Product Market Relatedness, Antitrust and Merger Decisions

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Abstract

We study how merger decisions between public firms in the US are affected by the similarity between the product markets of the acquirer and the potential target. The relation between the likelihood of the merger and the product market similarity is non-monotonic, in the shape of an inverted U. We offer two reasons for this finding. First, when the product markets are very similar, there is a high chance that antitrust investigations will block the merger. We find that this effect is stronger in markets that are more concentrated and in years where antitrust regulatory intensity is high. Second, the synergies from the merger are less if the product markets are very related. Hence, firms are more likely to acquire targets with which they have a medium rather than a high level of product market similarity.

Keywords: Mergers and Acquisitions, Product Markets, Synergies, Innovation, Antitrust Issues and Policies

JEL Classification: G34, L22, L25, O34, L41

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1 Introduction

We examine the effects of product market relatedness between two firms on the probability of a merger transaction between them. There are reasons to believe that this effect can be positive or negative. First, synergies, the excess value created when a firm merges with another, are often cited as a reason for the merger. Synergies in turn may be related to the similarity in product offerings of the two firms. Second, antitrust laws may block the merger of two firms if they are competitors operating in the same product market. If firms anticipate this, the similarity of product markets between them may lead to lesser chance of merger incidence. We investigate the direction and magnitude of the effect before delving into the possible causes and consequences of it.

Synergies are closely related to how similar the product markets of the acquirer and target are. For example, Kaplan et al. [2000] state that "While there is considerable disagreement as to whether mergers create value in general (which we describe below), there is something of a consensus that combinations of related companies can realize synergies and are, therefore, more valuable than unrelated combinations". Morck et al. [1990] and Berger and Ofek [1995] look at the effect of a firm entering an unrelated market on the firm value and document a negative relationship. However, this view has been disputed by many studies which point out the advantages of acquiring a firm that has complementary assets rather than similar ones. Indeed, similarity in product markets may lead to cannibalization of sales and redundancies whereas complementarity can allow the firm to redeploy resources or expand into another market[1].

Even if we establish the direction of the effect of product market relatedness (henceforth PMR) on synergies, higher or lower synergies by themselves do not necessarily result in a higher or lower chance of the merger happening. Higher synergies, if they are a result of pricing power after the merger, may lead to the merger being blocked for violating the antitrust guidelines. The Federal Trades and Commission website states that "During a merger investigation, the agency seeks to identify those mergers that are likely either to increase the likelihood of coordination among firms in the relevant market when no coordination existed prior to the merger, or to increase the likelihood that any existing coordinated interaction among the remaining firms would be more successful, complete, or sustainable." Overall, it is not clear whether the probability of a transaction is increasing, decreasing or even monotonic in the product market

[1]See Capron et al. [1998], Wang and Zajac [2007], Cassiman and Veugelers [2006] and Fulghieri and Sevilir [2012]).

similarity between the potential acquirer and target.

Previous studies have looked at effects of acquisitions of firms in the same industry versus diversifying acquisitions on acquirer profitability. While this is an informative distinction, even firms in the same industry may differ in the similarity of their product markets across time and in the cross section. To address our research question, it is crucial to use a continuous variable to measure product market relatedness. For this purpose, we use the firm pair-year level PMR measure based on the similarity between the product description sections of the 10-K forms of the two firms in that year as in Hoberg and Phillips [2010].

Our findings are as follows. We find a nonlinear inverted U-shaped relationship between the probability of a merger and the product market relatedness between the acquirer and the target. This relationship is robust to controlling for deal fixed effects and a host of acquirer and target characteristics. We also control for technological similarity between the firms to ensure that it does not drive our results. Not only is the effect of PMR robust to controlling for technological overlap, but the effect of technology overlap is itself in the shape of an inverted U.

This finding can either be because of the synergies themselves having a non-monotonic relationship with the PMR, or because the probability is less due to other factors, for example antitrust investigations blocking the merger of firms which are very similar. We attempt to disentangle these measures in two ways. We first show that in regimes where the antitrust regulatory intensity is higher and in markets which are more concentrated, the inverted U-shape is more pronounced. This leads us to conclude that the decrease in likelihood can be partially attributed to stronger antitrust measures.

We then examine the effect of the PMR on the synergy, premium paid and the cumulative abnormal returns of both acquirer and target in the [-10,0] window around the merger announcement date. We find that the synergies, premium and the acquirer CAR have an inverted U-shaped relationship with the PMR as well. This suggests that in addition to the anti-takeover laws, synergy considerations were indeed significant in determining merger firm pairings. Acquirers are less likely to merge with targets that are very similar or very dissimilar to themselves. The former offer synergies arising from economies of scale and the latter those from economies of scope. Firms prefer intermediate levels of both kinds of synergies than a very high level of one and low level of the other.

We make significant contributions to the existing literature on firm similarity, antitrust,

synergies and likelihood of mergers. First, to the best of our knowledge, this is the first study to show a non monotonic relationship between acquirer-target product market similarity and the probability of a merger. Second, we find that technological similarity has a similar effect on merger likelihood even when controlling for the product market similarity. Third, we demonstrate convincingly that the effect is different in different antitrust regimes. Finally, we show that the inverted U relationship holds between the synergies and the PMR as well.

Our paper is most closely related in certain aspects to two previous studies Hoberg and Phillips [2010] and Bena and Li [2014]. However, our analysis differs from theirs in the following ways.

In terms of the research question, Hoberg and Phillips [2010] look at how the similarity between firms in an industry affect the chance of one of them being part of a merger transaction, but do not look at the bilateral similarity between the acquirer and potential targets. Bena and Li [2014] look at the effect of technological overlap between two firms whereas we look at the effect of product market overlap. In addition, they do not examine the effect of technological similarity on any of the deal financial variables like market reactions or synergies.

In terms of methodology, Hoberg and Phillips [2010] do not control for a given acquirer-target pair since they do not focus on bilateral similarity. Bena and Li [2014] employ a control sample of potential acquirers and targets which did not merge for each merger in their sample. In contrast, our control sample is the acquirer-target pair in the years previous to the acquisition. This specification has the advantage that it enables us to remove the effects of time-invariant acquirer and target characteristics.

Last, in terms of results, unlike them, our main result across most of our specifications and a host of dependent variables is a non-monotonic relationship between acquirer-target similarity and the decision to merge. None of their findings involve such a relationship.

The rest of the paper is organized as follows. Section 2 discusses the research design and the empirical specifications. Section 3 describes the data sources . Section 4 summarizes the empirical results on the relationship between merger incidence and PMR. Section 5 explores our findings in greater depth and offers two possible explanations. Section 6 concludes.

2 Empirical Methodology

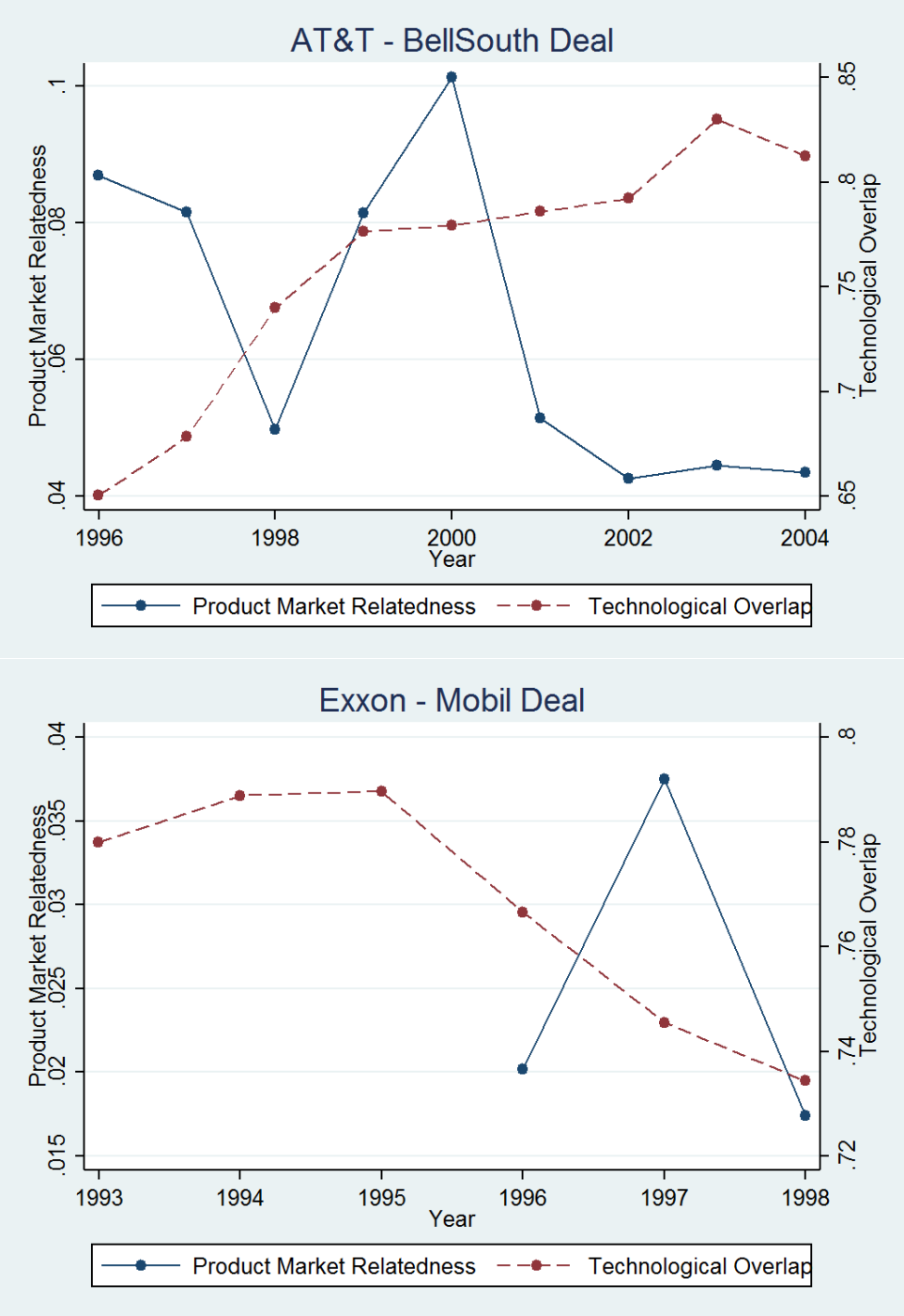


Figure 1: **PMR and Technology Overlap- examples**

The figure shows the PMR and Technology Overlap between the acquirer and target firms in the years leading up to the deal for two different deals. The PMR measure is from Hoberg and Phillips [2010] and is based on the degree to which two firms use the same words in their 10-K product descriptions. We construct the Technology Overlap measure based on the similarity of the patent portfolios of the two firms as described in the Appendix.

Since we are interested in the effect of the PMR between the acquirer and the target on the likelihood of the merger, our dependent variable is an indicator that takes a value of 1 if the two firms merged and 0 otherwise. If we only use the data for the acquirer and target in the merger years, we will have no variation in the dependent variable since it always takes a value of 1. To obtain our estimates, we need a set of control firms for each deal.

We use the AT&T - BellSouth $ 86 billion deal announced in 2006 to illustrate the rationale behind our empirical methodology. Figure 1 shows the PMR and the technology overlap between the two firms in the years leading to the acquisition. Ideally, we would want a control sample of the targets which were considered by AT&T but with whom the merger did not happen. In settings similar to ours, choosing an appropriate control sample is tricky. Since we do not know the consideration set of targets, there are two possible approaches to choose controls.

One approach is to generate matched sample of firms based on some criteria like size, year and industry, and consider them as potential targets which were not chosen, as Bena and Li [2014] do. If we were to use this specification and then include a deal fixed effect, we would exploit the variation among the PMRs of the target with each of the matched firms. However, what matters for the acquisition decision might be the change in PMR between the acquirer and the eventual target over time. The time series variation in the PMR for a selected target may be more relevant than the cross sectional variation in PMR between firms that are selected and not selected, particularly if target selection is driven by time-invariant firm-specific effects that we cannot control for.

Motivated by this logic, we assume that the appropriate control sample for the target firm in the year of acquisition is the target firm in the years leading to the acquisition. In terms of our example, the assumption is that AT&T viewed BellSouth as a potential candidate in the years prior to the acquisition before finally acquiring it when it matched the criteria for acquisition.[2] This is similar to Blonigen and Pierce [2016], who, in one of their difference-in-difference specifications, compare plants acquired in a year with a control group made up of plants that will be acquired in subsequent years.[3] The advantage of this specification is that all time-invariant acquirer and target characteristics which affect the deal will be captured by our deal-specific fixed effects and thus will not bias our estimates.[4]

[2]In other words, AT&T acquired BellSouth in a year not because BellSouth had a "more suitable" PMR than (fictitious control firms) BellNorth, BellEast and BellWest, but because it had a "more suitable" PMR than itself in previous years.

[3]They argue that "this is a valid strategy if the attributes that make a plant more likely to be a target exist for a few years before a successful match with an acquirer is made." Our argument is exactly the same.

[4]In addition, we can interpret our results as either the choice of the acquisition decision or of acquisition

Our main regression specification is

$$Merger_{i,t} = \alpha_i + \beta_1 PMR_{i,t-1} + \beta_2 PMR^2_{i,t-1} + \gamma X_{i,t-1} + \epsilon_{it} \tag{1}$$

where $Merger_{i,t}$ is an indicator variable that takes a value 1 if the deal happened in that year and 0 if it did not. PMR is the product market relatedness defined in more detail in section 3.3. X is a vector of controls defined in the Appendix. Notice that in this specification, we add a fixed effect for each deal. In essence, our results are thus driven by variation within a deal. In addition to the linear term, we use the quadratic term to check whether the effect of PMR is non-linear or indeed even non-monotonic. We cluster the standard errors at the deal level.

In regressions where we test for the effect of innovation overlap, the specification we adopt is similar

$$\begin{aligned} Merger_{i,t} = \alpha_i &+ \beta_1 PMR_{i,t-1} + \beta_2 PMR^2_{i,t-1} \\ &+ \beta_3 TechnologyOverlap_{i,t-1} + \beta_4 TechnologyOverlap^2_{i,t-1} + \gamma X_{i,t-1} + \epsilon_{it} \end{aligned} \tag{2}$$

where $TechnologyOverlap$ is the measure of technological overlap described in section 3.3. We employ a linear and quadratic term for the innovation overlap too, exactly like for the PMR.

Next, we look at possible mechanisms through which the PMR affects transaction incidence. First, we explore the effects of antitrust regulation on the relationship between the merger decision and PMR by interacting the PMR variable and its square with the Herfindahl Hirschman Index (HHI) for the market. The specification is[5]

$$\begin{aligned} Merger_{i,t} = &\beta_1 PMR_{i,t-1} + \beta_2 PMR^2_{i,t-1} + \beta_3 HHI + \beta_4 PMR_{i,t-1} * HHI \\ &+ \beta_5 PMR^2_{i,t-1} * HHI + \gamma X_{i,t-1} + \epsilon_{it} \end{aligned} \tag{3}$$

To evaluate a second potential channel through which PMR affects merger decisions, we look at how the synergies (and the premium paid) in the deal vary with the PMR. For these regressions, we cannot use deal fixed effects since there is only one observation per deal. The regressions we run take the form:

$$SynergyMeasure_i = \beta_1 PMR_i + \beta_2 PMR^2_i + \gamma X_i + \epsilon_i \tag{4}$$

timing.

[5]We do not include deal-specific fixed effects in this specification because there isn't enough variation within a deal to look at the differential effect of PMR on the merger likelihood depending on the value of HHI.

The PMR and the controls correspond to the year before the merger.

3 Data and Summary Statistics

3.1 Sample Construction

The sample includes mergers and acquisitions of US listed corporations during the period of 1996 to 2015. We compile our data from several databases. We obtain the mergers and acquisitions (M&A) information from the Securities Data Company (SDC) M&A database. We collect PMR and market concentration (HHI) data from Hoberg-Phillips's Data Library website[6] and the patent data from National Bureau of Economic Research (NBER) Patent Citation database. To construct the corporation-level control variables, we obtain financial statement items from Compustat Industrial Annual Files and security prices from the Center for Research in Security Prices (CRSP) database.

We begin with a total of 28,395 deals from SDC and then apply the following filters to the data:

1. Keep only the transactions where both the target and acquirer are publicly listed US firms. This is because we have the PMR data only for publicly listed US firms. This filter decreases our sample to 12,420 deals.

2. We also exclude any recapitalization, exchange offer and buybacks. This step removes 1,655 deals from the sample.

3. We remove 139 duplicates where the details to a specific entry was difficult to ascertain, leaving us with 10,482 deals.

4. We keep deals with announcement date between January 1, 1996 and December 31, 2015. This is because the PMR data starts from 1996. This reduces our sample by 2,232 deals.

This leaves us with a sample of 8,250 deals. We then merge this data with firm-year level financial data (for both acquirer and target) from Compustat and the stock price data from CRSP. We remove any deals with missing Compustat and CRSP identifier, leaving us with 3,616 merger and acquisition deals. We exclude deals where PMR and other controls variables are missing in the merger year. We also ensure that each deal has at least two years of observations. The final sample includes 896 deals and 4,767 deal-years.

[6] http://hobergphillips.usc.edu/

Table 1: Corporate Acquisitions over Time

Year	Total Acquirer-Target Sample	Acquirer-Target with non-missing PMR Sample	Acquirer-Target with non-missing PMR and Technology Overlap Sample
1996	301	NA	NA
1997	379	100	9
1998	386	110	26
1999	406	122	16
2000	331	67	13
2001	216	49	14
2002	129	35	15
2003	150	41	9
2004	148	44	13
2005	138	29	12
2006	139	33	8
2007	156	38	NA
2008	106	33	NA
2009	88	24	NA
2010	83	25	NA
2011	64	24	NA
2012	87	27	NA
2013	92	26	NA
2014	98	32	NA
2015	119	37	NA
	3616	896	135

This table reports the number of announced corporate acquisitions by the year of the bid announcement over the period January 1, 1996 to December 31, 2015. We require that both acquirer and target are US public companies. A deal enters the *Acquirer-Target Sample* if both the acquirer and the target firm are covered by Compustat/CRSP. For the *Acquirer-Target Sample with PMR*, we require that the acquirer and the target both have a valid *PMR* measure and other control variables, particularly in the year of the bid announcement. For the *Acquirer-Target Sample with PMR and Overlap*, we require that the acquirer and the target both have a valid *PMR* and *Technology Overlap*. The PMR measure, from Hoberg and Phillips [2010], is based on the degree to which two firms use the same words in their 10-K product descriptions and is available only from 1996. *Technology Overlap* is a measure based on the overlap in the patent portfolios of the two firms, calculated as described in the Appendix, and is available only till 2006.

For our tests related to technological overlap, we combine our acquirer-target sample with NBER dataset. The NBER dataset is only available until 2006 and further limits our combined PMR and technology overlap sample to 135 deals and 561 deal-years. Table 1 summarizes the year-wise merger announcements for the entire sample, non-missing PMR sample and non-missing PMR and technology overlap sample.

3.2 Dependent Variables

3.2.1 Merger

For our 4,767 deal-years, our dependent variable is an indicator variable, Merger, which takes a value of 1 if the merger between the two firms was announced in that year and 0 otherwise.

3.2.2 Synergies

For our deal-level regressions, we look at merger synergies and related variables. To compute the combined synergies of the transaction and the share captured by the target, we use the methodology in many previous studies, for example Golubov et al. [2012], Kale et al. [2003] and Bradley et al. [1988]. We begin by calculating the cumulative abnormal returns for the acquirer and the target in the window [-10,0].The abnormal returns are calculated using the market adjusted model where CRSP value-weighted index return is the market return. We then multiply the CARs for each firm by the respective market capitalization at $t = -10$ to get the extra value created by the merger i.e. the synergies. The synergies are then added together to get the combined synergies.

$$Synergies(Dollars) = CAR_{Acquirer} \times MarketCap_{Acquirer} + CAR_{Target} \times MarketCap_{Target}$$

However, it is difficult to compare dollar synergies across deals. So, we divide the synergies in dollar terms by the sum of the market capitalizations of both firms at $t = -10$ to get the combined synergies.

$$Synergies(\%) = \frac{CAR_{Acquirer} \times MarketCap_{Acquirer} + CAR_{Target} \times MarketCap_{Target}}{MarketCap_{Acquirer} + MarketCap_{Target}}$$

The share of the synergies that go to the target's shareholders is calculated as:

$$Target's\ Share\ of\ Synergies = \begin{cases} \frac{CAR_{Target} \times MarketCap_{Target}}{Synergies(Dollars)} & \text{if } Synergies(Dollars) \geq 0 \\ 1 - \frac{CAR_{Target} \times MarketCap_{Target}}{Synergies(Dollars)} & \text{if } Synergies(Dollars) < 0 \end{cases}$$

The premium is calculated as a fraction of the target's market capitalization at $t = -10$:

$$Premium = \frac{Payment}{MarketCap(t = -10)_{Target}}$$

3.3 Independent Variables

3.3.1 Product Market Relatedness (PMR)

The product market relatedness (PMR) data were downloaded from the Hoberg-Phillips's Data Library website. We use the larger TNIC Database (which is calibrated to have the same granularity as two-digit SIC codes) so that we can increase the number of matches in our sample. For each deal, we retain the acquirer-target pairwise similarity from 1996 to the acquisition date. This gives us the time series of the product similarity between the acquirer and target for each transaction from the SDC database.

3.3.2 Technology Overlap

It is calculated (based on Jaffe [1986]) as :

$$\frac{S_{acq}S'_{tar}}{\sqrt{S_{acq}S'_{acq}}\sqrt{S_{tar}S'_{tar}}}$$

where the vector $S_{acq} = (S_{acq,1}, ...S_{acq,J})$ captures the innovation activity of the acquirer firm and vector $S_{tar} = (S_{tar,1}, ...S_{tar,J})$ captures the innovation activity of the target firm, and J denotes the technology class. S_{acq} is calculated as the ratio of number of patents awarded in technology class J till date to the total number of patents awarded till date in all technology classes to the acquirer. S_{tar} is defined similarly.

3.3.3 Herfindahl Hirschman Index (HHI)

We obtain HHI from Hoberg-Phillips's Data Library website[7]. It is a proxy for the level of competition in the market. Specifically the Text-based Network Industry Classifications Herfindahl index in Hoberg and Phillips [2016] has been calculated using a dynamic industry classification based on each firm's product descriptions from annual 10-K filings.

The summary statistics of the variables used in our regressions are presented in Table 2.

[7] http://hobergphillips.usc.edu/industryconcen.htm

Table 2: **Summary Statistics**

Panel A: Deal-Year Variables

	Count	Mean	SD	Min	P25	P50	P75	Max
Acquirer Book to Market	4767	0.558	0.718	-7.750	0.252	0.437	0.680	13.918
Target Book to Market	4767	0.634	0.958	-23.284	0.288	0.516	0.811	29.923
Acquirer Leverage	4767	0.229	0.202	0.000	0.065	0.189	0.340	2.071
Target Leverage	4767	0.234	0.226	0.000	0.046	0.190	0.362	3.044
Acquirer Stock Runup	4767	5.865	38.538	-91.477	-14.241	1.211	17.920	501.780
Target Runup	4767	3.337	53.333	-96.419	-19.742	-2.084	16.858	1405.284
Acquirer Volatility	4767	0.026	0.016	0.005	0.015	0.021	0.032	0.185
Target Volatility	4767	0.032	0.020	0.006	0.018	0.027	0.040	0.227
Acquirer Cash to Assets	4767	0.138	0.180	0.000	0.024	0.059	0.170	0.956
Target Cash to Assets	4767	0.158	0.208	0.000	0.021	0.059	0.214	0.974
Acquirer Return on Assets	4767	0.020	0.160	-3.491	0.008	0.031	0.069	1.336
Target Return on Assets	4767	-0.027	0.262	-5.130	-0.004	0.017	0.055	2.154
Acquirer Total Assets	4767	10.371	27.765	0.003	0.563	2.212	8.337	707.121
Target Total Assets	4767	2.801	6.746	0.001	0.142	0.562	2.263	102.580
PMR	4767	0.119	0.110	0.000	0.054	0.096	0.153	0.939
HHI	4767	0.136	0.131	0.016	0.056	0.094	0.162	1.000
Technology Overlap	561	0.217	0.256	0.000	0.000	0.102	0.356	1.000

Panel B: Deal Characteristics

	Count	Mean	SD	Min	P25	P50	P75	Max
Deal Value	896	2.455	7.478	0.000	0.057	0.246	1.262	89.168
Premium	896	1.398	1.053	0.000	1.047	1.332	1.725	15.014
Acquirer CAR	896	-0.009	0.098	-0.579	-0.056	-0.010	0.036	0.640
Target CAR	896	0.179	0.310	-0.546	0.008	0.116	0.267	3.881
Synergies	896	0.020	0.099	-0.329	-0.031	0.015	0.068	0.839
Form	896	0.824	0.381	0.000	1.000	1.000	1.000	1.000
All Cash Deal Indicator	896	0.249	0.433	0.000	0.000	0.000	0.000	1.000
Mixed Deal Indicator	896	0.443	0.497	0.000	0.000	0.000	1.000	1.000
Hostile Takeover Indicator	896	0.038	0.191	0.000	0.000	0.000	0.000	1.000
Tender Offer Indicator	896	0.102	0.302	0.000	0.000	0.000	0.000	1.000
Reverse Takeover Indicator	896	0.035	0.183	0.000	0.000	0.000	0.000	1.000
Acquirer Market Capitalization	896	14.084	44.465	0.007	0.475	1.616	6.753	492.460
Target Market Capitalization	896	1.873	5.769	0.001	0.068	0.233	1.107	65.386
PMR	896	0.142	0.129	0.000	0.062	0.116	0.179	0.939
HHI	896	0.141	0.139	0.016	0.059	0.094	0.172	1.000
Technology Overlap	135	0.223	0.253	0.000	0.014	0.116	0.323	1.000

This table reports summary statistics for the dependent, independent and control variables used in our regressions. Panel A reports the statistics for variables defined at the deal-year level and Panel B for the variables defined only in the year of the merger. Definitions of the variables are provided in the Appendix.

4 Results

4.1 Product Market Relatedness and Acquisition likelihood

We start by examining how the Product Market Relatedness affects the likelihood of the merger.

Table 3 presents the results from the regression specification described in equation (1).

Table 3: **Main Results**

	(1) Merger	(2) Merger	(3) Merger	(4) Merger	(5) Merger	(6) Merger
PMR	0.750***	0.885***	2.414***	4.898***	5.957***	18.197***
	(6.78)	(7.84)	(7.03)	(7.08)	(8.18)	(6.81)
PMR^2	-0.629***	-0.780***	-1.484**	-4.358***	-5.489***	-14.583***
	(-3.65)	(-4.28)	(-2.01)	(-4.50)	(-5.27)	(-3.16)
Target Book to Market		0.002	0.004		0.009	0.002
		(0.27)	(0.27)		(0.20)	(0.06)
Acquirer Book to Market		0.002	0.021		0.011	0.048
		(0.20)	(1.48)		(0.23)	(0.42)
Acquirer Leverage		0.057*	0.132*		0.349*	0.327
		(1.84)	(1.71)		(1.75)	(0.54)
Target Leverage		0.008	0.096		0.053	1.086
		(0.27)	(1.37)		(0.29)	(1.48)
Acquirer Volatility		-2.657***	-5.443***		-18.472***	-38.240***
		(-5.71)	(-6.69)		(-5.06)	(-5.19)
Target Volatility		2.758***	2.872***		17.000***	14.954***
		(6.51)	(4.05)		(6.96)	(3.86)
Acquirer Total Assets		0.000***	0.000**		0.000***	0.001***
		(2.89)	(2.12)		(3.18)	(5.75)
Target Total Assets		-0.000	0.000**		-0.000	0.000***
		(-0.18)	(2.17)		(-0.09)	(2.77)
Constant	0.115***	0.057***	-0.134**	-1.956***	-2.324***	
	(11.61)	(2.98)	(-2.49)	(-27.00)	(-18.25)	
Observations	4,767	4,767	4,767	4,767	4,767	4,767
R-squared	0.0132	0.0322	0.1931	0.0132	0.0323	0.283
Deal FE	NO	NO	YES	NO	NO	YES

Our main regression specification is:

$$Merger_{i,t} = \alpha_i + \beta_1 PMR_{i,t-1} + \beta_2 PMR^2_{i,t-1} + \gamma X_{i,t-1} + \epsilon_{it} \quad (5)$$

where $Merger_{i,t}$ is an indicator variable that takes a value 1 if an M&A transaction between the two firms occurred in that year and 0 if it did not. The PMR variable is a measure of the product market relatedness between the two firms based on the product descriptions in the 10-K forms as in Hoberg and Phillips [2010]. It lies in the interval (0,1) and a higher similarity measure implies that the two firms have product descriptions more closely related to each other. X is a vector of controls. Columns (1)-(3) provide results for the OLS regression estimation, columns (4)-(5) for the logistic regressions and column (6) for the conditional logistic regression. The sample covers mergers announced between January 1, 1996 and December 31, 2015. Definitions of the variables are provided in the Appendix. T-stats (based on clustered standard errors) are reported in parentheses; *, **, and *** denote significance at the 10%, 5% , and 1% respectively.

In column (1), we pool all the observations together and do not add any deal fixed effects. Our results suggest that the relationship between likelihood of the merger and the PMR is not

monotonic, but an inverted U. The likelihood of the merger decreases when the PMR increases above a threshold. Even below the threshold, the marginal effect of an increase in the PMR on the likelihood decreases as the PMR increases. In other words, at low values of PMR, a small increase in PMR leads to a larger increase in likelihood of merger than at high values.

Column (2) represents the same specification with the control variables for the target and acquirer added. Comparing the coefficients on the linear and quadratic terms of the PMR variable, we find that the estimates including the controls are similar to those without them[8].

In column (3), we add deal fixed effects to the specification in column (2). The fixed effects are added to see whether our results change once we account for the average PMR between the target and acquirer across years. It might be the anticipated increase or decrease in the PMR that matters rather than the absolute level. Deal fixed effects enables us to remove the effect of the average PMR from the probability of the transaction and thus concentrate purely on the within-deal variation. The coefficients of the linear and quadratic term change when we include the deal-specific fixed effects. However, the statistical significance of our estimates at 1% and the inverted U-shape persist under all three specifications.

Columns (4) and (5) employ a logistic regression specification rather than an OLS regression. This change doesn't affect the statistical significance of our coefficients. Column (6), the conditional logistic regression, allows us to include deal-specific fixed effects for each transaction. This is our most preferred specification.

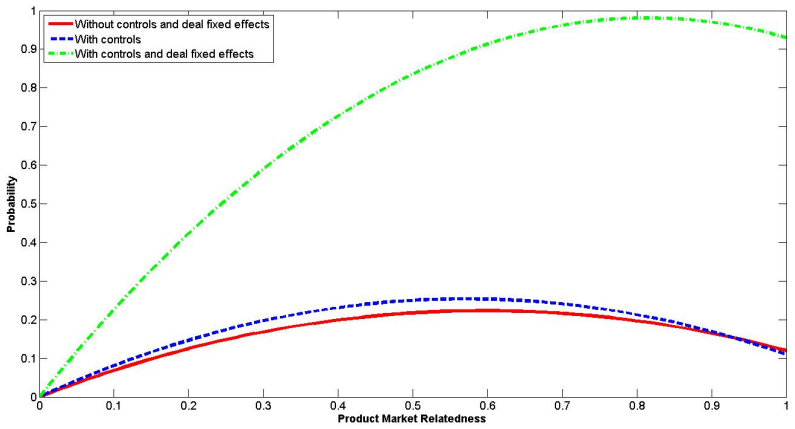
Across all the specifications in Table 3, both the linear and the quadratic terms retain their signs and continue to be highly significant. We conclude that the non-monotonic inverted-U relationship between PMR and transaction likelihood is robust to various regression specifications and controls. The peaks of the graphs, which is the point after which an increase in PMR decreases the likelihood of the merger, are 0.60, 0.57 and 0.81 for the OLS regressions and 0.56, 0.54 and 0.62 for the logistic regressions. Thus, the peak is stable across the regressions too.

Determining the magnitude of the effect is tricky due to the presence of the quadratic term in all our regressions. In Figure 2, we plot the marginal effect of the PMR on the likelihood of the merger. For the linear regressions, we plot the marginal effects due to the linear and quadratic

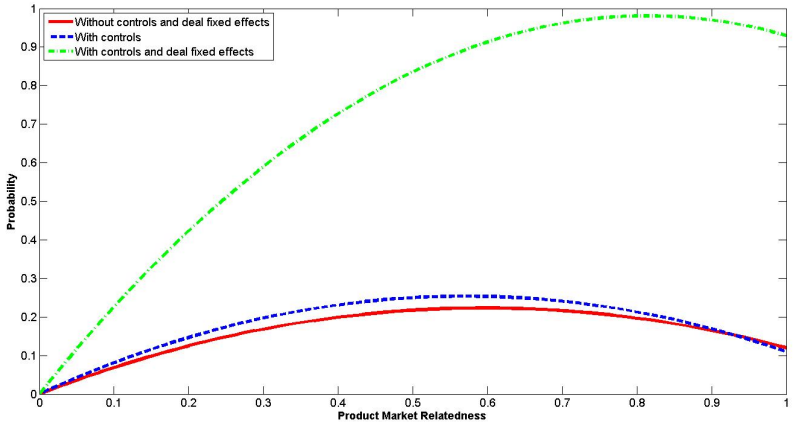
[8]This is not surprising. The only way omitted variables can bias the regression estimates is if they are correlated with both the outcome variable (probability of the transaction) and the dependent variables (PMR). While the control variables doubtless affect the outcome, there is no reason to suppose that the PMR between two firms would be related to any of their financial variables like cash, book to market ratio etc. This points to another advantage of the measure and why it can be considered plausibly exogenous. The measure is affected by the decisions of two firms, so that in the absence of coordination between them, one would not expect it to be related to the financial variables of either firm.

terms of equation (1) since the other terms only affect the level. For the logistic regression without controls and deal-fixed effects, we plot the probabilities directly as a function of the PMR using the exponential specification of the logistical regression. For the regression with controls but without the deal fixed effects, we calculate the probability assuming that each control variable takes the median value in the sample.

Figure 2: **The Non-monotonic Effects of PMR on Transaction Incidence**
Panel A: OLS regressions



Panel B: Logistic regressions



The figure shows the effects of PMR on the probability of transaction incidence based on the regressions in Table 3. Panel A corresponds to the OLS specification and Panel B to the logistic regression specification. For the OLS regressions, we only plot the linear and quadratic terms in PMR. For the logistic regressions, we assume that the control variables are at the mean levels. For the conditional logistic regression, we assume a suitable value for the deal-specific fixed effect to plot the graph since the fixed effects are not estimated in a conditional logistic regression.

4.2 Technological overlap and acquisition likelihood

So far, we have looked at one measure of firm similarity i.e. product market relatedness. We now examine another dimension along which two firms can be similar, the technological overlap between them. Bena and Li [2014] show that technological overlap between the acquirer and target affects the likelihood of the transaction. So, there may be a concern that our results so far are driven by the fact that firms with high PMR may also have high technological overlap. To check whether this is the case, we see whether the effect of product market overlap persists after controlling for the technological overlap.

Table 4: **PMR and Technology Overlap**

	(1)	(2)
	Merger	Merger
PMR	34.037***	36.991***
	(3.20)	(3.16)
PMR^2	-50.073***	-53.693***
	(-2.75)	(-2.61)
Technology Overlap		29.921***
		(3.43)
Technology $Overlap^2$		-21.023***
		(-2.67)
Observations	561	561
Deal FE	YES	YES
R-squared	0.364	0.446
Controls	YES	YES

The conditional logit specification to test the effect of PMR and Technology Overlap on the probability of merger incidence is as follows:

$$Merger_{i,t} = \alpha_i + \beta_1 PMR_{i,t-1} + \beta_2 PMR^2_{i,t-1} + \beta_3 TechnologyOverlap_{i,t-1} + \beta_4 TechnologyOverlap^2_{i,t-1} + \gamma X_{i,t-1} + \epsilon_{it}$$

where $Merger_{i,t}$ is an indicator variable that takes a value 1 if an M&A transaction between the two firms occurred in that year and 0 if it did not. The PMR variable is a measure of the product market relatedness between the two firms based on the product descriptions in the 10-K forms as in Hoberg and Phillips [2010]. *Technology Overlap* is the measure of technological innovation overlap between the acquirer and the target. Both measures of similarity lie in the interval (0,1) and a higher similarity measure implies that the two firms have product descriptions / patent portfolios that are more closely related to each other. X is a vector of controls. Definitions of the variables are provided in the Appendix. All specifications include deal fixed effects. T-stats (based on clustered standard errors) are reported in parentheses; *, **, and *** denote significance at the 10%, 5% , and 1% respectively.

Table 4 displays the results of our analysis. In column (1), we run the same regression

specification as in column (6) of Table 3 to ensure that any difference in this sub-sample results is not an artifact of the sub-sample selection. The result of the regression indicates that the relationship between transaction incidence and PMR is broadly the same in this sub-sample as for the whole sample. Both the linear and the quadratic terms are significant, and the signs remain the same.

Column (2) reports the results once we add the technological overlap and its square as independent variables. We find that the effect of the PMR remains, that is the PMR matters over and above the technological similarity. Also, the coefficient on the PMR variable and its squared terms in column (2) are very similar to those in column (1), confirming that it is not the correlation between PMR and technology overlap that drove our earlier results.

Further, we confirm the Bena and Li [2014] result that technology overlap is independently significant in determining the merger likelihood. Unlike them, however, we find that the effect is nonlinear. The square of technological relatedness is negative and statistically significant at the 1% level, so the inverted U shaped relationship we find between merger likelihood and the PMR holds for the technology overlap too.[9]

5 Possible Mechanisms

So far, we have established that both the PMR and the innovation overlap have non-monotonic effects on the likelihood of a firm acquiring a target. We now examine the mechanism through which these effects manifest themselves.

High firm similarity may dissuade firms from merging due to two reasons. Consider first the antitrust explanation. If two firms are very similar, specifically in the product market, antitrust regulators may block the merger from happening. Anticipating this, firms may decide not to merge with the firm till the PMR decreases in the future. The alternative mechanism is through the effect of PMR on synergies rather than antitrust investigations. The likelihood of the firms merging varies in proportion to the synergies. Maybe the synergies have an inverted U relationship with PMR which leads to the likelihood of merger incidence having the same relationship.

[9] Ahuja and Katila [2001] shows a nonlinear impact of technological overlap on the post-acquisition innovation output of the acquiring firm. However, their study differs from ours in numerous ways. Their sample only includes the chemical industry, their overlap measure differs from ours, their effect is on subsequent innovation rather than on merger incidence, and their result only holds for technological acquisitions within the industry. Bena and Li [2014] do not find a nonlinear effect even on the post-acquisition innovation output

5.1 Antitrust regulation

Section 7 of the Clayton Act bars mergers if "in any line of commerce or in any activity affecting commerce in any section of the country, the effect of such acquisition may be substantially to lessen competition, or to tend to create a monopoly."[10] The line of commerce referred to constitutes a product market. The FTC guidelines on horizontal mergers states that "When a product sold by one merging firm (Product A) competes against one or more products sold by the other merging firm, the Agencies define a relevant product market around Product A to evaluate the importance of that competition."[11]

The definition of the relevant product market is crucial in determining whether the merger is blocked or not. Two contrasting recent examples are the Staples and Office Depot merger in 1997 which was blocked whereas the Whole Foods Market's acquisition of Wild Oats Market went ahead in 2007.[12] In one case, the market was defined narrowly whereas in the other case, it was defined more broadly.[13] As the PMR between two firms increases, the firms are viewed as competitors and the chances of the merger being blocked thus increases.

The second important factor in determining whether a horizontal merger should be allowed is the industry concentration. The FTC guidelines state that the Herfindahl-Hirschman Index, a measure of market concentration if a factor that the agencies take into account. If antitrust plays a key role in merger decisions, it is likely to do so in markets where the acquirer's market concentration is high. So, the effect of PMR on merger decisions should be particularly pronounced in markets which are concentrated. We test this hypothesis by adding interaction terms for the PMR and its square with the HHI. The results are given in Table 5.

[10] 15 U.S. Code §18.

[11] As quoted in the horizontal merger guidelines at the FTC site, available online at www.ftc.gov/sites/default/files/attachments/mergers/100819hmg.pdf, last accessed on March 31th, 2017

[12] This is not just a recent phenomenon. Writing a few decades ago, Manne [1965] expressed the opinion that "Antitrust problems in the merger field seem more and more to be confined to discussions of relevant product and geographic markets and perhaps to the issue of quantitative substantiality"

[13] See Varner and Cooper [2007] for more details on these two proposed mergers and the role the definition of the relevant product market played in both of them.

Table 5: **PMR and Market Concentration**

	(1) Merger	(2) Merger	(3) Merger	(4) Merger
PMR	0.557***	0.682***	3.977***	4.866***
	(3.24)	(4.09)	(3.67)	(4.44)
PMR2	-0.354	-0.445*	-2.984*	-3.657**
	(-1.31)	(-1.81)	(-1.91)	(-2.55)
HHI	-0.006	-0.241	0.080	-1.412
	(-0.07)	(-1.64)	(0.14)	(-1.36)
HHI × PMR	2.138**	2.134**	10.748*	11.548*
	(2.12)	(2.12)	(1.81)	(1.81)
HHI × PMR^2	-2.852**	-3.361***	-14.729*	-18.424**
	(-2.05)	(-2.60)	(-1.78)	(-2.29)
Constant	0.110***	0.088***	-2.003***	-2.136***
	(6.95)	(2.97)	(-17.22)	(-10.45)
Observations	4,767	4,767	4,767	4,767
R-squared	0.0161	0.0384	0.0159	0.0378
Deal FE	NO	NO	NO	NO
Controls	NO	YES	NO	YES

The table reports results from the following regression specification

$$Merger_{i,t} = \beta_1 PMR_{i,t-1} + \beta_2 PMR^2_{i,t-1} + \beta_3 HHI + \beta_4 PMR_{i,t-1} * HHI + \beta_4 PMR^2_{i,t-1} * HHI + \gamma X_{i,t-1} + \epsilon_{it}$$

where $Merger_{i,t}$ is an indicator variable that takes a value 1 if an M&A transaction between the two firms occurred in that year and 0 if it did not. The PMR variable is a measure of the product market relatedness between the two firms based on the product descriptions in the 10-K forms as in Hoberg and Phillips [2010]. HHI is a measure of market concentration based on Hoberg and Phillips [2016]. X is a vector of controls. This specification does not include deal fixed effects. Columns (1)-(2) employ a linear regression specification and columns (3)-(4) employ a logistic regression specification. Definitions of the variables are provided in the Appendix. T-stats (based on clustered standard errors) are reported in parentheses; *, **, and *** denote significance at the 10%, 5% , and 1% respectively.

In columns (1) - (2), we employ a linear regression specification and in columns (3)-(4) a logistic regression specification. We do not include deal-fixed effects since there is not enough variation within a deal to capture the differential effect of PMR depending on HHI. We run regressions with and without controls. Across all specifications, we find that the interaction coefficient of the squared term is negative, thus showing that high values of market concentration affect merger decisions at higher PMRs more than low values of market concentration.

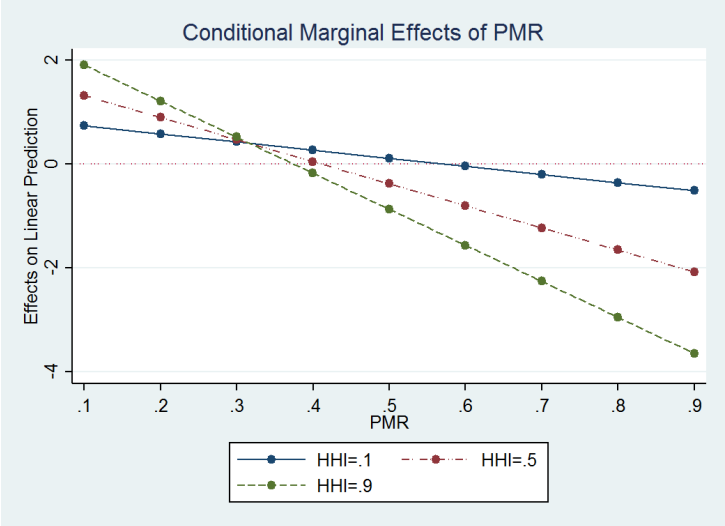
Since our regressions have both linear and squared terms, we plot the marginal effects of the PMR on the probability for easy interpretation and visualization.[14] Our preferred specification is the logistical regressions with controls, column (4). Figure 3 shows that as HHI increases, a

[14]This is just the partial derivative of the probability with respect to the PMR

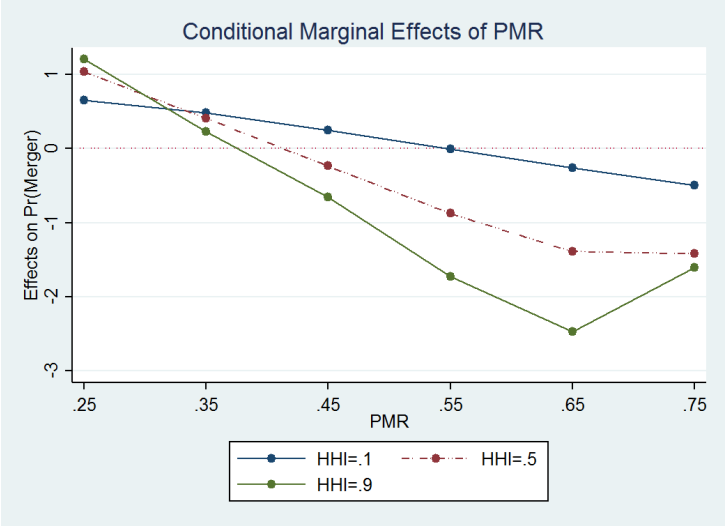
small change in the PMR leads to a larger drop in the probability of the transaction incidence. It is clear from the graph that the value of the PMR at which the marginal effect starts becoming negative[15] decreases as the market concentration increases. This strongly suggests that antitrust acts as a deterrent for firms to consider merging with a target which operates in very similar product markets.

Figure 3: **The Marginal Effects of PMR on transaction incidence**

Panel A: OLS regressions



Panel B: Logistic regressions

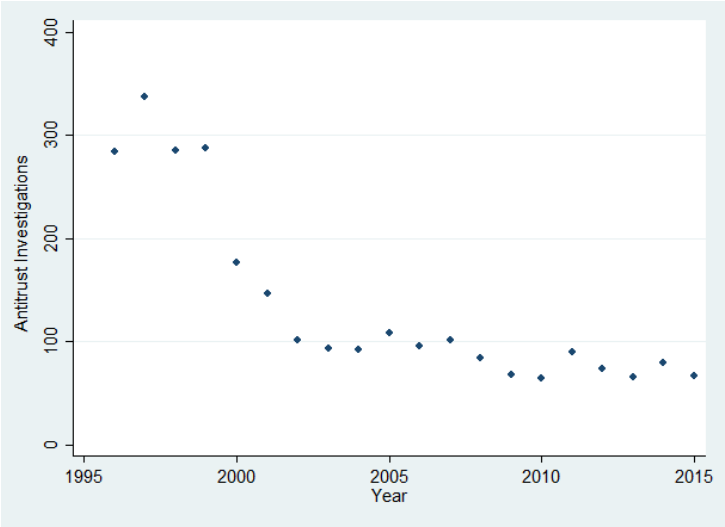


The figure shows how the marginal effects of PMR on the probability of transaction incidence vary with the market concentration. The estimates are based on the regressions in Table 5. We plot the marginal effects for low, medium and high values of market concentration (0.1, 0.5 and 0.9). All control variables are assumed to be at their mean levels. Panel A corresponds to the OLS regression specification and Panel B to the logistic regression specification.

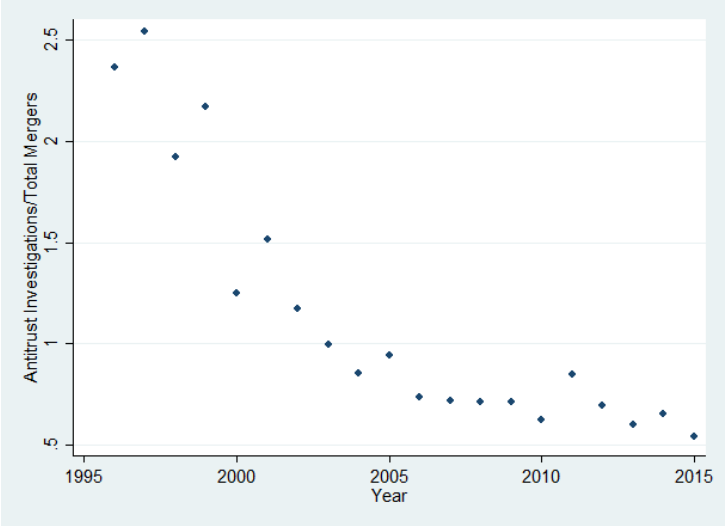
[15] from which point an increase in PMR causes the probability of transaction to decrease

Figure 4: **Antitrust investigations - Time Trend**

Panel A: Total antitrust investigations



Panel B: Total antitrust investigations scaled by total merger announcements



Panel A shows the total number of antitrust investigations in each year from 1996 – 2015. Panel B shows the ratio of antitrust investigations to the total number of mergers and acquisition in that year. The data is taken from the ten year workload statistics, available at the website of the Department of Justice (https://www.justice.gov/atr).

To bolster our results further, we next examine whether PMR affects merger decisions more in times of higher regulatory intensity. There are reasons to believe that the antitrust regulators were more active during certain years in the two decades covered by our sample. Katz and Shelanski [2007], for example, mentions the unusually high number of merger investigations initiated by the Antitrust Division of the U.S. Department of Justice in the years from 1996 to 2005. We collect the data on the investigations from the DOJ website.[16]

[16]The Ten Year Workload Statistics Report can be accessed at https://www.justice.gov/atr/division-operations

Table 6: **PMR and Antitrust Intensity**

	(1) 1996 - 2005 Merger	(2) 2006 - 2015 Merger	(3) 1996 - 2015 Merger	(4) 1996 - 2015 Merger
PMR	5.884***	6.098***	6.098***	7.499***
	(6.52)	(4.22)	(-4.22)	(3.43)
PMR2	-5.048***	-6.421***	-6.421***	-8.463***
	(-3.86)	(-3.48)	(-3.48)	(-2.88)
High			-1.153***	-0.194
			(-3.92)	(-0.73)
High × PMR			-0.215	-3.849
			(-0.12)	(-1.55)
High × PMR^2			1.373	7.119**
			(0.60)	(2.11)
HHI				1.045
				(1.08)
HHI × PMR				-10.333
				(-0.97)
HHI × PMR^2				12.679
				(1.05)
High × HHI				-1.743
				(-1.58)
High × HHI × PMR				32.025**
				(2.50)
High × HHI × PMR^2				-47.124***
				(-2.75)
Constant	-2.729***	-1.576***	-1.576***	-2.148***
	(-15.16)	(-7.06)	(-10.95)	(-7.07)
Observations	3,496	1,271	4,767	4,767
Deal FE	NO	NO	NO	NO
R-Squared	0.0417	0.0394	0.0461	0.0409
Controls	YES	YES	YES	YES

Columns (1) and (2) provide subsample regressions similar to our main specification for time periods 1996-2005 and 2006-2015 respectively. In columns (3) and (4), we use run the following regression specification for the whole sample to test the effect of antitrust intensity (as measured by the antitrust investigations in a given year).

$$\begin{aligned} Merger_{i,t} = {} & \beta_1 PMR_{i,t-1} + \beta_2 PMR^2_{i,t-1} + \beta_3 HHI + \beta_4 High + \beta_5 PMR_{i,t-1} * HHI \\ & + \beta_6 PMR^2_{i,t-1} * HHI + \beta_7 PMR_{i,t-1} * High + \beta_8 PMR^2_{i,t-1} * High + \beta_9 HHI * High \\ & + \beta_{10} PMR^2_{i,t-1} * HHI * High + \beta_{11} PMR^2_{i,t-1} * HHI * High + \gamma X_{i,t-1} + \epsilon_{it} \end{aligned}$$

where $Merger_{i,t}$ is an indicator variable that takes a value 1 if an M&A transaction between the two firms occurred in that year and 0 if it did not. The PMR variable is a measure of the product market relatedness between the two firms based on the product descriptions in the 10-K forms as in Hoberg and Phillips [2010]. HHI is a measure of market concentration based on Hoberg and Phillips [2016]. *High* denotes an indicator variable that takes value 1 for the period 1996-2005 and 0 for 2006-2015. X is a vector of controls. Definitions of the variables are provided in the Appendix. T-stat (based on clustered standard errors) are reported in parentheses; *, **, and *** denote significance at the 10%, 5% , and 1% respectively.

To lessen concerns of reverse causality, that the investigations are higher because mergers were more likely, we also calculate the number of investigations as a fraction of the total number of mergers and acquisitions announced in the year. Figure 4 shows the graph of these variables. We find that in the first decade of the sample, both the number and fraction of mergers investigated was high in relation to our overall sample. We first run the regression specifications in Table 3 column (5) i.e. logit regressions for the subsample from 1996 to 2005. Note that we do not include deal-fixed effects since our data for some deals covers both the low and high intensity regimes.[17] Table 6 provides results for these tests. Columns (1)-(2) show that the effect of PMR was present in both high and low regulatory intensity regimes.

To examine the differential effect of the two regimes, we postulate that the differential effect of PMR due to the level of market concentration is further amplified if the antitrust regulators are more active. To test this, we add a double interaction term between the PMR, antitrust intensity and HHI. The regression with the double interaction takes the following form.

$$\begin{aligned} Merger_{i,t} = {} & \beta_1 PMR_{i,t-1} + \beta_2 PMR^2_{i,t-1} + \beta_3 HHI + \beta_4 High + \beta_5 PMR_{i,t-1} * HHI \\ & + \beta_6 PMR^2_{i,t-1} * HHI + \beta_7 PMR_{i,t-1} * High + \beta_8 PMR^2_{i,t-1} * High + \beta_9 HHI * High \\ & + \beta_{10} PMR^2_{i,t-1} * HHI * High + \beta_{11} PMR^2_{i,t-1} * HHI * High + \gamma X_{i,t-1} + \epsilon_{it} \end{aligned} \tag{6}$$

Where $High$ is an indicator variable that takes value 1 when the time period is 1996-2005 and 0 otherwise. HHI is a continuous variable that denotes acquirer's market concentration. All other variables have been defined previously.

The coefficients of interest here are β_{10} and β_{11}, which indicate the difference between the differential effect of PMR in markets with different market concentrations in regimes with high antitrust intensity versus those with low antitrust intensity. Column (4) shows that the interaction effect is positive for the linear PMR term (32.025) and negative for the quadratic PMR term (-47.124), which means that the negative effect dominates at high values of PMR.[18]

Overall, our findings in this section provide strong support to the hypothesis of antitrust regulation being a mechanism through which PMR affects the mergers. We thus make a contribution to the literature on the costs and benefits of antitrust regulation. For example, Stillman [1983] examines the question of whether horizontal mergers challenged in the past by the federal

[17] This is almost identical to the subsample for which we have the technology overlap proxy

[18] However, column (3) demonstrates that if we do not add the double interaction term, we find no statistically significant difference between the two decades, which further strengthens our conclusion.

government would have resulted in higher product prices to consumers while acknowledging that the study looks only at challenged mergers. However, we show that it is not enough to look only at the mergers which were challenged by the regulators to calculate the welfare effects absent antitrust since even the decision of firms to merge may be affected by the antitrust policies. In addition, we demonstrate that the effect of the policies are highest exactly in those industries and markets that they are designed for.

However, from Table 5, we see that the PMR has a non-monotonic effect even when the HHI is low, since the coefficients of the linear and quadratic terms are significant by themselves as well. This suggest that antitrust might not be the only factor at play. Also, in Table 4, we find technological overlap to have a non-monotonic effect on the transaction likelihood, which is difficult to explain purely through an antitrust mechanism. Motivated by this, we next turn to the effect of PMR on synergies as an alternative mechanism that affects merger likelihood.

5.2 Synergies, premium paid and stock market reaction

Prior literature, for example, Andrade et al. [2001] and Bradley et al. [1988] has documented that on average, mergers create value for shareholders of the combined merging parties. In this section, we examine the effect of PMR on total synergies and how they are split between the acquirer and target. Our dependent variables are total synergies, target share of synergies, premium paid, and cumulative abnormal market returns for the acquirer and the target.

Acquiring a firm that operates in similar product markets may lead to synergies from the economies of scale whereas acquiring a dissimilar firm may lead to economies of scope. It is certainly possible that the combined synergies from both these effects are highest when the target is neither very similar nor very dissimilar (in terms of product markets) from the acquirer. If this were the case, one would expect that the relationship between synergies and PMR exhibits an inverted U relationship analogous to that between merger likelihood and PMR.[19]

The results we obtain are presented in Table 7. Note that unlike the earlier specifications, we now have only one observation per deal. So, we employ more control variables to isolate the effect of PMR on the transaction-level synergy variables. Also, we drop two deals where the combined synergies exceeded 100% since they are outliers in our sample.

[19] A similar argument holds for innovation overlap too. However, we have very few deals with data for innovation overlap leading to insufficient power to test the hypothesis about gains from innovation overlap.

Table 7: **Merger Synergies and Premium**

	(1) Synergies	(2) TSOS	(3) Premium	(4) Acquirer CAR	(5) Target CAR
PMR	0.166***	2.673**	1.325**	0.113*	-0.105
	(2.98)	(2.09)	(2.27)	(1.90)	(-0.54)
PMR^2	-0.233***	-3.493**	-1.894***	-0.189**	-0.116
	(-3.07)	(-2.23)	(-2.70)	(-2.27)	(-0.51)
Acquirer Stock Runup				0.001***	0.000
				(4.03)	(0.60)
Acquirer Volatility				-0.312	0.685
				(-1.05)	(0.94)
Acquirer Book to Market				0.010*	-0.031**
				(1.79)	(-2.55)
All Cash Deal Indicator	0.019**	-0.232	-0.334***	0.012	0.054*
	(2.14)	(-1.33)	(-4.11)	(1.38)	(1.79)
Mixed Deal Indicator	0.008	0.150	0.155**	-0.007	-0.022
	(1.08)	(0.94)	(2.01)	(-0.84)	(-0.90)
Hostile Takeover Indicator	0.012	0.790**	-0.035	-0.028**	-0.057
	(0.92)	(2.08)	(-0.20)	(-2.23)	(-1.21)
Tender Offer Indicator	0.018	0.061	0.627***	0.014	0.139***
	(1.42)	(0.39)	(2.76)	(1.21)	(3.16)
Reverse Takeover Indicator		0.365	0.008	-0.023	-0.014
		(0.65)	(0.10)	(-1.10)	(-0.46)
Deal Value	0.000				
	(0.65)				
Constant	-0.008	0.829***	1.230***	-0.019*	0.180***
	(-0.96)	(4.63)	(14.27)	(-1.72)	(5.29)
Observations	894	881	894	894	894
R-squared	0.0219	0.0177	0.0579	0.0555	0.0448
Deal FE	NO	NO	NO	NO	NO

The table presents results from the following regression specification

$$SynergyMeasure_i = \beta_1 PMR_i + \beta_2 PMR_i^2 + \gamma X_i + \epsilon_i$$

The dependent variable is the total synergies from the merger in column (1), the target's share of synergy in column (2), the premium in column (3) and the acquirer and target CARs in the [-10,0] window around the merger announcement date in columns (4) and (5) respectively. The PMR variable is a measure of the product market relatedness between the two firms based on the product descriptions in the 10-K forms as in Hoberg and Phillips [2010]. X is a vector of controls. Definitions of the variables are provided in the Appendix. T-stat (based on robust standard errors) are reported in parentheses; *, **, and *** denote significance at the 10%, 5% , and 1% respectively.

In column (1), we present evidence that the total synergies (in % terms) have an inverted U relationship with the PMR. Both the linear and quadratic terms are statistically significant at the 1% level. The synergies are increasing in PMR till PMR=0.36 and decrease afterwards. In addition to the statistical significance, the effect is economically significant too. For example, an increase of PMR from 0 to 0.36 (which corresponds to the peak of the inverted parabola) increases the synergy by 2.96%.

Prior research has shown that target shareholders on average extract most of the synergies in M&A transactions. The dependent variable in columns (2) and (3) are the fraction of synergies that accrue to the target's shareholders and the premium paid to the target. The inverted parabola shape continues to hold. Our findings show that when the firms become very related in the product markets, the target extracts less of the synergies. A possible explanation could be that the bargaining power of the acquirer increases if there are no other competing acquirers.

Finally, in columns (4) and (5), we look at the stock market reactions of the acquirer and target to the merger announcement. The cumulative abnormal return of the acquirer has the same inverted U relationship with the PMR as in previous regressions. An increase of PMR from 0 to the peak of the inverted parabola (which occurs at 0.3) increases the CAR of the acquirer by 1.69%. This is consistent with both columns (1) and (4) which show that the total synergies increase, but the fraction extracted by the target increases as well. So, the acquirer's CAR increases by less than the total synergies.

Considered in their totality, the results in this section indicate that synergies are a significant alternative channel through which the PMR affects merger likelihood. Since the relationship between PMR and synergies is not monotonic, even in the absence of antitrust, firms are not keen to acquire targets either very similar or very dissimilar to themselves in terms of product market relatedness.[20]

6 Discussion and concluding remarks

In this paper, we examine the effect of product market relatedness of two firms on the likelihood of incidence of a merger transaction between them. We find an inverted U-shaped relationship between PMR and transaction likelihood. We provide two possible mechanisms underlying the effect. The first is the possibility that antitrust investigations may block the merger of two related firms, causing firms to not contemplate a merger decision. The second is through the effect of synergies in the transaction, which have the same inverted U relationship with the PMR.

While we have considered the entire sample of mergers across industries in the past two decades, there are a few caveats that are in order. First, we look only at the acquisitions

[20] A similar effect may possibly hold for innovation overlap, but our subsample for which we have innovation overlap data is too small to test that hypothesis.

of public firms since the PMR variable is only available for public firms. The acquisition of private firms is an important part of the market for corporate control in the US, particularly in innovative sectors where private firms are the drivers of path-breaking innovation.Product market relatedness may play a different role in private firms due to lesser antitrust scrutiny, although this is changing in recent years.[21]

Perhaps more importantly, we only look at horizontal mergers since the PMR data is only available for firms that have some overlap to begin with. However, the fact that we find a robust relationship even among firms which are above a minimum threshold in PMR suggests that the results may be stronger in the entire sample of firms including firms which are in completely non-overlapping product markets. Past studies have looked at diversifying acquisitions, whereas our study shows that the degree of diversification within the same industry matters as well.

We leave to future work the welfare implications of antitrust laws and whether the efficiencies due to the mergers on average outweigh the anti-competitive effects brought about by them. It will be interesting to see how the product market relatedness influences post-merger pricing decisions.

Last, we look only at the firms which eventually announced their intention to merge. The effect is likely to be higher if we included mergers with potential targets which were not eventually announced. An important implication is that any examination of antitrust policy must take into account that antitrust measures are internalized by the firms even in the case of mergers which are not blocked or withdrawn due to antitrust concerns.

[21] See for example http://antitrustconnect.com/2016/09/18/antitrust-issues-facing-private-equity-entities/

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Appendix: Variable Definitions

Panel A: Main Variables	
Merger	Dummy Variable: one if the year is the same as the merger year, zero otherwise
PMR	Product Market Relatedness is a measure that lies in the interval (0,1) and is based on the degree to which two firms use the same words in their 10-K product descriptions. A higher PMR implies that the firm has product descriptions more closely related to those of the other firm.
Technology Overlap	It denotes technology overlap between two firms and is calculated (based on Jaffe [1986]) as : $\frac{S_{acq}S'_{tar}}{\sqrt{S_{acq}S'_{acq}}\sqrt{S_{tar}S'_{tar}}}$ where the vector $S_{acq} = (S_{acq,1}, ...S_{acq,J})$ captures the innovation activity of the acquirer firm and vector $S_{tar} = (S_{tar,1}, ...S_{tar,J})$ captures the innovation activity of the target firm, and J denotes the technology class. S_{acq} is calculated as the ratio of number of patents awarded in technology class J till date to the total number of patents awarded till date in all technology classes to the acquirer. S_{tar} is defined similarly.
HHI	Text-based Network Industry Classifications Herfindahl index in Hoberg and Phillips [2016], calculated using a dynamic industry classification based on each firm's product descriptions from annual 10-K filings.
Panel B: Deal-Year Variables	
Acquirer (Target) Total Assets	Total assets of the acquirer (target) in billions of dollars
Acquirer (Target) Return on Assets	Earnings before interest, taxes, depreciation, and amortization scaled by total assets of the acquirer (target)
Acquirer (Target) Leverage	Total financial debt (long-term debt plus debt in current liabilities) divided by the book value of total assets of the acquirer (target)
Acquirer (Target) Cash to Assets	Cash and short term investments scaled by total assets of the acquirer (target)
Acquirer (Target) Book to Market	The book value of common equity scaled by the market value of common equity of the acquirer (target)

Panel B: Deal-Year Variables *Continued*	
Acquirer (Target) Stock Runup	Market-adjusted buy-and-hold return of the bidding firm's stock over the period beginning 205 days and ending 6 days prior to the announcement date from CRSP of the acquirer (target).
Acquirer (Target) Volatility	Standard deviation of the firm's market-adjusted daily returns from CRSP over the period beginning 205 and ending 6 days before deal announcement date of the acquirer (target).
Panel B: Deal Variables	
Acquirer (Target) CAR	Cumulative abnormal return of the acquirer (target) firm's stock in the 11-day event window [-10,0] where 0 is the announcement day. The abnormal returns are calculated using the market adjusted model where CRSP value-weighted index return is the market return.
Synergies	Sum of bidder and target dollar denominated gains (computed as the sum of acquirer market value of equity 10 days prior to the announcement from CRSP in US$ Million times acquirer's CAR [-10,0] and target market value of equity 10 days prior to the announcement from CRSP in US$ Million times target's CAR [-10,0]) scaled by sum of acquirer and target market value of equity 10 days prior to the announcement
TSOS	Target share of synergy defined as target dollar denominated gain (market value of equity 10 days prior to the announcement from CRSP times target's CAR [-10,0]) divided by sum of bidder and target dollar denominated gains (computed as the sum of acquirer market value of equity 10 days prior to the announcement from CRSP in US$ Million times acquirer's CAR [-10,0] and target market value of equity 10 days prior to the announcement from CRSP in US$ Million times target's CAR [-10,0]) if total dollar denominated gain is positive and 1 minus (target dollar denominated gain/total dollar denominated gain) if total dollar denominated gain is negative [Bradley et al., 1988].

Panel B: Deal Variables *Continued*	
Deal Value	Value of transaction from Thomson Financial SDC in US$ Billion.
Premium	Takeover premium computed as Deal Value divided by the market value of target's equity 10 days before the acquisition announcement
Hostile Takeover Indicator	Dummy variable: one for deals defined as hostile or unsolicited by Thomson Financial SDC, zero otherwise.
All Cash Deal Indicator	Dummy variable: one for deals in which the sole consideration is cash, zero otherwise.
Mixed Deal Indicator	Dummy variable: one for deals in which consideration is neither all-cash nor all-stock, zero otherwise.
Tender Offer Indicator	Dummy variable: one for tender offers , zero otherwise.
Reverse Takeover Indicator	One for deals defined as reverse takover by Thomson Financial SDC, zero otherwise.
Acquirer (Target) Market Capitalization	Market value of equity 10 trading days prior to the acquisition announcement from CRSP in US$ Billion