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EFFECTIVE EUROPEAN ANTITRUST: DOES EC MERGER POLICY GENERATE DETERRENCE?

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We estimate the deterrence effects of European Commission (EC) merger policy instruments over the 1990-2009 period. Our empirical results suggest phase-1 remedies uniquely generate robust deterrence as – unlike phase-1 withdrawals, phase-2 remedies, and preventions – phase-1 remedies lead to fewer merger notifications in subsequent years. Furthermore, the deterrence effects of phase-1 remedies work best in high-concentration industries; i.e., industries where the HHI is above the 0.2 cut-off level employed by the EC. Additionally, we find phase-1 remedies do not deter clearly pro-competitive mergers, but do deter potentially anti-competitive mergers in high-concentration industries. (*JEL* K21, K40, L40)

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ABBREVIATIONS

DOJ: U.S. Department of Justice
EC: European Commission
EU: European Union
HHI: Herfindahl Hirschman Index
NAICS: North American Industry Classification System
NCAs: National Competition Authorities
OLS: Ordinary Least Squares
FTC: U.S. Federal Trade Commission

I. INTRODUCTION

The design and enforcement of competition rules is one of the cornerstones of European Union (EU) policy to support the European integration process and stimulate sustainable growth. In fact, the founding Treaty of Rome deemed that Member States would cede authority over competition issues to the European institutions, since this was considered to be essential for a well-functioning internal market. To support these objectives, the European Commission (EC) has been granted enhanced powers of enforcement in this field (Neven 2006). Nevertheless, the European environment for antitrust is characterized by a good bit of institutional complexity as in addition to the EC's Directorate-General for Competition, the 28 Member States of the EU also have national competition authorities (NCAs). Van Waarden and Drahos (2002) make clear the thresholds that demarcate the boundaries between the NCAs and the EC; but in essence, the EC has jurisdiction over community-wide competition matters, while the NCAs have jurisdiction over national-level competition matters. Accordingly, the EC represents both the lead antitrust agency in the European context (Barros et al. 2013) and the European peer with respects to the US DOJ and FTC (White 2014). Our focus here is then on the effectiveness of EC antitrust enforcement as the Commission represents the preeminent – though not sole – European antitrust agency.

Among the different sub-policies of antitrust enforcement (i.e., collusion, merger and abuse-of-dominance), this study focuses on EC merger policy.[1] While policy debate and academic studies on the effectiveness of merger control are often based on whether the correct decision is made in particular merger cases (e.g., Duso et al. 2007, 2011; Kwoka 2013), merger policy entails more than just direct effects from the detection, amelioration and prohibition of

[1]Buccirossi et al. (2013) study whether the enforcement of antitrust policy across 13 jurisdictions during the period 1995-2005 leads to enhanced efficiency and productivity. They find that institutional characteristics as well as enforcement efforts regarding merger control have a strong and significant effect on TFP growth. That said, they also show that institutions and enforcement activities related to 'abuse of dominance' and 'cartels' have even a greater impact.

anti-competitive merger activity. As many commentators agree (e.g., Nelson and Sun 2001; Davies and Majumdar 2002), direct effects might only represent the 'tip of the iceberg' when it comes to the overall impact of merger control, as substantial indirect effects also exist. In particular, indirect deterrence effects have been considered to be quite important, as firms are likely to internalize antitrust rules in their decision making and alter the types and frequencies of mergers they propose due to the presence – and changes in the tenor of – merger policy (Eckbo 1992; Crandall and Winston 2003). An effective merger policy should then create incentives that shape the behavior of firms in terms of violating these rules, since it is unreasonable (and inefficient) to assume that merger policy can thoroughly vet and police all of the applications for the antitrust laws (Baker 2003). Thus, the effects of merger policy are not limited to the specific firms targeted by merger control, but also include all firms whose behavior and performance might be affected – i.e., deterred – in the future by specific decisions and policies (Sørgard 2009; Salop 2013). In this vein, Joskow (2002, 99–100) notes that "the test of a good legal rule is not primarily whether it leads to the correct decision in a particular case, but rather whether it does a good job deterring anti-competitive behavior."

Since deterrence effects are so critical for effective merger policy, a small – but growing – literature exists that attempts to empirically capture merger-policy deterrence. Early empirical scholarship tended to employ broad comparisons in order to establish deterrence; e.g., Stigler (1966) compared changes in the composition of US merger activity in the years prior to and after the 1950 anti-merger amendment to the Clayton Act. Employing a similar approach, Eckbo and Wier (1985) considered changes in the composition of US activity with respect to the establishment of the Hart-Scott-Rodino (HSR) Act. In a later study, Eckbo (1992) compared US and Canadian merger activity (during a period where the US enforced and Canada lacked effective merger policy) in order to consider whether US transactions tended to be less anti-

competitive. Yet recent empirical scholarship has moved beyond such before/after and having/not-having comparisons in order to engage in specific analysis regarding the effectiveness of different merger-policy instruments. In particular, Seldeslachts et al. (2009) studied the general effectiveness of different merger-policy instruments across 28 antitrust jurisdictions and found prohibitions to uniquely yield deterrence in the cross-national context. In a follow-up study, Clougherty and Seldeslachts (2013) narrowed the scope of analysis to the industry level within arguably the most-important antitrust jurisdiction by considering the deterrence effects of US merger-policy instruments. Akin to the approach of Eckbo (1992) and Eckbo and Wier (1985), Duso et al.'s (2013) small-scale study considered whether EC merger-policy yields deterrence in the form of altered merger proposals in subsequent years; i.e., whether the mergers offered up were more likely to harm non-merging rival firms. To date, however, there has not been an equivalent industry-level deterrence study to the comprehensive US study of Clougherty and Seldeslachts (2013) that focuses on the European Commission: the preeminent European antitrust agency.

The principal aim of this study, therefore, is to investigate whether the employment of EC merger-policy instruments over the past two decades has yielded effective deterrence. Accordingly, we study the impact of EC merger-policy actions on firms' proclivity to engage in future merger activity at the industry-level. We concentrate on the ability of different merger-policy tools to generate forsaken merger activity; i.e., deals not proposed by potential merging parties. We also investigate whether EC merger policy yields greater deterrence in high-concentration than in low-concentration industries, as effective deterrence would seemingly involve merger-policy actions generating greater deterrence in high-concentration industries since such mergers would more likely to hinder effective competition. In addition, we consider whether EC merger-policy actions principally deter transactions that are potentially anti-

competitive as opposed to transactions that are clearly pro-competitive. Since the EC provides separate procedures for the notification of pro-competitive transactions, we can establish the population of transactions that are clearly pro-competitive and the population within which anti-competitive mergers may arise. Moreover, effective deterrence would seemingly involve merger-policy actions deterring potentially anti-competitive transactions in high-concentration industries.

For the above purposes, we gathered information regarding all mergers notified to the EC from 1990 until 2009 – over 4,200 mergers – and regarding the type and frequency of merger-policy actions taken by the EC: i.e., clearances, remedies, and prohibitions. We are also able to distinguish whether merger-policy actions took place in initial or secondary phases of the merger-review process. The ability to differentiate between different merger-policy actions at different stages is helpful as such differences can involve different costs for firms and, therefore, generate distinct deterrence effects (Seldeslachts et al. 2009; Salop 2013). We were also able to gather more precise information regarding the type of mergers (clearly pro-competitive and potentially anti-competitive) notified to the EC for the 2000-2009 period—a period where the EC created a 'simplified' track for pro-competitive merger notifications. The high level of detail involved with the EC merger reports suggests that our constructed database represents the best available data upon which to assess the industry-level deterrence effects generated by merger-policy actions.

The contributions of our study are threefold. First, we begin the process of factoring whether EC merger policy deters merger activity; thus, we begin the quantification of what has until now been un-quantified in the context of the European Commission. Second, we are able to examine which particular merger-policy instruments – and at what stage of the merger-review process – indicate substantial deterrence, and whether deterrence works better in those industries

where it might be most useful. As Crandall and Winston (2003, 4) argue, scholarship must "explain why some enforcement actions [...] are helpful and others are not." Third, we can investigate whether EC merger-policy instruments deter future merger notifications of the type (i.e., a subset of the horizontal and vertical activities) that EC officials consider to be potentially anti-competitive, or whether these instruments deter future activities that EC officials consider to be clearly pro-competitive. The remaining sections of the paper are structured as follows: Section II describes our deterrence framework. Sections III and IV respectively explain the data and estimation strategy. Section V discusses the empirical results, while Section VI concludes and provides some prescriptions regarding effective merger policy.

II. A DETERRENCE FRAMEWORK

We measure the deterrence effects of EC merger policy by employing the methodology from the economics of crime literature spawned by Becker (1968)—see Ehrlich (1972), Polinsky (1980), Shepherd (2004) and Dezhbakhsh and Shepherd (2006) for other studies in this tradition. In this framework, enforcement actions make criminals update their probabilities of being caught and their estimations of the punishments attached with being caught. The proposal of an anti-competitive merger is, of course, no crime in the strict sense, but the deterrence mechanism is analogous in this environment as undesirable actions are 'punished'. Effective deterrence requires those tempted by anti-competitive actions to believe that there is a reasonable probability that transgressing those rules leads to being caught and suffering consequences (Craswell and Calfee 1986; Baker 2003). As noted in the theoretical framework of Seldeslachts et al. (2009), changes in merger-policy actions represent manifestations of actual changes in merger policy. In this framework, firms update their beliefs regarding an authority's stance when they witness upticks and downticks in policy actions. For example, upticks in the

application of a particular merger-policy action lead to positive updating on the part of firms with respect to the probability of eliciting such an action in the future. Sah (1991) shows the above properties are satisfied when perceptions are described by Bayesian inference. Accordingly, the methodological framework from the economics of crime literature provides a sound means for a specific analysis of the deterrence effects involved with different EU merger-policy instruments (Garoupa 1997; Berk 2005).

With the above in mind, we can generate our empirical setup where we consider the impact of changes in merger-policy actions on future levels of notified merger activity. Our framework is based on the idea that if deterrence exists, then a positive change in merger-policy actions should signal to future merging parties that the expected cost of proposing an anti-competitive merger has increased; in turn, a proportion of the planned anti-competitive transactions will be forsaken. Accordingly, there should be a negative relationship between merger-policy actions and levels of proposed merger activity in subsequent years. Further, if deterrence is not at play (e.g., if a particular merger-policy instrument is not perceived by merging parties to be costly), then we should see no relationship between merger-policy actions and levels of proposed merger activity in subsequent years.

We must control for potential confounding factors; hence, the next section explains how we capture the merger wave, as this is an essential element in our empirical strategy to isolate deterrence effects. But our focus on changes in the frequency of future merger activity also raises the issue as to which merger types tend to be forsaken. Aaronson (1992) points out that deterrence manifests in two forms: frequency-based deterrence which focuses on forsaken mergers, and composition-based deterrence which focuses on future mergers being modified and shaped differently. Moreover, some scholars have expressed the concern that pro-competitive mergers are often deterred by antitrust (e.g., Eckbo 1989, 1992). It seems, however, more

probable that altering the tenor of merger policy would significantly impact anti-competitive activity. In line with this intuition, the Deloitte and Touche (2007) study for the UK Office of Fair Trading provides evidence via surveys that UK merger policy rarely deters pro-competitive mergers. More recently, Baarsma et al. (2012) completed a similar survey for the Dutch antitrust authority and confirmed this point regarding the rarity of pro-competitive mergers being deterred. Additionally, Clougherty and Seldeslachts (2013) find that changes in the tenor of US merger policy affect future horizontal merger activity but do not affect future non-horizontal merger activity. Since US authorities almost exclusively target horizontal merger activity as potentially anti-competitive, these results also support the idea that merger control does not deter anti-competitive mergers.

While the pre-existing empirical scholarship indicates that anti-competitive mergers are principally affected by changes in the tenor of merger control, we can extend our empirical setup in two directions so as to provide some additional evidence that this remains the case in the EC merger-policy context. First, we can differentiate between low-concentration and high-concentration industries, as mergers occurring in high-concentration industries are potentially more likely to be anti-competitive and impair effective competition in a market. The EC – and other antitrust authorities – employs such a logic in its initial-screening process, as it routinely clears mergers in low-concentration industries based on industry HHI and the market shares of firms, but takes a closer look at mergers notified in high-concentration industries.[2] While we will differentiate between low-concentration and high-concentration industries via HHI, the premise behind this extension is that effective EC merger policy would seemingly be

[2] In its horizontal merger guidelines (EC 2004, 6), the EC states that "The overall concentration level in a market may also provide useful information about the competitive situation. In order to measure concentration levels, the Commission often applies … HHI ... [as the] level of the HHI can give an initial indication of the competitive pressure in the market post-merger."

characterized by merger-policy actions involving a larger deterrence effect in high-concentration – as compared to low-concentration – industries.

Second, we can consider whether it is the horizontal and vertical merger activity considered by the EC to be potentially anti-competitive which is principally deterred by EC merger policy. Akin to the Clougherty and Seldeslachts (2013) setup, this differentiation takes advantage of the fact that EC officials deem certain horizontal and vertical mergers (i.e., non-conglomerate activity) to be the population within which anti-competitive mergers can arise, while the EC does not consider conglomerate merger activity – and certain types of horizontal and vertical merger activity – to generally raise competitive issues. We do, however, face the limitation that we can only identify these differences in clearly pro-competitive and potentially anti-competitive merger activity for a subset (2000-2009) of our data sample.

III. DATA

The employed data are panel in nature (where each industry sector represents a panel with observations from 1990 to 2009) and consist of matching two separate sources. First, the EC's webpage yields data on the frequency and type of notified mergers and the number of merger-policy actions at the sector-year level of analysis. Second, Thomson Reuter's Worldscope database allows compiling the necessary merger-wave controls at the sector-year level.

A. Merger and Merger Control Data

The principal source of information derives from the publicly accessible cases published by the Directorate-General Competition (DG Comp) of the EC on its webpage.[3] The entire history of European merger control – from its inception with the 1990 EU merger regulation – is

[3] The types of notified mergers, decisions taken, and reports for each of the EC's decisions can be downloaded from: http://ec.europa.eu/competition/mergers/cases/; http://ec.europa.eu/competition/mergers/legislation/simplified_procedure.html.

represented in these case files. To better understand the nature of this rich information, it is useful to briefly summarize the EC merger-control process.

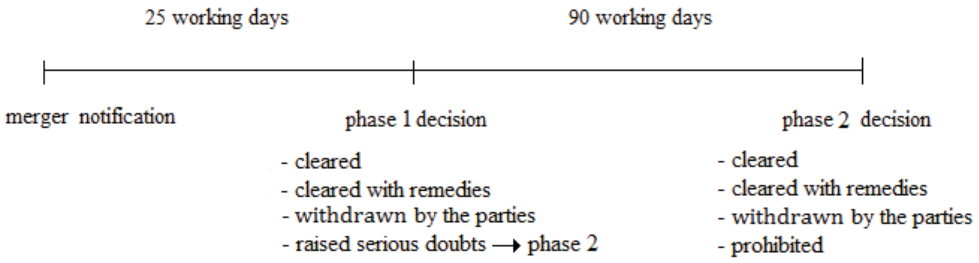
Mergers affecting European markets must be notified to the EC when the deal involves an EU community-wide dimension.[4] As an aside, smaller deals that generate competitive implications relevant to the national markets within the 28 Member States of the EU will be handled by the NCAs; hence, these are merger-policy proceedings beyond our current scope (see Van Waarden and Drahos 2002 for an explanation of European jurisdictional boundaries). As represented in Figure 1, the EC has 25 working days to make an initial assessment after receiving notification of the merger—the so-called 'phase-1 investigation'. This phase can be extended to 35 working days when merging firms submit potential remedies or if Member States request (or are requested to) referral of the case. Following this preliminary investigation, the EC can clear the proposed merger if it does not significantly impede competition ('phase-1 clearance'), or decide to accept remedies proposed by merging firms ('phase-1 remedy'). This occurs when the proposed commitments – e.g., divesting some problematic assets to a competitor – would attenuate the anti-competitive issues. The EC can also conclude that the proposed concentration raises competition issues that are not solved by the proposed remedies; if the case, then the EC initiates a more in-depth analysis ('phase-2 investigation'). Merging parties will also sometimes withdraw their proposed merger during the initial investigation phase ('phase-1 withdrawal').

Phase-2 investigations can go for a maximum of 90 working days. After this more detailed investigation, the EC can again unconditionally clear the merger ('phase-2 clearance'), clear the merger conditional on commitments ('phase-2 remedy'), or prohibit the merger ('phase-2

[4] A merger has an EU community dimension if "(i) It takes place between firms with a combined worldwide turnover of at least 5 billion Euros and, (ii) a turnover within the European Economic Area of more than 250 million Euros for each of at least two of the participating firms (unless each merging firm achieves more than 2/3 of its aggregate community turnover within one and the same Member State)." (Council Regulation No 139/2004 of 20 January 2004).

prohibition'). The merging parties may also withdraw the merger in the second phase ('phase-2 withdrawals'). Commentators (e.g., Bergman et al. 2003) have argued that withdrawing a merger in the second phase represents a virtual prohibition, as merging parties often formally withdraw a merger before an actual prohibition is commuted. For instance, GE's acquisition of Honeywell was officially a phase-2 withdrawal, as the EC's conditions for allowing the merger to proceed represented an 'effective prohibition' of the transaction (Clougherty 2005). Given that both phase-2 prohibitions and phase-2 withdrawals suggest a failure to find acceptable remedies that alleviate anti-competitive concerns, we aggregate phase-2 prohibitions and phase-2 withdrawals into 'phase-2 preventions'. Nevertheless, unreported estimations that keep both policy instruments separate yield qualitatively-identical results.

FIGURE 1
The Timing of European Merger Control



We analyze the first two decades of EC merger control (1990–2009) where a total of 4,284 mergers were notified to the Commission authorities. We have information on the name of the merging firms, the notification date, the type and date of the EC's decision(s), and the main industry affected by the merger. Industries are identified with NACE codes: a classification scheme used by the EU to categorize economic activities. After the relevant matching and selection processes, we have 37 NACE industries covering 1990-2009; thus, our unit of analysis

is a particular industry (m) in a particular year (t).[5] Table 1 reports the exact definition of our measures of merger activity and merger-policy actions.

TABLE 1
Definition of the Variables

Variable	Definition
NT_{mt}	# of total mergers notified to the EC in industry m in year t
NA_{mt}	# of potentially anti-competitive mergers notified to the EC in industry m in year t
NP_{mt}	# of clearly pro-competitive mergers notified to the EC in industry m in year t
$R1_{mt}$	# of mergers where remedies are applied in phase-1 in industry m in year t
$W1_{mt}$	# of mergers withdrawn by the merging firms in phase-1 in industry m in year t
$R2_{mt}$	# of mergers where remedies are applied in phase-2 in industry m in year t
$P2_{mt}$	# of preventions (prohibitions plus withdrawals) in phase-2 in industry m in year t
Sales Growth$_{mt}$	Mean of sales growth over a 2-year period for all firms i present in industry m in year t (as defined in Andrade and Stafford, 2004): $(sales_{imt} - sales_{imt-2})/sales_{imt-2}$
Share Return$_{mt}$	Mean of annual return on shares for firms i in industry m in year t: $(market\ value_{imt} - market\ value_{imt-1})/market\ value_{imt-1}$
Tobins Q$_{mt}$	Mean Tobin's Q for firms i in industry m in year t: $\frac{\text{asset value}_{imt}+\text{market value equity}_{imt}-\text{book value equity}_{imt}}{\text{asset value}_{imt}}$, where: $market\ value\ equity_{imt} = common\ stock\ outstanding_{imt} \times average\ closing\ price_{imt}$
HHI_{mt}	Herfindahl-Hirschman-Index in industry m in year t based on the sales for all firms i in industry m in time t: $HHI_{mt} = \sum_{i \in m} \left(\frac{sales_{imt}}{totalsales_{mt}}\right)^2$
Beta$_{mt}$	Captured by the time-industry-specific coefficients, $Beta_{mt}$, that are estimates from an OLS regression of variable profits on average costs for all firms i within industry m in year t: $\ln \pi_{imt} = \alpha + Beta_{mt}\frac{c_{imt}}{p_{imt}} + \varepsilon_{imt}$. Variable profits are defined as $\pi_{imt} \approx \text{sales}_{imt} - \text{cost of goods sold}_{imt}$, whereas average variable costs are defined as $\frac{c_{imt}}{p_{imt}} = \frac{c_{imt}q_{imt}}{p_{imt}q_{imt}} \approx \frac{cost\ of\ goods\ sold_{imt}}{sales_{imt}} = AVC_{imt}$.

Figure 2 illustrates the total number of mergers notified to the EC by year for all industries, and indicates that merger behavior follows a characteristic wave-like pattern. During the 1990s,

[5] Many industries exhibit a complete lack of merger-policy activity. Such industries do not help identify the deterrence effects of active enforcement, as deterrence in our framework functions via firms updating their beliefs about the EC's stance through actual changes in merger-policy actions. Therefore, we exclude inactive industries from our analysis by dropping industries where we observe 2 or less merger-policy actions over the two decades (1990-2009) of our data sample.

the number of merger notifications steadily increased. Yet following the burst in the dotcom bubble, we see a reversal in this trend through 2000-2003. Merger activity levels began to rise again after 2004 and reached a peak in 2007; though, the number of merger notifications indicates a significant downward trend with the financial crisis of 2008-2009.

FIGURE 2

Number of Notified Mergers per Year for All Industries

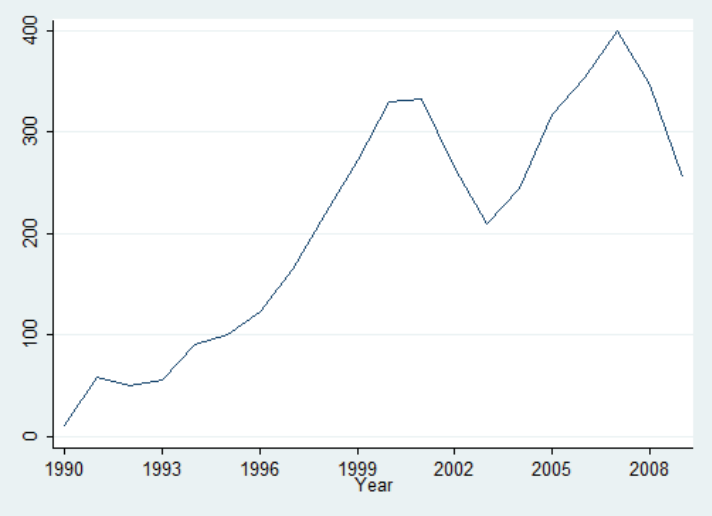
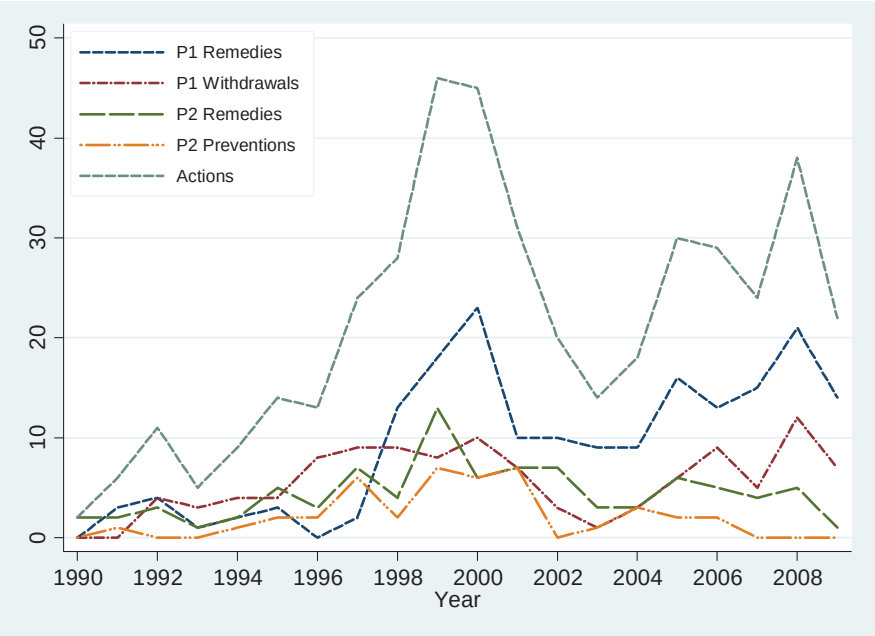


Figure 3 displays the total number of yearly merger-policy actions (Phase-1 Remedies, Phase-1 Withdrawals, Phase-2 Remedies, Phase-2 Preventions) taken by the EC: where Actions represents the sum of these four policy instruments. The annual levels of merger-policy actions appear to correlate to some extent with merger-activity levels; though, we should point out that the various merger-policy actions exhibit relatively-low pairwise correlations. Some additional factors, however, are seemingly at play in the observed patterns. After the reversal of four preventions by the European courts in the early 2000s (GE/Honeywell; Airtours/First Choice; Schneider/Legrand; and Tetra Laval/Sidel), both the number of phase-2 preventions and the number of phase-2 remedies decrease. Additionally, both phase-1 remedies and phase-1 withdrawals occur more frequently over the same period. Accordingly, there appears to be some

evidence here of a trend whereby EC officials and merging parties are more actively using the initial phase of the merger-review process to settle merger cases. This potentially indicates an improvement in reaching early agreements, thus suggesting more efficient communication between merging firms and the EC. As noted by Lyons (2009, 166), "Reasons for this include experience, more written guidance, a more economic approach, and the impact of the Courts." Alternatively, there may be a realization by the EC that they have greater bargaining power in phase 1—a topic we take up later in more detail.

FIGURE 3
Yearly Merger Policy Actions for All Industries



B. Control Variables

We follow Andrade et al. (2001) and Harford (2005) by constructing a set of variables that have been found to be important drivers of merger waves: the industry-median sales growth (*Sales Growth*$_{mt}$), the industry-median return on shares (*Share Return*$_{mt}$), and the industry-

median Tobin's Q (*Tobins* Q_{mt}). The three industry-level controls represent primary factors influencing merger activity levels. First, Andrade et al. (2001) find that industries with substantial sales growth tend to experience greater merger activity levels. Several related explanations exist behind this relationship; though in essence, once an economic shock occurs to industry sales, the collective reaction of firms is such that assets are reallocated via merger activity. Mergers will tend then to cluster in time, as managers simultaneously react to similar shocks by competing for the best combinations of assets. Second, industries with higher share prices and/or Tobin's Q ratios (i.e., market-to-book ratios) often indicate greater merger activity levels. The motivations behind this relationship come from the so-called misvaluation explanations, which tend to build on stock-market overvaluation. Proponents of this rationale argue that acquirers with temporarily overvalued shares will tend to exchange these shares for assets in undervalued targets; and target shareholders accept such a proposition due to having shorter time horizons (Harford 2005; Shleifer and Vishny 2003).

Table 1 also reports precise descriptions for these three control constructs and for some additional control variables. To build these constructs, we use information on European firms from Thomson Worldscope databases. Doing so ensures that our firm-level data matches the markets affected by the merger activity observed in our sample.[6] We aggregate this firm-level balance-sheet and income-statement information to the industry-year-level (*m*,*t*) and match these data with our relevant merger-activity and merger-policy constructs.[7]

[6] We use data from firms broadly defined to include all countries of the European Economic Area, plus Turkey. In particular, we include firms located in the following countries: Austria, Belgium, Bulgaria, Channel Islands, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, and United Kingdom.

[7] The primary industries of activity for firms in Worldscope are identified via US SIC codes, while the industry-merger activity is categorized according to EU NACE codes. Thus, we match these different industries by using the US census bureau table of conversion (http://www.census.gov/eos/www/naics/concordances/concordances.html). To avoid double counting, we employ a 1 to 1 matching procedure. However, this conversion table sometimes allocates the same SIC industry into different NACE industries. Hence, as a robustness check, we also define the industries via an alternative *m* to *1* matching procedure and find that qualitative results do not change when using this allocation process. This is unsurprising as industry-control variables capture broad changes in industry trends—trends that are only partially affected by the possible misallocation of some firms.

In order to account for the competitive conditions in the relevant industries, we construct the traditional measure of industry concentration (HHI_{mt}). The EC employs HHI as a means to initially screen merger cases (EC 2004); that said, HHI does have some shortcomings when it comes to measuring competition, as its theoretical foundations are based on quantity competition (see Buccirossi et al. 2009, for an overview). Accordingly, we also employ a measure of competition developed by Boone (2008) that was empirically operationalized by Griffith et al. (2005). This relative-profits measure quantifies the elasticity of a firm's profits with respect to its cost level ($Beta_{mt}$). More negative values of Beta indicate more intense competition as firm profits will be more 'negatively related' to costs. Boone et al. (2007) show that Beta is a reliable construct representing the development of competition for several models of competition when markets are oligopolistic.

Table 2 reports preliminary statistics for our base estimation sample of 637 observations over the 1990-2009 period. One caveat, however, is that the statistics for the 'potentially anti-competitive' and 'clearly pro-competitive' merger-notification variables are based on the smaller estimation sample covering 287 observations over the 2000-2009 period. The number of total merger notifications averages 5 per industry year over the full-sample period, while the number of 'potentially anti-competitive' and 'clearly pro-competitive' merger notifications respectively average 3.2 and 3.5 per industry year over the 2000-2009 period. As for merger-policy actions, they occur slightly more than once every two years (0.57 merger-policy actions per year on average). Phase-1 remedies represent the most common merger-policy action, followed by phase-1 withdrawals, phase-2 remedies, and then by phase-2 preventions. In terms of observable industry characteristics, the average HHI is 0.132 though the variance across industries is quite large; e.g., 0.751 represents the maximum concentration level. A similar pattern of variation across industries can be observed for the Beta constructs.

TABLE 2
Preliminary Statistics

	Mean	S.D.	Min	Max
Total Merger Notifications	5.176	5.296	0	28
Potentially Anti-competitive Merger Notifications	3.207	3.358	0	15
Clearly Pro-competitive Merger Notifications	3.542	3.418	0	22
P1 Remedies	0.259	0.569	0	3
P1 Withdrawals	0.143	0.388	0	3
P2 Remedies	0.116	0.379	0	3
P2 Preventions	0.055	0.248	0	2
HHI	0.132	0.123	0.013	0.751
Beta	-2.157	3.246	-27.229	23.743
Sales Growth (yearly mean)	0.156	0.293	-0.715	1.785
Tobin's Q (yearly mean)	4.161	34.727	0.382	853.553
Share Return (yearly mean)	0.130	0.407	-0.574	5.790

IV. ESTIMATION STRATEGY

A. Main Analysis

Our aim is to investigate the deterrence effects involved with the various EC merger-policy actions; thus, we study the impact of these actions on the proclivity of firms to engage in future merger activity at the industry level. Given that mergers in the European context manifest in wave-like patterns, we follow the empirical approach of Seldeslachts et al. (2009) and Clougherty and Seldeslachts (2013) to hold the merger wave constant in order to elicit deterrence effects. With this empirical approach, holding the merger wave constant allows measuring deterrence via foregone merger activity. Specifically, foregone merger activity is represented by the departure in actual merger activity levels from what the merger wave would otherwise predict. In essence, the merger wave sets the essential counterfactual (what would merger activity be like in the absence of a change in the tenor of merger policy) via which deterrence can be captured. In order to ensure a well-specified merger wave, we will control for

the wave via a variety of means: year fixed effects, lagged dependent constructs, and control variables from the finance literature on merger waves.

First, we include year dummy variables in order to capture economy-wide period-specific shocks that are common across industries and can trigger macro-level merger waves. In addition, our regression specifications will employ industry-level dummy variables in order to control for time-invariant industry-specific heterogeneity in merger behavior. Second, we include lagged dependent variables as right-hand side regressors; hence, past merger-activity levels partly explain current merger-activity levels.

Third, we include relevant measures that capture time-varying industry factors that explain merger-activity levels as indicated by the above-mentioned scholarship in finance economics. While much of the research in economics has failed to consider merger activity in its proper wave-like context, research in finance has advanced our understanding of merger waves (e.g., Harford 2005). In particular, the finance literature found that both economic and financial factors – such as sales growth, return on shares, Tobin's Q, and even industry concentration – tend to drive merger activity at the industry level. Our methodological approach builds upon this literature, as we take the wave-like nature of merger activity in our analysis explicitly into account by controlling for these industry-level drivers of merger-activity levels.

In sum, our methodological approach explicitly takes the wave-like nature of merger activity into account. By doing so, we can empirically capture deterrence (i.e., forsaken merger activity), as being the departure in merger-activity levels from those levels that would otherwise be predicted by the merger wave. The proper setting of the merger wave allows us then to establish the pivotal counter-factual: what would merger-activity levels be like in the absence of a change in the tenor of EC merger policy. With the above in mind, our first set of empirical tests focuses on investigating whether specific merger-policy actions generate deterrence effects.

By considering in detail how different merger-policy instruments affect future merger-activity levels, we can also investigate the implications of shifting from one merger-policy instrument towards other instruments. Such substitutions between instruments may also impact deterrence, as different merger-policy tools send different signals to firms about the toughness of the antitrust authority.

Accordingly, we estimate the following regression specification:

$$ln\,NT_{mt} = \alpha_0 + \alpha_1 lnNT_{mt-1} + \alpha_2 lnNT_{mt-2} + \beta_1 lnR1_{mt-1} + \beta_2 lnW1_{mt-1} + \beta_3 lnR2_{mt-1} + \beta_4 lnP2_{mt-1} + \alpha_3 X_{mt-1} + \eta_m + \eta_t + \varepsilon_{mt} \quad (1),$$

where *m* refers to industry (the 37 NACEs) and *t* refers to time (the year). Further, *NT* represents the number of total merger notifications, *R1* represents the total number of Phase-1 Remedies, *W1* represents the total number of Phase-1 Withdrawals, *R2* represents the total number of Phase-2 Remedies, *P2* represents the total number of Phase-2 Preventions, and *X* represents the vector of industry-specific characteristics. The terms $\boldsymbol{\eta_m}$ and $\boldsymbol{\eta_t}$ represent industry and time fixed-effects, respectively. Thus in addition to a base estimation via OLS, we will estimate our regression specification by employing a fixed-effects estimation method. In addition, extensive testing indicates that a model with two lagged dependent variables best captures merger waves in our data—a finding in line with precedents in the literature (Seldeslachts et al. 2009; Clougherty and Seldeslachts 2013). We will also correct the error term $\boldsymbol{\varepsilon_{mt}}$ by clustering at the industry level. Assuming clustered standard errors over the panel mitigates to an extent any remaining serial correlation in the merger series, and also represents the preferred practice in the deterrence literature (Donohue and Wolfers 2005).

We lag the specific merger-policy action variables and the industry control constructs by one year for two reasons. First, this helps ensure that the explanatory variables precede the dependent variable. Second, it remedies to some extent the potential endogeneity of the

explanatory variables due to simultaneity bias; e.g., industry concentration may go up due to increased levels of merger activity. More specifically, Bar-Gill and Harel (2001) note that the dependent variable in a deterrence context can influence expected sanctions. Thus, merger-policy variables potentially involve simultaneity-based endogeneity since merger-policy actions are a likely function of the number of notified mergers. Accordingly, we follow best practices in the deterrence literature where scholars have begun to lag the deterrence variables to mitigate endogeneity issues (e.g. Katz et al. 2003).[8]

In addition to considering the one-year lag for our merger-policy variables, we will also consider a lagged two-year average for these variables. Previous empirical work on deterrence effects and merger policy (Davies and Majumdar 2002; Seldeslachts et al. 2009; Clougherty and Seldeslachts 2013) convincingly argues that merger-policy actions are characterized by a two-year window where they affect the actions of firms in subsequent years. Accordingly, we will also consider the merger-policy activity taking place in year's t-1 and t-2 as potentially affecting merger behavior in year t.

Finally, we will log-transform our merger frequency and merger-policy variables in order to yield additional estimation advantages. In particular, Donohue and Wolfers (2005) argue that the consideration of scaling issues is essential when measuring deterrence, and the merger-policy deterrence studies by Seldeslachts et al. (2009) and Clougherty and Seldeslachts (2013) follow through on this advice by employing log-transformations of any count variables employed in regression specifications. It should also be noted that by employing the log of the absolute number for the specific merger-policy action variables, our regression specification departs

[8] Although lagging our explanatory variables eliminates correlation with contemporaneous error terms and substantially reduces the potential for bias in these coefficient estimates, lagged variables may still be potentially correlated with past error terms. If the case, then lagged explanatory variables are 'predetermined', which is less of a problem as compared to having endogenous variables. Predetermined variables can also potentially yield biased coefficient estimates (Bond 2002), but they are characterized by far less bias than do endogenous variables, as is extensively shown in Arellano (2003).

slightly from the conditional probabilities setup indicative of many empirical studies of deterrence that follow Becker (1968) and Ehrlich (1973). However, the EC institutional framework – with merger-policy actions manifesting in both phase-1 and phase-2 – does not provide the appropriate context to employ a conditional probabilities approach. Furthermore, constructing conditional probabilities would generate a linked variable in the construction of both the left-hand-side and right-hand-side variables; i.e., the number of notified mergers would show up both in the dependent variable and in the initial merger-policy variable. As is extensively argued – first by Klein et al. (1978) and more recently by Donohue and Wolfers (2005) – any measurement error in these linked variables could potentially lead to biased coefficient estimates that would favor empirically finding deterrence effects.

By using count measures for our merger-policy variables, we adopt the approach for measuring the deterrence variables employed by Seldeslachts et al. (2009) in their study of cross-jurisdictional deterrence. Dezhbakhsh and Rubin (2007) also argue for employing policy-action counts in deterrence frameworks and for considering spikes in these actions to be communication factors – or announcement effects – that signal public-policy shifts. In addition, there has been considerable debate within the 'economics of crime' literature as to whether conditional probabilities or announcement effects are the appropriate approach to measuring deterrence variables. Berk (2005) notes that complicating matters by adjusting and/or altering how the use of a policy instrument (e.g., mergers that are prevented) enters an empirical analysis of deterrence is not a sound strategy, as additional flawed measures for a normalizing denominator can bring about faulty measurement and over-fitting risks. Thus, a count measure of merger-policy actions is far less sensitive according to this perspective. A number of empirical papers in the deterrence literature follow this advice to employing count measures for the different policy actions (e.g., Dezhbakhsh and Shepherd 2006; Shepherd 2004; Grogger 1990); hence, our

approach to measuring the deterrence constructs rests on precedents from the 'economics of crime' literature.

B. Analysis of High and Low Concentration Industries

Our next step involves extending our basic model in order to differentiate between high-concentration and low-concentration industries—a distinction that allows investigating whether EC merger policy generates greater deterrence in high-concentration industries. To do so, we separate industries into those that have HHI's above (for high concentration) and below (for low concentration) a 0.2 cutoff point. This is the threshold employed by the EC as mergers in industries with HHIs above this threshold tend to be subjected to heavy scrutiny by the Commission. For instance, the EC generally challenges mergers in high-concentration industries even if the HHI increase is relatively small. Given that this EC-defined threshold is also known to the population of firms, it is a natural benchmark to separate the industries into high and low concentration for the purposes of studying EC merger policy. Thus, the 0.2 HHI-threshold should represent the perceptions of firms (both merging and non-merging) when considering what constitutes a low or high concentration industry.

Most importantly, effective employment of EC merger-policy instruments would seemingly lead to relatively large deterrence in high-concentration industries and minimal deterrence in low-concentration industries. To follow through on these conjectures regarding varied deterrence effects in high- and low-concentration industries, we will undertake fixed-effects regressions that are identical to the specification represented by equation 1. These regressions, however, will be estimated separately for the two different sub-samples (low and high concentration) of industries. Akin to the main-analysis estimations, we will also consider both a one-year lag and a lagged two-year average for the merger-policy variables.

C. Analysis of Potentially Anti-competitive & Clearly Pro-competitive Merger Notifications

In addition to considering high- and low-concentration industries, we can also take into account the different types of mergers that are notified to EC authorities. While conglomerate mergers have traditionally gone unscrutinized by EC authorities for anti-competitive concerns, horizontal and vertical mergers have been considered to potentially involve anti-competitive effects (Motta 2004). Nevertheless, the EC is cognizant that a large number of horizontal and vertical transactions will also be pro-competitive in nature. Since 2000, the EC has allowed 'simplified procedures' for those merger notifications that are very likely to be pro-competitive in nature. In particular, conglomerate mergers are notified under this procedure. Furthermore, certain types of horizontal mergers (where the merging parties have less than a 20% market share) and vertical mergers (where the merging parties have less than a 30% market share in both the upstream and downstream markets) are allowed to go through a simplified procedure.[9]

We gathered information then on the number of merger notifications to the EC that were processed via the simplified procedures, as these transactions can be considered as clearly pro-competitive from the EC's standpoint. Furthermore, those vertical and horizontal mergers notified outside of the simplified procedures can be considered as potentially anti-competitive transactions from the EC's standpoint. We should underscore that many of the vertical and horizontal mergers notified outside of the simplified procedures will ultimately be pro-competitive in nature; however, this is the population of merger activity in which anti-competitive mergers will arise according to the EC. Effective EC merger-policy would tend to deter the horizontal and vertical activities where anti-competitive transactions may arise and

[9] For an explanation of the EC's simplified procedures please see: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013XC1214%2802%29&from=EN

would tend to not deter the clearly pro-competitive activities where anti-competitive effects are unlikely to arise. Moreover, we can build upon the above idea that effective deterrence will generally take place in high-concentration industries as opposed to low-concentration industries. Thus, in addition to considering whether it is the potentially anti-competitive transactions that are principally deterred by the employment of merger-policy actions, we can also consider whether EC merger-policy actions principally deter the potentially anti-competitive transactions taking place in high-concentration industries as opposed to low-concentration industries.

This more-precise information regarding the type of mergers notified to the EC was only available for the 2000-2009 period, as it was only during that period that the EC allowed for the 'simplified procedures' which enable differentiating between clearly pro-competitive and potentially anti-competitive transactions. Thus, we can employ these data in order to create two additional dependent constructs: the number of potentially anti-competitive notifications, and the number of clearly pro-competitive merger notifications. Furthermore, it is the potentially anti-competitive mergers that should be principally affected by the employment of merger-policy tools, and this should be even more the case in high-concentration industries.

To follow through on these priors regarding the deterrence of anti-competitive and pro-competitive mergers in high- and low-concentration industries, we will undertake regressions that conform to the previous estimations by again employing fixed-effects estimations conducted on both low- and high-concentration industry sub-samples. Yet instead of employing the number of total merger notifications as the dependent variable, we will employ the number of potentially anti-competitive and the number of clearly pro-competitive merger notifications as the respective dependent constructs. For purposes of brevity, we will furthermore restrict our analysis to the lagged two-year average for the different merger-policy action variables, as the

precedents in the deterrence literature (e.g., Seldeslachts et al. 2009; Clougherty and Seldeslachts 2013) indicate the appropriateness of such an approach.

V. EMPIRICAL RESULTS

A. Main Results

Table 3 reports the empirical results for four regression estimations – OLS and fixed-effects estimations for both one-year and two-year lags of the merger-policy variables – of the base specification where we consider the deterrence effects generated by the various merger-policy actions. Before considering our variables of principal interest, we first discuss the appropriateness of our estimation models and the relevance of the control variables. For all three specifications, the lagged dependent variables – as well as some of the merger-wave control variables – appear to affect merger activity in subsequent years and indicate the expected signs. Hence, our empirical set-up appears to be appropriate as it accounts for the wave-like pattern in merger behavior. In particular, the two lagged dependent variables for merger-activity levels appear to be relevant: the first lagged dependent variable is positive and significant in all four estimations; the second lagged dependent variable is positive and significant in the OLS estimations. Moreover, the inclusion of two autoregressive terms is appropriate as the test for serial correlation in the error term performs better with the inclusion of a second lag. Of the three merger-wave control variables (sales growth, Tobin's Q, and share return), share return appears to yield the most robust effect on future merger-activity levels—a positive and significant effect in all four estimations, which provides tentative support for misvaluation theories of merger behavior. However, our competition measures (HHI and Beta) generally indicate insignificant effects on merger-activity levels, though HHI is negative and significant in the OLS estimations. The general insignificance of these competition measures may be due to

the fact that industries are quite heterogeneous in terms of competitiveness—an issue we discuss in more detail when considering sub-samples of low- and high-concentration industries.

TABLE 3
Main Regression Specification

	OLS One-year lag	**OLS Lagged two-year average**	**Fixed-Effects One-year lag**	**Fixed-Effects Lagged two-year average**
	(1)	**(2)**	**(3)**	**(4)**
Total Merger Notifications $_{t-1}$	0.416***	0.400***	0.124**	0.0978*
	(0.036)	(0.0360)	(0.0531)	(0.0522)
Total Merger Notifications $_{t-2}$	0.324***	0.330***	0.0278	0.0237
	(0.041)	(0.0431)	(0.0548)	(0.0519)
P1 Remedies $_{t-1}$	-0.150**	-0.138*	-0.161***	-0.174*
	(0.056)	(0.0756)	(0.0510)	(0.0884)
P1 Withdrawals $_{t-1}$	-0.012	-0.00480	-0.0395	0.0154
	(0.098)	(0.130)	(0.0748)	(0.106)
P2 Remedies $_{t-1}$	0.014	0.0780	0.0802	0.253*
	(0.108)	(0.119)	(0.0972)	(0.137)
P2 Preventions $_{t-1}$	0.030	0.0974	0.0323	0.102
	(0.148)	(0.125)	(0.120)	(0.129)
HHI $_{t-1}$	-0.533**	-0.530**	0.364	0.372
	(0.254)	(0.255)	(0.356)	(0.359)
Beta $_{t-1}$ (x 100)	-0.896	-0.902	-0.975	-0.931
	(0.905)	(0.929)	(0.768)	(0.747)
Sales Growth $_{t-1}$ (x 10)	-0.095	-0.090	0.168	0.141
	(0.387)	(0.388)	(0.453)	(0.464)
Tobin's Q $_{t-1}$ (x 100)	-0.007	-0.009	-0.056**	-0.060*
	(0.029)	(0.030)	(0.027)	(0.030)
Share Return $_{t-1}$	0.126**	0.123**	0.120***	0.112**
	(0.051)	(0.053)	(0.0434)	(0.043)
Constant	0.522***	0.532***	1.552***	1.596***
	(0.114)	(0.111)	(0.164)	(0.154)
Observations	637	637	637	637
R-squared	0.610	0.609	0.464	0.466

Notes: Columns 1 & 2 report OLS regression results. Column 3 & 4 report the results from a panel fixed-effect regression. Columns 1 & 3 report results for the specification where the explanatory variables are defined as the lagged values over the previous year. Columns 2 & 4 report the results for the specifications where the explanatory variables are defined as lagged average values over the previous two years. The dependent and merger-policy action variables are expressed in logs. In all regressions, we include year fixed-effects. We report heteroskedasticity robust standard errors clustered at the industry level in parentheses. Significance at the 1%, 5%, and 10% levels is represented by ***,**,* respectively. For the fixed-effects estimates in columns 2 & 4, we report the within R-square.

We can now consider the empirical results while focusing on the variables of principal interest: the relationship between the various merger-policy tools and future merger activity levels. First, phase-1 remedies indicate a statistically-significant negative impact on future merger-activity levels in all four estimations. Phase-1 remedies are unique, however, in that none of the other merger-policy action variables indicate any consistent statistically-significant deterrence effects across the four estimations. The consistent negative impact of the phase-1 remedies variable suggests that increasing the number of remedies in the initial stage of merger control leads to reduced merger activity levels in subsequent years. This suggests that a spike in the relative use of this particular merger-policy instrument tends to send a clear signal to firms that the EC will be tougher in the application of merger policy in the future.[10] In terms of economic significance, if one were to take the coefficient estimate for phase-1 remedies from the fourth estimation (-0.174) and consider the impact of a 1% increase in the application of that merger-policy action, then merger activity would tend to decrease in subsequent years by about 0.175% in a focal industry. In terms of a levels interpretation, the application of an additional phase-1 remedy will, on average, lead to almost one less merger notification per year in subsequent years.

B. Results for Low versus High Concentration Industries

Table 4 reports the empirical results for four fixed-effects estimations that involve sub-sampling between low- and high-concentration industries. While the base regression specification is still employed, the first two columns present estimation results where the merger-policy variables are respectively defined while employing one-year lags and lagged two-

[10] When we alter the form of the merger-policy variables to simple dummy constructs that capture whether a particular merger-policy action was applied or not (so irrespective of how many times these actions were applied) in the previous year (or two-year) period, we get empirical results largely in line with these results.

year averages for the sample of low-concentration industries. Furthermore, the later-two columns present estimation results where the merger-policy variables are again respectively defined with one-year lags and lagged two-year averages but for the sample of high-concentration industries. For brevity, we will focus on the variables of principal interest: the relationship between the various merger-policy tools and future merger activity levels in low- and high-concentration industries.

As can be seen from the four Table 4 estimations, phase-1 remedies tend to reduce merger-activity levels in both high- and low-concentration industries as the coefficient estimate for phase-1 remedies is negative throughout and statistically significant in three out of the four estimations. However, deterrence effects appear to be greatest in high-concentration industries, as the respective one-year-lag and lagged two-year average coefficient estimates (-0.282 and -0.504) for phase-1 remedies in high-concentration industries are significantly different when compared with the respective coefficient estimates (-0.098 and -0.103) for phase-1 remedies in low-concentration industries. If one were to take the coefficient estimate for phase-1 remedies from the fourth estimation (-0.504) and consider the impact of a 1% increase in the application of that merger-policy action in high-concentration industries, then merger activity would tend to decrease in subsequent years by a little over 0.5% in such industries. In terms of a levels interpretation, the application of an additional phase-1 remedy will, on average, lead in subsequent years to 2.5 fewer merger notifications per year in high-concentration industries.

We can also consider the empirical results for the other merger-policy variables across the four estimations in Table 4. Striking from a review of these results is that none of these variables indicate a consistently significant deterrence effect across the four regression specifications. Only phase-2 preventions appears to indicate a statistically robust effect in high-concentration industries; however, the impact of phase-2 preventions on future merger activity in high-

concentration industries is found to be positive—a surprising result. This counterintuitive finding likely represents a statistical artifact as there were only seven phase-2 preventions that manifested over the 1990-2009 period within highly-concentrated industries.

TABLE 4
Deterrence in Low- and High-Concentration Industries

	Low-Concentration One-year lag	**Low-Concentration Lagged two-year average**	**High-Concentration One-year lag**	**High-Concentration Lagged two-year average**
	(1)	**(2)**	**(3)**	**(4)**
Total Merger Notifications $_{t-1}$	0.092	0.064	0.024	-0.039
	(0.061)	(0.059)	(0.108)	(0.109)
Total Merger Notifications $_{t-2}$	0.048	0.037	-0.249***	-0.224**
	(0.058)	(0.052)	(0.096)	(0.101)
P1 Remedies $_{t-1}$	-0.098*	-0.103	-0.282*	-0.504**
	(0.056)	(0.101)	(0.158)	(0.210)
P1 Withdrawals $_{t-1}$	-0.042	0.051	0.118	-0.106
	(0.077)	(0.108)	(0.234)	(0.265)
P2 Remedies $_{t-1}$	0.123	0.293*	0.209	0.548
	(0.091)	(0.153)	(0.362)	(0.411)
P2 Preventions $_{t-1}$	-0.065	-0.008	0.713**	0.970*
	(0.118)	(0.125)	(0.315)	(0.505)
HHI $_{t-1}$	-1.327	-1.413	0.420	0.465
	(0.891)	(0.930)	(0.607)	(0.600)
Beta $_{t-1}$ (x 100)	-0.757	-0.742	-0.604	0.041
	(1.010)	(0.971)	(1.142)	(1.203)
Sales Growth $_{t-1}$ (x 10)	0.145**	0.133*	-0.035	-0.026
	(0.074)	(0.077)	(0.045)	(0.046)
Tobin's Q $_{t-1}$ (x 100)	0.300***	0.315***	-0.101**	-0.106***
	(0.057)	(0.059)	(0.042)	(0.027)
Share Return $_{t-1}$	0.116	0.117	0.096*	0.109**
	(0.073)	(0.075)	(0.053)	(0.044)
Constant	0.356*	0.684***	1.203*	1.013
	(0.193)	(0.181)	(0.655)	(0.684)
Observations	532	532	105	105
R-squared	0.7148	0.7133	0.6688	0.6696

Notes: We estimate these models via a sandwich estimator to account for co-variances between industries and to compare the impact of high- versus low-competition industries. We report the coefficient estimates from a panel fixed-effects regression. Columns 1 and 3 report results for specifications where the merger-policy variables are defined as the lagged values for the previous year. Columns 2 and 4 report the results for specifications where the merger-policy variables are defined as the lagged average over the previous two years. The dependent variable is the log of merger notifications, and the merger-policy variables are also expressed in logs. In all of the estimations, we include year fixed-effects. The threshold for high versus low concentration industries is an HHI of 0.2 (the EC's threshold in defining a concentrated-market). Heteroskedasticity robust standard errors clustered at the industry level are reported in parentheses. Significance at the 1%, 5%, and 10% significance levels is represented by ***,**,*.

The fact that phase-1 remedies are characterized by greater deterrence in high-concentration industries as compared to low-concentration industries is indeed encouraging, as it indicates that deterrence effects manifest where they are probably most desirable. Since high-concentration industries are more likely to involve merger transactions that significantly impair effective competition, it would seem appropriate that high-concentration industries would be most influenced by changes in the tenor of EC merger policy. Furthermore, these results provide some credibility for our methodological approach, as the results are consistent with the idea that it is anti-competitive mergers that are principally deterred by the existence of merger policy. Furthermore, these results provide additional evidence that it is phase-1 remedies that uniquely yield deterrence in the EC antitrust context.

C. Results for Potentially Anti-competitive and Clearly Pro-competitive Notifications

Table 5 reports the empirical results for four fixed-effects estimations that estimate the impact of merger-policy instruments on the proclivity of firms to offer up potentially anti-competitive and clearly pro-competitive transactions in subsequent years while also sub-sampling between low- and high-concentration industries. The first two columns present the respective results for the low- and high-concentration samples where the number of pro-competitive transactions represents the dependent construct. Furthermore, the later-two columns present the respective results for the low- and high-concentration samples where the number of anti-competitive transactions represents the dependent construct. While the more restrictive data on pro- and anti-competitive transactions leads to significantly fewer observations, the regression specifications are still reasonably well specified, as the R-squares range from 0.55 to 0.74. For brevity, we again follow precedent and simply present results that focus on lagged two-year averages for the merger-policy variables.

TABLE 5
Anti-competitive and Pro-competitive Mergers in High- and Low-Concentration Industries

	Pro-competitive Low-Concentration	**Pro-competitive High-Concentration**	**Anti-competitive Low-Concentration**	**Anti-Competitive High-Concentration**
Pro-/Anti-Competitive Notifications $_{t-1}$	-0.291***	-0.272	-0.115	-0.083
	(0.081)	(0.184)	(0.194)	(0.156)
Pro-/Anti-Competitive Notifications $_{t-2}$	-0.177**	-0.116	-0.464***	-0.284***
	(0.078)	(0.178)	(0.123)	(0.0838)
P1 Remedies $_{t-1}$	-0.076	-0.311	-0.177	-0.946***
	(0.135)	(0.195)	(0.203)	(0.338)
P1 Withdrawals $_{t-1}$	-0.005	-0.182	-0.343	-1.270***
	(0.137)	(0.392)	(0.321)	(0.451)
P2 Remedies $_{t-1}$	0.076	0.277	-1.199**	0.483
	(0.257)	(0.754)	(0.585)	(0.475)
P2 Preventions $_{t-1}$	0.168	0.0612	1.432***	1.968***
	(0.251)	(0.573)	(0.391)	(0.661)
HHI $_{t-1}$	-3.260	0.0483	0.745	0.479
	(3.143)	(0.471)	(0.729)	(0.676)
Beta $_{t-1}$ (x 10)	0.188	0.113	0.150***	0.211**
	(0.258)	(0.110)	(0.052)	(0.104)
Sales Growth $_{t-1}$ (x 10)	-0.527*	0.0157	0.113	0.102
	(0.281)	(0.136)	(0.077)	(0.135)
Tobin's Q $_{t-1}$ (x 100)	0.058	-0.178***	-0.019	0.022
	(0.048)	(0.028)	(0.042)	(0.040)
Share Return $_{t-1}$	-0.023	0.174***	0.235**	0.154*
	(0.117)	(0.042)	(0.095)	(0.083)
Constant	0.936*	1.927***	0.539*	0.977**
	(0.538)	(0.592)	(0.321)	(0.383)
Observations	230	57	230	57
R-squared	0.6773	0.7385	0.5555	0.733

Notes: We estimate these models via a sandwich estimator to account for co-variances between industries and to compare the impact of high- versus low-competition industries. We report the coefficient estimates from a panel fixed-effects regression. We report the specifications where the explanatory variables are defined as the lagged average values over the previous two years. The dependent variable is the log of merger notifications, and all the merger-policy action variables are expressed in logs. In all of the estimations, we include year fixed-effects. The threshold for high vs. low competition industries is 0.2 (the EC's threshold in defining a concentrated-market) for the case of the HHI construct. Heteroskedasticity robust standard errors clustered at the industry level are reported in parentheses. Significance at the 1%, 5%, and 10% significance levels is represented by ***,**,*.

The empirical results for the first two columns – where the impact of merger-policy actions on the frequencies of pro-competitive notifications in future years is considered – provide results that are in line with effective EC merger policy. Both in low-concentration and high-

concentration industries, the application of merger-policy instruments does not appear to significantly affect the frequencies of pro-competitive mergers in subsequent years. In other words, none of the merger-policy instruments (phase-1 remedies, phase-1 withdrawals, phase-2 remedies, and phase-2 preventions) yield deterrence in terms of pro-competitive transactions. These empirical results are consistent with the idea that harmless pro-competitive mergers are not affected by changes in the tenor of EC merger policy since these are in fact not the merger types that EC officials might have concerns. Put differently, these results suggest that EC merger policy does not yield over-deterrence.

The empirical results for the later-two columns – where the impact of merger-policy actions on the frequencies of anti-competitive notifications in future years is considered – also yield results that are generally in line with our previous findings. In particular, the application of phase-1 remedies in high-concentration industries leads to fewer merger notifications of potentially anti-competitive transactions in subsequent years. If one were to take the coefficient estimate for phase-1 remedies from the fourth estimation (-0.946) and consider the impact of a 1% increase in phase-1 remedies, then anti-competitive merger activity in high-concentration industries would tend to decrease in subsequent years by almost 1% in a focal industry. In terms of a levels interpretation, the application of an additional phase-1 remedy in high-concentration industries will, on average, lead in subsequent years to some 3 fewer 'potentially anti-competitive' merger notifications per year.

This finding is line with our previous findings concerning the unique ability of phase-1 remedies to generate substantial deterrence effects. However, the application of phase-1 withdrawals in high-concentration industries also leads to fewer merger notifications of potentially anti-competitive transactions in subsequent years. While this result is not robust across the previous specifications – unlike phase-1 remedies – it does suggest that phase-1

withdrawals may yield some deterrence. In addition, we again elicit the spurious result concerning the application of phase-2 preventions in high-concentration industries leading to more merger notifications of potentially anti-competitive transactions in subsequent years. As previously noted, this result is most likely a statistical artifact due to the extremely low number of preventions in our sampled period (only two preventions were present in this smaller data sample).

While keeping in mind that these estimations are based on a limited set of observations due to data restrictions, the empirical results – which consider the impact of the different merger-policy actions on future levels of clearly pro-competitive and potentially anti-competitive merger transactions in both low-concentration and high-concentration industries – are in line with our previous empirical findings. In particular, the deterrence effects due to the application of phase-1 remedies are again born out, as phase-1 remedies lead to fewer notifications of potentially anti-competitive mergers in high-concentration industries. If EC merger policy were to be effective, the deterrence of anti-competitive mergers in high-concentration industries would be the realm where it would seemingly be most beneficial to generate deterrence via changes in the tenor of merger policy. Thus, we again provide some evidence that phase-1 remedies appear to generate deterrence where it would be most desirable to do so.

VI. CONCLUSIONS & POLICY DISCUSSION

We set out here to investigate the deterrence effects generated by EC merger control. In particular, our aim was to uncover the specific merger-policy instruments that lead to forgone merger activity in subsequent years. The striking and consistent finding from our empirical results is that phase-1 remedies appear to uniquely generate robust deterrence in the European context. Furthermore, preventions, phase-2 remedies, and phase-1 withdrawals do not appear to

yield substantial deterrence effects. Several potential related explanations exist as to why phase-1 remedies yield significant deterrence while phase-2 remedies and the other merger-policy instruments do not.

First, it is possible that the EC has higher bargaining power in the initial stage of the merger-review process when merging firms are relatively eager to reach a deal in order to avoid the costs of waiting longer for the consummation of the merger in a second phase of the review process. As Clougherty (2005) notes, a delay represents a holdup to the intended strategy of the merging firms; hence, higher levels of scrutiny that push off the benefits of the transaction reflect higher costs for merging firms. Salop (2013) also argues that delays are costly as they increase the likelihood of failure for merging firms. Given that merging firms have a substantial interest in getting their transaction approved as quickly as possible, they are likely then to agree to relatively substantial remedies in the initial stages of the merger-review process so as to avoid a prolonged review in the second phase (Dertwinkel-Kalt and Wey 2012). Following this logic, the remedies agreed to during the initial stage should be remedies that involve a substantial cost to merging parties. Thus, an uptick in these phase-1 remedies will represent a significant deterrent to future merger activity, as non-merging firms will update their priors regarding the probability of incurring such costly remedies.

Phase-2 remedies, however, do not indicate significant deterrence in our various regression estimations. This result could be based on a similar logic regarding the bargaining-power of the EC. But in this case, once a merger has reached the second phase of the merger-review process, much less scope exists for the EC to delay the merger's onset. Instead, the EC's only recourse in the second stage is to threaten a potential prohibition; i.e., if the merging parties fail to agree on a remedy that alleviates the EC's anti-competitive concerns, then the EC could attempt to block the merger. However, the EC – and other antitrust-policy authorities – rarely employ

prohibitions as a policy instrument; e.g., Clougherty and Seldeslachts (2013) find only 0.072% of notified mergers receive a prohibition in the US context. Not only are prohibitions rare events in the cross-national context for antitrust, but they have become increasingly rare in the European context. In fact, the EC has been reluctant to employ prohibitions as a merger policy tool after the court setbacks of the early 2000s.[11] In essence, engaging in prohibitions became politically unfeasible after the European courts ruled against the EC's preventions of the GE/Honeywell, Airtours/First Choice, Schneider/Legrand and Tetra Laval/Sidel mergers.

The EC's bargaining power might then be severely curtailed in the secondary phase due to the absence of prohibitions as a viable option; i.e., threats by the EC to prohibit a merger would seemingly be assessed by merging firms as non-credible. Thus, drawn-out negotiations that get close to the 90-day deadline in the secondary phase might tend to find substantially-diminished EC bargaining power. The only 'real' option in these later stages of the merger-review process is for the EC to accept the less-substantial remedies being offered by merging firms.[12] Moreover, less-substantial remedies in the secondary phase are, in turn, less likely to represent a deterrent to future merger activity. In line with these priors, Duso et al. (2011) find that remedies negotiated by the EC in the first phase tend to be more effective at reducing the probability of anti-competitive mergers materializing as compared to remedies negotiated in the second phase.

In addition to phase-2 remedies, phase-1 withdrawals and phase-2 preventions also do not generate substantial deterrence according to our empirical results. The fact that preventions do not yield deterrence seems somewhat surprising, as preventions impose the highest possible cost on merging firms. Yet, the fact that preventions have been seldom employed over the last twenty years by the EC potentially explains our inability to detect significant deterrence for this merger-

[11] In recent years, the EC has increased its employment of prohibitions, though these years are not included in our sample period.
[12] In conversations we had with EC officials, they confirmed the intuition that they felt they had greater bargaining power in first-phase as compared to the second-phase.

policy instrument. Furthermore, the lack of robust deterrence for phase-1 withdrawals may be due to the fact that withdrawals do not send a clear signal about the EC's stance in a particular industry. In particular, a number of withdrawals in the first phase may be due to reasons internal to the merging parties—rationales that are independent of EC merger policy. Accordingly, an up-tick in the number of phase-1 withdrawals could very well be a noisy signal that does not provide clear information to firms about the actual costs incurred in navigating the merger-review process. As such, the lack of clear deterrence effects for this merger-policy instrument makes intuitive sense.

In terms of policy prescriptions, our results indicate that maximizing deterrence – at least according to the current EC merger-policy regime – requires the use of phase-1 remedies. Phase-1 remedies should be applied relatively frequently, as this is simply the only merger-policy instrument that appears to generate robust deterrence. From a deterrence perspective, it is then reassuring that phase-1 remedies are employed more than twice as frequently as phase-2 remedies. Furthermore, the application of more preventions in the second phase of the merger-review process may lead to greater deterrence effects for phase-2 remedies via direct and indirect channels. First, an increase in preventions would impose the highest possible cost upon merging firms; thus, increased employment of this merger-policy tool would seemingly enhance direct deterrence. Second, if firms believe that preventions are a relatively likely outcome when negotiations break down in the second phase, then these firms would perhaps be more willing to accept tougher phase-2 remedies. Thus, establishing prohibitions as a viable option for EC merger policy may enhance the EC's bargaining power in the second phase, which would indirectly lead to enhanced deterrence for phase-2 remedies. The recent turn in EC merger policy to re-embrace the application of preventions (Aegean Airlines/Olympic Air in 2011; Deutsche Börse/NYSE Euronext in 2012; TNT Express/UPS in 2013; and Ryanair/Air Lingus in

2013) would seemingly be a healthy practice in terms of generating enhanced deterrence both directly and indirectly via phase-2 remedies.

We also find the deterrence effects generated by phase-1 remedies to work best in high-concentration industries: where the HHI is above 0.2, the cut-off level employed by the EC in order to define an industry as highly concentrated. Furthermore, we find phase-1 remedies do not deter future notifications of clearly pro-competitive mergers in both high- and low-concentration industries; however, phase-1 remedies do lead to fewer notifications of potentially anti-competitive mergers in high-concentration industries. These results are, in our view, encouraging for two reasons. First, it indicates that EC merger-policy actions involve greater deterrence in high-concentration industries—industries where it would be quite beneficial to discourage further merger activity. Second, these results are also consistent with phase-1 remedies principally deterring anti-competitive as opposed to pro-competitive merger notifications. Taken together, we can tentatively conclude that deterrence takes place mainly in those industries where it matters most, and that this deterrence is desirable in terms of the types of mergers which are deterred.

In sum, we find phase-1 remedies to be effective – and phase-2 remedies and phase-2 preventions to be ineffective – in the deterrence of future merger activity. The weak deterrence implications of secondary-phase remedies and preventions may represent a concern for EC antitrust policy, as this suggests that the EC does not generate robust deterrence from any of its enforcement efforts taking place in the later stages of the merger review process. To the degree that EC antitrust authorities are concerned about merger-policy deterrence, our results suggest they should move more enforcement actions to the initial stages, or employ more preventions in order to create more bargaining power in the secondary stage.

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