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Pauline Affeldt, Tomaso Duso, Klaus Gugler and Joanna Piechucka

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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

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Abstract

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JEL Classification: L19, L24, L40, K21

Keywords: Compensating efficiencies, Efficiency gains, Merger Control, Concentration, Screens, HHI, mergers, Unilateral Effects, Market Definition, Entry Barriers

Pauline Affeldt - paffeldt@diw.de
†Deutsches Institut für Wirtschaftsforschung (DIW Berlin) & Technische Universität (TU) Berlin

Tomaso Duso - tduso@diw.de
DIW Berlin, Technische Universität Berlin, Berlin Centre for Consumer Policies and CEPR

Klaus Gugler - klaus.gugler@wu.ac.at
Vienna University of Economics and Business

Joanna Piechucka - jpiechucka@diw.de
Deutsches Institut für Wirtschaftsforschung (DIW Berlin) & BCCP

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Pauline Affeldt,† Tomaso Duso,‡
Klaus Gugler§, Joanna Piechucka ¶

November 5, 2021

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†DIW Berlin, Technische Universität Berlin, and BCCP. E-mail: paffeldt@diw.de.

‡*Corresponding author.* DIW Berlin, Technische Universität Berlin, CEPR, CESifo, and BCCP. E-mail: tduso@diw.de.

§Vienna University of Economics and Business. E-mail: klaus.gugler@wu.ac.at.

¶DIW Berlin and BCCP. E-mail: jpiechucka@diw.de.

1. Introduction

The common wisdom in merger analysis is that, absent efficiency gains, mergers decrease consumer surplus by reducing competition in the market. Yet, mergers can create economies of scale, knowledge sharing, patent-pooling, etc., that may allow the merged entity to increase its efficiency, ultimately benefiting consumers. What counts is the balance between these two effects. Farrell and Shapiro (1990) show that there exists a critical level of merger-specific efficiency gains that exactly compensates any increases in market power such that the new equilibrium price and aggregate production are the same pre- and post-merger. Following a small, but well established, literature and legal practice, we call them "compensating efficiencies".[1]

While there is a sizeable and growing empirical literature assessing the (anti-)competitive effects of mergers, much less is known about their efficiency effects.[2] Specifically, neither is there systematic empirical evidence on the presence of cognizable *realized* efficiencies, nor is there systematic evidence on how large *compensating* efficiencies should be to prevent mergers from harming consumers.[3]

Yet, antitrust authorities worldwide clear most horizontal mergers unconditionally, neither knowing the distribution of actual efficiency gains nor knowing how large compensating efficiencies must be such that consumers are not harmed (see also the discussion in Kaplow, 2021). According to Kwoka (2014), among the large horizontal mergers that needed to be reported to antitrust authorities in the US between 2003 and 2012, second requests were issued in only 3.1% of the cases and many fewer mergers were blocked. For the EU, (Affeldt et al., 2018) report that around 94% of mergers are cleared without commitments, around 6% of mergers are allowed with remedies, and less than 0.5% of mergers are blocked or withdrawn by the parties in phase 2. The main contribution of this paper is to shed light on the question of how large compensating efficiencies must be such that mergers notified to the European Commission (EC) over almost three decades would not harm consumers.

We adopt the framework of Nocke and Whinston (2021), which provides both theoretical foundation and empirical validation for using measures based on concentration thresholds to assess a merger's likely unilateral price effects and, thus, compensating efficiencies. For different models of competition and assumptions on their primitives, they derive the critical level of efficiency gains necessary to make mergers consumer-welfare neutral. One of their

[1] The idea of compensating efficiencies originates with Werden (1996) and Werden and Froeb (1996), who specify the Compensating Marginal Cost Reductions (CMCR) necessary for the post-merger equilibrium prices and quantities not to change compared to their pre-merger levels. Goppelsroeder et al. (2008) generalize this concept to any number of goods and firms competing either in quantities or prices.

[2] For a review of the literature on the price (i.e., the net) effects of mergers see Ashenfelter et al. (2014) as well as Asker and Nocke (2021). Furthermore, some studies evaluate the effectiveness of EU merger control (see e.g. Duso et al., 2007, 2011, 2013) as well as US merger policy (Kwoka, 2014, 2016).

[3] For a possible exception, see Sheen (2014), who finds that mergers reduce prices due to operational efficiencies and lower costs. See also Stennek et al. (2001) for an early discussion on the role of efficiencies in EU merger control. The scattered existing literature on efficiencies in an antitrust sense also includes Ashenfelter et al. (2015), Blonigen and Pierce (2016), Charpin and Piechucka (2021), Kwoka and Pollitt (2010), Harrison (2011) or Bitzan and Wilson (2007). Estimated cost savings range from zero to 11.4%.

main results is that the critical level of efficiencies depends predominantly on the merging firms' market shares and, thus, the naïve change in the Herfindahl-Hirschman index (HHI) rather than its level. These results hold true for several models of competition such as the Cournot model of output/capacity competition with homogeneous goods, as well as models of multi-product price competition with differentiated products and multinomial logit (MNL) or constant elasticity of substitution (CES) demand systems.

We apply this framework to a novel database comprising merger control decisions of the Directorate-General for Competition (DG Comp) of the EC. We collect information on almost the complete population of DG Comp merger decisions between 1990 and 2018. The full dataset contains 6,429 mergers. These are generally large transactions possibly affecting several EU member states or world-wide markets. Since each merger can potentially affect several different markets – either in terms of products or in terms of geography – the dataset contains 42,453 well-defined antitrust markets. In the market definition stage, the Commission identifies, for each affected product of the merging parties, the effective competitors acting in the same market. For several geographic-product markets, the Commission explicitly reports figures on the market shares of the merging firms as well as their major competitors. This allows us to calculate sensible concentration measures as, for instance, a market-specific HHI or, particularly relevant for our analysis, the change in the HHI due to the merger. Since market shares are not always reported, our final estimation sample contains 12,325 markets belonging to 1,014 merger decisions.

Using this data and the methodological framework of Nocke and Whinston (2021), we assess EC merger control decisions between 1990 and 2018. We empirically derive the level of compensating efficiency gains needed for making these mergers consumer surplus neutral. For reasonable assumptions on the price elasticity of demand, we find that compensating efficiencies are sizeable on average. Assuming a conservative demand elasticity of two, average (median) compensating efficiencies to prevent the merger from harming consumers are 6.19% (4.54%) with Cournot competition. If anything, results based on models with differentiated product indicate even larger compensating efficiencies.

We further analyze which observable merger and market characteristics are correlated to the size of compensating efficiencies. Compensating efficiencies systematically fall with the number of firms competing in the market – a measure of actual competition. For example, for the Cournot model and an assumed demand elasticity of two, a three-to-two merger would require 1.2 percentage points larger efficiencies than a merger that leaves five or more firms in the market. Compensating efficiencies almost double in antitrust markets where the Commission identified barriers to entry – a proxy for (the absence of) potential competition. These findings can give guidance to antitrust authorities regarding the expected level of compensating efficiencies depending on the observed level of actual and/or potential competition in the market.

We conclude by conjecturing whether the Commission committed Type I and Type II errors in its merger control decisions. Assuming a 5% compensating efficiency threshold to indicate whether a merger is likely to be consumer surplus neutral, we observe ca. 11% Type I errors and around 49% Type II errors among the 1,014 mergers in our sample. Thus,

the Commission did not intervene in almost half of the mergers where it should have, while it "wrongly" intervened in one out of 10 mergers that were increasing consumer surplus.[4] Similar results are also obtained for other parametrizations and/or assumptions on the mode of competition and demands.

The large compensating efficiencies that we compute do not square well with the fact that most mergers remain unchallenged by antitrust authorities worldwide, unless the authorities' presumption is that (merger specific) efficiencies resulting from those mergers are indeed as sizeable.[5] These findings also speak to the intense debate about increasing concentration as well as its macroeconomic consequences and, in particular, to the role of underenforcement of competition policy to explain these patterns.

2. A Theoretical Evaluation Framework

Let us start with the standard Cournout model of horizontal mergers based on Farrell and Shapiro (1990). Following a merger and absent efficiency gains, the merging parties – the insiders – have a unilateral incentive to reduce their joint output. Because of strategic substitutability, the outsiders of the merger have the opposite incentive and increase their output. The workhorse of their analysis is to show that the aggregate output change of the outsiders is lower than the aggregate output change of the insiders. The implication is that total output in the market, following the merger, is reduced and, therefore, the market price increases. Consumers are hurt since they face a lower output and higher price in the post-merger equilibrium. Thus, absent efficiency gains, a horizontal merger is consumer-welfare reducing.

Mergers can however create synergies. The merging parties, by combining assets, might reduce their marginal costs and produce more efficiently than before. Farrell and Shapiro (1990) show that there exists a critical level of merger-specific efficiency gains that exactly compensates the market power effect, such that the new equilibrium price and aggregate production are the same pre- and post-merger. This level of efficiency gain is needed to make mergers consumer-welfare neutral: the compensating efficiencies.

Nocke and Whinston (2021) build on these insights and determine the level of compensating efficiency for the general case of mergers between asymmetric firms. The critical percentage change in the output-weighted pre-merger marginal cost (c_M) (i.e. the critical efficiency gains, where $\overline{c}_M$ is the post-merger marginal cost) that makes the merger consumer-surplus neutral is a function of the merger-induced change in HHI (ΔHHI), the joint market share of the merging firms (s_M), and the price elasticity of market demand (ϵ):

[4] We acknowledge that static unilateral effects and efficiencies are not the only decision criteria for the Commission. Non-price effects (e.g. product repositioning), the reaction of rivals (e.g. entry), or dynamic effects (e.g. innovation incentives) all play a role in the decision making process. Moreover, if two distant competitors merge, we may overestimate compensating efficiencies.

[5] Kaplow (2021, p.41) criticizes this "concept of an efficiency credit, although it is alluring and superficially rationalizes some current practice," since it "violates fundamental principles of optimal information collection and decision-making."

$$\frac{c_M - \bar{c}_M}{c_M} = \frac{\Delta HHI}{s_M(\epsilon - s_M) + \Delta HHI} \tag{1}$$

Equation 1 can be operationalized based on data from well-defined antitrust markets with specific information on the merging parties market shares and under assumptions on the elasticity of demand.

2.1. Generalizations: Aggregative Games

A nice feature of the homogeneous goods Cournot model is that it generates an aggregative game in the sense that the strategic choices of competitors only enter the profit function of the focal firm(s) through a one-dimensional 'aggregator.' This property is intuitive in the Cournot model but can be generalized to the case of oligopolistic price competition with multiproduct firms and differentiated goods. For the CES and MNL demand systems, Nocke and Schutz (2018) show that the pricing game of multiproduct firms is aggregative. Consequently, a firm's type entails all relevant information for determining its markup. Thus, the optimal vector of equilibrium prices is a function of competitors' prices only through the aggregator and is characterized by a uni-dimensional statistic.

Based on this, Nocke and Whinston (2021) generalize the derivation of compensating efficiencies to models of multiproduct firms as well as CES and MNL demands. Here, we highlight the key insights, whereas in Appendixes A.3 and A.4, we report the expressions generalizing equation 1. Although the exact values of compensating efficiencies depend on the chosen model and its parameters, the qualitative results are similar to the Cournot model. The main reason is that, independent of the model, compensating efficiencies predominantly depend on the merging firms' market shares as well as the elasticity of demand.

While in a model with homogeneous goods a merger can only create synergies through a marginal cost reduction, in markets with product differentiation, a merger can also create synergies by changing the parties' product portfolios as well as product quality. Therefore, for both models, Nocke and Whinston (2021) differentiate between cost and type synergies. The former is equivalent to what discussed in equation 1 when there is no product repositioning or changes in quality after the merger. The latter can be seen as a more general concept that non-linearly combines quality and marginal cost improvements due to the merger into a uni-dimensional variable. Specifically, type efficiencies can be interpreted as an increased contribution of a firm to the aggregator – and, thus, to consumer surplus – if that firm were to price competitively.

3. Data

EU Merger Database. We start with the (almost) complete population of merger decisions by DG Comp of the EU Commission for the 1990–2018 period.[6] Merger cases and their decisions are publicly accessible and published by DG Comp on the EC's website. Each

[6] See Affeldt et al. (2018) for a data documentation for the period 1990–2014. For this study, we updated the data with all merger cases decided between 2015 and 2018.

decision (between 20 and more than 400 pages) was carefully read and, for each merger, the following information was codified: the identity of the merging parties and their competitors in each product/geographic market defined by DG Comp affected by the merger (each merger affects one or more product/geographic markets); the market shares of all firms (merging parties and competitors), if available;[7] whether the market is defined at the national/local, EU wide, or worldwide level, or whether the extent of the geographical market was left open. Moreover, we codify several characteristics of the Commission's decision at the level of the affected markets, e.g. whether the Commission raised competitive concerns in the respective relevant market, whether the merger had (also) vertical or conglomerate aspects, or whether the Commission identified significant entry barriers. The full data set covers 6,429 DG Comp merger decisions over the 1990–2018 period giving rise to 42,453 (product/geographic) market level observations.

Sample Construction. For this analysis, we cannot use all observations contained in the merger database. First, we need to compute the merger-induced change in HHI to calculate the critical efficiency gains. Thus, we only keep observations for which the Commission separately outlines the market shares of acquirers and targets.[8] Second, we drop all observations where the exact definition of the geographic market was left open. Third, we drop markets that were vertically affected by the merger or markets in which the merger was conglomerate in nature. Lastly, for technical reasons, we also dropped mergers with more than one acquirer and target, as well as markets in which the merging parties reached 100% market share post-merger. This leads to a final data set used in the empirical analysis containing 12,325 product/geographic market level observations belonging to 1,014 DG Comp merger decisions. All summary statistics and analysis presented in the following are based on this data set.

3.1. Compensating Efficiencies

We compute the compensating efficiency gains to make a merger consumer welfare neutral based on the Cournot model and under various assumptions regarding the price elasticity of market demand. We use equation 1 and apply it to our sample of 12,325 antitrust markets affected by large horizontal mergers. Further, we assume values for the elasticity of demand that vary between one and 3.5.[9] The key ingredients to compute efficiencies are the market shares of the merging parties as well as the ΔHHI. In the upper part of Table 1 we report preliminary statistics for these variables (see Appendix A.1 for a deeper discussion). The

[7] Market shares are mostly reported in intervals, e.g. [30-40] percent. We take the midpoints. When market shares are reported in intervals of five percentage points, we take the lower bound. If the lower bound of the market share interval is zero, we use the midpoint of the smallest interval [0,5]. See Affeldt et al. (2018) and Affeldt et al. (2021) for a discussion.

[8] While the *joint* market shares for the merging parties is reported for around 30,000 markets (ca. 72% of the markets), the Commission separately outlines the market share of acquirers and targets in around 19,000 markets (ca. 46% of the markets).

[9] While we assume that the demand elasticity takes the same value in all markets, in section 4.3 and Appendix A.5 we provide extensions that relax this assumption. We simulate different values for the elasticity in each market by taking random draws from different elasticity distributions.

average post-merger joint market share is 37.5%, the post-merger HHI is on average 2,613 while ΔHHI is 48.

The computed values for compensating efficiencies reported in Figure 1 and Table 1 are sizeable (see also Table 5 in Appendix A.2). For instance, assuming a demand elasticity of two across all markets, the average (median) compensating efficiencies for the merger not to harm consumers are 6.19% (4.54%).[10] Compensating efficiency estimates are heterogenous across markets and are sensitive to variations in the assumed demand elasticity. Assuming an elasticity of 1.0, average compensating efficiencies increase up to 16.65%, if one assumes an elasticity of 3.5, average compensating efficiencies decrease to 3.27%. Moreover, as shown in Figure 1, the smaller the assumed price elasticity of demand in absolute terms, the more spread out are the computed compensating efficiency gains across markets. However, for all assumed elasticities, there is a large right tail of compensating efficiencies, i.e., a large share of mergers with high compensating efficiencies. With an elasticity of two, 41% (18%) of mergers require more than 5% (10%) marginal cost reductions not to harm consumers. The results obtained with the models that assume product differentiation and multiproduct firms are similar and reported in Appendix A.3 (CES demand) and Appendix A.4 (MNL demand).

4. Econometric analysis

4.1. Econometric model

In this section, we assess which merger and market characteristics help explain the large variation in compensating efficiencies across markets. This might help to provide guidance on which mergers should be examined more carefully, since compensating efficiencies are likely to be high, possibly implausibly high to be achievable through the actual synergies generated by the merger. We derive different sets of explanatory factors from the existing literature.

Market structure – actual competition. In most models of oligopolistic competition, market structure, as a proxy for actual competition, is an important determinant of equilibrium pricing and, thus, implicitly determines compensating efficiencies. The number of firms active/remaining in the market is often seen as an important determinant of the unilateral effects of merger.[11] The intuition is that market power is likely to increase by less due to the merger if there is more competition in the market pre-merger. Accordingly, we analyze how the compensating efficiencies depend on the number of firms active in the relevant market. Moreover, we allow this relationship to be non-linear by using dummies for three-to-two, four-to-three, and five-to-four mergers.

Barriers to entry – potential competition. The existence of barriers to entry might also be an important determinant of compensating efficiencies. Indeed, entry barriers rep-

[10] There are no cross-industry studies on price elasticities of demand. However, an elasticity of two is a conservative number. For example, Miller and Weinberg (2017, Table IV) estimate median market price elasticities for beer to lay between -0.6 and -1.1 depending on the used demand specification.

[11] See, for instance, Reisinger and Zenger (2021). This relationship is also observed empirically. Kwoka (2016, p. 868) reports that, in the US between 1996 and 2011 there "were literally no enforcement actions taken against any mergers that resulted in five or more significant competitors."

resent one important feature that influences the strength of potential competition (see for a discussion, OECD, 2021). Specifically, Caradonna et al. (2021) study whether merger-induced entry is sufficient to restore consumer surplus. They show that merger efficiencies must exist – or the entrant's products must be substantially differentiated from the merging parties' – in order to make mergers profitable. Compensating efficiencies must be even more substantial if there are significant entry barriers that reduce the likelihood of merger-induced entry. Thus, we analyze whether concerns about the existence of substantial entry barriers correlate with the levels of compensating efficiencies.

Other determinants. Compensating efficiencies, as we defined them, crucially depend on the market shares of the merging firms and the changes in HHI, which, in turn, are strictly related to the extent of the market – both in terms of geography as well as products. Thus, we include dummies that capture the geographic market definition, i.e. dummies for EU wide and world-wide markets (with base category national/local markets) as well as for product markets. Concerning the latter, we create a "broad product market" variable that provides a standardized description of the specific product markets named in the EC decision and contains 28 product market categories.[12]

We run the following regression for antitrust market i in industry j in year t:

$$CEff_{ijt} = \alpha_0 + \alpha_1 Nfirms_{ijt} + \alpha_2 Barriers_{ijt} + \alpha_3 GeoMarket_{ijt} + \alpha_7 X_{ijt} + \eta_j + \eta_t + \varepsilon_{ijt} \tag{2}$$

where $CEff_{ijt}$ are compensating efficiencies, $Nfirms_{ijt}$ is a set of dummies for three-to-two, four-to-three, and five-to-four mergers, respectively, (the base category being markets with five or more firms remaining post-merger), $Barriers_{ijt}$ denotes a dummy indicating the existence of barriers to entry in market i, industry j, and year t, $GeoMarket_{ijt}$ indicates national/regional, EU-wide, or worldwide markets. The matrix X_{ijt} includes a dummy for the manufacturing sector, dummies for the acquirer's country, and a cross-border dummy, i.e. a cross-border dummy indicating that target and acquirer are from different countries. The terms η_j and η_t are broad-product market and time fixed effects, respectively. The error terms ε_{ijt} are assumed to be correlated either at the industry or at the merger level. Table 1 reports summary statistics for the variables used in the regressions.

4.2. Econometric results

We present our findings using the Cournot model in Table 2. In Appendixes A.3 and A.4, we report a full replication of our main results for the CES and MNL models, respectively. We focus on the results reported in the third column of Table 2, where we assume an elasticity of two equal across all markets. Compensating efficiencies systematically fall with the number of firms competing in the market. A three-to-two (four-to-three) merger would require 1.2 (0.66) percentage points larger efficiencies than a merger that leaves five or more firms in the market. A five-to-four merger also increases compensating efficiencies, albeit significantly so

[12] More details on the distribution by "broad product market" are provided in Table 4 in Appendix A.2.

only for assumed elasticities smaller than two. Thus, the number of firms remaining active in the market post-merger is a significant factor for understanding compensating efficiencies.[13]

If the Commission identified barriers to entry in an affected antitrust market, compensating efficiencies increase by 4.1 percentage points relative to markets without barriers to entry. Given the average compensating efficiencies of 6.19%, this is a strong indication that, in markets with significant barriers to entry, compensating efficiencies need to be significantly larger. For example, for a four-to-three merger where the Commission identified entry barriers, we would estimate that this merger must generate on average 10.56% (=5.8%+4.1%+0.66%) synergies relative to the output-weighted pre-merger average marginal costs. This appears to be too large to be achievable, on average.

In EU-wide markets compensating efficiencies appear to be significantly lower (by 0.5 percentage points) than in either "small" (national/regional) or "large" (worldwide) markets. Whether relevant antitrust markets are in manufacturing or services does not seem to make a significant difference.

The results obtained with different (smaller as well as larger) elasticities are consistent with the reasoning that more elastic markets require lower efficiencies for the merger to be consumer surplus neutral and less elastic markets require higher efficiencies. In most cases, the correlations between merger characteristics and compensating efficiencies maintain sign and significance, albeit changing in size, if compared to the results we discussed.

4.3. Robustness

Relaxing the assumption of equal elasticity across markets. We assumed equal elasticities for each market, which is clearly an unrealistic assumption. To understand how this assumption affects our findings, we relax it by simulating different values for the elasticities in the various markets. We randomly draw different sets of elasticities from given distributions for each of our 12,325 markets. We draw elasticities from the range 1.0 and 3.5, then either assume either a uniform distribution, where the likelihood of occurrence of each elasticity within the range is the same, or two different beta distributions: one that puts more weight on elasticities in the middle and one that puts more weight on the extreme values of the range (see Figure 8 in Appendix A.5). For each of these distributions, we take 1,000 independent draws, i.e. we generate 1,000 sets of 12,325 elasticities. For each of these three times 1,000 draws, we run again our regressions.

Looking at barriers to entry, for instance, independently of the chosen distribution, the estimated correlation with the compensating efficiencies is almost perfectly bounded by the estimates obtained assuming an equal elasticity of 1 and an equal elasticity of 3.5 for all markets.[14] For all three distributions, the mean estimated correlation is even larger than the

[13] Because for some mergers we do not observe the number of competitors, we control for this issue with two dummies that differentiate this information between phase 1 and phase 2 cases. In phase 1 cases, the Commission is less likely to report information on competitors because the mergers are less problematic and, consequently, the market definition is not reported. In phase 2 cases, missing information for competitors might instead indicate that there were no large, well-identified substantial competitors in the relevant market. We find that compensating efficiencies are significantly lower only in the former case.

[14] In Figures 12 to 15 in Appendix A.5 we report the distribution of the estimated coefficients for each of

estimates we obtain for an elasticity of two. This suggests that the discussion based on an elasticity of two for the Cournot model provides a reasonable view.

4.4. Generalizations

The CES model. Following Nocke and Whinston (2021), we compute the compensating efficiencies in a model of multiproduct firms offering differentiated goods and competing in prices and CES demand. To be consumer surplus neutral, the merger-induced (cost and type) synergies must satisfy a condition that depends on the market shares of the two merging parties – which depend on the market share of the outside good –, the naïve joint market shares, as well as the parameter measuring the elasticity of substitution (σ). We report the complete analysis in Appendix A.3.

The distribution of compensating efficiencies is similar to the one observed for the Cournot model. Assuming a zero market share for the outside good, the mean compensating efficiencies range between around 5% (for an elasticity of substitution of 6 or 7) and almost 11% (for an elasticity of substitution of two). These values decrease with an increasing market share of the outside good. We also show that the distribution of compensating type synergies has a similar shape as the distribution of cost synergies but are larger in magnitude.

The findings from the regression analysis are qualitatively identical to the results obtained for the Cournot model: the compensating efficiencies are even larger when a market faces barriers to entry and when the number of active firms is lower. For example, with a σ of five, and assuming a zero share for the outside good, we estimate that a four-to-three merger where the Commission identified entry barriers must generate 14.7% (=6.2%+6.7%+1.8%) cost efficiencies relative to the output-weighted pre-merger average marginal costs to be consumer-welfare neutral. Again, the influence of entry barriers and number of firms is even larger for type synergies. Generally, assumptions on the share of the outside good have a large effect on estimated compensating efficiencies.

The MNL model. Finally, we compute compensating efficiencies for a model with MNL demand. In this model, the market shares of the two merging parties – thus, the size of the outside good – are the sole determinants of compensating efficiencies.[15] We report the complete analysis in Appendix A.3.

The mean compensating type synergies vary between 8.56% (zero share for the outside good) and more than 20% (50% share of the outside good). The regression analysis is again consistent with our results assuming an homogenous Cournot model or differentiated products with CES demand. Entry barriers significantly increase compensating efficiencies and the number of active firms decrease them. For example, assuming a share of 50% for the outside good, we would estimate that a four-to-three merger where the Commission identified entry barriers must generate 17.4% (=8.0%+7.9%+1.5%) type efficiencies relative to before the merger to be consumer-welfare neutral.

the main explanatory variables. We also report the coefficient estimates from column 3 of Table 2 for comparison.

[15] For MNL demand, only absolute (and not relative) compensating cost synergies can be calculated (with the exception of assuming symmetric firms and products).

Summarizing, irrespective of what we assume on the mode of competition and demand, our computed compensating efficiencies are sizeable and depend on actual (the number of firms) and potential competition (entry barriers). Compensating type synergies are – for given assumptions on substitutability – larger than compensating cost synergies. The exact size of compensating efficiencies depends on assumptions on the elasticity of demand (Cournot), the elasticity of substitution (CES), and the share of the outside good (CES and MNL).

5. Policy implications

We estimate that a large proportion of mergers notified to the EU require sizeable compensating efficiencies to become consumer surplus neutral. Combined with the fact that the EC allows the overwhelming majority of large horizontal mergers without remedies or commitments, it suggests that EU merger control might be too lenient. Compensating efficiencies appear to be simply too large to be achieved by real world mergers, especially if compared to the estimates on *actual* efficiencies reported in the literature.

To quantify this observation, we use our framework to assess the decisions of the Commission in terms of Type I and Type II errors. A Type I error is defined as an intervention of the Commission when the merger is likely to increase consumer surplus, and a Type II error is defined as an unconditional clearance when the merger is likely to reduce consumer welfare. We use the computed compensating efficiencies to assess the potential anti-competitive nature of the merger.

A merger can be deemed to be pro-competitive if the compensating efficiencies are 'small' and anti-competitive if they are 'large.' In this case, if the Commission blocked or remedied the merger it can be seen as a potential Type I error.[16] Instead, situations in which the Commission allowed the merger unconditionally and the compensating efficiencies are 'large' can be seen as a potential Type II error. Thus, we can define these two types of errors by making assumptions on the value of the critical compensating efficiencies.

For the Cournot model, we show in Figure 2 how the rates of Type I and Type II errors change with different values of the demand elasticity as well as thresholds for the critical level of compensating efficiencies by considering three thresholds: 3%, 5%, or 7%. As an example, consider the case of a demand elasticity of two and let us assume that mergers requiring more than 5% compensating efficiencies are consumer welfare decreasing. The results for our sample of 1,014 mergers indicate that the Commission committed a Type I error in 11% of the likely pro-competitive mergers and a Type II error in around 49% of the likely anti-competitive mergers.[17] Thus, the Commission did not intervene in almost half of mergers

[16] Actually, the use of remedies in mergers that are on average pro-competitive must not necessarily be an error. Indeed, even mergers that are on average pro-competitive might entail anti-competitive effects that might be rightly targeted by the remedy.

[17] See also Table 16 in Appendix A.6.1. It is important to note that these numbers are affected by the sample selection. For 2,376 mergers the EC does not report the market shares of the merging parties, possibly because these mergers are unproblematic. Were we to consider all these mergers to be pro-competitive, then any intervention would be a potential (weak) Type I error, while no Type II error would be possible.

where it should have intervened. Similar patterns can be observed for the other models as reported in Appendixes A.6.2 and A.6.3.

While these exact numbers must be taken cautiously, as they are sensitive to the parametrization of the model and our assumption on the threshold level of achievable efficiencies, they clearly indicate a potential issue of under-enforcement in EU merger control. The main insights are that the rate of Type II errors is, for all combinations, large and always higher than the rate of Type I errors. The gap between Type I and Type II errors is large for low elasticities– both the elasticity of demand in the Cournot model and the elasticity of substitution in the CES model – and decreases with higher values. Yet, it never closes, even not for (implausibly) high thresholds to define potentially anti-competitive mergers.

6. Conclusion

Antitrust authorities regularly decide on large horizontal mergers knowing neither how large required compensating efficiencies are such that the merger does not harm consumers, nor the distribution of actual efficiency gains that might be generated by the merger. The main contribution of this paper is to shed light on the first question: how large are compensating efficiencies such that the merger does not harm consumers in a large sample of the most important mergers scrutinized by the EC over 28 years. By doing so, we can also attempt to evaluate the Commission's merger enforcement.

We apply the theoretical framework of Nocke and Whinston (2021) to a set of 1,014 mergers notified to the EU affecting 12,325 well defined antitrust markets. For each of these markets, we have information on market shares of insiders. We compute the compensating efficiencies – the efficiencies that a merger must generate in order for consumer surplus not to deteriorate after a horizontal merger – under different sets of assumptions on the mode of competition and the primitives of these models. We show that these compensating efficiencies are sizeable. Using the Cournot model and assuming a reasonable but conservative demand elasticity of two, the average (median) compensating efficiencies that are just enough to prevent the merger from harming consumers are 6.19% (4.54%). Importantly, 41% of mergers require more than 5% marginal cost reductions and 18% of mergers require more than 10% marginal cost reductions to not harm consumers.

Further, we analyze how different observable merger characteristics help explain the variation in the computed compensating efficiencies across markets. According to our findings, the existence of barriers to entry makes compensating efficiencies implausibly high to be achievable, on average. We estimate almost a doubling of compensating efficiencies in such markets. Moreover, compensating efficiencies systematically fall with the number of firms competing in the market. Finally, in 'small' (e.g. national and/or local) or 'very large' (worldwide) antitrust markets compensating efficiencies are larger than in EU wide markets.

In the EU, as well as worldwide, the overwhelming majority of large horizontal mergers are cleared unconditionally by antitrust authorities, only few with remedies and commitments,

A rough estimate of the Type I error rate would therefore be 5.6%. This number is well below the 11% reported above, which can therefore be considered an upper bound.

and just a tiny number of mergers are blocked. Our results indicate that, for a large fraction of mergers notified to the EC, compensating efficiencies are likely to be larger than empirical magnitudes and prevalence of actual efficiencies would suggest. This means that the presumption of antitrust authorities that (merger specific) efficiencies resulting from those mergers are sizeable and outweigh compensating efficiencies appears to be too optimistic in many cases. Compensating efficiencies in a large number of mergers are simply too large to be plausibly achievable in real world mergers. Indeed, independent of the model parametrization and thresholds for the compensating efficiency that might indicate a potentially anti-competitive merger, we show that the EC unconditionally cleared between 30% and 70% of those mergers that would have been warranted – according to our reasoning – to be remedied or blocked. Instead, the rate of potential Type I errors stays below 20%, which can be seen as an upper bound since not all remedied potentially pro-competitive mergers must be defined as Type I errors. This evidence would call for a more aggressive merger policy.

In closing, we must mention some caveats. We need to make assumptions on the form of competition (e.g., Cournot or multiproduct price competition) and the price elasticity of demand (or other primitives of the model such as the elasticity of substitution or the share of the outside good) in order to be able to calculate compensating efficiencies. While we support our main results by showing how they vary if we allow for more flexibility in the distribution of elasticities, as well as report results for many ranges of elasticities, real world elasticities may differ. Moreover, we only account for the static unilateral effects of mergers and do not account for other competitive effects, like the reaction of potential competitors (e.g. entry), or dynamic effects (e.g. effects on innovation incentives). Nevertheless, static price effects and worries on increasing concentration are at the heart of merger control analysis. The surge in literature on the mostly detrimental effects of increasing concentration for macroeconomic outcomes witnesses a growing awareness on the central role of competitive markets. We add to this literature by showing that merger control – given unachievably high estimates of compensating efficiencies – appears to be too lenient even in one of the arguably strictest enforcement regimes worldwide, the EU.

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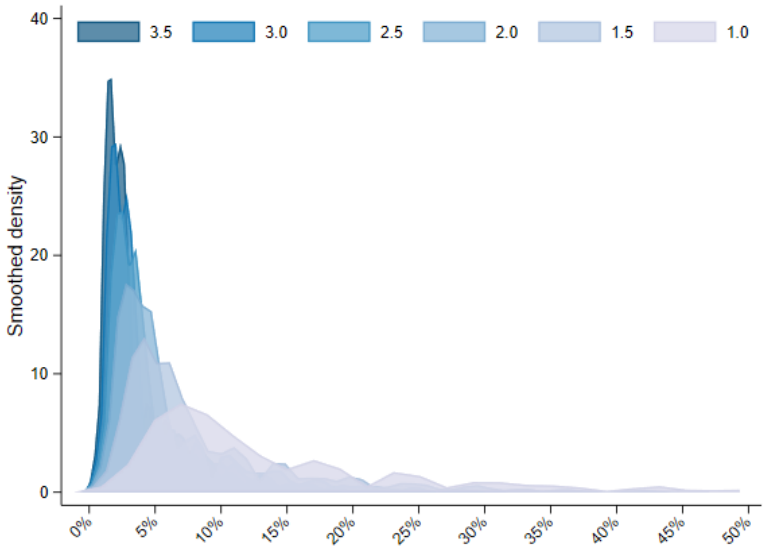
Tables and Figures

Table 1: Summary statistics of compensating cost efficiencies – homogenous-goods Cournot model, by demand elasticity (ϵ) and explanatory variables used in the econometric model

Variable	Mean	Median	SD	Min.	Max.	N
Concentration measures						
Post-merger MS (%)	37.47	30.00	21.26	0.41	99.00	12,325
Post-merger HHI	2,613.11	2,162.50	2,131.98	1.06	9,876.55	12,325
Δ HHI	48.06	25.00	62.63	0.01	450.00	12,325
Compensating cost efficiencies (%)						
$\epsilon = 1.0$	16.65	10.64	15.60	0.06	96.57	12,325
$\epsilon = 1.5$	8.87	6.49	7.32	0.04	46.27	12,325
$\epsilon = 2.0$	6.19	4.54	4.98	0.03	31.09	12,325
$\epsilon = 2.5$	4.77	3.43	3.78	0.02	23.41	12,325
$\epsilon = 3.0$	3.88	2.83	3.05	0.02	18.77	12,325
$\epsilon = 3.5$	3.27	2.40	2.56	0.02	15.67	12,325
Market structure						
3 to 2 merger	0.08	0.00	0.27	0.00	1.00	12,325
4 to 3 merger	0.17	0.00	0.38	0.00	1.00	12,325
5 to 4 merger	0.17	0.00	0.37	0.00	1.00	12,325
5 or more firms post-merger	0.27	0.00	0.44	0.00	1.00	12,325
No INFO on competitors × Phase 1 merger	0.28	0.00	0.45	0.00	1.00	12,325
No INFO on competitors × Phase 2 merger	0.04	0.00	0.19	0.00	1.00	12,325
Entry barriers	0.15	0.00	0.36	0.00	1.00	12,325
Geographic market						
National and regional	0.74	1.00	0.44	0.00	1.00	12,325
EU-wide	0.17	0.00	0.38	0.00	1.00	12,325
Worldwide	0.08	0.00	0.28	0.00	1.00	12,325
Industry						
Services	0.27	0.00	0.44	0.00	1.00	12,325
Manufacturing	0.73	1.00	0.44	0.00	1.00	12,325

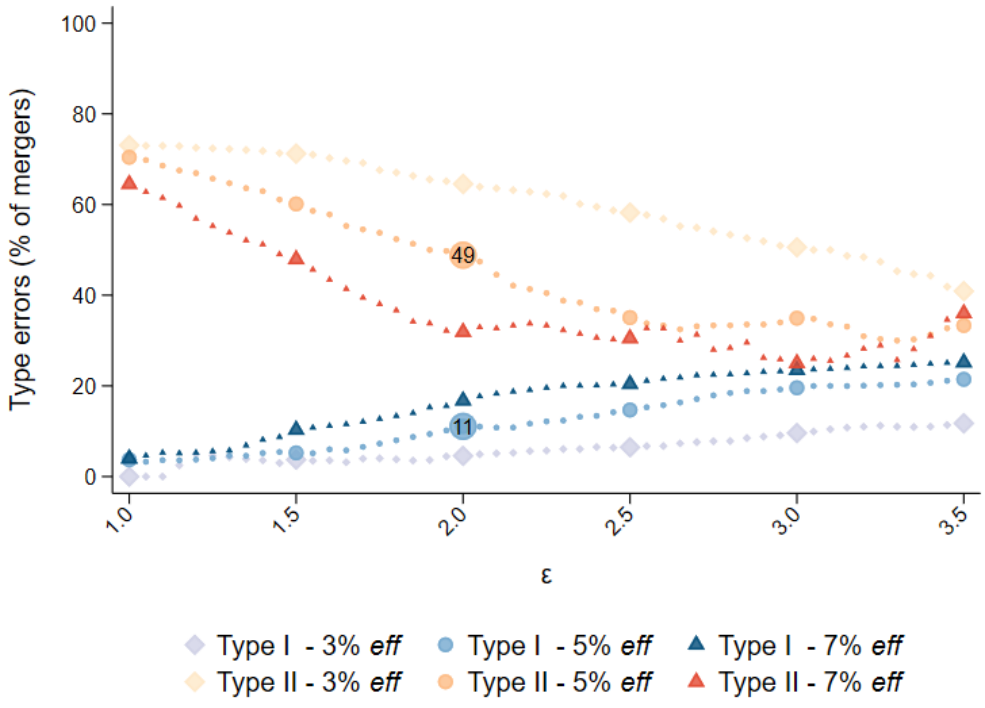
Source: Our elaboration on EU merger data. Industry is defined at the merger level, where Manufacturing encompasses NACE Rev. 2 sections A-D and Services encompasses NACE Rev. 2 sections E-T. In our empirical model, we also consider broadmarket industry dummies defined at the market level. Details on the two industry definitions are provided in Appendix A.2.

Figure 1: Kernel density of compensating cost efficiency – homogeneous-goods Cournot model, by demand elasticity (ϵ)



Source: Our elaboration on EU merger data.
Note: For purpose of visual clarity, the x-axis is limited to values not exceeding 50%.

Figure 2: Type errors based on compensating cost efficiencies – homogenous goods Cournot model



Source: Our elaboration on EU merger data.
Note: ϵ denotes demand elasticity and eff cost efficiencies thresholds.

Table 2: Linear regression – compensating cost efficiencies – homogenous-goods Cournot model, by demand elasticity (ϵ)

	$\epsilon = 1.0$	$\epsilon = 1.5$	$\epsilon = 2.0$	$\epsilon = 2.5$	$\epsilon = 3.0$	$\epsilon = 3.5$
3 to 2 merger	0.059	0.020	0.012	0.0081	0.0062	0.0050
	[0.0095]***	[0.0057]***	[0.0041]***	[0.0031]**	[0.0026]**	[0.0022]**
4 to 3 merger	0.030	0.011	0.0066	0.0046	0.0036	0.0029
	[0.0098]***	[0.0039]***	[0.0026]**	[0.0020]**	[0.0016]**	[0.0013]**
5 to 4 merger	0.011	0.0050	0.0031	0.0023	0.0018	0.0014
	[0.0056]*	[0.0030]*	[0.0021]	[0.0016]	[0.0013]	[0.0011]
Entry barriers	0.12	0.062	0.041	0.031	0.025	0.021
	[0.013]***	[0.0058]***	[0.0039]***	[0.0029]***	[0.0024]***	[0.0020]***
Market = EU-wide	-0.025	-0.0080	-0.0049	-0.0035	-0.0027	-0.0022
	[0.0074]***	[0.0033]**	[0.0022]**	[0.0017]**	[0.0014]**	[0.0011]*
Market = Worldwide	-0.0077	0.00069	0.00071	0.00061	0.00053	0.00046
	[0.0080]	[0.0041]	[0.0029]	[0.0022]	[0.0018]	[0.0015]
Manufacturing	0.027	0.0065	0.0036	0.0025	0.0019	0.0015
	[0.0079]***	[0.0048]	[0.0034]	[0.0026]	[0.0021]	[0.0018]
No INFO on competitors × Phase 1 merger	-0.0092	-0.015	-0.011	-0.0091	-0.0075	-0.0064
	[0.0068]	[0.0027]***	[0.0018]***	[0.0014]***	[0.0011]***	[0.00094]***
No INFO on competitors × Phase 2 merger	0.021	0.00015	-0.0016	-0.0019	-0.0019	-0.0017
	[0.029]	[0.016]	[0.011]	[0.0082]	[0.0066]	[0.0056]
Constant	0.16	0.082	0.058	0.045	0.037	0.031
	[0.034]***	[0.018]***	[0.012]***	[0.0093]***	[0.0075]***	[0.0063]***
Year dummies	X	X	X	X	X	X
Broadmarket ind. dummies	X	X	X	X	X	X
Country dummies	X	X	X	X	X	X
Cross-border dummy	X	X	X	X	X	X
Clustered SE	X	X	X	X	X	X
Observations	12,325	12,325	12,325	12,325	12,325	12,325
R2	0.23	0.22	0.21	0.20	0.20	0.20

Notes: Standard errors clustered at the broadmarket industry – geographic market group level in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Facing a small number of observations for the years 1990-1994 (73 in total), we regroup observations prior to 1995 as one year dummy. Broadmarket industry dummies refer to market-level industry dummies, the estimated coefficients are graphically reported in Figure 4 in Appendix A.2. Country dummies are constructed by considering the country of acquirer and only those countries for which there are at least 100 observations (USA, Germany, France, Netherlands, UK, Switzerland, Sweden, Japan), creating a category "Other" for those countries accounting for fewer observations. Cross-border dummy refers to a cross-border merger where the target and acquirer are from different countries.

A. Online Appendix

A.1. EC Merger Concentration Screens

Table 3 provides richer summary statistics on market shares and concentration measures. The upper part reports these statistics at the market level (12,325 observations), while the lower part reports the statistics at the merger level (1,014 observations). The latter statistics are calculated as the mean of all values across all relevant antitrust markets affected by a specific merger. In the market-level analysis, we divide the sample by the variable "concern" – an indicator for whether the Commission found competitive concerns in the relevant antitrust market – and in the merger-level analysis we split the sample by the decision type (clearance without remedies, clearance with remedies, and prohibition, each further divided into phase 1 and phase 2 decision).

Table 3: Summary statistics of screening thresholds, by Commission decision

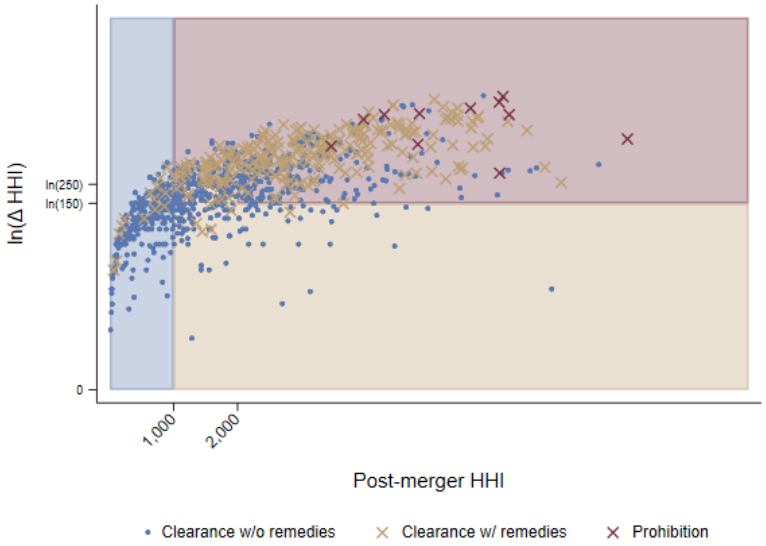
	Commission decision	Mean	SD	Min.	Max.	N
Market level variables						
Post-merger MS (%)	Overall	37.47	21.26	0.41	99.00	12,325
	No concern	32.42	18.43	0.41	99.00	9,605
	Concern	55.32	20.96	4.50	97.50	2,720
Post-merger HHI	Overall	2,613.11	2,131.98	1.06	9,876.55	12,325
	No concern	2,174.55	1,885.17	1.06	9,876.55	9,605
	Concern	4,161.77	2,229.46	56.25	9,731.25	2,720
Δ HHI	Overall	480.58	626.29	0.06	4,500.00	12,325
	No concern	316.79	370.24	0.06	4,500.00	9,605
	Concern	1,058.96	929.65	10.00	4,500.00	2,720
Merger level variables						
Post-merger MS (%)	Overall	30.95	14.94	3.00	90.00	1,014
	Phase 1 - Clear w/o remedies	26.38	12.43	3.00	87.50	723
	Phase 2 - Clear w/o remedies	38.39	11.75	16.67	65.00	26
	Phase 1 - Clear w/ remedies	40.52	13.67	7.50	75.00	187
	Phase 2 - Clear w/ remedies	44.85	14.74	17.50	82.50	67
	Phase 2 - Prohibit	66.36	11.80	43.75	90.00	11
Post-merger HHI	Overall	1,992.12	1,467.96	12.25	8,100.00	1,014
	Phase 1 - Clear w/o remedies	1,562.47	1,230.81	12.25	7,656.25	723
	Phase 2 - Clear w/o remedies	3,007.46	1,115.12	1,159.28	5,212.50	26
	Phase 1 - Clear w/ remedies	2,808.63	1,418.49	56.25	7,062.00	187
	Phase 2 - Clear w/ remedies	3,391.31	1,351.33	531.25	6,806.25	67
	Phase 2 - Prohibit	5,429.04	1,314.19	3,461.46	8,100.00	11
Δ HHI	Overall	344.34	370.98	4.00	2,700.00	1,014
	Phase 1 - Clear w/o remedies	219.54	227.06	4.00	2,700.00	723
	Phase 2 - Clear w/o remedies	641.41	461.48	59.33	2,000.00	26
	Phase 1 - Clear w/ remedies	578.69	382.22	25.00	2,080.00	187
	Phase 2 - Clear w/ remedies	740.66	504.41	75.00	2,450.00	67
	Phase 2 - Prohibit	1,446.68	720.09	340.00	2,653.83	11

Source: Our elaboration on EU merger data. Merger level variables were obtained by taking the mean values across all relevant markets affected by a specific merger.

The average post-merger market share is between 31% (merger level) and 37.5% (market level). In markets where the Commission did not identify competitive concerns, the average market share is slightly above 32%, while it goes up to over 55% in markets where the Commission did have such concerns. The same pattern is detected when looking at the post-

merger HHI and delta HHI: they are significantly higher in markets where the Commission had concerns (4,162 and 1,059, respectively) than in markets with no concern (2,175 and 317). As expected, levels and changes in concentration increase with the strictness of the Commission decision. Thus, these patterns seem at first glance consistent with a coherent enforcement of the merger guidelines: the Commission's concern and its intervention decisions are correlated with higher values of market shares as well as concentration levels and changes.

Figure 3: Screening thresholds in the EC 2004 Horizontal Merger Guidelines *versus* Commission decision at merger level



Source: Our elaboration on EU merger data.
Note: An additional threshold concerns naïve post-merger joint market share at the level of 50%.

To dig deeper into this issue, Figure 3 plots the aggregated, merger-level (naïve) post-merger HHI against the change in the HHI due to the merger for all 1,014 mergers in our final sample. In the background, we also depict the thresholds on HHI levels and HHI deltas discussed in the EU horizontal merger guidelines.[18] According to these guidelines, there is a safe harbor level of the post-merger HHI of less than 1,000 ("these markets normally do not require extensive analysis"). Moreover, the EC is "unlikely to identify horizontal competition concerns," (1) in a merger with a post-merger HHI between 1,000 and 2,000 and a delta below 250 or (2) in a merger with a post-merger HHI above 2,000 and a delta below 150.[19]

While prohibitions and remedied mergers are much more likely outside the regions where

[18] See Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings (2004/C 31/03), p.7.

[19] Except special circumstances, for example, where one or more of the following factors are present: (a) a merger involves a potential entrant or a recent entrant with a small market share; (b) one or more merging parties are important innovators in ways not reflected in market shares; (c) there are significant cross-shareholdings among the market participants; (d) one of the merging firms is a maverick firm with a high likelihood of disrupting coordinated conduct; (e) indications of past or ongoing coordination, or facilitating practices, are present; and/or (f) one of the merging parties has a pre-merger market share of 50% or more. Each of these HHI levels, in combination with the relevant deltas, may be used as an initial indicator of the absence of competition concerns. However, they do not give rise to a presumption of either the existence or the absence of such concerns. See Guidelines on the assessment of horizontal

horizontal competition concerns are generally not presumed, the Commission also remedied 16 out of 299 mergers (5%) inside those regions and, more importantly, did not remedy or block 279 out of 513 mergers (54%) in the highly concentrated regions.[20] Looking at this picture, the Commission appears to be too lenient as judged by its own guidelines.[21]

For example, when looking at the mergers unconditionally cleared in phase 2, the average merger displays a post-merger HHI of about 3,007.46 and a delta HHI of 641.41, way above the "unlikely to identify horizontal competition concerns" regions of the guidelines. Moreover, the Commission allows almost 65% of the mergers in the "red zone" without remedies.

mergers under the Council Regulation on the control of concentrations between undertakings (2004/C 31/03), p.7.

[20] We do, of course, acknowledge that levels and changes in concentration are not the only decision criteria. We also acknowledge a possible selection bias in our sample of mergers. In the population of mergers, the Commission allows 94% or mergers without remedies, in our sample this number is 69%. Thus, we over-sample more problematic mergers, because for these mergers the Commission collects market share data for the merging parties with a larger likelihood (and therefore they end up in our sample with a larger probability). However, our sample contains the most relevant mergers and, therefore, we believe that our conclusions are informative for the controversial discussions about the right level of enforcement in merger control.

[21] A similar pattern has been observed in the US. Kwoka (2016) not only shows that several mergers in markets with HHIs in the range 2500–3000 were approved by the FTC, but he also provide evidence that these mergers lead to anti-competitive increases in prices.

A.2. Additional descriptive and econometric results

Table 4: Distribution of the number of markets classified as Services or Manufacturing, by broad product markets

Broad product market (market-level)	Services	Manufacturing (merger-level)
Agricultural prod.	19	534
Air transport and travel	507	0
Airport, ships and port ser.	93	11
Automotive ind. and car components	16	812
Banking, financial ser. and insurance	620	0
Building materials	32	141
Chemicals	11	708
Communication devices and ser.	282	34
Computers (hard- and soft-ware)	148	86
Cosmetics	23	207
Electrical appliances	60	320
Electricity devices	15	266
Electronic components and devices	40	73
Energy and electricity supply	15	444
Food and beverages	60	843
IT and personnel ser. and consulting	217	7
Machinery and equipment	6	302
Media	184	16
Medical devices, ser. and prod.	14	741
Metals, minerals and metal prod.	1	191
Packaging	0	120
Paper and paper prod.	9	299
Pharmaceuticals	67	2054
Printing	0	102
Protective equipment	0	119
Raw materials	8	129
Transport and logistics	536	0
Other	307	476
Total	3290	9035

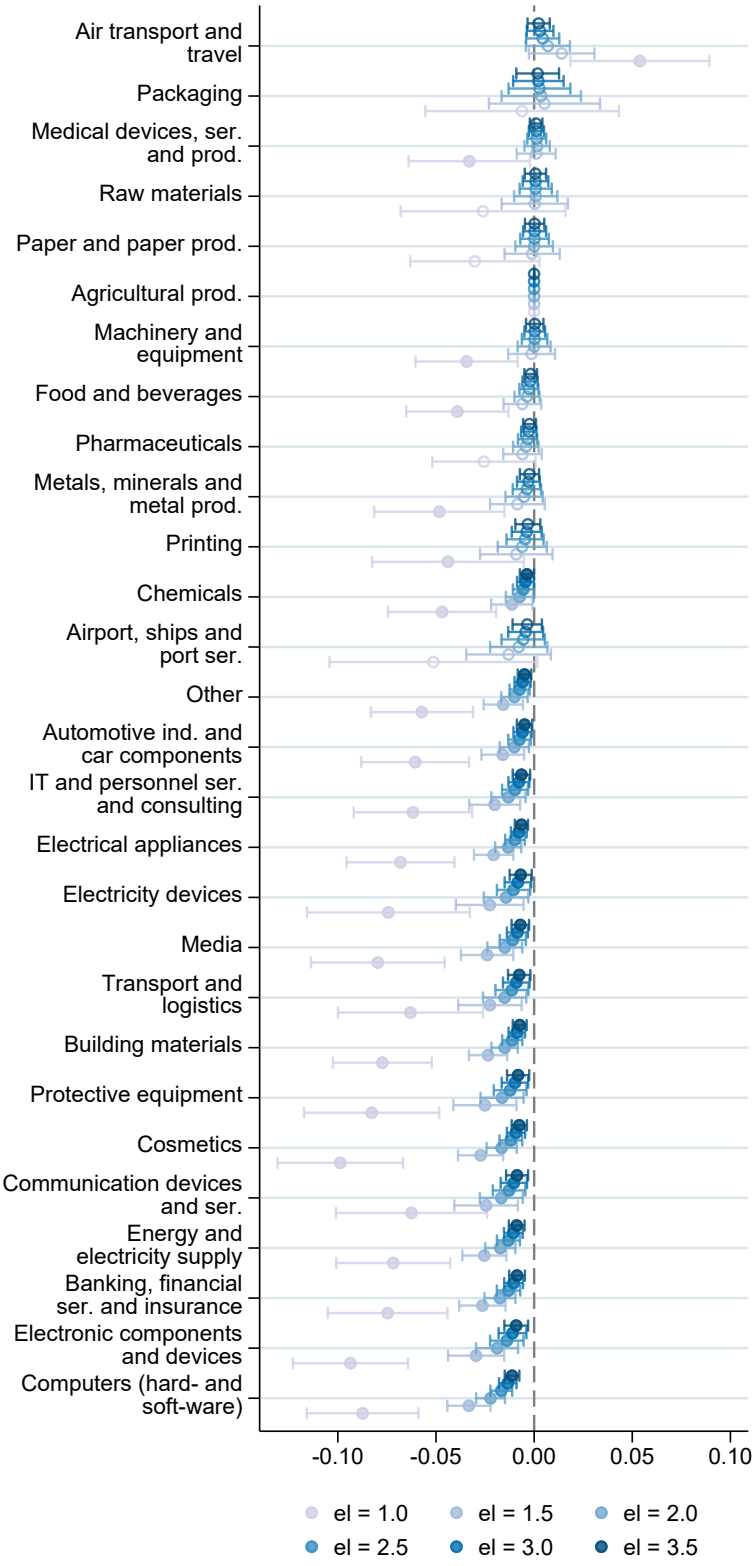
Source: Our elaboration on EU merger data.

Table 5: Summary statistics of compensating cost efficiencies (in %) – homogenous-goods Cournot model

Commission decision	Statistic	$\epsilon = 1.0$	$\epsilon = 1.5$	$\epsilon = 2.0$	$\epsilon = 2.5$	$\epsilon = 3.0$	$\epsilon = 3.5$
Market level variable		.	.	.	.	.	.
Overall	Mean	16.65	8.87	6.19	4.77	3.88	3.27
	SD	*15.60*	*7.32*	*4.98*	*3.78*	*3.05*	*2.56*
No concern	Mean	12.68	6.96	4.92	3.81	3.11	2.63
	SD	*10.99*	*4.88*	*3.38*	*2.59*	*2.10*	*1.77*
Concern	Mean	30.67	15.63	10.69	8.15	6.58	5.52
	SD	*20.58*	*10.00*	*6.80*	*5.15*	*4.15*	*3.48*
Merger level variable		.	.	.	.	.	.
Overall	Mean	12.67	7.10	5.02	3.89	3.17	2.68
	SD	*9.24*	*4.69*	*3.22*	*2.46*	*1.99*	*1.67*
Phase 1 - Clear w/o remedies	Mean	9.42	5.51	3.94	3.07	2.52	2.13
	SD	*6.02*	*3.20*	*2.24*	*1.73*	*1.41*	*1.19*
Phase 2 - Clear w/o remedies	Mean	19.66	11.50	8.15	6.31	5.15	4.35
	SD	*10.17*	*5.66*	*3.93*	*3.01*	*2.44*	*2.05*
Phase 1 - Clear w/ remedies	Mean	19.01	10.14	7.06	5.43	4.41	3.71
	SD	*9.43*	*4.58*	*3.12*	*2.37*	*1.91*	*1.60*
Phase 2 - Clear w/ remedies	Mean	22.78	12.14	8.43	6.47	5.25	4.42
	SD	*10.90*	*5.70*	*3.91*	*2.98*	*2.41*	*2.02*
Phase 2 - Prohibit	Mean	40.27	19.44	13.12	9.92	7.98	6.68
	SD	*12.75*	*7.81*	*5.50*	*4.23*	*3.43*	*2.89*

Source: Our elaboration on EU merger data.

Figure 4: Coefficients of broadmarket industry dummies corresponding to Table 2



Source: Our elaboration on EU merger data.

A.3. Main results for CES model

In Corollary 3 (ii), Nocke and Whinston (2021) focus on mergers between multiproduct firms offering differentiated goods and competing in prices with a constant elasticity of substitution (CES) demand system. They determine the compensating synergies under the assumption that the percentage marginal cost changes are the same for all products of the merging firms. Considering a merger $M = m, n$ between firms m and n, with CES demand, if the marginal cost of each product $j \in (m \cup n)$ changes by the same fraction ϕ, consumer surplus remains unchanged if and only if:

$$\phi = 1 - \left(\frac{s_M \left(\sigma + \frac{s_M}{1-s_M} \right)^{\sigma-1}}{s_m \left(\sigma + \frac{s_m}{1-s_m} \right)^{\sigma-1} + s_n \left(\sigma + \frac{s_n}{1-s_n} \right)^{\sigma-1}} \right)^{1/(1-\sigma)}, \tag{3}$$

where s_m and s_n are pre-merger market shares of firms m and n, respectively, $s_M \equiv s_m + s_n$ is their combined post-merger market share, and $\sigma > 1$ denotes the elasticity of substitution. Note that this assumes that the number and quality of the merging parties' products are unaffected by the merger.

If instead the merger is allowed to affect product quality, Nocke and Whinston (2021) show in Proposition 2 for the case of CES demand that, for merger $M = m, n$ to be CS-neutral, the merger- induced type synergies have to satisfy the following condition:

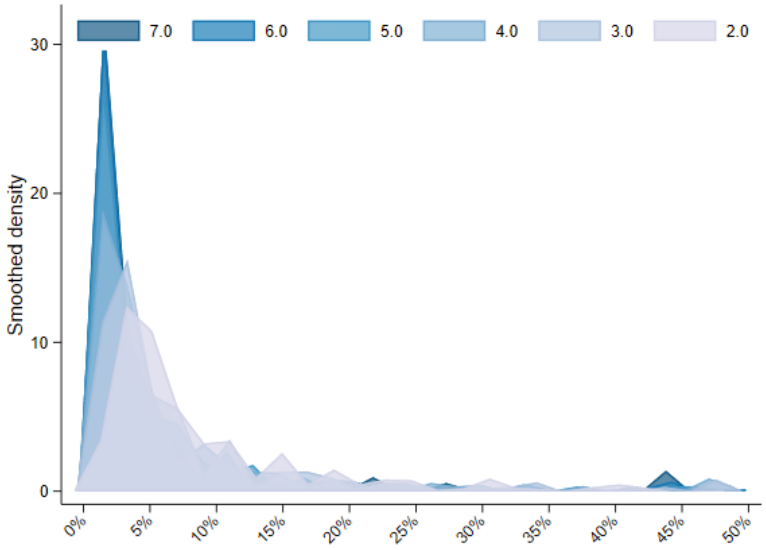
$$\frac{\overline{T}_M}{T_m + T_n} = \frac{s_M \left(\sigma + \frac{s_M}{1-s_M} \right)^{\sigma-1}}{s_m \left(\sigma + \frac{s_m}{1-s_m} \right)^{\sigma-1} + s_n \left(\sigma + \frac{s_n}{1-s_n} \right)^{\sigma-1}}, \tag{4}$$

where $\overline{T}_M$ is the merged firm's type, while T_m and T_n are firms m and n pre-merger types.

Note that one needs information or an assumption on the share of the outside good to calculate market shares. In the following analysis, we assume that the market share of the outside good market is zero (as in (Nocke and Whinston, 2021)), 20%, or 50% in *each* of the markets in our sample.

A.3.1. Cost efficiencies

Figure 5: Kernel density of CS-neutral merger necessary efficiency gains – differentiated goods with price-setting competition and CES demand, under the assumption of 0% market share of outside good, by elasticity of substitution (σ)



Source: Our elaboration on EU merger data.
Note: For purpose of visual clarity, the x-axis was limited to values not exceeding 50%.

Table 6: Summary statistics of compensating cost efficiencies (in %) – differentiated goods with price-setting competition (CES), by elasticity of substitution (σ)

Variable	Mean	Median	SD	Min.	Max.	N
CS-neutral efficiency gains (in %) and 0% MS of OG						
$\sigma = 2.0$	10.72	5.85	12.64	0.03	94.25	12,325
$\sigma = 3.0$	8.39	4.09	11.30	0.02	93.13	12,325
$\sigma = 4.0$	6.99	3.15	10.33	0.01	92.14	12,325
$\sigma = 5.0$	6.05	2.56	9.58	0.01	91.19	12,325
$\sigma = 6.0$	5.36	2.16	8.98	0.01	90.29	12,325
$\sigma = 7.0$	4.83	1.86	8.47	0.01	89.41	12,325
CS-neutral efficiency gains (in %) and 20% MS of OG						
$\sigma = 2.0$	6.76	4.34	6.85	0.02	49.34	12,325
$\sigma = 3.0$	4.94	3.00	5.41	0.02	41.33	12,325
$\sigma = 4.0$	3.91	2.30	4.48	0.01	35.56	12,325
$\sigma = 5.0$	3.24	1.86	3.83	0.01	31.21	12,325
$\sigma = 6.0$	2.76	1.56	3.35	0.01	27.80	12,325
$\sigma = 7.0$	2.41	1.35	2.97	0.01	25.07	12,325
CS-neutral efficiency gains (in %) and 50% MS of OG						
$\sigma = 2.0$	3.41	2.35	3.04	0.01	20.37	12,325
$\sigma = 3.0$	2.37	1.66	2.20	0.01	15.15	12,325
$\sigma = 4.0$	1.82	1.26	1.72	0.01	12.06	12,325
$\sigma = 5.0$	1.48	1.02	1.41	0.01	10.02	12,325
$\sigma = 6.0$	1.24	0.85	1.20	0.00	8.57	12,325
$\sigma = 7.0$	1.07	0.73	1.04	0.00	7.48	12,325

Source: Our elaboration on EU merger data.

Table 7: Linear regression – compensating cost efficiencies – differentiated goods with price-setting competition (CES) under the assumption of 0% market share of outside good, by elasticity of substitution (σ)

	$\sigma = 2.0$	$\sigma = 3.0$	$\sigma = 4.0$	$\sigma = 5.0$	$\sigma = 6.0$	$\sigma = 7.0$
3 to 2 merger	0.051	0.047	0.044	0.041	0.038	0.036
	[0.0076]***	[0.0067]***	[0.0061]***	[0.0057]***	[0.0054]***	[0.0052]***
4 to 3 merger	0.024	0.022	0.020	0.018	0.016	0.015
	[0.0081]***	[0.0074]***	[0.0068]***	[0.0063]***	[0.0060]***	[0.0056]***
5 to 4 merger	0.0094	0.0085	0.0076	0.0069	0.0062	0.0057
	[0.0045]**	[0.0039]**	[0.0035]**	[0.0032]**	[0.0030]**	[0.0028]**
Entry barriers	0.100	0.085	0.075	0.067	0.061	0.056
	[0.011]***	[0.010]***	[0.0093]***	[0.0087]***	[0.0082]***	[0.0078]***
Market = EU-wide	-0.019	-0.017	-0.016	-0.014	-0.014	-0.013
	[0.0057]***	[0.0050]***	[0.0044]***	[0.0040]***	[0.0037]***	[0.0035]***
Market = Worldwide	-0.0069	-0.0074	-0.0076	-0.0078	-0.0079	-0.0079
	[0.0064]	[0.0057]	[0.0053]	[0.0050]	[0.0047]*	[0.0045]*
Manufacturing	0.020	0.018	0.016	0.015	0.015	0.014
	[0.0063]***	[0.0053]***	[0.0046]***	[0.0041]***	[0.0037]***	[0.0034]***
No INFO on competitors × Phase 1 merger	-0.0024	0.0023	0.0048	0.0063	0.0071	0.0076
	[0.0052]	[0.0048]	[0.0045]	[0.0042]	[0.0041]*	[0.0039]*
No INFO on competitors × Phase 2 merger	0.024	0.026	0.026	0.026	0.025	0.024
	[0.022]	[0.018]	[0.016]	[0.014]*	[0.013]*	[0.012]**
Constant	0.10	0.083	0.070	0.062	0.056	0.052
	[0.025]***	[0.022]***	[0.019]***	[0.017]***	[0.016]***	[0.015]***
Year dummies	X	X	X	X	X	X
Broadmarket ind. dummies	X	X	X	X	X	X
Country dummies	X	X	X	X	X	X
Cross-border dummy	X	X	X	X	X	X
Clustered SE	X	X	X	X	X	X
Observations	12,325	12,325	12,325	12,325	12,325	12,325
R2	0.22	0.20	0.19	0.19	0.18	0.17

Notes: Standard errors clustered at the broadmarket industry – geographic market group level in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Facing a small number of observations for 1990 through 1994 (73 in total), we regroup observations prior to 1995 as one year dummy. Broadmarket industry dummies refer to market-level industry dummies. Country dummies are constructed by considering the country of acquirer and only those countries for which there are at least 100 observations (USA, Germany, France, Netherlands, UK, Switzerland, Sweden, Japan), creating a category "Other" for those countries accounting for fewer observations. Cross-border dummy refers to a cross-border merger where the target and acquirer are from different countries.

Table 8: Linear regression – compensating cost efficiencies – differentiated goods with price-setting competition (CES) under the assumption of 20% market share of outside good, by elasticity of substitution (σ)

	$\sigma = 2.0$	$\sigma = 3.0$	$\sigma = 4.0$	$\sigma = 5.0$	$\sigma = 6.0$	$\sigma = 7.0$
3 to 2 merger	0.023	0.019	0.016	0.014	0.013	0.011
	[0.0051]***	[0.0039]***	[0.0032]***	[0.0027]***	[0.0023]***	[0.0021]***
4 to 3 merger	0.012	0.0097	0.0081	0.0070	0.0062	0.0055
	[0.0039]***	[0.0031]***	[0.0026]***	[0.0022]***	[0.0019]***	[0.0017]***
5 to 4 merger	0.0054	0.0044	0.0038	0.0033	0.0029	0.0026
	[0.0027]**	[0.0021]**	[0.0017]**	[0.0014]**	[0.0012]**	[0.0011]**
Entry barriers	0.058	0.046	0.038	0.032	0.028	0.025
	[0.0054]***	[0.0043]***	[0.0035]***	[0.0030]***	[0.0026]***	[0.0023]***
Market = EU-wide	-0.0077	-0.0062	-0.0051	-0.0044	-0.0038	-0.0034
	[0.0030]**	[0.0023]***	[0.0019]***	[0.0016]***	[0.0014]***	[0.0012]***
Market = Worldwide	-0.000046	-0.00021	-0.00028	-0.00030	-0.00031	-0.00030
	[0.0036]	[0.0028]	[0.0023]	[0.0019]	[0.0017]	[0.0015]
Manufacturing	0.0063	0.0051	0.0042	0.0036	0.0032	0.0028
	[0.0043]	[0.0033]	[0.0027]	[0.0023]	[0.0020]	[0.0018]
No INFO on competitors × Phase 1 merger	-0.0096	-0.0063	-0.0046	-0.0035	-0.0028	-0.0024
	[0.0024]***	[0.0019]***	[0.0016]***	[0.0013]***	[0.0012]**	[0.0010]**
No INFO on competitors × Phase 2 merger	0.0056	0.0061	0.0059	0.0055	0.0051	0.0047
	[0.013]	[0.010]	[0.0083]	[0.0070]	[0.0061]	[0.0053]
Constant	0.062	0.045	0.035	0.029	0.025	0.022
	[0.015]***	[0.012]***	[0.0097]***	[0.0082]***	[0.0071]***	[0.0063]***
Year dummies	X	X	X	X	X	X
Broadmarket ind. dummies	X	X	X	X	X	X
Country dummies	X	X	X	X	X	X
Cross-border dummy	X	X	X	X	X	X
Clustered SE	X	X	X	X	X	X
Observations	12,325	12,325	12,325	12,325	12,325	12,325
R2	0.21	0.21	0.21	0.21	0.21	0.20

Notes: Standard errors clustered at the broadmarket industry – geographic market group level in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Facing a small number of observations for 1990 through 1994 (73 in total), we regroup observations prior to 1995 as one year dummy. Broadmarket industry dummies refer to market-level industry dummies. Country dummies are constructed by considering the country of acquirer and only those countries for which there are at least 100 observations (USA, Germany, France, Netherlands, UK, Switzerland, Sweden, Japan), creating a category "Other" for those countries accounting for fewer observations. Cross-border dummy refers to a cross-border merger where the target and acquirer are from different countries.

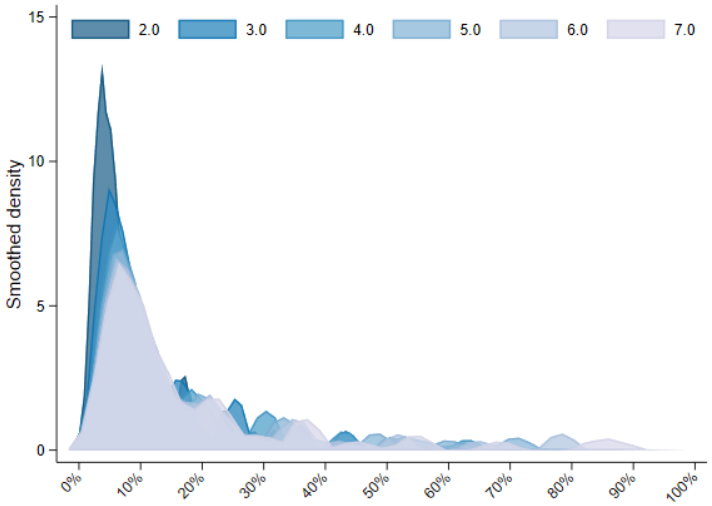
Table 9: Linear regression – compensating cost efficiencies – differentiated goods with price-setting competition (CES) under the assumption of 50% market share of outside good, by elasticity of substitution (σ)

	$\sigma = 2.0$	$\sigma = 3.0$	$\sigma = 4.0$	$\sigma = 5.0$	$\sigma = 6.0$	$\sigma = 7.0$
3 to 2 merger	0.0076	0.0058	0.0047	0.0039	0.0034	0.0029
	[0.0025]***	[0.0018]***	[0.0014]***	[0.0011]***	[0.00095]***	[0.00083]***
4 to 3 merger	0.0041	0.0031	0.0025	0.0021	0.0018	0.0015
	[0.0016]**	[0.0012]**	[0.00094]***	[0.00077]***	[0.00066]***	[0.00057]***
5 to 4 merger	0.0020	0.0015	0.0012	0.00099	0.00085	0.00074
	[0.0013]	[0.00090]	[0.00070]*	[0.00058]*	[0.00049]*	[0.00042]*
Entry barriers	0.025	0.018	0.014	0.012	0.0100	0.0087
	[0.0024]***	[0.0017]***	[0.0013]***	[0.0011]***	[0.00094]***	[0.00082]***
Market = EU-wide	-0.0030	-0.0022	-0.0017	-0.0014	-0.0012	-0.0010
	[0.0013]**	[0.00094]**	[0.00074]**	[0.00060]**	[0.00051]**	[0.00044]**
Market = Worldwide	0.00027	0.00018	0.00013	0.00010	0.000083	0.000070
	[0.0017]	[0.0012]	[0.00094]	[0.00077]	[0.00065]	[0.00056]
Manufacturing	0.0021	0.0015	0.0012	0.0010	0.00086	0.00075
	[0.0020]	[0.0015]	[0.0011]	[0.00093]	[0.00079]	[0.00069]
No INFO on competitors × Phase 1 merger	-0.0063	-0.0043	-0.0033	-0.0026	-0.0022	-0.0019
	[0.0011]***	[0.00077]***	[0.00060]***	[0.00049]***	[0.00042]***	[0.00036]***
No INFO on competitors × Phase 2 merger	-0.00022	0.00019	0.00029	0.00032	0.00031	0.00030
	[0.0063]	[0.0045]	[0.0035]	[0.0028]	[0.0024]	[0.0021]
Constant	0.032	0.022	0.017	0.014	0.012	0.010
	[0.0072]***	[0.0051]***	[0.0040]***	[0.0033]***	[0.0028]***	[0.0024]***
Year dummies	X	X	X	X	X	X
Broadmarket ind. dummies	X	X	X	X	X	X
Country dummies	X	X	X	X	X	X
Cross-border dummy	X	X	X	X	X	X
Clustered SE	X	X	X	X	X	X
Observations	12,325	12,325	12,325	12,325	12,325	12,325
R2	0.20	0.20	0.20	0.20	0.20	0.20

Notes: Standard errors clustered at the broadmarket industry – geographic market group level in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Facing a small number of observations for 1990 through 1994 (73 in total), we regroup observations prior to 1995 as one year dummy. Broadmarket industry dummies refer to market-level industry dummies. Country dummies are constructed by considering the country of acquirer and only those countries for which there are at least 100 observations (USA, Germany, France, Netherlands, UK, Switzerland, Sweden, Japan), creating a category "Other" for those countries accounting for fewer observations. Cross-border dummy refers to a cross-border merger where the target and acquirer are from different countries.

A.3.2. Type efficiencies

Figure 6: Kernel density of CS-neutral type synergies – differentiated goods with price-setting competition CES demand, under the assumption of 0% market share of outside good, by elasticity of substitution (σ)



Source: Our elaboration on EU merger data.
Note: For purpose of visual clarity, kernel densities for all elasticities of substitution (σ) were plotted by dropping observations with values of type synergies assuming σ=7 exceeding 100% (resulting in a sample of 11,176 observations).

Table 10: Summary statistics of compensating type efficiencies (in %) – differentiated goods with price-setting competition (CES), by elasticity of substitution (σ)

Variable	Mean	Median	SD	Min.	Max.	N
CS-neutral type synergies (in %) and 0% MS of OG						
$\sigma = 2.0$	8.23	5.76	6.85	0.03	35.30	11,176
$\sigma = 3.0$	12.16	8.58	10.89	0.04	56.53	11,176
$\sigma = 4.0$	14.54	10.08	13.65	0.04	71.31	11,176
$\sigma = 5.0$	16.17	10.93	15.70	0.05	82.05	11,176
$\sigma = 6.0$	17.36	11.52	17.32	0.05	90.19	11,176
$\sigma = 7.0$	18.28	11.94	18.63	0.05	96.57	11,176
CS-neutral type synergies (in %) and 20% MS of OG						
$\sigma = 2.0$	6.68	4.54	6.36	0.02	37.59	11,981
$\sigma = 3.0$	9.74	6.29	9.92	0.03	60.13	11,981
$\sigma = 4.0$	11.54	7.22	12.22	0.04	75.02	11,981
$\sigma = 5.0$	12.73	7.79	13.83	0.04	85.57	11,981
$\sigma = 6.0$	13.57	8.19	15.02	0.04	93.43	11,981
$\sigma = 7.0$	14.21	8.47	15.94	0.04	99.50	11,981
CS-neutral type synergies (in %) and 50% MS of OG						
$\sigma = 2.0$	3.64	2.41	3.53	0.01	25.59	12,325
$\sigma = 3.0$	5.09	3.41	5.16	0.02	38.91	12,325
$\sigma = 4.0$	5.88	3.88	6.11	0.02	47.06	12,325
$\sigma = 5.0$	6.37	4.17	6.72	0.02	52.55	12,325
$\sigma = 6.0$	6.71	4.36	7.16	0.02	56.50	12,325
$\sigma = 7.0$	6.96	4.50	7.48	0.03	59.48	12,325

Source: Our elaboration on EU merger data. Note: Summary statistics for the respective assumptions on market share of outside good were calculated by dropping observations with values of type synergies assuming σ=7 exceeding 100%.

Table 11: Linear regression – compensating type efficiencies – differentiated goods with price-setting competition (CES) under the assumption of 0% market share of outside good, by elasticity of substitution (σ)

	$\sigma = 2.0$	$\sigma = 3.0$	$\sigma = 4.0$	$\sigma = 5.0$	$\sigma = 6.0$	$\sigma = 7.0$
3 to 2 merger	0.0036	0.0093	0.015	0.020	0.024	0.028
	[0.0053]	[0.0083]	[0.010]	[0.012]	[0.013]*	[0.014]*
4 to 3 merger	0.0053	0.010	0.015	0.018	0.021	0.024
	[0.0036]	[0.0058]*	[0.0074]*	[0.0087]**	[0.0096]**	[0.010]**
5 to 4 merger	0.0014	0.0028	0.0040	0.0050	0.0058	0.0065
	[0.0028]	[0.0043]	[0.0054]	[0.0061]	[0.0067]	[0.0071]
Entry barriers	0.044	0.070	0.088	0.10	0.11	0.12
	[0.0054]***	[0.0084]***	[0.010]***	[0.012]***	[0.013]***	[0.014]***
Market = EU-wide	-0.0091	-0.015	-0.019	-0.023	-0.025	-0.027
	[0.0031]***	[0.0048]***	[0.0060]***	[0.0068]***	[0.0074]***	[0.0079]***
Market = Worldwide	-0.0010	-0.0013	-0.0015	-0.0015	-0.0016	-0.0016
	[0.0052]	[0.0083]	[0.010]	[0.012]	[0.013]	[0.014]
Manufacturing	0.0099	0.017	0.022	0.026	0.030	0.033
	[0.0036]***	[0.0054]***	[0.0065]***	[0.0073]***	[0.0079]***	[0.0083]***
No INFO on competitors × Phase 1 merger	-0.021	-0.030	-0.035	-0.038	-0.040	-0.041
	[0.0026]***	[0.0041]***	[0.0051]***	[0.0059]***	[0.0064]***	[0.0069]***
No INFO on competitors × Phase 2 merger	-0.021	-0.030	-0.035	-0.037	-0.038	-0.039
	[0.016]	[0.024]	[0.030]	[0.034]	[0.037]	[0.039]
Constant	0.072	0.10	0.12	0.14	0.14	0.15
	[0.017]***	[0.026]***	[0.032]***	[0.036]***	[0.039]***	[0.041]***
Year dummies	X	X	X	X	X	X
Broadmarket ind. dummies	X	X	X	X	X	X
Country dummies	X	X	X	X	X	X
Cross-border dummy	X	X	X	X	X	X
Clustered SE	X	X	X	X	X	X
Observations	11,176	11,176	11,176	11,176	11,176	11,176
R2	0.16	0.16	0.16	0.16	0.16	0.16

Notes: Standard errors clustered at the broadmarket industry – geographic market group level in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Facing a small number of observations for 1990 through 1994 (73 in total), we regroup observations prior to 1995 as one year dummy. Broadmarket industry dummies refer to market-level industry dummies. Country dummies are constructed by considering the country of acquirer and only those countries for which there are at least 100 observations (USA, Germany, France, Netherlands, UK, Switzerland, Sweden, Japan), creating a category "Other" for those countries accounting for fewer observations. Cross-border dummy refers to a cross-border merger where the target and acquirer are from different countries.

Table 12: Linear regression – compensating type efficiencies – differentiated goods with price-setting competition (CES) under the assumption of 20% market share of outside good, by elasticity of substitution (σ)

	$\sigma = 2.0$	$\sigma = 3.0$	$\sigma = 4.0$	$\sigma = 5.0$	$\sigma = 6.0$	$\sigma = 7.0$
3 to 2 merger	0.012	0.022	0.028	0.034	0.038	0.041
	[0.0055]**	[0.0085]**	[0.010]***	[0.012]***	[0.013]***	[0.013]***
4 to 3 merger	0.011	0.018	0.023	0.026	0.029	0.031
	[0.0035]***	[0.0056]***	[0.0070]***	[0.0080]***	[0.0087]***	[0.0093]***
5 to 4 merger	0.0013	0.0022	0.0029	0.0034	0.0038	0.0041
	[0.0027]	[0.0042]	[0.0051]	[0.0057]	[0.0062]	[0.0065]
Entry barriers	0.050	0.079	0.098	0.11	0.12	0.13
	[0.0054]***	[0.0084]***	[0.010]***	[0.012]***	[0.013]***	[0.013]***
Market = EU-wide	-0.0072	-0.011	-0.014	-0.016	-0.018	-0.019
	[0.0029]**	[0.0045]**	[0.0055]**	[0.0062]**	[0.0067]***	[0.0071]***
Market = Worldwide	0.00041	0.00044	0.00034	0.00020	0.000047	-0.000096
	[0.0033]	[0.0049]	[0.0059]	[0.0065]	[0.0070]	[0.0074]
Manufacturing	0.0063	0.010	0.013	0.015	0.016	0.018
	[0.0034]*	[0.0050]**	[0.0061]**	[0.0068]**	[0.0072]**	[0.0076]**
No INFO on competitors × Phase 1 merger	-0.015	-0.022	-0.025	-0.027	-0.028	-0.029
	[0.0022]***	[0.0034]***	[0.0042]***	[0.0047]***	[0.0051]***	[0.0054]***
No INFO on competitors × Phase 2 merger	-0.0087	-0.011	-0.011	-0.011	-0.011	-0.011
	[0.013]	[0.020]	[0.024]	[0.027]	[0.029]	[0.030]
Constant	0.069	0.10	0.12	0.13	0.14	0.15
	[0.016]***	[0.024]***	[0.030]***	[0.033]***	[0.036]***	[0.038]***
Year dummies	X	X	X	X	X	X
Broadmarket ind. dummies	X	X	X	X	X	X
Country dummies	X	X	X	X	X	X
Cross-border dummy	X	X	X	X	X	X
Clustered SE	X	X	X	X	X	X
Observations	11,981	11,981	11,981	11,981	11,981	11,981
R2	0.19	0.19	0.19	0.19	0.19	0.19

Notes: Standard errors clustered at the broadmarket industry – geographic market group level in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Facing a small number of observations for 1990 through 1994 (73 in total), we regroup observations prior to 1995 as one year dummy. Broadmarket industry dummies refer to market-level industry dummies. Country dummies are constructed by considering the country of acquirer and only those countries for which there are at least 100 observations (USA, Germany, France, Netherlands, UK, Switzerland, Sweden, Japan), creating a category "Other" for those countries accounting for fewer observations. Cross-border dummy refers to a cross-border merger where the target and acquirer are from different countries.

Table 13: Linear regression – compensating type efficiencies – differentiated goods with price-setting competition (CES) under the assumption of 50% market share of outside good, by elasticity of substitution (σ)

	$\sigma = 2.0$	$\sigma = 3.0$	$\sigma = 4.0$	$\sigma = 5.0$	$\sigma = 6.0$	$\sigma = 7.0$
3 to 2 merger	0.0095	0.015	0.018	0.020	0.021	0.023
	[0.0028]***	[0.0041]***	[0.0048]***	[0.0053]***	[0.0057]***	[0.0059]***
4 to 3 merger	0.0049	0.0074	0.0090	0.0100	0.011	0.011
	[0.0019]**	[0.0028]**	[0.0034]***	[0.0037]***	[0.0040]***	[0.0041]***
5 to 4 merger	0.0024	0.0037	0.0044	0.0049	0.0053	0.0056
	[0.0014]*	[0.0021]*	[0.0025]*	[0.0027]*	[0.0029]*	[0.0030]*
Entry barriers	0.029	0.043	0.050	0.055	0.059	0.062
	[0.0028]***	[0.0040]***	[0.0048]***	[0.0052]***	[0.0056]***	[0.0058]***
Market = EU-wide	-0.0034	-0.0050	-0.0059	-0.0065	-0.0069	-0.0072
	[0.0015]**	[0.0022]**	[0.0025]**	[0.0028]**	[0.0029]**	[0.0031]**
Market = Worldwide	0.00022	0.00028	0.00029	0.00028	0.00027	0.00026
	[0.0019]	[0.0028]	[0.0033]	[0.0036]	[0.0038]	[0.0040]
Manufacturing	0.0023	0.0034	0.0041	0.0045	0.0048	0.0050
	[0.0023]	[0.0034]	[0.0040]	[0.0044]	[0.0047]	[0.0049]
No INFO on competitors × Phase 1 merger	-0.0066	-0.0090	-0.010	-0.011	-0.011	-0.012
	[0.0012]***	[0.0017]***	[0.0021]***	[0.0023]***	[0.0024]***	[0.0025]***
No INFO on competitors × Phase 2 merger	0.00063	0.0018	0.0027	0.0034	0.0039	0.0043
	[0.0070]	[0.010]	[0.012]	[0.013]	[0.014]	[0.014]
Constant	0.034	0.048	0.055	0.060	0.063	0.065
	[0.0081]***	[0.012]***	[0.014]***	[0.015]***	[0.016]***	[0.017]***
Year dummies	X	X	X	X	X	X
Broadmarket ind. dummies	X	X	X	X	X	X
Country dummies	X	X	X	X	X	X
Cross-border dummy	X	X	X	X	X	X
Clustered SE	X	X	X	X	X	X
Observations	12,325	12,325	12,325	12,325	12,325	12,325
R2	0.20	0.20	0.20	0.20	0.19	0.19

Notes: Standard errors clustered at the broadmarket industry – geographic market group level in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Facing a small number of observations for 1990 through 1994 (73 in total), we regroup observations prior to 1995 as one year dummy. Broadmarket industry dummies refer to market-level industry dummies. Country dummies are constructed by considering the country of acquirer and only those countries for which there are at least 100 observations (USA, Germany, France, Netherlands, UK, Switzerland, Sweden, Japan), creating a category "Other" for those countries accounting for fewer observations. Cross-border dummy refers to a cross-border merger where the target and acquirer are from different countries.

A.4. Main results for MNL model

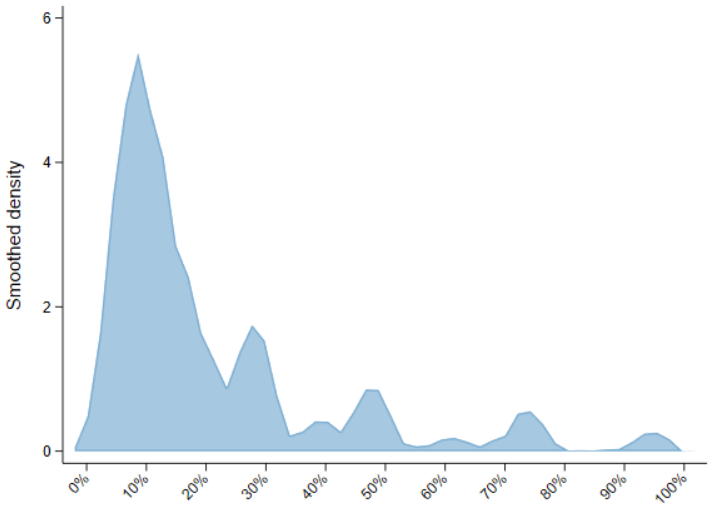
In Proposition 3, Nocke and Whinston (2021) focus on mergers between multiproduct firms offering differentiated goods and competing in prices with a multinomial logit (MNL) demand system. They show that for merger $M = m, n$ to be CS-neutral, the merger-induced type synergy has to satisfy:

$$\frac{\overline{T}_M}{T_m + T_n} = \frac{s_M \exp\left(\frac{1}{1-s_M}\right)}{s_m \exp\left(\frac{1}{1-s_m}\right) + s_n \exp\left(\frac{1}{1-s_n}\right)}, \tag{5}$$

where $\overline{T}_M$ is the merged firm's type, while T_m and T_n are firms m and n pre-merger types, s_m and s_n are pre-merger market shares of firms m and n, and $s_M \equiv s_m + s_n$ is their combined pre-merger market share.

Note, that only a condition for the compensating absolute marginal cost changes – rather than percentage changes – can be derived in this setting unless one is willing to assume symmetry among merging firms. Therefore, in the MNL model, we only focus on type synergies, which can be express in terms of percentage changes. Note also, that one needs information or an assumption on the share of the outside good to calculate market shares. As for the CES demand, we assume market shares of the outside good of zero, 20%, or 50% for *each* market in our sample. The following computations are all based on these assumptions.

Figure 7: Kernel density of CS-neutral type synergies – differentiated goods with price-setting competition and MNL demand, under the assumption of 0% market share of outside good



Source: Our elaboration on EU merger data.
Note: For purpose of visual clarity, the kernel densities were plotted by dropping observations with values of type synergies exceeding 100% (approx. 87% of all observations in our sample).

Table 14: Summary statistics of compensating type efficiencies (in %) – differentiated goods with price-setting competition (MNL), by market share of outside good (%)

Variable	Mean	Median	SD	Min.	Max.	N
MS of outside good = 0%	20.76	12.73	19.70	0.06	99.78	10,777
MS of outside good = 20%	16.43	10.26	16.87	0.05	99.82	11,727
MS of outside good = 50%	8.56	5.36	9.68	0.03	80.68	12,325

Source: Our elaboration on EU merger data. Note: Summary statistics were calculated by dropping observations with values of type synergies assuming σ=7 exceeding 100%.

A.4.1. Regression analysis

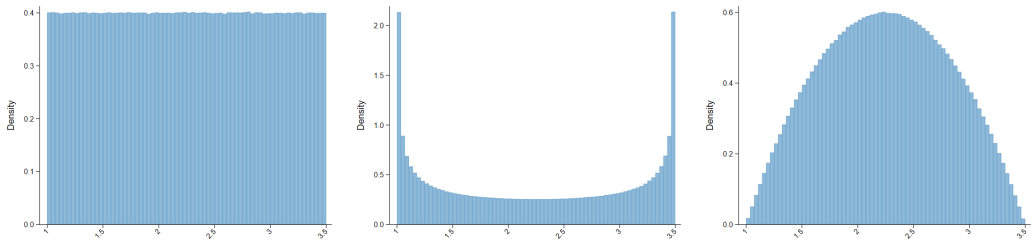
Table 15: Linear regression – compensating type efficiencies – differentiated goods with price-setting competition (CES), by market share of outside good

	0%	20%	50%
3 to 2 merger	0.0091	0.022	0.030
	[0.013]	[0.012]*	[0.0075]***
4 to 3 merger	0.011	0.023	0.015
	[0.011]	[0.0090]**	[0.0054]***
5 to 4 merger	0.0024	0.0022	0.0074
	[0.0076]	[0.0067]	[0.0038]*
Entry barriers	0.12	0.11	0.079
	[0.018]***	[0.012]***	[0.0075]***
Market = EU-wide	-0.023	-0.024	-0.0094
	[0.0084]***	[0.0079]***	[0.0039]**
Market = Worldwide	0.00035	0.00052	0.00016
	[0.014]	[0.0091]	[0.0051]
Manufacturing	0.030	0.026	0.0065
	[0.0099]***	[0.0075]***	[0.0062]
No INFO on competitors × Phase 1 merger	-0.058	-0.032	-0.014
	[0.0068]***	[0.0073]***	[0.0032]***
No INFO on competitors × Phase 2 merger	-0.066	-0.026	0.0075
	[0.048]	[0.031]	[0.018]
Constant	0.20	0.18	0.080
	[0.055]***	[0.047]***	[0.021]***
Year dummies	X	X	X
Broadmarket ind. dummies	X	X	X
Country dummies	X	X	X
Cross-border dummy	X	X	X
Clustered SE	X	X	X
Observations	10,777	11,727	12,325
R2	0.15	0.17	0.19

Notes: Standard errors clustered at the broadmarket industry – geographic market group level in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Facing a small number of observations for 1990 through 1994 (73 in total), we regroup observations prior to 1995 as one year dummy. Broadmarket industry dummies refer to market-level industry dummies. Country dummies are constructed by considering the country of acquirer and only those countries for which there are at least 100 observations (USA, Germany, France, Netherlands, UK, Switzerland, Sweden, Japan), creating a category "Other" for those countries accounting for fewer observations. Cross-border dummy refers to a cross-border merger where the target and acquirer are from different countries.

A.5. Results based on simulated demand elasticity

Figure 8: Distribution of simulation demand elasticities (1,000 draws)



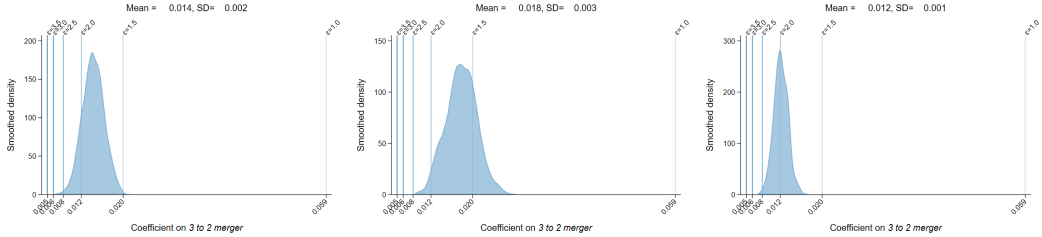
(a) Demand elasticities simulated from Uniform(1.0, 3.5)

(b) Demand elasticities simulated from beta distribution: Beta(0.5,0.5)*2.5+1

(c) Demand elasticities simulated from Beta(2,2)*2.5+1

A.5.1. Cournot model

Figure 9: Distribution of the estimated coefficients for *3 to 2 merger = 1* (1,000 draws)

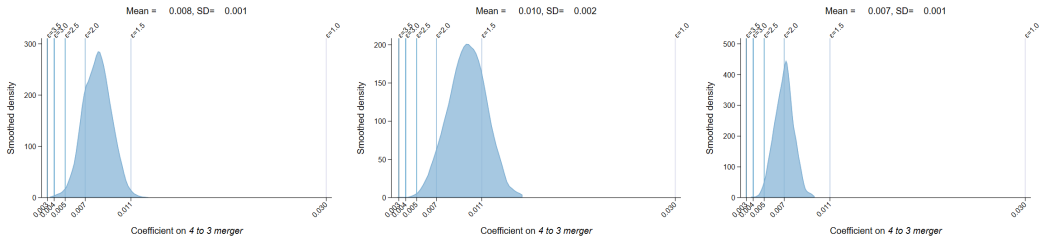


(a) Uniform(1.0, 3.5)

(b) Beta(0.5, 0.5)*2.5+1

(c) Beta(2, 2)*2.5+1

Figure 10: Distribution of the estimated coefficients for *4 to 3 merger* (1,000 draws)

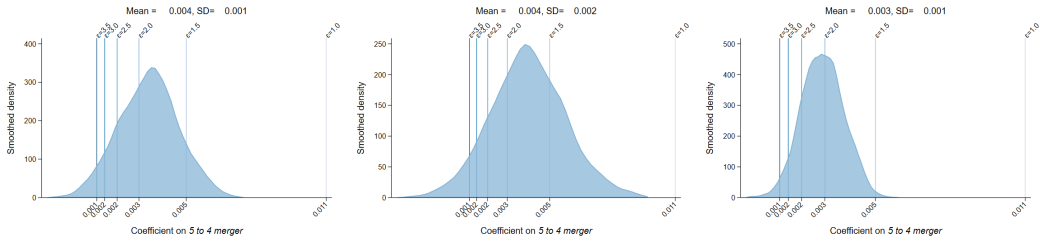


(a) Uniform(1.0, 3.5)

(b) Beta(0.5, 0.5)*2.5+1

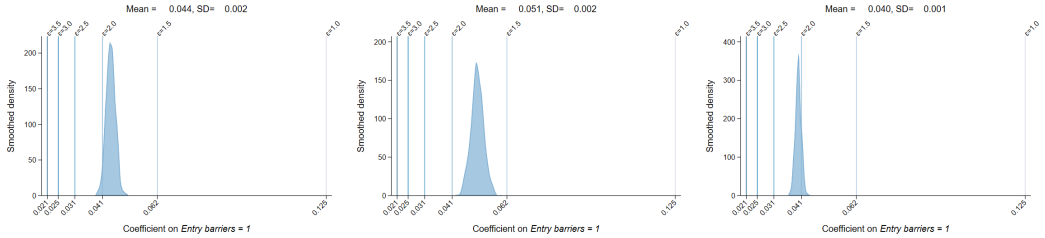
(c) Beta(2, 2)*2.5+1

Figure 11: Distribution of the estimated coefficients for *5 to 4 merger* coefficient (1,000 draws)



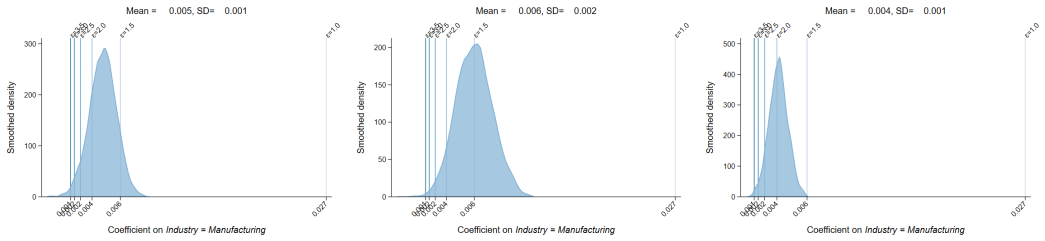
(a) Uniform(1.0, 3.5) (b) Beta(0.5, 0.5)*2.5+1 (c) Beta(2, 2)*2.5+1

Figure 12: Distribution of the estimated coefficients for *Entry barriers = 1* (1,000 draws)



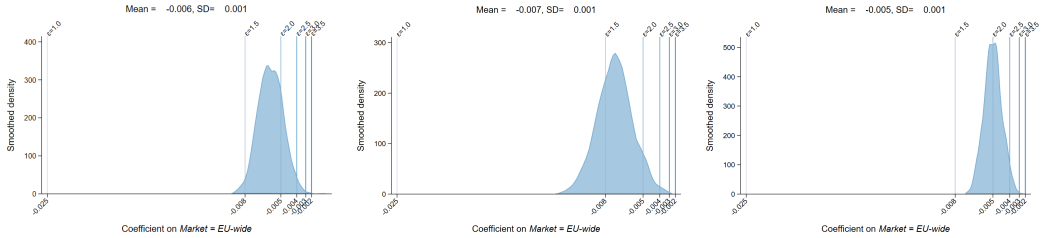
(a) Uniform(1.0, 3.5) (b) Beta(0.5, 0.5)*2.5+1 (c) Beta(2, 2)*2.5+1

Figure 13: Distribution of the estimated coefficients for *Industry = Manufacturing* (1,000 draws)



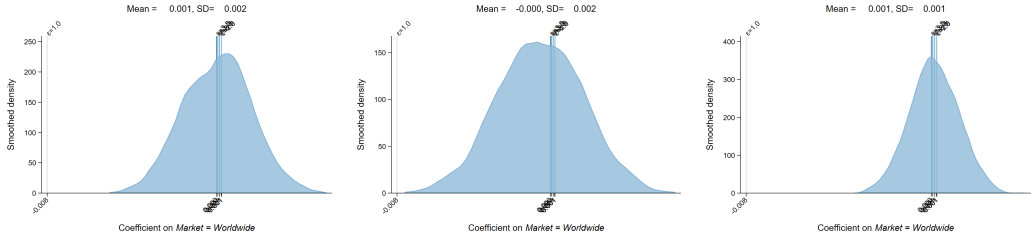
(a) Uniform(1.0, 3.5) (b) Beta(0.5, 0.5)*2.5+1 (c) Beta(2, 2)*2.5+1

Figure 14: Distribution of the estimated coefficients for *Market = EU-wide* coefficient (1,000 draws)



(a) Uniform(1.0, 3.5) (b) Beta(0.5, 0.5)*2.5+1 (c) Beta(2, 2)*2.5+1

Figure 15: Distribution of the estimated coefficients for *Market = Worldwide* coefficient (1,000 draws)



(a) Uniform(1.0, 3.5) (b) Beta(0.5, 0.5)*2.5+1 (c) Beta(2, 2)*2.5+1

A.6. Type I and type II errors

A.6.1. Cournot model

Table 16: Assessment of EU merger decisions at merger level – homogenous-goods Cournot model

	Prediction	
Decision	No intervention	Intervention
No intervention	True negative: 88.94% (563 mergers)	False negative: 48.82% (186 mergers)
Intervention	False positive: 11.06% (70 mergers)	True positive: 51.18% (195 mergers)

Source: Our elaboration on EU merger data. *Prediction* relies on demand elasticity of $\epsilon = 2$ and 5% cost efficiencies threshold, where values $< 5\%$ are predicted as *No intervention* and values $\geq 5\%$ are predicted as *Intervention* .

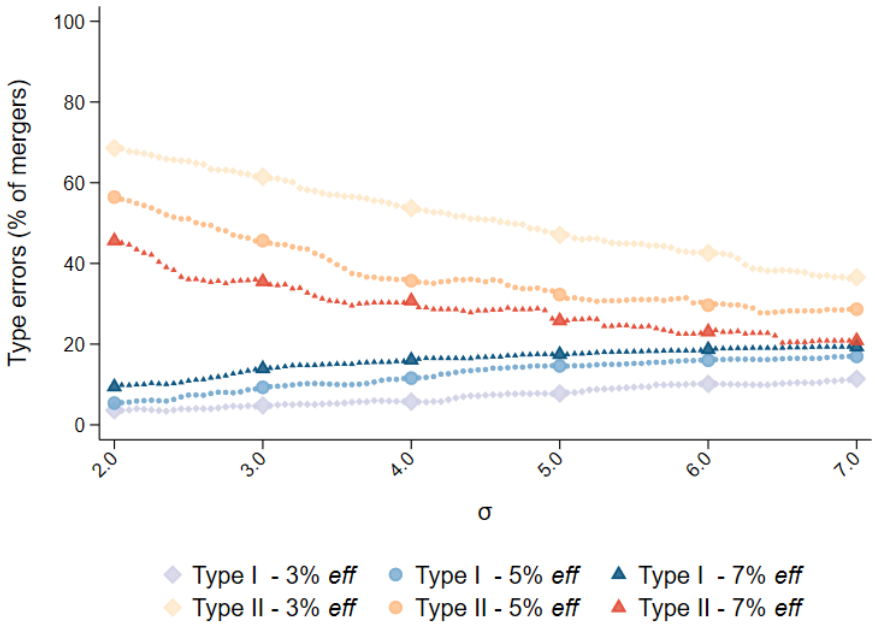
A.6.2. CES model

Table 17: Assessment of EU merger decisions at merger level – differentiated goods with price-setting competition (CES) under the assumption of 0% market share of outside good

	Prediction	
Decision	No intervention	Intervention
No intervention	True negative: 88.42% (649 mergers)	False negative: 35.71% (100 mergers)
Intervention	False positive: 11.58% (85 mergers)	True positive: 64.29% (180 mergers)

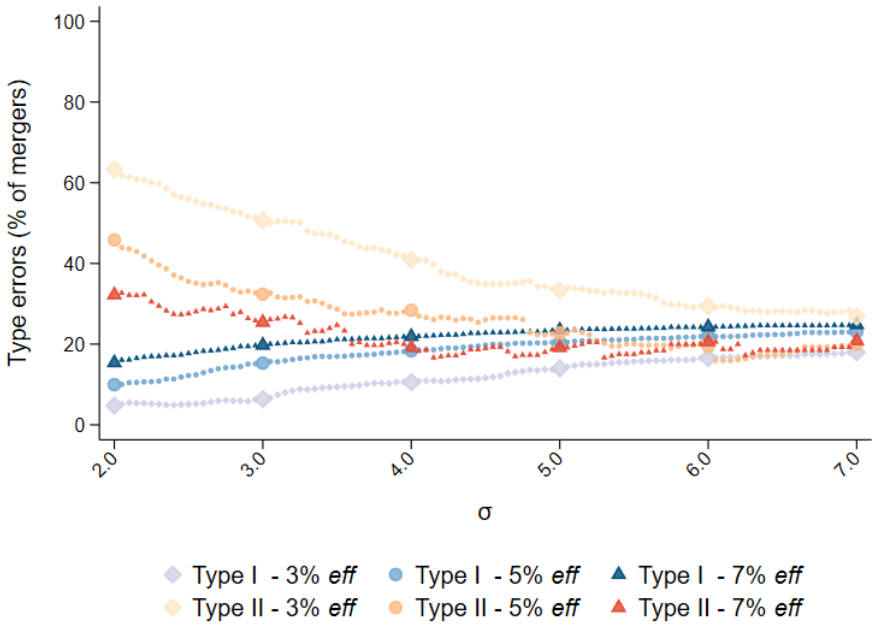
Source: Our elaboration on EU merger data. *Prediction* relies on elasticity of substitution of $\sigma = 4$ and 5% cost efficiencies threshold, where values $< 5\%$ are predicted as *No intervention* and values $\geq 5\%$ are predicted as *Intervention* .

Figure 16: Type errors based on compensating cost efficiencies – differentiated goods with prices setting competition (CES) and assumed 0% market share of outside good



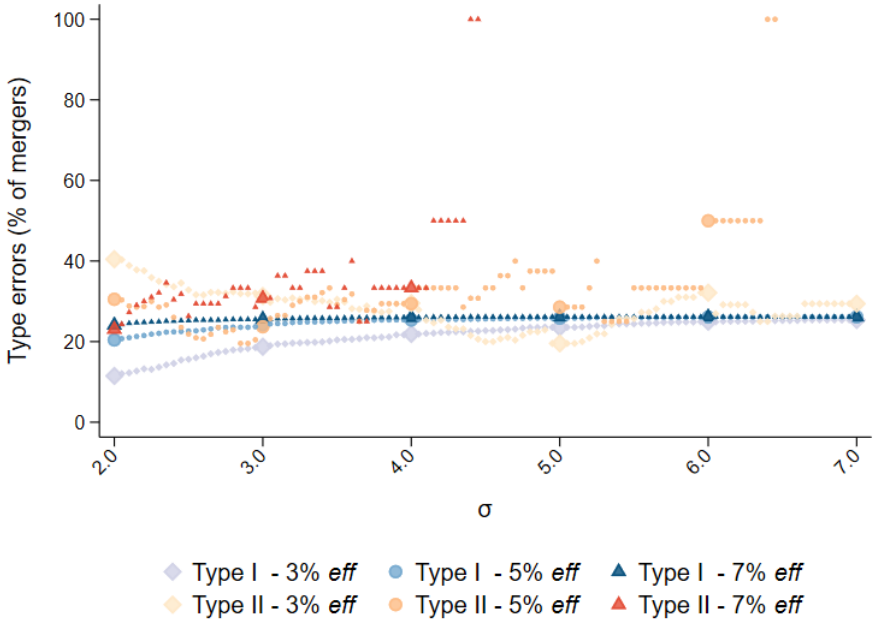
Source: Our elaboration on EU merger data.
Note: σ denotes elasticity of substitution and eff cost efficiencies thresholds.

Figure 17: Type errors based on compensating cost efficiencies – differentiated goods with prices setting competition (CES) and assumed 20% market share of outside good



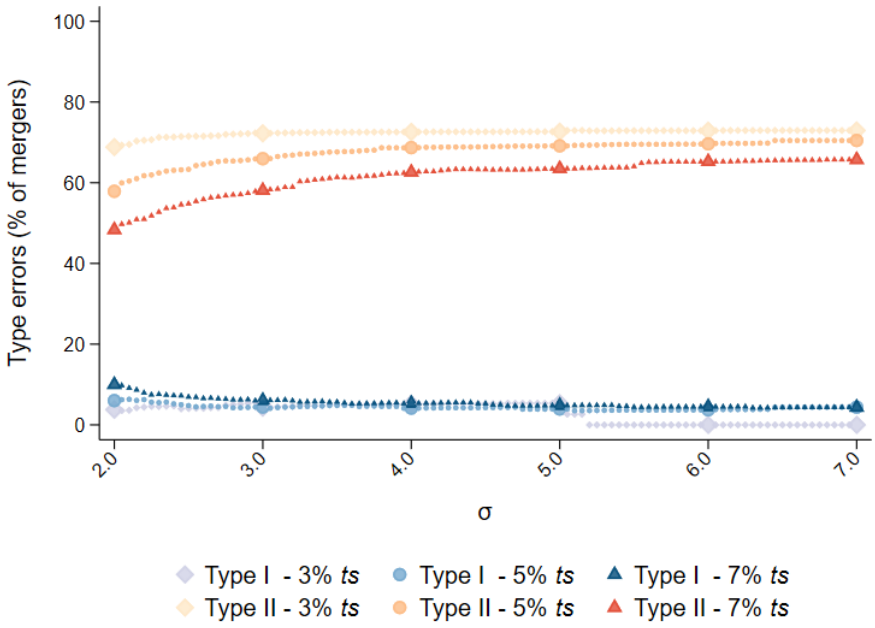
Source: Our elaboration on EU merger data.
Note: σ denotes elasticity of substitution and eff cost efficiencies thresholds.

Figure 18: Type errors based on compensating cost efficiencies – differentiated goods with prices setting competition (CES) and assumed 50% market share of outside good



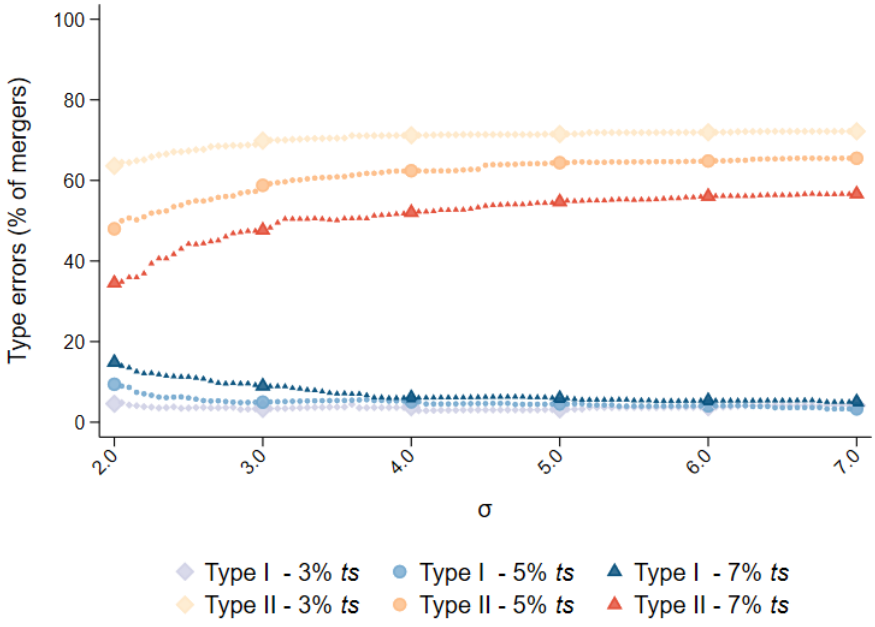
Source: Our elaboration on EU merger data.
Note: σ denotes elasticity of substitution and eff cost efficiencies thresholds.

Figure 19: Type errors based on compensating type efficiencies – differentiated goods with price setting competition (CES) and assumed 0% market share of outside good



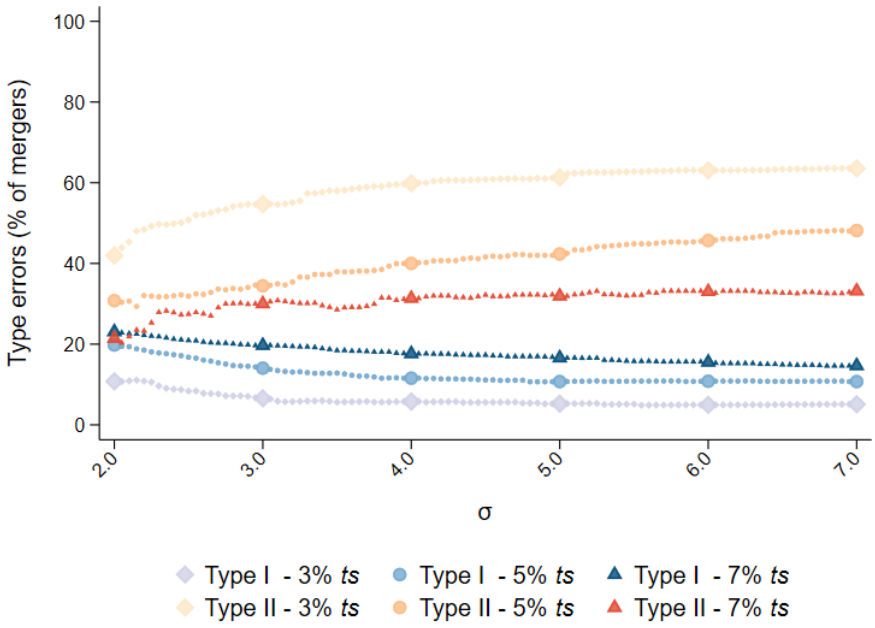
Source: Our elaboration on EU merger data.
Note: σ denotes elasticity of substitution and eff cost efficiencies thresholds.

Figure 20: Type errors based on compensating type efficiencies – differentiated goods with price setting competition (CES) and assumed 20% market share of outside good



Source: Our elaboration on EU merger data.
Note: σ denotes elasticity of substitution and eff cost efficiencies thresholds.

Figure 21: Type errors based on compensating type efficiencies – differentiated goods with price setting competition (CES) and assumed 50% market share of outside good



Source: Our elaboration on EU merger data.
Note: σ denotes elasticity of substitution and eff cost efficiencies thresholds.

A.6.3. MNL model

Table 18: Type errors based on compensating type efficiencies – differentiated goods with price setting competition (MNL), by market share of outside good

Type error	Value (%)
Type I error	
MS of outside good = 0%	4.35
MS of outside good = 20%	3.66
MS of outside good = 50%	7.18
Type II error	
MS of outside good = 0%	71.69
MS of outside good = 20%	68.65
MS of outside good = 50%	53.20

Source: Our elaboration on EU merger data.