THE UNIVERSITY OF CHICAGO

MERGERS, AGGREGATE PRODUCTIVITY, AND MARKUPS

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To my better half

and the munchkins.

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ABSTRACT

I study the aggregate impact of mergers on productivity and markups growth for a sample of 16 European economies. Instrumented with staggered antitrust policy changes and predetermined firm-size distributions, a three-percentage-point increase in an industry's merger rate causes a one-percentage-point increase in annual productivity growth. The effect on an industry's markups growth is statistically indistinguishable from zero. I use deal-level data to explore the firm-level mechanism. Relative to peer firms, an acquired firm experiences faster Hicks-neutral productivity growth and rising market share, suggesting the quantitatively important channel is scale economies. Markups growth is also higher among acquired firms, but the impact is offset in the aggregate by decreases in peer-firm markups growth.

CHAPTER 1

INTRODUCTION

Mergers and acquisitions play a prominent role in business dynamism today. Over 90% of public firms have acquired another firm, and over 60% of delistings are due to acquisitions.[1] Earlier work has investigated the impact of mergers on firm-level economic activity relative to peer firms. Potential spillover effects on competing firms could either counteract or amplify these findings at the industry-level. Moreover, many studies are often conducted on specific segments of the economy, and their results do not apply broadly. Whether the existing firm-level findings translate to aggregate outcomes remains under-explored.

In this paper, I examine the economic role of mergers in 16 European economies and 28 broad sectors. Specifically, I address the following questions: Have mergers accelerated productivity growth and markups growth at the country-industry level? If so, what are the channels?

The two outcome variables have long been linked to mergers. A long list of literature has found evidence for, or against, efficiency gains through mergers.[2] Others have found that business combinations impact firm-level innovation, even though the implications are nuanced and differ across studies. With the recent influx of works claiming rising markups, mergers have been hypothesized to play a critical role in the consolidation of market power, leading to superstar firms and rising profits.[3]

This line of inquiry faces two major challenges. First, when observed revenues cannot be decomposed into prices and quantities, identifying the impact of mergers on productivity and markups separately is empirically difficult. Firm-level datasets that encompass both

1. These statistics are calculated using Compustat North America and Compustat Global databases. Ninety percent of all firms in these databases have non-zero accounting Goodwill, which arises only in the aftermath of an M&A deal. Sixty percent of all delistings are due to acquisitions. This statistic also includes delistings through buyouts.

2. See Andrade, Mitchell, and Stafford (2001) and Kaplan and Weisbach (1991) for an overview of this body of work.

3. See DeLoecker and Eeckhout (2017), Gutirrez and Philippon (2018), and Barkai (2017).

manufacturing and service sectors are typically subject to this limitation. Therefore, in most studies of mergers that span across industries, increased pricing power and increased productivity are observationally equivalent. At the industry level, quantity and price data are more readily available. By conducting my analysis at a higher level of aggregation, I circumvent this measurement issue.

The second challenge is in claiming the causal impact of mergers. Whether a firm chooses to join another is an endogenous outcome. The economic motivation for merging may influence future productivity and profitability, regardless of the decision to merge. I address this issue by constructing an instrument that interacts changes in country-level merger policy and variation in the firm-size distributions across industries. This instrument introduces exogenous shifts to the merger rate at the country-industry-year level and allows for quantifying its causal impact on aggregate productivity and markups growth.

Using the identification strategy above, I find that a three-percentage-point increase in an industry's merger rate causes a one-percentage-point increase in annual productivity growth. However, the effect on industry markups growth is statistically indistinguishable from zero. I supplement these aggregate findings by exploring the associated firm-level mechanisms. Relative to peer firms, acquisition targets experience faster Hicks-neutral revenue productivity growth; that is, the rise in productivity is not coupled with a statistically significant shift in the labor-to-capital ratio. Combined with the evidence that acquisition targets gain market share, these firm-level results jointly suggest the quantitatively important channel for efficiency gains is scale economies.

Although the statistical evidence for the impact of mergers on industry-level markups is non-significant, at the firm-level, acquisition targets exhibit higher markups growth relative to peer firms. A story emerges from these findings: acquired firms' productivity growth lowers costs, allowing them to compete on price without eroding margins. In fact, as long as the rate of price decline is slower than the rate of productivity gain, acquired firms can enjoy rising markups even with falling prices. On the other hand, peer firms face downward price pressures and declining margins. This negative spillover effect on competitors offsets the relative increase in markups growth observed among acquired firms. Thus, on net, mergers do not cause accelerated markups growth in the aggregate.

A similar story was *cemented* in a case study of the U.S. ready-mixed concrete market. Hortacsu and Syverson (2007) show that plants who vertically integrate tend to be more productive, ex-ante, and further enhances efficiency, ex-post, through increased scale.[4] This allows integrated firms to charge lower prices and gain market share. Their observations resonate with my findings across countries and industries. In a broader empirical setting, Maksimovic and Phillips (2002) analyze plant-level data from the U.S. Census of Manufacturing and find that mergers and the transfers of corporate assets lead to more efficient allocation of resources and hence higher productivity.

More recently, Blonigen and Pierce (2016) use the same US plant-level data to show a positive average treatment effect of mergers on plant-level markups, relative to the control group. The authors also find in many of their specifications that mergers positively impact revenue productivity, though not as robustly as the impact on markups. As will be shown in section 3, my firm-level analysis finds qualitatively similar results using a European sample. The inferences we make on the impact of mergers on true, quantity-based productivity is different, however. Without observing prices separately from revenues, Blonigen and Pierce (2016) use non-parametric methods developed by DeLoecker and Warzynski (2012) to claim mergers negatively impact true productivity. I observe that merger targets have faster market-share growth relative to peer firms, suggesting that under typical demand environments, merger target's output prices have likely fallen relative to peer firms in order to attract additional demand for their goods. Thus, the joint observation of increasing revenue productivity and market-share growth leads me to infer mergers have a positive impact on firm-level true productivity growth.

In the firm-level section of my paper, I test whether observed productivity gains are

4. Specifically, owning plants at more locations reduces the cost of delivering cement.

channeled through technology diffusion. There is a body of literature documenting mixed evidence on the relationship between mergers and innovations. Bena and Li (2013) show that firms with large patent portfolio and low R&D expenditures are typically acquirers, whereas the reverse characterizes targets. Furthermore, they find evidence that synergies from innovation are an important driver for mergers. More recently, in Ma, Ouimet, and Simintzi (2018) argue mergers facilitate technology adoption and increase the productivity of high-skill workers. On the flip side, Seru (2014), using failed mergers as controls, shows conglomeration stifles future patent-based innovations.

My paper also relies on the insight from the literature on merger waves. Harford (2005) documents that mergers cluster by industry and over time, and finds that regulatory, economic, and technological shocks drive merger waves. In a follow-up work, Ahern and Harford (2013) demonstrate that merger waves also propagate through industry linkages. Rhodes-Kropf and Viswanathan (2004) build the theoretical foundations for stock-market-valuation-driven merger waves and find empirical support for this hypothesis in Rhodes-Kropf, Robinson, and Viswanathan (2005). These works highlight the importance of a valid instrument in identifying the causal impact of mergers and industry-level outcomes.

The analysis in this paper also relates to the recent discussion on the increase of market concentration and markups. This line of work was recently revitalized by DeLoecker and Eeckhout (2017), who argue that average markup has increased among US public firms. Barkai (2017), who documents the joint decline in labor and capital shares, argues that changes in industry concentration may play a role in the increase in profit share. Many papers have been written about this topic since, but they are mostly US centric. A recent working paper by Gutirrez and Philippon (2018) shows that concentration in the EU has, in fact, not increased, and suggests tighter merger controls in the EU relative to the US might have an effect on this outcome.

In terms of methodology, I take inspiration from two papers in particular. First, the idea of jointly using staggered policy changes in the EU interacted with the cross-industry variation in firm-size distribution comes from Breuer (2017), who uses changes in accounting reporting rules to investigate the impact of disclosure on resource allocation. On the firm-level analysis, I use the same technique as Davis, Haltiwanger, Handley, Jarmin, Lerner, and Miranda (2015) in grouping firms by size, age, industry, and pre-trends to define relevant control groups to study the treatment effect of mergers.

The remainder of the paper is organized as follows: Section 2 discusses the aggregate level analysis; section 3 discusses firm-level analysis; and section 4 concludes, followed by tables and figures.

CHAPTER 2

COUNTRY-INDUSTRY EVIDENCE

In this section, I establish the relationship between mergers, aggregate productivity, and markups at the country-industry level.[1] In the first subsection, I explain how merger rates are measured in the aggregate. In the second subsection, I introduce the measurements of country-industry productivity growth and markups growth, and how they relate to aggregate quantities and prices. In the third subsection, I show how these measures correlate in the cross-section. Finally, I close with causal evidence.

2.1 Measuring Industry Merger Rates

I measure industry merger rates as the annual average number of firms acquired in the country-industry over a rolling window $t-\delta \sim t$, divided by the number of incumbent firms at year t:

$$MRd(\delta)_{ci}^{t} = \frac{\sum_{x\in[0,\delta]} Deal\,Count_{ci}^{t-x}}{Firm\,Count_{ci}^{t}}$$

In words, this measure captures the percentage of firms acquired on an annual basis in a country industry over a time window of length δ. In Table 1(a) and Table 1(b), I list the top 12 countries and top 12 industries by mergers rates calculated over the full sample.

The time series of the total firm count in a country-industry is obtained through Eurostat's Structural Business Statistics. The deal count variable is computed by aggregating (year-by-year) the number of merger targets in a country-industry that appear in the BvD Zephyr Merger Dataset. This Europe-centric database contains coverage of merger deals since 1999 that are either over 1 million GBP in value or constitute at least a 2% stake in the target. In total, there are 373 thousand deals involving European parties in the Zephyr database, compared to 232 thousand deals in the other popular merger data source: SDC

1. 16 European Countries ×25 Industries across manufacturing and services.

platinum.[2] I exclude share repurchases, capital injections, and minority stake deals from the database.

The deal-based measure of merger rate equally weighs all mergers within a country-industry-year . I propose the following alternative measure that weighs deals by size, measured by the number of employees acquired:

$$MRe(\delta)_{ci}^{t} = \frac{\sum_{x\in[0,\delta]} Acq.\, Employee\, Count_{ci}^{t-x}}{Total\, Employees_{ci}^{t}} \tag{2.1}$$

The total number of employees in a country-industry is again readily available from the Structural Business Database. The total number of acquired employees, or more precisely, the sum of the employees of acquisition targets, is obtained through Zephyr. This employee-weighted measure has a mean of 0.6% with a standard deviation of 0.9%. The main results are robust to the choice of merger rate measure, as well as for different rolling window lengths.

With these definitions of merger rate, I present stylized facts that foreshadow the main result of this paper. The top panel of Figure 1 plots the relationship between deal-based merger rate, measured over the full sample (e.g. 1997-2015), and the country-industry's annual growth rate in output per worker over the same time period. The positive slope shows that country-industries with higher merger rates tend to have higher growth in labor productivity. Similarly, in the bottom panel of the same figure, we observe that higher merger rate is associated with faster growth in output per unit of capital. These two panels suggest that the prevalence of merger activity in a country-industry is positively correlated with the growth in productivity, or the ability to transform units of labor or capital input into output.

Next, I present stylized facts on how merger rates relate to price growth. If one believes that combining businesses generally leads to the consolidation of market power, then one would expect prices to rise faster in country-industries with many mergers. In Figure 2, top panel, I plot the relationship between deal-based merger rate and the percent change

2. See Bollaert and Delanghe (2015).

in output prices relative to wages. Contrary the conjecture above, country-industries with higher merger rates have slower growth in prices relative to wages. Similarly, in the bottom panel of the same figure, merger rate is negatively correlated with the percent change in the price to capital rent ratio.

In summary, these plots show that mergers are correlated with output quantities growth (Figure 1) and negatively correlated with price growth (Figure 2). While these facts are suggestive of certain directional relationships between mergers, productivity and markups, I explore these relationships in more detail after defining my measurements of productivity and markups in the following subsection.

2.2 Measuring Productivity and Markups

I begin with a Cobb-Douglas production function, where total factor productivity of a country-industry ci at time t is expressed as the ratio of the value added Q_{cit} to the product of factor inputs: labor L_{cit} and capital K_{cit}.

$$A_{cit} = \frac{Q_{cit}}{L_{cit}^{\alpha_{ci}} \times K_{cit}^{1-\alpha_{ci}}} \tag{2.2}$$

The exponent on labor is equal to the average labor cost share in a country-industry over the duration of the sample, e.g.

$$\alpha_{ci} = Avg_{t \in T}\left[W_{cit}L_{cit}/(W_{cit}L_{cit} + R_{cit}K_{cit})\right] \tag{2.3}$$

where W_{cit} is wage and R_{cit} is capital rent. This quantities-based productivity measure reflects how efficiently a country-industry can transform units of labor and capital into units of output.[3] Importantly, prices do not enter Equation 2.2, meaning forces that impact prices but are unrelated to production technology will not cause changes in A. Thus, this chosen

3. To be precise, it's units of output less units of intermediate input.

measure of productivity is insulated from changes in revenue due to market power.

Price movements play a central role in the measurement of markups, defined as the ratio of price to marginal cost. By writing down the cost minimization problem subject to the Cobb-Douglas production technology, I arrive at the following expression for the minimum total cost:

$$TC_t = \frac{[\alpha W_t]^{\alpha}\left[(1-\alpha)R_t\right]^{1-\alpha}}{A_t}Q_t \tag{2.4}$$

where A is defined in Equation 2.2 with subscripts ci suppressed henceforth. Taking the derivative of Equation 2.4 with respect to Q gives marginal cost, leading to the following expression for markups:

$$\mu_t = \frac{P_t}{MC_t} = A_t \times \left(\frac{P_t}{W^{\alpha} \times R^{1-\alpha}}\right) \times \alpha^{\alpha}(1-\alpha)^{\alpha} \tag{2.5}$$

I use the EU KLEMS database for annual measures of value added, labor, and capital for a set of 16 European countries and 25 2-digit level NACE industries that span across manufacturing and services.[4] For each of the aforementioned four variables, the database provides quantity and price indices from 1997 to 2015.[5] I then translate these indices into growth rates of productivity and markups using log-differences:

$$\begin{aligned} dln\,(A) &= dln\,(Q) - \alpha \times dln\,(L) - (1-\alpha) \times dln\,(L) && (2.6)\\ dln\,(\mu) &= dln\,(A) + dln\,(P) - \alpha \times dln\,(W) - (1-\alpha) \times dln\,(R) && (2.7) \end{aligned}$$

It's useful to note that productivity growth and markups growth are closely related. As seen in Equation 2.5, if we hold price term constant, productivity and markups move one-to-one. The intuition is that as productivity increases, fewer units of input are needed to

4. I limit my sample to counties and industries with non-missing information for both labor and capital quantities indexes.

5. In EU KLEMS, the indices of P, Q, W, L, $and\, K$ are measured directly. To impute the growth rates of the capital rent R, capital share is assumed to be the residual of the labor share. In order to allow for positive aggregate profits, I rely on the user cost equation developed in Hall and Jorgenson (1967) to measure capital rent. Details of this adjustment will be included in the forthcoming appendix.

produce the same units of output, thereby lowering the cost of production. Thus, holding the prices charged to customers fixed, markups rise as the cost of producing an additional unit falls. To push this logic even further, in the presence of strong productivity growth, it is possible to have falling output prices and rising markups at the same time.

As previewed in Figure 1 and Figure 2, merger rate is positively correlated with output-to-input quantity growth and negatively correlated price growth. Jointly, these illustrative facts suggest that industries that have gone through more mergers are more likely to have experienced higher productivity growth, but are inconclusive about markups growth.[6]

2.3 Correlations

I verify these relationships between mergers, productivity and markups growth at the country-industry level over time through the following regressions:

$$dlog(LHS_{ci})^{t\sim t+\delta} = \beta MR_{ci}^{t-\delta\sim t} + FE + \epsilon_{ci}$$

where the LHS variable could either be productivity or markups as defined in Section 2.2, and MR denotes merger rate as defined in Section 3.1 , and δ is the window length in number of years. I employ the following layers of fixed effects to control for unobserved characteristics: industry$\times$year, country$\times$industry, and country$\times$year.

The industry $\times$ year fixed effects strip out the time-varying dynamics that impact specific industries. As documented in Harford (2005) and others, mergers cluster in waves especially across industries. Many of the identified drivers of mergers might jointly drive future productivity growth. For example, a technology shock sometimes induces firms to merge, as the firms with the new technology want to expand, and the firms without access to the new technology are more willing to sell due decreased competitiveness. The industry$\times$ year fixed

6. In a standard Cobb-Douglas setup, profit maximization leads to the following relationships: output-to-input quantity ratio is proportional to TFPQ, and output-to-input price ratio is proportional to $\frac{MarkUp}{TFPQ}$.

effects remove these forces that jointly cause mergers to cluster across industries over time and drive industry-wide productivity or markups growth. After adding all three layers of fix effects, the only residual variation left has to act at the country-industry-year level only. These include country-industry specific regulatory changes or technical innovations.

The country × industry fixed effects strip out static characteristics that may jointly determine the magnitude of merger rate and productivity or markups growth across country-industries. Importantly, these factors include the cross-sectional differences in regulation, market concentration, reliance on imports or exports; any of them could jointly impact the barriers to merge and the growth prospects of productivity and markups.

The country × year fixed effects further remove time-varying forces that might drive mergers and growth at the country level. These factors include overall improvements in credit conditions, as well as spikes in stock market valuations as documented in Rhodes-Kropf, Robinson, and Viswanathan (2005). Moreover, in the next section, I exploit country-level policy changes in studying the casual impact of mergers. These country × year fixed effects strip out the impact of unobserved factors that might have driven both the policy changes as well as growth. In the main correlations. As I will show immediately, this third layer of controls adds little in explaining the variation of growth in productivity or markups.[7]

2.3.1 Mergers and Productivity Growth

The results are presented and Table 2. In Panel (a) columns (1) through (4), we see that the deal-based merger rate is positively correlated with productivity growth. In terms of magnitude, a 1 percentage point increase in merger rate is associated with a 1.3 to 1.8 percentage point increase in annual productivity growth. The difference between columns (1) and (2), and also between columns (3) and (4), is the inclusion of country×year fixed effects. These controls only marginally raise the explanatory power of the regressions, and have no substantive impact on the estimated coefficient between merger rate and productivity

7. In Table 2, $R-squared$ increases by less than .06 in all specifications.

growth.

Comparing columns (1) and (2) against columns (3) and (4), we see that this positive correlation is more tightly estimated when merger rates and productivity growth are measured using the shorter window length of three years, as oppose to the longer five-year window. In fact, when I further expand the window length to seven years, this relationship becomes non-significant. These results indicate that any impact mergers may have on productivity growth will be more pronounced in the medium-short run, and less impactful for long-run growth.

I replace the deal-based merger rate with employee-based merger rate in Panel (b) of the same table. Consistent with the analyses above, I find a positive and significant impact on productivity growth. A 1 percentage point increase in employee-weighted merger rate is associated with a 0.2 to 0.3 percentage point increase in annual productivity growth. This result rules out the concern that the positive relationship observed using deal-based merger rate is driven mostly by small mergers. As we see with the employee-weighted merger rate, larger deals also drive this positive relationship with TFP growth. This is an important result that I will return to when I discuss my identification strategy in the next section.

I proceed to explore whether productivity gains are consistent with expansion or cost-shedding. Another way is to frame this question is, have the industries with high merger rate and accelerated productivity growth expanded or shrunk relative to other industries? The answer is in Table 3(a). In columns 1 and 2, we see that output grows faster for firms that have increased merger intensity. The rest of the column shows that the merger rate is not correlated with either labor or capital input growth, giving evidence against cost-shedding. Therefore industries with higher merger rates not only grow faster in terms of productivity but also expand in size relative to other industries.

2.3.2 Impact by Deal Characteristics

In the subsection, we investigate whether differences and deal characteristics would lead to different correlations between merger rates and productivity growth. I explore three dichotomies: stock versus non-stock; horizontal versus non-horizontal; across versus within-country. In exploring each of these dichotomies, I split merger rates by group, such that the sum of the two merger rates would equal to the baseline.

In a frictionless world, how a deal is financed should not matter to the outcome of the deal. However, that is certainly not the case according to Table 4 columns 1 and 2. Here, stock deals refer to mergers that are over 50% financed by equity. Despite having a greater impact on average, these deals have far greater variation and how much impact they have on ex-post productivity growth, leading to non-statistically significant coefficients. In contrast, non-equity financed merger rates positively and significantly correlates with productivity growth, with coefficient estimates that are similar in magnitude to the baseline results with employee-based merger measure.

What is the main friction that could drive this difference between stock vs non-stock deals? One potential answer alludes to Rhodes-Kropf, Robinson, and Viswanathan (2005), where the authors empirically document that equity finance deals tend to happen when stock valuations are high relative to reasonable benchmarks. In other words, stock deals tend to happen when the managers believe that the firm's shares are likely overvalued, and want to use this opportunity to purchase other firms with its overvalued shares. In these instances, deals are executed not because of underlying synergies or prospects of growth but are rather due to animal spirits fueled by overvalued equities. Another interpretation is that equity finance deals tend to be larger, which presents more substantial frictions in how the two firms can assimilate organizationally and culturally. These considerations tend to be less prominent when the acquirer is far larger than the target, as is the case for debt or cash financed deals.

I now turn to cross-country versus domestic deals. As shown in Columns 5 and 6 of the same table, merger rates of cross-country deals are more strongly associated with aggregate productivity growth. There are a few explanations. First, when new foreign technologies are introduced to the domestic sector, this is typically followed by robust efficiency gains. Advanced foreign firms dissipate these new technologies to domestic firms, leading to higher productivity growth. Another interpretation is that gains in productivity are highest when there are scale effects. By introducing domestic products to foreign markets through cross-border acquisitions, the domestic firms can quickly increase scale and improve efficiency.

2.3.3 Mergers and Markups Growth

The same analysis is done to quantify the impact of merger rate on markups growth. As shown in Table 2(a) columns 5 and 6, the impact is non-statistically significant for 3-year windows and negative and significant at the 5-year level. When using employee-based merger intensity, I find no effect on markups growth as shown in columns 7 and 8. As I've mentioned in the measurement section, both productivity and output prices have positive impacts on markups. Therefore, the fact that we observe higher productivity growth but no higher markups growth suggest that mergers must have a negative impact of price growth to counteract higher productivity growth. That is indeed the case as shown in Table 4(b). In columns 1 and 2, we see that output price growth is negatively correlated with merger rates. Input prices growth, on the other hand, does not correlate with mergers, as shown in columns 3 through 6.

These results are somewhat surprising, given the number of papers speculating that business consolidation is at the core of rising market power and profit share.[8] My results show that markups do not rise more for country-industries that have gone through mergers. In addition price growth actually falls to counteract rising productivity. For future research, more analysis is needed to understanding why price levels fall with higher merger intensity. Could it be that mergers, in fact, raise competition? For example, anti-trust regulators may

8. See DeLoecker and Eeckhout (2017); Barkai (2017)

bar industry leaders to merge but might prefer mergers between smaller players to compete against firms with large market shares. Could this be specific to Europe? As Gutirrez and Philippon (2018) documents, concentration has not risen in Europe; this fact sharply contrasts the findings in the US where concentration was found to be rising.

2.4 Causal Evidence

The results presented in the previous sections have layers of fixed effects, such that the only remaining variation is purely country-industry-time specific. These fixed effects help to reduce the likelihood of unobserved factors jointly driving mergers and the aggregate outcome of interest. However, these fixed effects cannot strip out forces that act specifically in a country-industry. As shown in Harford (2005), the early onset of an industry-specific technology shock or the anticipation of industry deregulation drives merger waves; these factors can surely impact productivity growth as well. Similarly, the null result between merger and markups growth could be due to the fact that forces driving mergers are also slowing down markups growth, for example, country-industry-specific import competition. These examples cast doubt on whether the results so far are anything more than just spurious correlations.

To tease out the causal impact of mergers, I need events in which the likelihood of merging in a country-industry changes for reasons unrelated to potential confounding factors that jointly drive markups or productivity growth. This event-study design allows me to isolate the impact of increasing merger rates on outcomes of interest. I introduce my empirical setting in the next subsection.

2.4.1 EU Merger Control

The European Union has two layers of governance that dictate whether any particular merger needs to be modified or disallowed. The largest deals that span across country borders are governed by the European Commission. Deals that are mostly domestic fall under the jurisdiction of the national competition authorities. These deals tend to be smaller in size and more numerous in volume.

The national authorities cannot physically inspect every deal. Thus, every country has revenue thresholds, such that deals that fall below these thresholds can be executed without prior notification. For the most part, the notification thresholds are of the following forms: (a) combined turnover exceeding X Euros (upper threshold) or (b) each merging firm has turnover exceeding X Euros (lower threshold). In some countries, both conditions need to be met for the deal to be mandated for audit. In other countries, meeting only one of the conditions is sufficient. These thresholds vary by country. More importantly, these thresholds change for different countries at different points in time.

From each of the 16 national authority's web pages, I hand-collect the reporting thresholds, year-by-year. I show a selected sample of thresholds and changes in Table 5 and highlight the following observations. First, there are substantial cross-sectional differences in the size of the thresholds. For example, the current lower threshold for Austria is 5 million Euros, while the same threshold for Belgium is 40 millions Euros. This difference is despite the fact that the median Belgium firm is only a modest 1.4 times the size of the median Austrian firm. Second, most threshold changes are upwards (e.g. loosening of merger policy), but there are also instances of declining thresholds.[9] Lastly, most of these changes are sizable, ofter increasing by more than a factor of two.

The threshold changes act at the country×year level. To generate variation within a country-year, I rely on the differences in firm-size distributions across industries. More specifically, in industries where firms cluster around the size threshold, movements in the threshold would have a large impact on the share firms mandated to report should they choose to merge; in industries with firms that are either very small or very large and only

9. Denmark's lower threshold decreased from 300M Krone (40M Euros) to 100M Krone (13M Euros) in 2010, and France's upper threshold decreased from 150M Euros to 75M Euros

a few close to the threshold, moving the cut-off would have little impact. Therefore, the interaction of changes in country-specific notification thresholds and industry-specific firm-size distributions generates variation in the cost of merging, thereby shifting merger intensity across country-industry-time. [10]

For both the upper and the lower thresholds, I measure the share of firms that have turnovers above them in each country-industry-year:

$$Z_{ciy}^{Upper} = \frac{\#Firms\,Above\,Upper\,Threshold_{ciy}}{Total\,\#\,Firms_{ciy}} \tag{2.8}$$

$$Z_{ciy}^{Lower} = \frac{\#Firms\,Above\,Lower\,Threshold_{ciy}}{Total\,\#\,Firms_{ciy}} \tag{2.9}$$

The larger the increase in the instrument, the more firms would now need to report should they merge, corresponding to a more stringent policy. Conversely, a decline in the instrument would indicate policy loosening.

2.4.2 Instrument Relevance (First Stage)

For this set of instruments to cause shifts in merger rates, reporting must be costly: lawyers and accountants need to be hired, a long period of time is needed for approval, and there are increased uncertainties around whether a deal will be executed.[11] To test whether the relevance criteria holds, I run the following (first-stage) regression

$$MRd_{ciy} = Z_{ciy}^{j\in(Upper,Lower)} + FE + \epsilon_{ciy} \tag{2.10}$$

$$MRe_{ciy} = Z_{ciy}^{j\in(Upper,Lower)} + FE + \epsilon_{ciy} \tag{2.11}$$

10. This identification technique originates from Matthias Breuer's job market paper, where he uses financial reporting size thresholds to study the impact of disclosure on resource allocation.

11. See Andersson and Legnerflt (2008) as well as other uncredited practitioner's articles at the end of the bibliography.

where MRd and MRe are merger rates measured by deal count or employee count as described in section 2.1. , with the same layers of fixed effects as in the previous section. As I will explain later when discussing instrument exogeneity, the country×year fixed effects are especially crucial, given the threshold changes are determined nationally. The results of these regressions are reported in Table 6(a).

The first two columns have deal-based merger rates on the left hand side, while columns 3 and 4 have employee-based merger rates. The deal-based merger rate is negatively correlated with the instruments. The larger share of firms above the threshold, the lower the deal-based merger rate. Comparing the relevance of the two instruments (e.g. columns 1 and 2), the one constructed on the lower threshold has a stronger effect on merger rate: a one percent increase in the instrument correlates with a 3.6 basis point decrease in merger rate. In other words, if the number of firms larger than the reporting threshold increases by 1% of total firms, then on average, there would be a decrease of 1 acquisition per 2,800 firms in the country-industry. By no means is this a large effect; however, the coefficient is tightly estimated.

Employee-based merger rate, on the other hand, does not respond to the instrument (columns 3 and 4). This is not a surprising outcome: the employee-weighted merger rate is driven by the mega deals, which are typically far above the threshold and would have to be reported to the authorities regardless of policy changes. In other words, my chosen instrument only has relevance for medium and small deals. Thus, any forthcoming causal evidence I present using this instrument can only be interpreted as the impact of non-mega-mergers, since that is the local treatment group; I cannot extrapolate my results to apply to mergers generally. I will return to this issue in the next subsection, after documenting the second stage estimates.

2.4.3 Second Stage and Interpretation

In the second stage of the 2SLS estimation procedure, I regress the outcome of interest (e.g. productivity growth or markups growth) on the value of the deal-based merger intensity measure as predicted by the lower-threshold instrument:

$$dln(TFPQ\, or\, Markup)_{ciy} = \beta \times \widehat{MRd}_{ciy} + FE + \epsilon_{ciy}$$

The result ins presented in Table 6(b). Through this 2SLS procedure, I find that a one percent increase in merger rate increases annual productivity growth by 0.33 percentage points (column 1). In other words, a three percentage point increase in an industry's merger rate causes a one percentage point increase in annual productivity growth. The effect on an industry's markups growth is statistically indistinguishable from zero (column 2).

While the causal evidence on productivity growth is statistically significant, its magnitude is roughly a fifth of the size of the correlation between mergers and productivity growth.[12] The gap in magnitudes has two non-mutually-exclusive explanations. First, because the instrument has relevance only for mergers around the threshold, the estimated causal impact only pertain to those mergers, and exclude the impact of very large or very small mergers. The other explanation is that the instrument worked, in the sense that it succeeded in distilling correlations due to unobserved factors that jointly drive the left and the right hand side variables. In a future draft, I will aim to bring clarity on the relative quantitative importance of these two explanations.

For markups growth, the casual estimates are statistically indistinguishable from zero, suggesting mergers around the threshold do not accelerate the consolidation of market power. However, the fact the instrument doesn't act on mega deals mean that I cannot rule out a positive causal impact of large mergers. Nonetheless, recall that we did not observe any correlation between size-weighted merger rate and markups growth. Thus, for there to be a

12. In Table 2(a) column 1, over a 3 year window, a merger rate increase of 1 percentage point is associated with a 1.4 percentage point increase in annual productivity growth.

causal impact without correlation, an unobserved factor must drive mergers and markups in opposite direction. This warrants further investigation in forthcoming revisions.

2.4.4 Exclusion Restriction

The variation of the instrument can come from movements in the reporting threshold or movements in the size distribution of firms. Movements in the reporting threshold are decided at the national level. Thus, by including country× year fixed effects, I remove all confounding factors at the country level that could have jointly impacted the decision-making process of reporting threshold and productivity or markups growth. There may also be concerns that the firms anticipate imminent rule changes and merge preemptively. However, if this were the case, then we would not expect any effect in the first stage.

Movements in the size distribution of firms in a country-industry can indeed be endogenous. More work needs to be done to rule this out. I outline two ideas here. First, I can generate a placebo instrument, where reporting thresholds are assumed to be fixed, such that all movements in the instrument comes solely from movements in firm-size distributions. If this alternative instrument passed the first stage and produces similar second stage estimates, then this would be problematic for my identification strategy. However, if this alternative instrument doesn't pass the relevance condition, then I can claim with greater confidence that the aforementioned results are likely driven by the interaction of the threshold and the static firm-size distribution.

Another strategy is to fix the firm size distribution and let the variation in the instrument come only from country-level movements in reporting threshold interacted with the static firm size distribution. If I find that this instrument passes the 1st stage with similar magnitude, then I can safely rule out stories where changes in firm size distribution are causing both the instrument and productivity growth to rise.

CHAPTER 3

FIRM-LEVEL EVIDENCE

In this section, I turn to within-country-industry dynamics. Do acquired firms experience higher productivity growth relative to peer firms? Similarly, is the growth rate in markups different for acquisition targets than for other similar firms in the same industry?

Unlike at the aggregate level, where data on price and quantity growth are well measured, only data on revenue are available at the firm-level. Therefore, the only measurable productivity growth is that of revenue productivity, the rise and fall of which could be either due to movements in quantities or in prices. This measurement issue similarly impacts markups. The rise in markups could be due to increasing prices, or decreasing marginal costs; the latter is determined by a firm's true, quantity-based productivity.

Using firm- and deal-level data jointly, I can investigate the post-trends in revenue productivity and markups of acquisition targets, relative to the post-trends of comparable but non-acquired firms. To select the relevant control group, I follow Davis, Haltiwanger, Handley, Jarmin, Lerner, and Miranda (2015), who sort firms into cells defined by the cross product of country, industry, year, revenue decile, and age quintile. I then perform a difference-in-difference analysis between the target firm and other firms in the same cell.

As a preview of the forthcoming results, I find acquired firms experience higher revenue productivity growth relative to peer firms. As for markups, despite no relation with mergers in the aggregate, I find that relative to firms in the peer group, acquisition targets exhibit higher markups growth. The country-industry and firm-level result jointly imply that higher markups growth among acquisition targets is offset by the decline in markups growth among peer firms, netting little aggregate impact.

To understand whether these within-country-industry dynamics are driven by relative price growth or relative productivity growth, I look at the post-merger trend in market share of acquisition targets. Importantly, I look only at the market-share changes of the merger target separately from its acquirer, and not of the combined merged entity. Under well-behaved demand systems, and holding product quality constant, a firm cannot gain market share by increasing prices relative to peer firms. Thus, if I observe that market share increases faster post-acquisition, the observed acceleration in revenue productivity growth and markups growth is likely not due to pricing power but to increased efficiency.

In what follows, the first subsection describes the data and methodology. The second subsection provides details of the aforementioned within-country-industry findings. The third subsection exploits the richness of the deal-firm panel and empirically verifies two hypothesized channels of productivity growth: economies of scale and technology adoption.

3.1 Data and Measurement

The basis of this section's analysis is a combined data source of financial statements and merger-deal-level details. The firm-level data source is BvD Amadeus, and the deal-level data source is BvD Zephyr. The two data sets are compiled by the same data vendor, Bureau van Dijk, and conveniently share firm-identifier codes that map one-to-one across these two databases.

The Amadeus dataset contains unconsolidated financial statements of public and private limited-liability entities in the EU since 1999, with over 120 million firm-year observations. The information contained in these statements include revenues, the number of workers employed, capital expenditures, age, as well as country and industry classifications. Importantly, these financial statements are unconsolidated, which allows the researcher to observe subsidiaries separately from their parent companies. In other words, I can still assess the productivity of merger targets separately from the acquiring firm, as long as the target is not fully dissolved. This feature of the underlying data is an advantage over many other merger studies, where only the performance of the combined firms is analyzed. Regarding the coverage of the dataset, I referred the reader to Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych, and Yesiltas (2015).

For consistency, I limit the scope of the dataset to the 16 countries and 25 industries studied in the aggregate section for consistency. I drop firms without information on employment, revenues, industry or country classification, resulting in over 17 million firm-year observations.

I compute capital stock using the perpetual-inventory method, where depreciation rate comes from industry aggregate data provided by EU KLEMS, and the earliest non-missing record of tangible assets is set initial capital stock. I also follow the convention of assuming that growth rates in factor input prices are homogenous in a country-industry-year; therefore, observed differences in growth rates of spending on labor or capital across firms within a peer group are assumed to be driven by differences in input-quantities growth, rather than in wages or rent. With these ingredients, I can proceed to calculate productivity and markups growth under the standard Cobb-Douglas production function.

Revenue productivity growth is calculated using the standard expression,

$$dlog(TFPR)_t = dlog(Revenue) - \alpha \times dlog(L) - (1 - \alpha) \times dlog(K)$$

where α is the industry specific average cost share, growth in L is measured by employee growth, and growth in K is measured by the changes in real capital stock imputed through the perpetual inventory method. Markups are calculated by first assuming labor is a flexible input and capital faces an adjustment cost, and then applying the method pioneered in DeLoecker and Warzynski (2012):

$$\mu = \underbrace{\left(\frac{\partial Q}{\partial L}\frac{L}{Q}\right)}_{\theta^L}\left(\frac{WL}{PQ}\right)$$

where the output elasticity θ^L is estimated at the industry level using the estimation procedure of Ackerberg, Caves, and Frazer (2015).

I take this rich firm-level dataset and combine it with the merger-deal-level dataset, Zephyr. The Zephyr database contains coverage of deals over 1 million GBP or at least 2%

stake that are listed in official sources, news services, official company filings, and adviser data submissions. In total, there are 373 thousand deals involving European parties in the Zephyr database, which compares favorably to the 232 thousand deals in the other popular merger data source: Thomson Reuters SDC platinum.[1] The deal-level dataset contains firm identifiers for both the target and the acquirer, which simplifies the merging process with the Amadeus. I use the following steps to construct my panel. First, I merge the deal-level data with the firm-level data by the acquiring firm's identification number and year, dropping all observations that appear only in the firm-level database and not in the deal-level database. Then, I merge once again with the firm-level database, but this time, by the target's identification number and year. Then, I drop deals for which no corresponding firm could be found in the firm-level database for the year in which the deal was executed. Each observation in the resulting panel represents a firm in a year, with information on its productivity, markups, country, and industry classification, as well as the same set of information for its acquirer. The structure of this database lends itself to studying whether acquisitions positively or negatively impacts productivity and markups growth and whether the characteristics of the acquirer plays a role in the magnitude of the impact. The key is in choosing the right control group. I describe my methodology in the following subsection.

3.2 Methodology

I begin with 120 million entity-year observations. I drop observations with missing sales, age, employment, or capital stock, as well as those for which I cannot calculate TFPR or markups. Of the remaining observations, 12 thousand went through an acquisition. Within each country, industry, and year, I create revenue deciles, and age quintile. This results in over 10,000 "grids". Then, I drop the grids in which no merger had occurred, arriving at 17 million total entity-year observations. I run the following regressions with grid dummy

1. See Bollaert and Delanghe (2015)

variables:

$$dln(TFPR)^{Post} = \alpha + \beta_{TFP} \times I_{Acquired} + \gamma \times dln(...)^{Pre} + FE_{grid} \quad (3.1)$$

$$dln(Markup)^{Post} = \alpha + \beta_{\mu} \times I_{Acquired} + \gamma \times dln(...)^{Pre} + FE_{grid} \quad (3.2)$$

where $I_{Acquired}$ takes the value of 1 if and only if this entity was acquired in this year. The variables $dln(...)^{Pre}$ and $dln(...)^{Post}$ denote the three-year pre and three-year post-trends for an entity in a particular year. Because the outcomes of interest are productivity and markups growth, the pre-trends of both are included as controls.

The coefficients of interest are the β's, which represent the difference in the post-trends between merger targets and un-acquired firms within the same grid, controlling for pre-trends. To have clean treatment and control groups within every grid, in each year, I drop firms that were acquired in any of the previous three years or would be acquired in any of the three forthcoming years. Because these analyses are performed for the acquisition target alone, separate from its acquirer, the merger dummy can be interpreted as a treatment variable for the target firm. The identification assumption is that the selection of which firms were acquired in this peer group is unrelated to other unobserved characteristics that might jointly drive productivity growth.

This identification assumption is admittedly strong. Although quantitative and observable characteristics of potential targets provide important information for prospective acquirers, the decision to merge or not critically depends on other qualitative aspects of the firm, such as the potential of the management team and current work force, or the off-balance-sheet intangible assets that have not yet been realized. The grid defined above does not capture differences along these dimensions. And as seen in the aggregate section, the magnitude of the causal channel may only be a fraction of the size of the raw correlations. For future research, removing the above selection issue will help crystallize the causal impact. A popular selection strategy follows Seru (2014), who compares the outcomes of acquisition targets with the outcomes of firms in a failed merger. This strategy removes the selection issue coming from the choice to merge, but introduces a new, but arguably less severe, selection issue from deal failures.

3.3 Results

This section reports the relationship between mergers, revenue productivity and markups growth across firms and within peer groups. Because prices cannot be separately observed from quantities, I cannot identify whether changes in revenue productivity and markups relative to peer firms are due to relative pricing increases or true productivity increases. I first present results on revenue productivity and mark up. Then, using results on market share with assumptions on the demand system, I try to find evidence for, or against, prices being the driver of these results.

I run the regression prescribed in Equation 3.1. The results are shown in Table 7. As shown in column 1, on average, acquired firms exhibit 3% higher growth in revenue productivity over the three years following the merger than non-acquired firms in the same peer group. I run a similar regression, replacing post-merger growth in revenue productivity with markups, as in Equation 3.2. The results are shown in column 2 of the same table. Relative to peer firms, acquisition targets exhibit 2.6% higher growth in markups over the ensuing three years. Recall from the industry-level analysis, I did not find mergers to be robustly correlated with markups growth. This indicates that despite the null relationship between mergers and aggregate markups growth, acquired firms see their margins grow faster or decline more slowly than other similar firms in the same country-industry.

The question remains: whether this within-country-industry difference in revenue productivity or markups growth is due to increased relative prices of acquisition targets, or increased true productivity such that marginal costs fall.

To answer this question, I rely on the assumption that within a country-industry, the demand system has a price elasticity of greater than 1. In other words, when the relative price of the firm increases by 1%, the demand for its good falls by more than 1%. Furthermore, I also assume the product and its demand does not change in the event of an acquisition. This assumption rules out complementarity between the acquirer's products and services and the target's products and services. Under these conditions, the only way for which a firm's market share could rise is if prices are falling relative to other firms in the same market. Therefore, if I see that market-share growth of merger targets accelerates in response to an acquisition, then under these demand conditions, I can rule out faster-rising prices being the driver for increases in revenue productivity and markups growth. To verify, I run the following regression:

$$dln(Market\,Share)^{Post} = \alpha + \beta_{MS} \times I_{Acquired} + \gamma \times dln(...)^{Pre} + FE_{grid} \quad (3.3)$$

The results are reported in Table 7, column 3: the market shares of acquisition targets rises faster post-merger. This finding is evidence against the hypothesis that the observed growth in revenue productivity and markups is due to increasing market power. Instead, mergers likely accelerate true,quantity-based, productivity growth. In the following subsection, I investigate two hypothesized channels of growth.

3.4 Channels of Productivity Growth

Using the richness of the panel, I test these two channels of efficiency gains: economies of scale and technology adoption. Borrowing from the previous subsection, the fact that acquisition targets have faster growing market shares is consistent with the scale hypothesis. To further test this hypothesis, I run the following regression to verify whether productivity growth is associated with shifts in capital-to-labor ratio.

$$dln(K/L)^{Post} = \alpha + \beta_{KL} \times I_{Acquired} + \gamma \times dln(...)^{Pre} + FE_{grid} \quad (3.4)$$

A positive (negative) estimate of β_{KL} would imply that productivity growth is accompanied by a shift towards (away from) capital. On the other hand, if estimated coefficient is statistically indistinguishable from zero, then growth is neither labor- or capital-enhancing. As seen in Table 7, column 4, the labor-to-capital ratio of acquisition targets does not change in response to acquisitions, suggesting the productivity gains achieved through mergers are factor neutral. One way to expand the target's scale is through the introduction of new customers from its acquirers. The larger the acquirer, the bigger the pool of prospective customers the merger can introduce to the target. And if productivity gains are through scale economies, then one would expect a positive relationship between the target's productivity growth and the acquirer-to-target size ratio. I run the following regression to test this hypothesis:

$$\begin{aligned} dln(TFPR)^{Post} &= \alpha + \rho_1 \times I_{Acquired} + \\ &+ \rho_2 \times I_{Acquired} \times \left(Rev_{Acq}/Rev_{Target}\right) \\ &+ controls \end{aligned}$$

A positive and significant ρ_2 suggests economies of scale play a role in accelerating productivity growth through mergers. In Table 8, column 1, I show that, indeed, the higher the revenue ratio of the acquirer to the target, the larger the gains in productivity growth.

To test the technology-adoption channel, I perform the following analysis. First, I test whether post-merger productivity growth relates positively to the gap in productivity between the target and the acquirer. The intuition is that the more productive the acquirer is relative to the target, the more the target can learn from the acquirer, resulting in faster productivity growth post-merger. Specifically, I run the following regression:

$$\begin{aligned} dln(TFPR)^{Post} &= \alpha + \beta_1 \times I_{Acq} + \\ &+ \beta_2 \times I_{Acq} \times \left(TFPR_{Acq}/TFPR_{Target}\right) \\ &+ controls \end{aligned}$$

where the coefficient of interest is β_2. A positive and significant β_2 suggests technology adoption is likely a valid channel. To add to this analysis, as shown in Bena and Li (2013) and Ma, Ouimet, and Simintzi (2018), technology adoption is more achievable between firms that have similar production processes. Therefore, I would expect this effect to be even stronger among within-industry deals. The results of these analyses are presented in Table 8, columns 2 and 3. The point estimate of β_2 is positive, but non-significant, suggesting the gap in productivity between merging parties is only loosely associated with the target's productivity growth. When I add yet another interaction term with within-industry dummies, no statistical significance remains. These results suggest technology adoption is likely not what empirically drives post-merger productivity growth.

Taking stock, I find that scale economies are likely an important channel of efficiency gains through mergers. The evidence is weaker for technology adoption. Further due diligence needs to be done to ensure that the results are not artifacts of the data. Some costs might fall off the books of the acquired firm and be shifted to the parent company in the aftermath of the merger. This possibility could explain why I observe faster productivity growth amongst big-buying-small deals. Furthermore, the existing literature has cited other potential channels of productivity growth, such as the reallocation of assets.[2] This hypothesis is testable with my current panel, and I plan to append this analysis in a forthcoming revision.

2. See Maksimovic and Phillips (2002)Maksimovic and Phillips (2002)

CHAPTER 4

CONCLUSION

I find business combinations accelerate country-industry productivity growth for a set of 16 European economies. The effect on an industry's markups growth is statistically indistinguishable from zero. To my best knowledge, this is the first empirical exercise to establish the causal link between mergers and aggregate outcomes.

I use staggered merger policy changes and industry firm-size distributions to instrument for merger rates. Although the causal evidence is statistically significant, its magnitude is roughly a fifth of the size of the correlations. Two factors contribute to this difference in magnitudes. First, because the chosen instrument only impacts the cost of merging among medium-sized firms, my causal estimates excludes the impact of mega-deals. Second, this identification strategy removed the spurious correlation attributed to omitted variables that jointly drive mergers and growth. As an important next step, I will look to clarify the quantitative importance of the two interpretations above.

In contrast to the popular view that business combinations cause market power to rise, I do not find a causal link between industry merger rates and aggregate markups growth. However, this null relationship masks the firm-level differential impact on acquisition targets relative to peer firms. On average, markups growth is higher among acquired firms, but the impact is offset in the aggregate by decreases in peer-firm markups growth.

Additional analyses are needed to fortify my results. First, aside from scale economies and technology adoption, I will look to bring other potential channels of growth to the data. Second, more investigation is warranted to rule out the possibility that the firm-level findings are artifacts of creative accounting between acquired firms and their parent companies. Beyond these short-term extensions, this paper can benefit from a tighter quantitative link between the aggregate findings and firm-level findings. Subsequent iterations of this paper will aim to quantify the within-firm and between-firm channels of industry-level growth associated with mergers. Finally, the firm-level estimates can be sharpened by more careful sample selection. Using failed mergers as the relevant control group may yield results more in line with the true causal impact of mergers on productivity and markups growth at the firm-level.

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Table 1(a): Top 12 Countries by Merger Rate

Country Name	Group	Annual Merger Rate (*p.p.*)	Rank by Size
Denmark	Periph	1.13	10
Netherlands	Core	1.09	5
Luxembourg	Periph	1.01	15
Ireland	Periph	0.95	11
Poland	Periph	0.56	6
Belgium	Periph	0.53	8
Finland	Periph	0.39	12
Germany	Core	0.38	1
Austria	Periph	0.37	9
Sweden	Periph	0.27	7
Spain	Core	0.19	4
France	Core	0.19	2

Table 1(b): Top 12 Industries by Merger Rate

Indus (NACE)	Group	Annual Merger Rate (*p.p.*)	Rank by Size
Petro (19)	Manu	0.88	23
Chemicals (20-21)	Manu	0.87	10
Telecom (61)	Serv	0.71	16
Elect. Eq. (26-27)	Manu	0.53	13
Mining (B)	Manu	0.51	25
Trans. Eq. (29-30)	Manu	0.36	12
Mach. Eq. (28)	Manu	0.35	14
Broadcast (58-60)	Serv	0.28	21
IT & Info (62-63)	Serv	0.27	11
Food (10-12)	Manu	0.27	9
Utilities (D-E)	Manu	0.26	6
Rubber Plast (22-23)	Manu	0.24	18

Table 1: Ranking of Countries and Industries by Merger Intensity

Note: Merger rate is the annual average number of completed merger deals in the industry-country divided by the number of incumbent firms at the end of the sample. Size rank is by GDP/GVA of the country/industry. There are 16 countries and 25 2-digit level NACE industries.

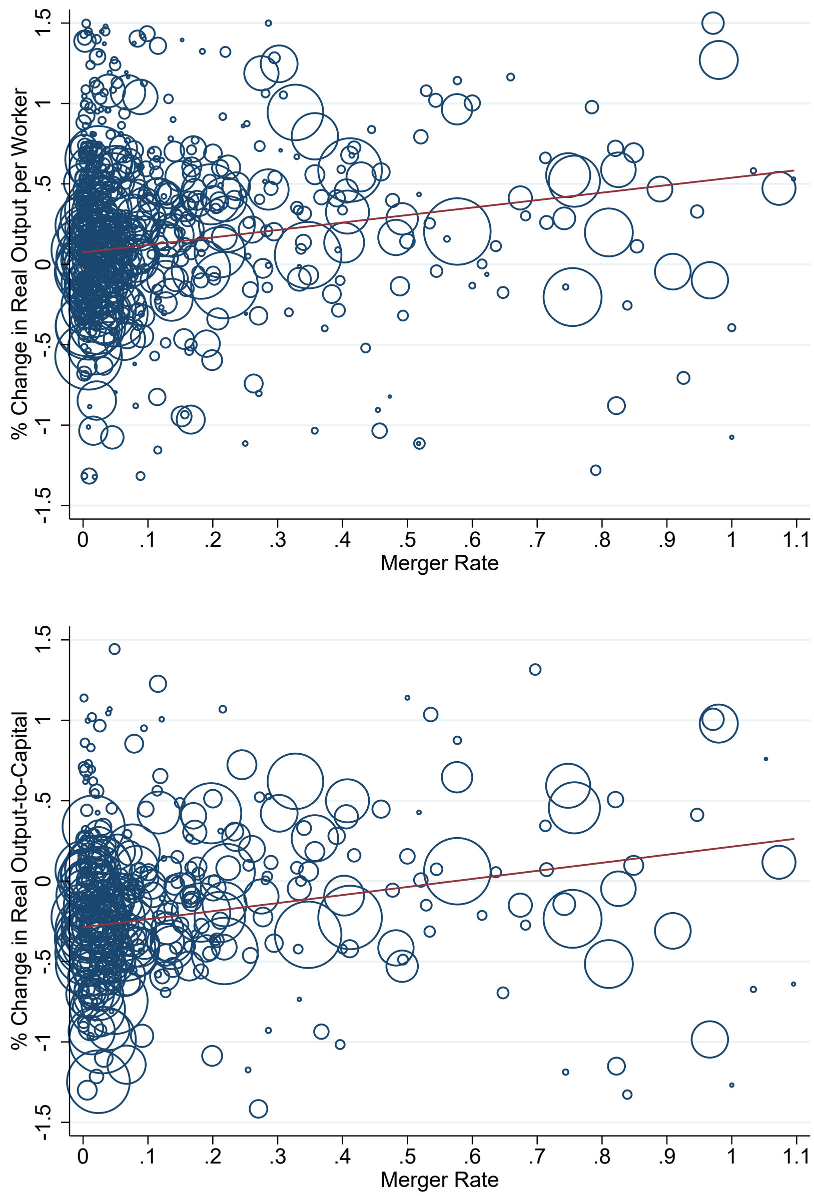

Figure 1: Mergers and Growth in Quantities

Note: Each of the 341 hollow circles denotes an industry within a country. The circumference of the circle denotes the relative size (by GVA) of the industry-country pair. The trend line is drawn with GVA weights. Merger rate is the annual average number of acquisition targets in a country-industry divided by the number of firms at the end of the sample.

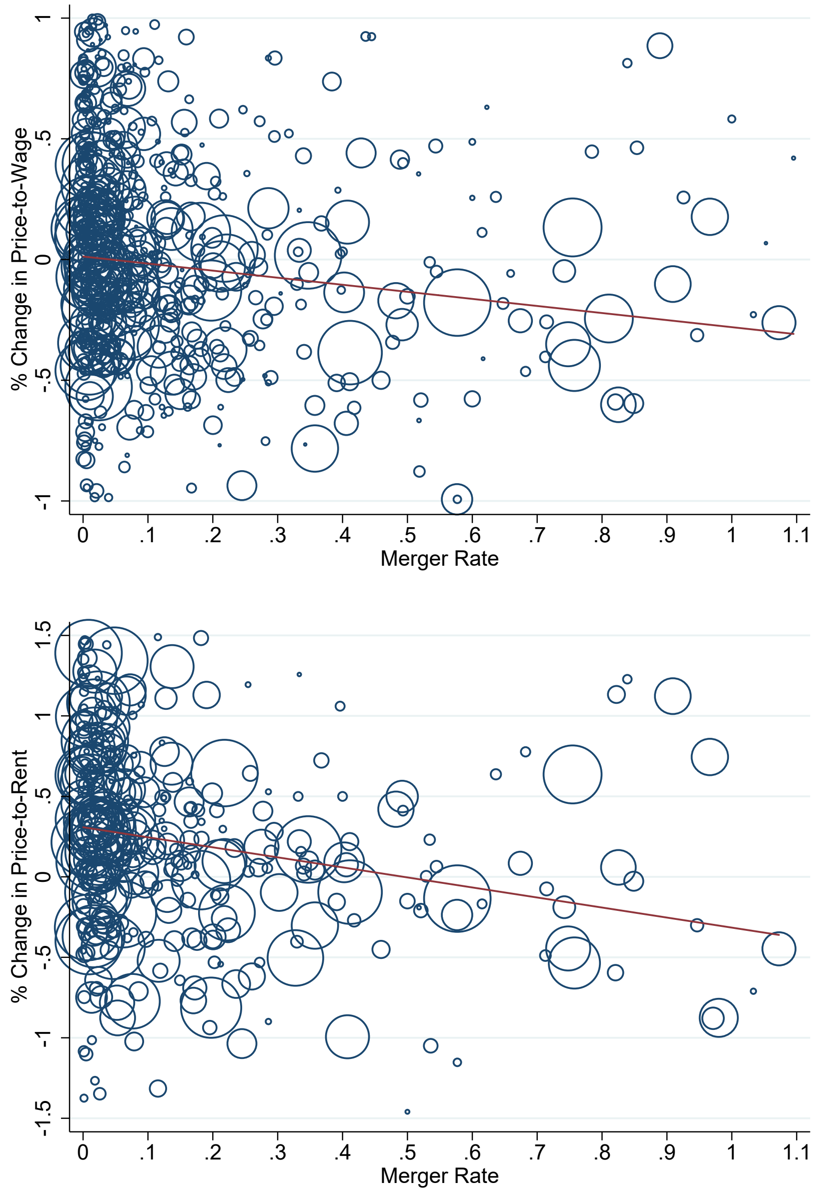

Figure 2: Mergers and Growth in Prices

Note: Each of the 341 hollow circles denotes an industry within a country. The circumference of the circle denotes the relative size (by GVA) of the industry-country pair. The trend line is drawn with GVA weights. Merger rate is the annual average number of acquisition targets in a country-industry divided by the number of firms at the end of the sample.

Table 2(a): Deal-Based Merger Rate: MRd (Baseline)

	Productivity: $dln(TFPQ)^{t\sim t+\delta}$				Mark-up: $dln(P/MC)^{t\sim t+\delta}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MRd^{t-\delta\sim t}$	1.42***	1.33***	1.62**	1.82**	-0.47	-0.53	-1.31*	-1.36*
	(0.48)	(0.48)	(0.73)	(0.72)	(0.53)	(0.53)	(0.75)	(0.78)
Observations	5,503	5,503	5,162	5,162	4,828	4,828	4,520	4,520
R-squared	0.448	0.504	0.570	0.624	0.331	0.388	0.414	0.471
Window Len. (δ)	3 yr	3 yr	5 Yr	5 Yr	3 yr	3 yr	5 Yr	5 Yr
FE & Clust.	$IYCI$	$CYIYCI$	$IYCI$	$CYIYCI$	$IYCI$	$CYIYCI$	$IYCI$	$CYIYCI$

Table (b): Employee-Based Merger Intensity: MRe (Robustness)

	Productivity: $dln(TFPQ)^{t\sim t+\delta}$				Mark-up: $dln(P/MC)^{t\sim t+\delta}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MRe^{t-\delta\sim t}$	0.22**	0.22***	0.23**	0.29***	-0.00	-0.02	0.04	0.08
	(0.09)	(0.08)	(0.11)	(0.10)	(0.11)	(0.11)	(0.10)	(0.11)
Observations	5,503	5,503	5,162	5,162	4,828	4,828	4,520	4,520
R-squared	0.433	0.498	0.565	0.614	0.323	0.376	0.401	0.423
Window Len.(δ)	3 yr	3 yr	5 Yr	5 Yr	3 yr	3 yr	5 Yr	5 Yr
FE & Clust.	$IYCI$	$CYIYCI$	$IYCI$	$CYIYCI$	$IYCI$	$CYIYCI$	$IYCI$	$CYIYCI$

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2: Mergers, Aggregate Productivity, and Markups Growth

Note: The regression specification is $dln(LHS_{ci})^{t\sim t+\delta} = \beta MR_{ci}^{t-\delta\sim t} + FE + \epsilon_{ci}$, where the LHS variable could be productivity or markups, MR is the either the deal-based or employee-based merger rate as defined in section 2.1, $\delta$is the window length over which annual merger rates and annual growth rates are averaged. All variables winsorized at the 1% level.

Table 3(a): Output and Input Quantities Growth

	$dln(Output)^{t\sim t+\delta}$		$dln(Labor)^{t\sim t+\delta}$		$dln(Capital)^{t\sim t+\delta}$	
	(1)	(2)	(5)	(6)	(7)	(8)
$MRd^{t-\delta\sim t}$	1.47***	2.13***	-0.13	-0.01	0.16	0.38
	(0.51)	(0.73)	(0.21)	(0.28)	(0.22)	(0.31)
Observations	5,553	5,187	5,553	5,187	5,553	5,187
R-squared	0.742	0.811	0.701	0.775	0.661	0.753
Window Len.(δ)	3 yr	5 yr	3 yr	5 yr	3 Yr	5 Yr
FE & Clust.	$C \times Y$, $I \times Y$, $C \times I$					

Table 3(b): Output and Input Price Growth

	$dln(Price)^{t\sim t+\delta}$		$dln(Wage)^{t\sim t+\delta}$		$dln(Rent)^{t\sim t+\delta}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$MRd^{t-\delta\sim t}$	-1.10**	-1.93**	0.30	0.12	0.02	0.03
	(0.49)	(0.89)	(0.21)	(0.19)	(0.02)	(0.03)
Observations	5,553	5,187	5,503	5,162	4,828	4,520
R-squared	0.733	0.801	0.675	0.760	0.701	0.775
Window Len.	3 yr	5 yr	3 yr	5 yr	3 Yr	5 Yr
FE & Clust.	$C \times Y$, $I \times Y$, $C \times I$					

*** p<0.01, ** p<0.05, * p<0.1

Table 3: Mergers, Quantities, and Price Growth (Rolling Window)

Note: The regression specification is $dln(LHS_{ci})^{t\sim t+\delta} = \beta MR_{ci}^{t-\delta\sim t} + FE + \epsilon_{ci}$, where the LHS variable could be Output or Input Prices or Quantities, MRd is the the deal-based merger rate as defined in section 2.1, $\delta$is the window length over which annual merger rates and annual growth rates are averaged. All variables winsorized at the 1% level.

	Stock vs Non-Stock		Horiz. vs. Non		Dom. vs. X	
	(1)	(2)	(3)	(4)	(5)	(6)
$Stock\,Deals^{t-x\sim t}$	0.575	1.591				
	(2.25)	(1.22)				
$Non-Stock\,Deals^{t-x\sim t}$	0.212***	0.237***				
	(0.08)	(0.08)				
$Horizontal^{t-x\sim t}$			0.221	0.295		
			(0.218)	(0.301)		
$Non-Horiz^{t-x\sim t}$			0.305**	0.310*		
			(0.15)	(0.16)		
$Domestic^{t-x\sim t}$					0.273**	0.189**
					(0.12)	(0.09)
$Cross-Border^{t-x\sim t}$					0.003	0.384*
					(0.21)	(0.20)
R-squared	0.448	0.624	0.448	0.624	0.448	0.624
Window Len.(δ)	3 yr	5 yr	3 yr	5 yr	3 yr	5 yr
FE & Clust.			$C \times Y$, $I \times Y$, $C \times I$			

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Type of Mergers and Productivity Growth

Note: The regression specification is $dln(TFP_{ci})^{t\sim t+\delta} = \sum \beta_\tau MRe(\tau)_{ci}^{t-\delta\sim t} + FE + \epsilon_{ci}$, where $MRe(\tau)$ is the the employee-based merger rate of type τ such that $\sum MRe(\tau)_{ci} = MRe$, $\delta$is the window length over which annual meager rates and annual growth rates are averaged. All variables winsorized at the 1% level.

Country	Year of Threshold Change	Threshold	$\triangle$in National Currency
Austria	2005	Lower	2M to 5M
Austria	2005	Upper	15M to 30M
Belgium	2005	Lower	15M to 40M
Belgium	2005	Upper	40M to 100M
Denmark	2010	Lower	300M to 100M
France	2008	Lower	15M to 50M
France	2008	Upper	150M to 75M
Spain	2002	Lower	Instituted for the first time
Spain	2002	Upper	Instituted for the first time
Sweden	2009	Lower	10M to 20M (non retail sector)

Table 5: EU Merger Control Threshold Changes

Note: These thresholds are set by the respective national competition authorities. The thresholds are of the following forms: (a) Combined Turnover exceeding X (Upper Threshold) or (b) Each has Turnover exceeding X (Lower Threshold), where X is denominated in national currency.

Table 6(a): First Stage

	$MId^{t-3\sim t}$		$MIe^{t-3\sim t}$	
	(1)	(2)	(3)	(4)
$LowThreshold^{t-3\sim t}$	-3.56e^{-2}***		-2.78e^{-2}	
	(1.41e^{-2})		(6.80e^{-2})	
$HighThreshold^{t-3\sim t}$		-1.23e^{-2}*		-0.72e^{-3}
		(0.64e^{-2})		(0.72e^{-3})
R-squared	0.865	0.865	0.529	0.529
FE & Clust.	$C \times Y$, $I \times Y$, $C \times I$			

*** p<0.01, ** p<0.05, * p<0.1

Table 6(b): Second Stage

	$dln(TFPQ)^{t\sim t+3}$	$dln(Markup)^{t\sim t+3}$
	(1)	(2)
$\widehat{MRd}^{t-3\sim t}$	0.33**	0.08
	(0.16)	(0.10)
		4.23
Instrument	Lower Threshold	
FE & Clust.	$C \times Y$, $I \times Y$, $C \times I$	

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Two Stage Least Squares

Note: In the first stage, I run the following regression $MRd_{ciy} = \beta_{1s} \times Z_{ciy}^{j\in(Upper,Lower)} + FE + \epsilon_{ciy}$, where $Z_{ciy}^{j} = \#Firms\,Above\,Threshold(j)_{ciy}/Total\,\#\,Firms_{ciy}$ and MRd is the deal-based annual merger rate. In the second stage, I run $dln(TFPQ\,or\,Markup)_{ciy} = \beta_{2s} \times \widehat{MRd}_{ciy} + FE + \epsilon_{ciy}$ where $\widehat{MRd}$ is the predicted merger rate from the first stage.

	TFPR	Markups	Market Share	L/K
	(1)	(2)	(3)	(4)
I_{Acq}	3.146***	2.618**	0.207***	-0.142
	(1.094)	(1.248)	(0.026)	(0.160)
R-squared	0.628	0.624	0.891	0.712
Observations	17.1M			
Window Length	3 years			

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Mergers and Firm-Level Outcomes

Note: Each observation represents an entity in a given year. Within each country, industry, year, I create revenue deciles crossed with age deciles. This results in over 10,000 "grids". I run the following regressions with grid dummy variables: $dln(X)^{Post} = \alpha + \beta \times I_{Acquired} + \gamma \times dln(...)^{Pre} + FE_{grid}$, where X could be TFPR, Markups, Market Share, or Labor-to-Capital ratio, and $I_{Acquired}$ is a dummy indicating that whether the firm was acquired in this observation year. The Pre and Post trends are calculated over the period of 3 years. To have clean treatment and control groups within every grid, in each year, I drop firms that had been acquired in any of the previous 3 years or would be acquired in any of the future 3 years. All variables winsorized at the 1% level.

	Scale Economies	Tech Adoption	
	(1)	(3)	(4)
$I_{Acq} \times \frac{Acquirer\,Revenue}{Target\,Revenue}$	0.224***		
	(0.016)		
$I_{Acq} \times \frac{Acquirer\,TFPR}{Target\,TFPR}$		0.230	0.306
		(0.224)	(0.234)
$I_{Acq} \times \frac{Acquirer\,TFPR}{Target\,TFPR} \times I_{Within\,I}$			-0.024
			(0.021)
R-squared	0.652	0.629	0.629
Observations		17.1M	
Window Length		3 years	

*** p<0.01, ** p<0.05, * p<0.1

Table 8: Mergers and Firm-Level Channels of Growth

Note: Each observation represents an entity in a given year. Within each country, industry, year, I create revenue deciles crossed with age deciles. This results in over 10,000 "grids". I run the following regressions with grid dummy variables: $dln(TFPR)^{Post} = \alpha + \beta \times I_{Acquired} + \gamma \times dln(...)^{Pre} + FE_{grid}$, where $I_{Acquired}$ is a dummy indicating that whether the firm was acquired in this observation year, $I_{Cross\,CI}$ is a dummy indicating that the acquirer is not from the same country×industry, and $I_{Within\,I}$ is a dummy indicating that the acquirer is in the same industry. The Pre and Post trends are calculated over the period of 3 years. To have clean treatment and control groups within every grid, in each year, I drop firms that had been acquired in any of the previous 3 years or would be acquired in any of the future 3 years. All variables winsorized at the 1% level.