5.1	96.5	N
India	2009	4.7	41.1	N	Taiwan	2012	5.0	74.6	N
Indonesia	No LP	4.6	22.3	.	Thailand	No LP	4.1	47.1	.
Ireland	2001	5.0	91.4	Y	Turkey	2009	4.6	54.7	N
Israel	2005	4.5	90.3	Y	Ukraine	2012	3.1	15.7	N
Italy	2007	3.8	67.1	N	United Kingdom	1998	5.4	93.8	Y
Japan	2005	5.3	87.4	Y	United States	1993	5.3	90.2	Y
Jordan	No LP	4.4	61.3	.	Venezuela	No LP	2.8	13.5	.
Latvia	2004	4.0	63.0	N	Vietnam	No LP	.	32.5	.
Lithuania	2008	3.8	65.8	N					

A.5 Estimation of the Number of New Domestic Horizontal MS by Stake Size

Table A4: ZINB estimations of the number of new domestic horizontal MS acquisitions by stake size (below or above median)

	(1) Small stakes	(2) Large stakes
LP-1	0.24	0.00
	(0.17)	(0.14)
LP	0.46**	0.15
	(0.20)	(0.16)
LP+1	0.29	0.20
	(0.22)	(0.18)
After LP+1	0.14	0.11
	(0.25)	(0.20)
Country FE	Yes	Yes
Year FE	Yes	Yes
Macroeconomic covariates	Yes	Yes
Financial covariates	Yes	Yes
F-test	0.00	0.00
R^2	0.59	0.64
Observations	1018	1018

Notes: Standard errors clustered at the country level in parenthesis. Inflation equation is reported in the online Appendix. The macroeconomic and financial covariates are as in Table 2. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

A.6 Outliers

Table A5: ZINB estimations for the number of new domestic horizontal MS acquisitions after dropping subsets of countries

Excluded countries:	LP in 2004	3 largest	EU	Non-OECD
LP-1	0.10	0.06	0.23	0.17
	(0.15)	(0.14)	(0.19)	(0.18)
LP	0.26*	0.28*	0.55***	0.39*
	(0.16)	(0.14)	(0.18)	(0.24)
LP+1	0.19	-0.00	0.38	-0.03
	(0.19)	(0.15)	(0.25)	(0.31)
After LP+1	0.03	-0.04	0.25	-0.11
	(0.21)	(0.18)	(0.28)	(0.36)
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Macro covariates	Yes	Yes	Yes	Yes
Financial cov.	Yes	Yes	Yes	Yes
F-test	0.00	0.00	0.00	0.00
R^2	0.65	0.65	0.66	0.64
Observations	875	958	645	560

Notes: Standard errors clustered at the country level in parenthesis. Inflation equation appears in the online Appendix. The macroeconomic and financial covariates are as in Table 2. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

A.7 The Effect of Reforms

Table A6: ZINB estimations of the number of new domestic horizontal MS acquisitions - controlling for reforms of competition and merger law

	(1)	(2)	(3)	(4)
LP-1	0.07	0.10	0.12	0.08
	(0.14)	(0.14)	(0.13)	(0.18)
LP	0.32*	0.27*	0.32**	0.31*
	(0.17)	(0.14)	(0.16)	(0.18)
LP+1	0.14	0.07	0.14	0.21
	(0.19)	(0.17)	(0.19)	(0.19)
After LP+1	0.07	-0.02	0.05	0.12
	(0.23)	(0.19)	(0.21)	(0.17)
First competition law	-0.16		-0.27	
	(0.24)		(0.25)	
Competition law reform 1	-0.02		-0.08	
	(0.22)		(0.21)	
Competition law reform 2	-0.23		0.27	
	(0.44)		(0.18)	
Merger law reform		0.26	0.22	
		(0.24)	(0.23)	
Country FE	Yes	Yes	Yes	
Year FE	Yes	Yes	Yes	
Macroeconomic covariates	Yes	Yes	Yes	Yes
Financial covariates	Yes	Yes	Yes	Yes
F-test	0.01	0.02	0.01	0.00
R^2	0.66	0.66	0.66	0.69
Observations	939	769	760	574

Notes: Standard errors clustered at the country level in parenthesis. Inflation equation is reported in the online Appendix. The macroeconomic and financial covariates are as in Table 2. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

A.8 Lewbel (2012) instrumental Variable Approach

To apply the Lewbel (2012) approach we replace the dependent variable with its logarithm to allow a comparison of the coefficients from the Lewbel IV with those from the ZINB estimations.[55] Column (1) shows results from an Lewbel IV estimation where we instrument for *LP* and *After LP*. As Lewbel (2012) shows, the model can be identified if the errors from a regression of the endogenous variable on covariates from the main model are heteroskedastic and the variance of these errors is correlated with at least some of the covariates but not with the covariances of these errors and the second stage errors. We test the heteroskedasticity requirement based on the residuals of the first stage regression, using a modified Wald statistic for groupwise heteroskedasticity as well as the Koenker (1981) version of the Breusch-Pagan test for heteroskedasticity. The tests lead us to reject the null hypotheses of constant variance and homoskedasticity as can be seen in Table A7. Moreover, the instruments are not correlated with the error term as shown by the Hansen J test.

However, the Kleibergen-Paap F-statistic is rather low suggesting that the instruments are too weak. This is because the *After LP* dummy is only weakly identified by the instruments as it does not vary after its introduction, regardless of the development of other things.[56]. In Column (2) we remove the *After LP* dummy and instead use three dummies. One which is equal to 1 for the three years before the LP (*LP-3 to LP-1*), one which is equal to 1 for the three years after the LP (*LP+1 to LP+3*), as well as the *LP* dummy which is equal to 1 for the year the LP is introduced. This specification gives a Kleibergen-Paap F-statistic which exceeds 1 and allows interpreting the results. The control group now also includes the post-LP period, but since the *LP 1 to 3* dummy is not significant, this should to introduce a bias. In Column (3) we interact the the LP dummies with dummies indicating whether a country has an effective or ineffective antitrust-authority based on the Anti-Monopoly Index (AMPI) introduced earlier.[57] In Column (4) we do the same as in Column (3) but this time use the Corruption Control Index and in Column (5) we interact the LP dummy with a variable indicating whether a country has criminal sanctions for cartel conduct or not.[58]

[55]Hence, zeros drop out in the estimation. However, the results are similar when alternative transformations of zero values are applied, e.g., adding small values to the dependent variable before computing logs.

[56]The First Stage F statistic is 3.44 for the *After LP* variable and 20.86 for the *LP* variable

[57]For each country we compute its average AMPI value and classify countries that have an average AMPI below the median of all countries as having an effective competition authority and those below the media as having an ineffective authority.

[58]A ZINB model with a residual inclusion control function cannot be applied in our case as it requires the endogenous regressors to be continuously distributed. See for instance Blundell and Powell (2003).

The estimates from the Lewbel IV also suggest that introducing LPs increases MS acquisitions. The LP has particularly an immediate effect and particularly if its introduced by an effective competition authority, in a country with low levels of corruption or in countries with criminal sanctions for cartel conduct. Nonetheless, the Durbin-Wu-Hausman test does not point towards an endogeneity issue as it fails to reject the null hypothesis of the LP introduction being exogenous.[59]

Table A7: Lewbel (2012) IV estimation of the log-number of new domestic horizontal MS acquisitions

	(1)	(2)	(3)	(4)	(5)
LP-3 to LP-1		0.06			
		(0.08)			
LP	0.11	0.19**			
	(0.10)	(0.08)			
LP+1 to LP+3		0.08			
		(0.09)			
After LP	-0.14				
	(0.17)				
LP×Effective Enforcement			0.19**		
			(0.08)		
LP×Ineffective Enforcement			0.12		
			(0.07)		
LP×Low Corruption				0.29***	
				(0.10)	
LP×High Corruption				0.19**	
				(0.08)	
LP×Criminal sanctions					0.44***
					(0.10)
LP×No criminal sanctions					0.01
					(0.08)
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Macroeconomic covariates	Yes	Yes	Yes	Yes	Yes
Financial covariates	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap F stat.	3.37	11.05	70.88	66.74	56.10
Hansen J stat. (p-val.)	0.41	0.63	0.12	0.25	0.51
Durbin-Wu-Hausman test for endogeneity (p-val.)	0.93	0.91	0.60	0.92	0.95
First-stage Wald test for group heteroskedasticity (p-val.)	0.00	0.00	0.00	0.00	0.00
First-stage Koenker score test for heteroskedasticity (p-val.)	0.00	0.00	0.00	0.00	0.00
Observations	739	739	731	739	739

Notes: Standard errors corrected for using generated instruments and robust to heterokedasticity in parenthesis. All LP variables are instrumented using Lewbel's (2012) heteroskedasticity based IV approach (LP, LP-1 to LP-3, LP+1 to LP+3, LP×Enforcement variables, LP×Corruption variables, and After LP). The macroeconomic and financial covariates are as in Table 2. $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$.

[59] InTables E8 and E9 in the online Appendix we report results from OLS and ZINB estimatations with the same set of variables for comparison.