European Commission

Modelling the macroeconomic impact of competition policy: 2020 update and further development

Prepared by

European Commission

Competition

EUROPEAN COMMISSION

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Luxembourg: Publications Office of the European Union, 2021

Catalogue number: KD-04-21-012-EN-N
ISBN: 978-92-76-28611-0
DOI: 10.2763/473550

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1. INTRODUCTION

This study conducts a number of model simulations aimed at assessing the macroeconomic impact of competition policy interventions by the European Commission over the period 2012-2019. The study is a collaborative effort of the Commission's Joint Research Centre (JRC), the Directorate General for Competition (DG COMP) and the Directorate General for Economic and Financial Affairs (DG ECFIN). The study's assessment of the impact of competition policy interventions is useful both for competition advocacy and for defending the legitimacy of Commission's competition policy interventions. Advocacy and legitimacy arguments are more effective when supported by strong evidence and sound economic analysis.

Based on information provided by DG COMP on its merger interventions and cartel prohibitions, the JRC has used two models for the macroeconomic simulations: the QUEST III macro-model of the EU economy, which was developed by DG ECFIN for assessing the impact of Commission policies, and an EU-wide input-output model, which allows for an investigation of the sectorial differentiation and spillover effects of competition policy interventions. These two modelling tools are complementary. The QUEST III model allows evaluating the impact of competition policy enforcement on economy-wide measures of performance such as GDP, employment, prices and productivity. The input-output model explores the price effects of competition policy interventions at the industry level, by exploiting information on the sector distribution of such interventions and by tracking the interlinkages between industries.

This year's annual report adopts a new format with a jointly prepared main report followed by a number of technical annexes drafted under the responsibility of different contributing teams. The main report is relatively concise, focusing on the main methods used and results obtained, with technical details and explanations being moved to the annexes. This year's technical annexes focus on issues of particular interest such as: (i) the modelling of the deterrent effects of competition policy; (ii) the measurement of developments over time in mark-up levels; (iii) the integration in the input-output model of the duration of the effects of competition policy interventions; (iv) the impact of mark-up shocks associated with competition policy interventions on labour augmenting productivity; and (v) antitrust interventions (other than cartel prohibitions) by the European Commission over the period 2012-2019. These annexes provide valuable insights on how to improve the quality and relevance of the model simulations going forward.

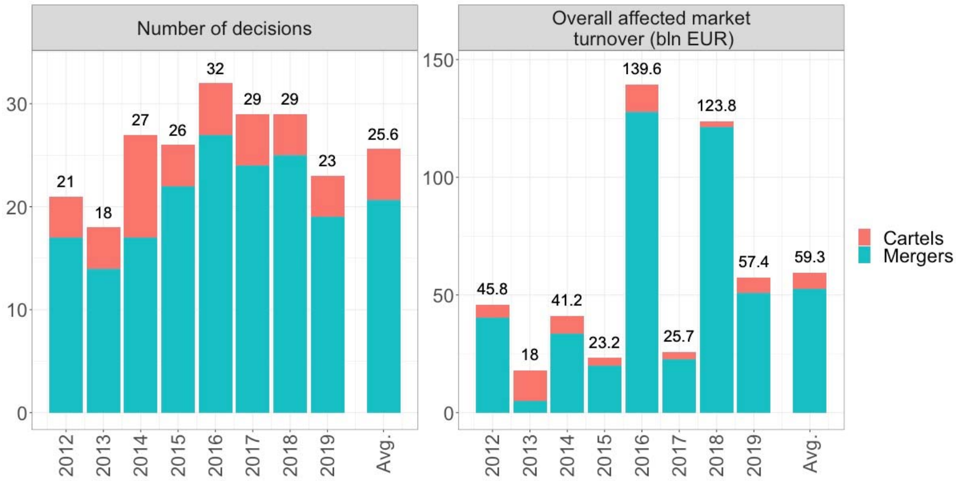
The main report is structured as follows. Section 2 describes the database of European Commission merger interventions and cartel prohibitions, which has been updated to include data for 2019. Section 3 describes the theoretical foundations of the QUEST macro-model and input-output model, which have been used to simulate the impact of the Commission's competition policy interventions. The focus of this section is on the modelling of the direct and deterrent effects of such interventions. Sections 4 and 5 present the results of the macro-model and input-output model simulations, respectively. Section 6 summarises the on-going research aimed at further developing the data analysis and modelling of the impact of competition policy. Section 7 concludes.

2. DESCRIPTIVE ANALYSIS OF 2020 DATASET, INCLUDING 2012-1029 COMPETITION POLICY INTERVENTIONS

This section presents a brief overview of the European Commission's competition policy enforcement activity between 2012 and 2019, the period relevant for our modelling exercise. As in the rest of the main report, only two types of decisions are considered here, namely, cartel prohibitions and merger interventions. Additional information on the merger and cartel dataset on which this analysis is based can be found in Dierx and Ilzkovitz (2020). Antitrust interventions other than cartel prohibitions are presented in Annex A.5. However, they are not yet considered in our macroeconomic model simulations, as the data collection effort is still underway.

Figure 2.1 describes the evolution over time of the number of cartel and merger decisions by the European Commission (left-hand panel) and of the overall turnover in the markets affected by those decisions (right-hand panel). The total sample includes 40 cartel and 165 merger cases. When changing from one year to another, the number of decisions adopted remains relatively stable. The case count ranges from a low of 18 (in 2013) to a high of 32 (in 2016), but in most years it does not depart much from its average value of 26. Cases, however, vary widely in terms of associated market turnover. Thus, the total size of the markets affected by the decisions can change remarkably from one year to another. In 2016 and 2018, for instance, total affected market size is more than twice the average over the whole period (59.3 billion). By contrast, 2013, 2015 and 2017 can be characterised as years with a comparatively low total affected market size. With 23 decisions and an overall affected turnover of about 57 billion euros, 2019 is close to average both in terms of case count and total market size.

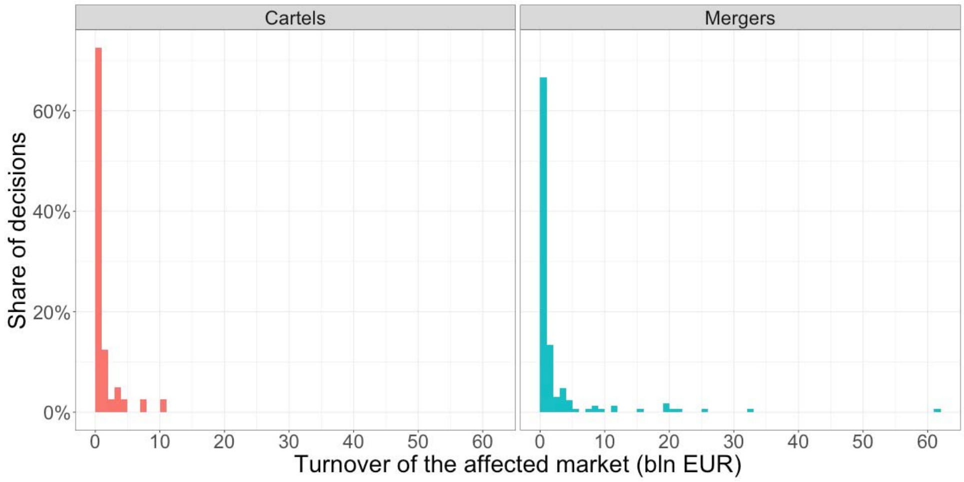
Figure 2.1 European Commission decisions, 2012-2019



Cartel prohibitions account for about one fifth of all decisions made over the relevant period. In an average year, cartels are responsible for roughly 10 percent of the overall affected market turnover. A notable exception to this pattern is the year 2013, when almost three quarters of the total affected market turnover was accounted for by cartels.

As measured by associated turnover, merger cases have a larger mean size (2.6 billion euros) than cartel cases (1.3 billion euros). This results mostly from a handful of large decisions adopted predominantly in the years 2016 and 2018. As can be appreciated from Figure 2.2, such large decisions are relatively uncommon. The overwhelming majority of cases – whether concerning mergers or cartels – target comparatively small markets. The median affected market size is 0.59 billion euro for cartels and 0.51 billion euro for mergers.

Figure 2.2 Cartel and merger cases by market turnover



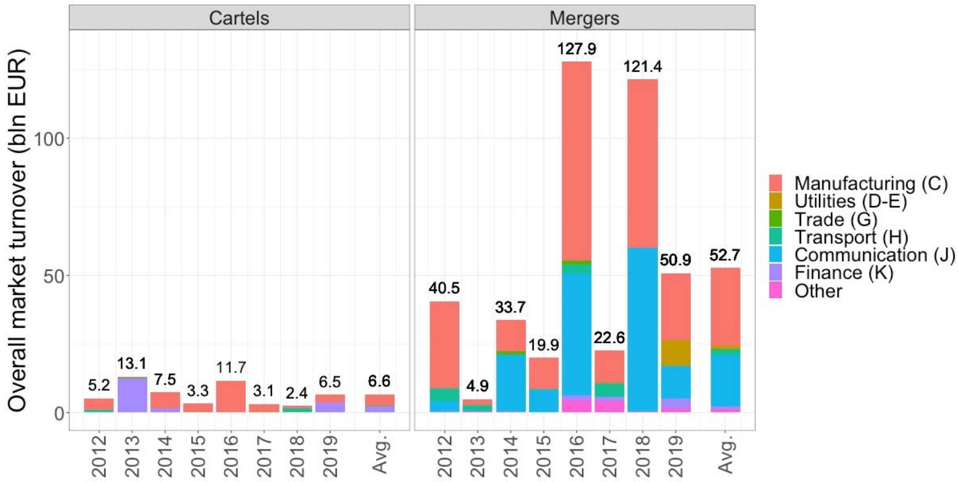
Cartel prohibitions and merger interventions do not appear to differ systematically in terms of the estimated duration of their effects (Table 2.1). There is however, a tendency for more recent decisions to have a longer associated duration than those adopted in earlier years, with the average duration increasing from around 2½ years over the period 2012-2016 to 3½ years over the period 2016-2019. In this context, the term duration refers to the estimated period of time during which the anti-competitive behaviour would have lasted had the European Commission not intervened. It is worth noting that, starting from 2016, DG COMP modified the methodology by which it uses to assess case duration. Consequently, we cannot rule out the possibility that the observed trend towards longer durations is to some extent an artefact of that methodological change.

Table 2.1 Average case duration by type and year

Year		**Cartels**			**Mergers**			**Total**	
		Case count	Average duration		Case count	Average duration		Case count	Average duration
2012		*4*	*2.0*		*17*	*3.3*		*21*	*3.0*
2013		*4*	*2.0*		*14*	*2.4*		*18*	*2.3*
2014		*10*	*2.4*		*17*	*2.5*		*27*	*2.5*
2015		*4*	*3.0*		*22*	*2.5*		*26*	*2.6*
2016		*5*	*4.2*		*27*	*3.9*		*32*	*3.9*
2017		*5*	*3.8*		*24*	*3.2*		*29*	*3.3*
2018		*4*	*4.5*		*25*	*3.4*		*29*	*3.5*
2019		*4*	*3.3*		*19*	*3.4*		*23*	*3.4*
Avg.		*5.0*	*3.1*		*20.6*	*3.1*		*25.6*	*3.1*
Avg. 2012-2015		*5.5*	*2.2*		*17.5*	*2.8*		*23.0*	*2.6*
Avg. 2016-2019		*4.5*	*3.9*		*23.8*	*3.5*		*28.3*	*3.5*

To a significant extent, the markets targeted by the European Commission's decisions are concentrated in the manufacturing sector (Figure 2.3). This applies to both cartel prohibitions and merger interventions. In the case of mergers, however, another large chunk of the overall affected turnover is accounted for by cases in the communication sector. Regarding cartels, on the other hand, a number of important decisions, especially in the year 2013, are found in the financial sector.

Figure 2.3 Cartel and merger cases by sector (NACE Rev. 2 sections)



3. MODELLING OF THE EFFECTS OF CARTEL PROHIBITIONS AND MERGER INTERVENTIONS

3.1. Modelling of direct and deterrent effects of competition policy

The impact of competition policy interventions is modelled by means of a mark-up shock reflecting both the direct effects in affected markets and the deterrent effects in the corresponding subsectors. The direct effects of the avoided price increases due to competition policy interventions correspond to the customer savings from EU competition policy.[1] The assumptions on the size of the avoided price increases (3% for merger interventions and 15% for cartel prohibitions, under the baseline scenario) are based on the economic literature.[2] The duration of these price effects depends on the specific characteristics of the markets affected by the competition policy interventions. While the avoided price increase is based on assumptions derived from the literature, the size of the market directly affected by a decision and the duration of the price effects are based on information provided by the case team involved in the decision.

Nonetheless, the direct effects provide only a partial view of the benefits of competition policy, as its deterrent effects are not taken into account. The idea is that cartels and anticompetitive mergers are less likely in sectors where the competition authorities have recently prohibited a cartel or merger, or imposed merger remedies. We therefore assume that the avoided price increase from a cartel prohibition or merger intervention affects not only the directly affected market(s) but also the NACE four-digit sector to which these markets belongs. As an example, an important airline merger intervention addressing competition concerns covering specific routes only, is supposed to produce deterrent effects in all of the passenger air transport sector,

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1 See Dierx and Ilzkovitz (2019, 2020) for a presentation of the methodology used to calculate the customer savings from the European Commission's merger interventions and cartel prohibitions.

2 The empirical evidence on cartels, for example, suggests a median cartel overcharge of 17%-30% (Connor and Botolova, 2006; Smuda, 2013). For a sample of cartels detected by the European Commission, Combe and Monnier (2011) observe an average cartel overcharge of 34%. Therefore, the 15% assumption used in the baseline model simulations is rather conservative. Similarly, a review of merger decisions in the EU by Ormosi et al. (2015) showed an average price increase of 5% for approved mergers and of less than 2% for the more problematic mergers approved with remedies. This evidence suggests that the remedies required for merger clearance reduce prices by more than 3%.

meaning that other airline companies will be less likely as well to propose mergers having a negative effect on competition in the passenger air transport market.

However, such deterrent effects cannot be measured directly since it is not obvious how to relate the importance of the deterrent effects to the characteristics of the market and sectors affected by the competition policy interventions. The assumption we use is that when the size of the affected market is large relative to the size of the sector concerned, the deterrent effects of a given decision within that sector are likely to be large as well. Of course, if the affected market is relatively small, deterrence will be less important. In addition, we assume that deterrence effects may reach a point of saturation, when the size of the market directly affected approaches the size of the NACE four-digit sector to which the market belongs.

Based on these principles, it is possible to model deterrence as a gradual process of diffusion with the size of deterrent effects depending on the magnitude of the affected market relative to that of the four-digit sector concerned. The deterrence multiplier is an indicator of the size of these deterrent effects. It refers to the ratio of the size of the markets indirectly affected because of deterrence over the size of the markets directly affected by the competition policy intervention. Modelling deterrence as a gradual process of sector diffusion allows us to impose limits on the overall importance of deterrence in line with the business surveys,[3] while at the same time allowing for a non-linear relationship between direct and deterrent effects. In practice, the diffusion of deterrent effects is modelled as a logistic function of the size of the directly affected market relative to the size of the NACE four-digit sector concerned (see section 6.1 for further details). According to this sector-based approach, we calibrate the logistic function used to model the diffusion of the deterrent effects, assuming that the average deterrence multiplier equals to 10 for mergers, and 20 for cartels.

3.2. Application of a mark-up shock to the QUEST macro-model

The information on the avoided price increases associated with the European Commission's competition policy interventions is used to calibrate mark-up shocks, which are then applied to the QUEST III macroeconomic model.[4] More specifically, in QUEST III the aggregate change in mark-up due to merger interventions and cartel prohibitions can be defined as follows:

$$MUP_K = \sum_{i \in \{I_K\}} \left[\frac{\Delta P_i}{P_i} (1 + MUP_i) \right] \frac{GO_{2i}}{GO} \qquad (3.1)$$

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3 Business surveys are carried out to get the views of businesses and legal advisors about the deterrent effects of competition authorities' work across different areas (such as cartel policy enforcement or merger control). The results of these surveys show that between 4 and 8 mergers are deterred per intervention by the competition authorities in a merger case and that between 5 and 28 cartels are deterred for every cartel detected (see Dierx et al., 2020).

4 QUEST III belongs to the class of New-Keynesian Dynamic Stochastic General Equilibrium (DSGE) models widely used by international institutions and central banks. The model relies on rigorous microeconomic foundations derived from utility and profit optimisation and include frictions in goods, labour and financial markets as well as market distortions. With empirically plausible estimation and calibration, the model is able to fit the main features of the macroeconomic time series. In this model, the level of competition among firms is captured by the inverse elasticity of substitution between the goods varieties, which can be directly related to the mark-up. Competition policy acts as an instrument to increase competition amongst companies and thereby contributes to a decrease in the level of mark-ups.

where I_K is the set of NACE two-digit sectors *i* in which competition policy interventions by the European Commission have led to a change in customer prices ($\frac{\Delta P_i}{P_i}$).[5]

Equation (3.1) shows that the aggregate mark-up shock depends on the price shocks in the sectors affected by the European Commission's competition policy interventions, the gross mark-up in the NACE two-digit sectors concerned $(1 + MUP_i)$[6] as well as their share of total gross output within the EU business economy (GO_{2i}/GO).

The price shock in each sector *i*, in turn, is computed as the weighted sum of the price changes caused by competition policy interventions in that sector:

$$\frac{\Delta P_i}{P_i} = \sum_{k \in M_i} \frac{\Delta P_k}{P_k} MS_{ik} + \sum_{k \in C_i} \frac{\Delta P_k}{P_k} MS_{ik} \qquad (3.2)$$

where the sets M_i and C_i are comprised of merger interventions and cartel prohibitions, respectively, affecting markets in sector *i*. In the following simulations, we assume a price change of 3 percent for merger interventions and of 15 percent for cartel prohibitions under the baseline scenario.

The market weights MS_{ik} depend on the size of the markets directly or indirectly affected by the competition policy interventions. A distinction is made between mark-up shocks reflecting only the direct effects of competition policy interventions and shocks including their deterrent effects as well. The weights MS_{ik} used to compute the direct price change at the two-digit sector level, are defined as the share of the affected turnover in the relevant market (mkt_{ik}) over the gross output in the corresponding sector (GO_{2i}):

$$MS_{ik} = \frac{mkt_{ik}}{GO_{2i}} \qquad (3.3)$$

When deterrence is taken into account, the total weights MS_{ik}^T – including both the direct effects and the indirect deterrent effects of competition policy interventions – are defined as follows:

$$MS_{ik}^T = \frac{mkt_{ik}^T}{GO_{2i}} \qquad (3.4)$$

where mkt_{ik}^T is the total market affected by competition policy intervention *k* in sector *i*. The total market affected includes both the markets directly affected by intervention *k* (mkt_{ik}) and the markets affected indirectly through sectoral deterrence (mkt_{ik}^D):

---

5 When firms charge a mark-up over the marginal cost of production, the percentage price change in sector i can be expressed as $\frac{\Delta P_i}{P_i} = \frac{\Delta(1+MUP_i)}{1+MUP_i} + \frac{\Delta(MC_i)}{MC_i}$, where MUP_i is the mark-up. Assuming that $\frac{\Delta(MC_i)}{MC_i} = 0$ and $\Delta(1 + MUP_i) = \Delta MUP_i$, we obtain $\Delta MUP_i = \frac{\Delta P_i}{P_i}(1 + MUP_i)$. Equation (3.1) aggregates the relevant mark-up changes using the corresponding gross output shares in the EU business economy as weights.

6 Mark-ups levels are calibrated according to the method proposed by Thum-Thysen and Canton (2015), which extends Roeger's (1995) mark-up calculation method by including the effects of product market reforms (see Annex A.2).

$$mkt_{ik}^T = mkt_{ik} + mkt_{ik}^D \quad (3.5)$$

The deterrent effects of competition policy interventions consist in discouraging firms from engaging in anticompetitive behaviour, even if they are not directly targeted by such interventions. The importance of such deterrent effects depends on the awareness of companies that anticompetitive behaviour may trigger a reaction of the European Commission similar to what was observed previously. It is reasonable to think that important merger or cartel decisions in a given sector deter other companies active in that same sector.

Finally, we also take into account information about the duration of the price increases avoided because of the European Commission's competition policy interventions. This implies that the mark-up shock in a given year is the sum of the effects of competition policy interventions in that year and of interventions from previous years, which continue to have an effect in the current year. The macroeconomic results of the simulations carried out with the QUEST III model are presented in Section 4.

3.3. Application of a price mark-up shock to an EU-wide input-output model

A central premise of this report is that when the European Commission decides to break up a cartel or block an anticompetitive merger, prices in the relevant market decrease (or are prevented from increasing). The effects of the decision, however, are likely to propagate to other markets, as firms downstream in the supply chain can now source their inputs more cheaply. It is reasonable to expect that, at least to some extent, the resulting cost savings will lead those firms to reduce the price of their own products. To analyse how the effects of competition policy enforcement are transmitted across markets, we use information on economic interdependencies retrieved from the input-output table of the European Union. This section briefly outlines the main features of our approach. The results are presented in Section 5.

The input-output table on which the analysis is based categorises production units into 64 branches of economic activities ('industries' for short), which are defined based on the NACE Rev. 2 statistical classification. In any given industry, competition policy interventions lead to a certain 'total' price reduction. The total price reduction – which can conceivably be zero – consists of two components: (a) a 'within-industry' effect; and (b) a 'spillover' effect.

The within-industry effect reflects the immediate repercussions of cartel prohibitions and merger interventions on the markets they affect. In a manner entirely consistent with the analysis conducted with the QUEST macro-model of section 3.2, the within-industry effect in industry i is computed according to equation (3.2). It is worth noting, however, that in this case the relative price drop computed through equation (3.2) represents only one component of the overall price change in industry i (the other one being the spillover effect). For this reason, we will not denote it by $\Delta P_i/P_i$. Instead, it will be referred to as WITHIN_i. As before, deterrent effects are incorporated in the analysis as described in equations (3.4) and (3.5).

The spillover effect, on the other hand, captures the ripple effects caused by the European Commission's competition policy interventions as the price drops they generate in the specific markets they target are transmitted downstream along the supply chain. Spillovers are computed from the within-industry effects on the basis of a standard input-output price model. In this sense, the within-industry effects represent the exogenous shock in the analysis. The model assumes that each industry produces its own distinctive output using Leontief technology. In other words, each product is produced according to a fixed recipe that spells out the input requirements in terms of all the other products. Information about those recipes can be inferred from an input-output table. When an input becomes cheaper, producers will entirely pass on the ensuing cost savings to their customers in the form of lower output prices. In turn, those customers will also reduce the price of their products. The percent reduction in the price of industry i's output due to spillover effects will be denoted $\mathrm{SPILLOVER}_i$. Then the overall price reduction in industry i (including the deterrent effects) is given by $\mathrm{TOTAL}_i = \mathrm{WITHIN}_i + \mathrm{SPILLOVER}_i$.

With regard to the time dimension, our analysis of competition policy enforcement is conducted on a year-by-year basis. In each year for which data are available (i.e., from 2012 to 2019), the exogenous within-industry price effects are calculated taking into account the cartel and merger cases that are relevant in that year and then fed to the input-output model to obtain the corresponding spillovers. In addition to the annual results, average impacts over the entire period under analysis are also computed.

A related issue concerns the handling of duration in the analysis. Duration refers to the fact that, according to the European Commission's calculations, the price reducing effects of cartel prohibitions and merger interventions typically last for more than one year. In this respect, we produce two independent sets of results. One ('with duration') – in the spirit of the QUEST simulations – does take into consideration the fact that decisions by the European Commission can produce their effects over several years. Thus, the merger and cartel cases accounted for in the computation of, say, the 2018 within-industry effect include not only those cases for which a decision was reached in 2018 itself, but also those from earlier years that are deemed to be still producing their effects in 2018. By contrast, our second set of results ('without duration') completely disregards all information about case duration: decisions are only relevant in the year in which the decision is adopted.

While our input-output analysis aims primarily at constructing industry-level price impact estimates, aggregating those results into a single economy-wide figure provides a useful summary measure of the impact of competition policy interventions. To this end, the industry-specific results are averaged using weights that reflect industry size. Specifically, each industry i contributes to the average in proportion to its gross output GO_{2i}. Thus, economy-wide within-industry, spillover and overall price changes, respectively, can be defined as:

$$\mathrm{WITHIN} = \sum_{i=1}^{n} (GO_{2i}/GO)\,\mathrm{WITHIN}_i$$

$$\mathrm{SPILLOVER} = \sum_{i=1}^{n} (GO_{2i}/GO)\,\mathrm{SPILLOVER}_i$$

$$\mathrm{TOTAL} = \sum_{i=1}^{n} (GO_{2i}/GO)\,\mathrm{TOTAL}_i = \mathrm{WITHIN} + \mathrm{SPILLOVER}$$

where $GO = \sum_{i=1}^{n} GO_{2i}$ and the summation index i runs over all the n industries that comprise the economy. Finally, we assess the significance of spillover effects relative to within-industry and total effects in terms of the ratios $\mathrm{SPILLOVER}/\mathrm{WITHIN}$ and $\mathrm{SPILLOVER}/\mathrm{TOTAL}$.

4. RESULTS OF THE MACRO-MODELLING ANALYSIS

In this section, we report the main results of the simulation analysis performed to assess the macroeconomic impact of European Commission competition policies implemented over years 2012-2019.

The logic of the simulations is as follows: we convert merger interventions and cartel prohibitions into a mark-up shock, which is the difference between the observed mark-up affected by competition policy interventions, and the counterfactual mark-up computed in a macroeconomic scenario without competition policy interventions.

For each merger intervention and cartel prohibition, DG Competition computes the annual value of sales in the affected market(s) in millions of euros at current prices. By exploiting assumptions on the avoided price increase, its duration and the importance of deterrent effects, we convert these values into sectoral mark-up shocks. Subsequently, we aggregate these shocks into a single economy-wide mark-up shock, which is the input used for simulating the macroeconomic impact of competition policies with the QUEST macro-model that has been calibrated for the European Union.

In the following, we present the simulation results obtained by applying a permanent shock to the QUEST III model (see Box 1).

Box 1. THE COMPUTATION OF THE PERMANENT MARK-UP SHOCK

We denote by $MUP_{AAAA(XY)}$ the mark-up shock associated with mergers and cartels decisions of year $AAAA$ lasting at least X years, and we denote by $MUP_{AAAA(ALL)}$ the mark-up shock associated with all cases in a given year $AAAA$. In year 201*x*, the computed mark-up shock is the sum of the contributions from decisions taken in the current year and from decisions taken in previous years having a duration of sufficient length to have an impact on the current year:

$$\mathrm{MUP}_{201\mathrm{x(ALL)}} + \mathrm{MUP}_{201\mathrm{(x-1)(2Y)}} + \mathrm{MUP}_{201\mathrm{(x-2)(3Y)}} + \mathrm{MUP}_{201\mathrm{(x-3)(4Y)}} + \cdots$$

In order to compute the macroeconomic impact of competition policy interventions, we need to specify the dynamics of the mark-up shock not only in the present but also in the future. Thus, we need to make some conjecture about the future dynamics of the aforementioned shocks for years when data on decisions are not yet available, that is from 2020 onwards. Our approach consists in estimating the missing data relying on average values of the decisions taken in past years with the same duration. For instance, for estimating the impact of competition policy interventions of 2020, we compute the average contribution of MUP shock over years 2012-2019:

$$MUP_{2020(ALL)} = (MUP_{2012(ALL)} + MUP_{2013(ALL)} + MUP_{2014(ALL)} + MUP_{2015(ALL)} + MUP_{2016(ALL)} + MUP_{2017(ALL)} + MUP_{2018(ALL)} + MUP_{2019(ALL)})/8$$

On the contrary, for estimating the component of the mark-up shock of 2020 arising from decisions taken in previous years, we use real data on decisions taken in 2019 and before. When making this computation for the year 2021, we have to estimate not only the impact of current-year decisions, but also the impact of decisions taken in 2020 with a duration longer than one year. As we move in the future, the computed shock will rely more on estimated values and less on the impact of actual previous decisions. When we compute the mark-up shock for year 2025, we do not have effective data on decisions, as the maximum duration is 6 years, and therefore the computation of the mark-up shock will rely entirely on historical averages. From this year onwards, the computation of the mark-up shock does not change, and this identifies the permanent (invariant) mark-up shock, which is used to build the macroeconomic simulation scenarios.

This means that we compute a time-invariant, permanent mark-up shock generated by the European Commission's competition policy interventions, and we use this shock to simulate the macroeconomic impact through QUEST. The permanence of the mark-up shock reflects companies' expectations that in the foreseeable future the European Commission will continue to enforce EU competition policy rules at the same average pace as the one observed over the period 2012-2019.

We build five different scenarios, where we make different assumptions regarding the avoided price increase and the average multiplier employed to compute deterrent effects. This sensitivity analysis serves to understand better the impact of some key assumptions on the macroeconomic outcomes. In Table 4.1, we report all the assumptions underlying each of the five selected scenarios as well as the resulting permanent mark-up shock (expressed in percentage points and in percentage change). In the baseline scenario, we assume an avoided price increase of 3% for merger interventions and of 15% for cartel prohibitions, respectively. Furthermore, as we explained above, we assume that the average deterrence multiplier equals to 10 for mergers, and 20 for cartels.

Table 4.1 - Selected list of scenarios: logistic approach to deterrence

		Baseline	*Lower Bound Overcharge*	*Upper Bound Overcharge*	*Lower Bound Deterrence*	*Upper Bound Deterrence*
Avoided price increase (%)	*Mergers*	*0.03*	*0.01*	*0.05*	*0.03*	*0.03*
	Cartels	*0.15*	*0.10*	*0.20*	*0.15*	*0.15*
Average multiplier	*Mergers*	*10*	*10*	*10*	*5*	*15*
	Cartels	*20*	*20*	*20*	*10*	*30*
Mark-up shock	*Percent points*	*-0.571*	*-0.306*	*-0.836*	*-0.381*	*-0.715*
	Percent change	*-3.68%*	*-1.97%*	*-5.39%*	*-2.46%*	*-4.61%*

The remaining four scenarios aim to identify the sensitivity of the macroeconomic impact of the European Commission's competition policy interventions to different assumptions regarding the avoided price increase and the average multipliers capturing the extent of deterrence. In synthesis, the first two alternative scenarios analyse the impact of a change in the assumption regarding the avoided price increase (or overcharge), while the remaining two scenarios analyse the impact of different assumptions on the average deterrence multiplier.

Under the baseline scenario, the level of the mark-up decreases in absolute terms by 0.571 percentage points corresponding to a decrease in mark-up by 3.68%. When comparing the six scenarios, we observe that the biggest reduction in mark-up is the one computed in the Upper Bound Overcharge case (-0.836 p.p.), while the smallest decrease in mark-up is associated with the Lower Bound Overcharge (-0.306 p.p.).

In Table 4.2, we report the results of the macroeconomic impact of competition policy enforcement under the baseline scenario.[7] We observe that the reduction of mark-up implied by the European Commission's competition policy interventions triggers an increase of real GDP equal to 0.27% after five years. The increased competition brings about a reduction in inflation as measured by the GDP deflator. This reduction in inflation becomes significant after 5 years (-0.15%). All the main components of aggregate demand increase. More specifically, after 5 years we simulate substantial increases in consumption (0.25%) and investment (0.52%) in spite of the decline in profits associated with the negative mark-up shock. These simulation exercises have been developed under the assumption that the economy is hit by the mark-up shock while being in the steady-state. Therefore, these simulations do not take into account possible nonlinear responses of the economy generated by the current deep recessionary state of the economy induced by the ongoing pandemic. However, from a medium-term perspective, competition policy is expected to play an important role in allowing the necessary economic adjustment to take place (see OECD, 2020).

[7] These medium term model simulations are not affected by COVID-19 pandemic.

Table 4.2 - Macroeconomic impact of permanent mark-up shock in the baseline scenario

	1	*5*	*10*	*50*
GDP	***0.158***	***0.274***	***0.367***	***0.529***
GDP deflator	*-0.114*	*-0.152*	*-0.209*	*-0.345*
Employment	*0.125*	*0.197*	*0,237*	*0.239*
Labour productivity	*0.033*	*0.078*	*0.129*	*0.290*
Consumption	*0.172*	*0.253*	*0.343*	*0.493*
Investment	*0.248*	*0.516*	*0.635*	*0.838*
Profits	*-4.044*	*-5.459*	*-5.151*	*-4.470*

*Numbers represent percentage deviation from the equilibrium un-shocked values. Columns report the impact after 1,5,10, and 50 years

In Table 4.3, we present the results of the macroeconomic impact of competition policy enforcement under the alternative scenarios defined in Table 4.1. For the sake of synthesis, we report the impact of a permanent shock on real GDP only. We observe that the assumptions on the key parameters "avoided price increase" and "average multiplier" are indeed influential in driving the simulation outcomes. In this setting, the baseline becomes a central scenario.

Table 4.3 - Impact on real GDP in percentage points in selected scenarios

After n years	*Baseline*	*Lower Bound Overcharge*	*Upper Bound Overcharge*	*Lower Bound Deterrence*	*Upper Bound Deterrence*
1	***0.158***	*0.085*	*0.233*	*0.106*	*0.199*
5	***0.274***	*0.147*	*0.402*	*0.183*	*0.344*
10	***0.367***	*0.196*	*0.537*	*0.245*	*0.460*
50	***0.529***	*0.284*	*0.774*	*0.353*	*0.662*

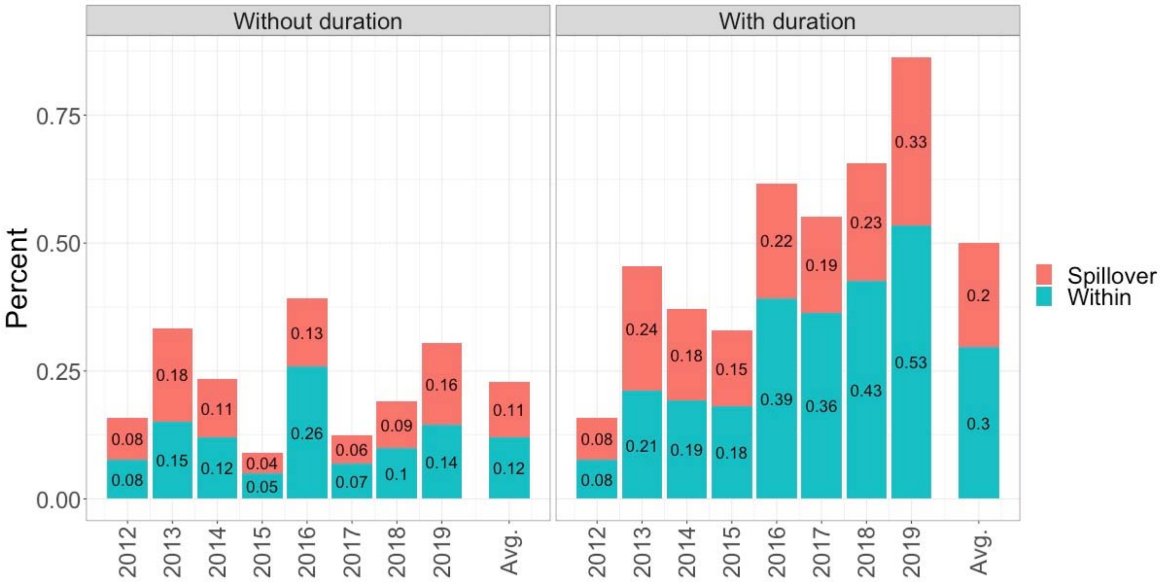
A comparison of the selected scenarios shows a relatively small impact on real growth after five years under the Lower Bound Overcharge scenario (0.147%), while the impact under the Upper Bound Overcharge scenario is relatively large (0.402%). The choice of a different value for average deterrence also entails a significant impact on the GDP response. After five years, in the Lower Bound Deterrence scenario, the impact on real GDP is estimated at 0.183%, while in the Upper Bound Deterrence scenario, the impact on real GDP rises to 0.344%. In the long-run, that is after 50 years since the starting point of our simulations, the cumulated impact on GDP increases: the rise in real GDP across the different scenarios ranges between a minimum of 0.284% and a maximum value of 0.774%.

5. RESULTS OF THE INPUT-OUTPUT MODELLING ANALYSIS

As discussed in Section 3.2, one strand of our analysis uses an input-output framework to explore the impact of competition policy enforcement on prices in the European economy. The main findings are presented below. In each case, we report two separate sets of results: one takes case duration into account and another does not. In all cases, the deterrent effects are accounted for. All price changes, although displayed in absolute value, are to be understood as price reductions. Figure 5.1 gives an overview of the repercussions of cartel prohibitions and merger interventions on the overall price level of the European Union.

First, consider the results without duration in the left-hand panel. In an average year, competition policy enforcement is found to lower prices by about 0.23%. Approximately half of that effect (*TOTAL*) can be attributed to the within-sector impact of the European Commission's competition policy interventions (*WITHIN*), with the remaining part resulting from propagation of this impact between sectors (*SPILLOVER*). Over time, the results display substantial variation from one year to another. The pattern of the fluctuations over time reflects quite closely the dynamics of enforcement activity on the part of the European Commission (e.g., figure 2.1). For instance, the year 2016, which witnessed a comparatively large number of sizable decisions (concerning the AB InBev acquisition of SABMiller, the Hutchison H3G WIND joint venture and Hutchison 3G UK acquisition of Telefónica UK, for example, as well as the trucks cartel), exhibits a total price reduction of 0.39%. By contrast, the corresponding figure for 2015 is a mere 0.09%. It is indeed clear from equation (3.4) that, everything else being the same, a greater affected market turnover means greater within-industry effects. In turn, larger within-industry effects give rise to larger spillovers. In addition to the size of the affected markets, the type of decisions made in a certain year also matters, as cartel prohibitions produce more pronounced price reductions than merger interventions. Thus, the year 2013, in spite of being fairly unremarkable in terms of overall affected market size, is among those in which the largest total price reductions are observed. This is because several competition policy interventions in that year concerned cartel cases in the financial services sector (e.g., the euro interest rate derivatives and the yen interest rate derivatives cases).

Figure 5.1 Impact of competition policy enforcement on the overall price level



As is apparent from the right-hand panel of Figure 5.1, taking duration into account greatly increases all of our calculated price impacts: in an average year, the total price reduction associated with competition policy enforcement is equal to 0.50%, more than doubling the results without duration. The reason is straightforward: with duration, a greater number of cases contribute to the exogenous shock in any given year. Without duration, the *WITHIN* effect for, say, 2017 only embodies the decisions made in 2017 itself. With duration, the 2017 *WITHIN* effect also incorporates the 2016 cases with an avoided price increase that lasts two or more years, the 2015 cases with duration of three or more years, etc. In addition to raising all estimated price impacts, this carryover of cases from one year to the next tends to smooth the dynamics over time.

With duration, the impact of competition policy on the EU price level appears to increase over time. To a significant extent, this is an artefact of the lack of pre-2012 data. Because it is not possible to account for any carry-over effects from interventions made in 2011 or earlier, we are not actually able to properly account for duration in the early part of our period of interest. In part, however, the observed increase in price impacts over time could have been driven by a certain tendency for more recent cases to have longer duration than older ones.

Depending on the year, spillover effects (Table 5.1) represent from about one third to little more than half of the total price impact. The *SPILLOVER*/*TOTAL* ratio (and correspondingly the *SPILLOVER*/*WITHIN* ratio) is primarily a function of the distribution of the cartel and merger cases across industries. In the mechanics of the input-output price model, industries with many important downstream links (i.e. those that sit higher up in supply chains) produce stronger spillover effects than industries with few downstream connections (i.e. those that sell a large share of their output to final users). Activities with large spillovers include finance, insurance and business services, resource extraction, the energy sector, basic manufacturing, and certain components of the transport network. Thus, the *SPILLOVER*/*TOTAL* ratio tends to be higher (lower) in those years in which the European Commission's competition policy interventions are concentrated in high- (low-) spillover industries. This is easier to see from the results without duration. Consider, for example, the year 2016. In terms of overall enforcement effort put forth by the European Commission (as measured by overall market turnover affected by its interventions), this is the biggest year on record (Figure 2.1), which indeed translates into a comparatively large reduction in the price level (Figure 5.1). Nevertheless, the spillover ratios for 2016 are the lowest of the entire period. This is because the main competition policy interventions of 2016 concerned anticompetitive behaviour in relatively downstream markets (e.g., motor vehicles). By contrast, the decisions made in 2013 predominantly targeted industries – such as finance – with strong downstream connections, explaining why the spillover ratios for that year are comparatively large. In 2019, spillover ratios are also fairly large, due to important cartel decisions in the financial services sector.

Table 5.1 Relative significance of price spillovers

	SPILLOVER/*WITHIN*		*SPILLOVER*/*TOTAL*	
	Without duration	With duration	Without duration	With duration
2012	*1.05*	*1.05*	*0.51*	*0.51*
2013	*1.21*	*1.15*	*0.55*	*0.54*
2014	*0.93*	*0.92*	*0.48*	*0.48*
2015	*0.84*	*0.82*	*0.46*	*0.45*
2016	*0.52*	*0.57*	*0.34*	*0.36*
2017	*0.80*	*0.52*	*0.44*	*0.34*
2018	*0.93*	*0.54*	*0.48*	*0.35*
2019	*1.11*	*0.61*	*0.53*	*0.38*
Avg.	*0.92*	*0.77*	*0.47*	*0.43*

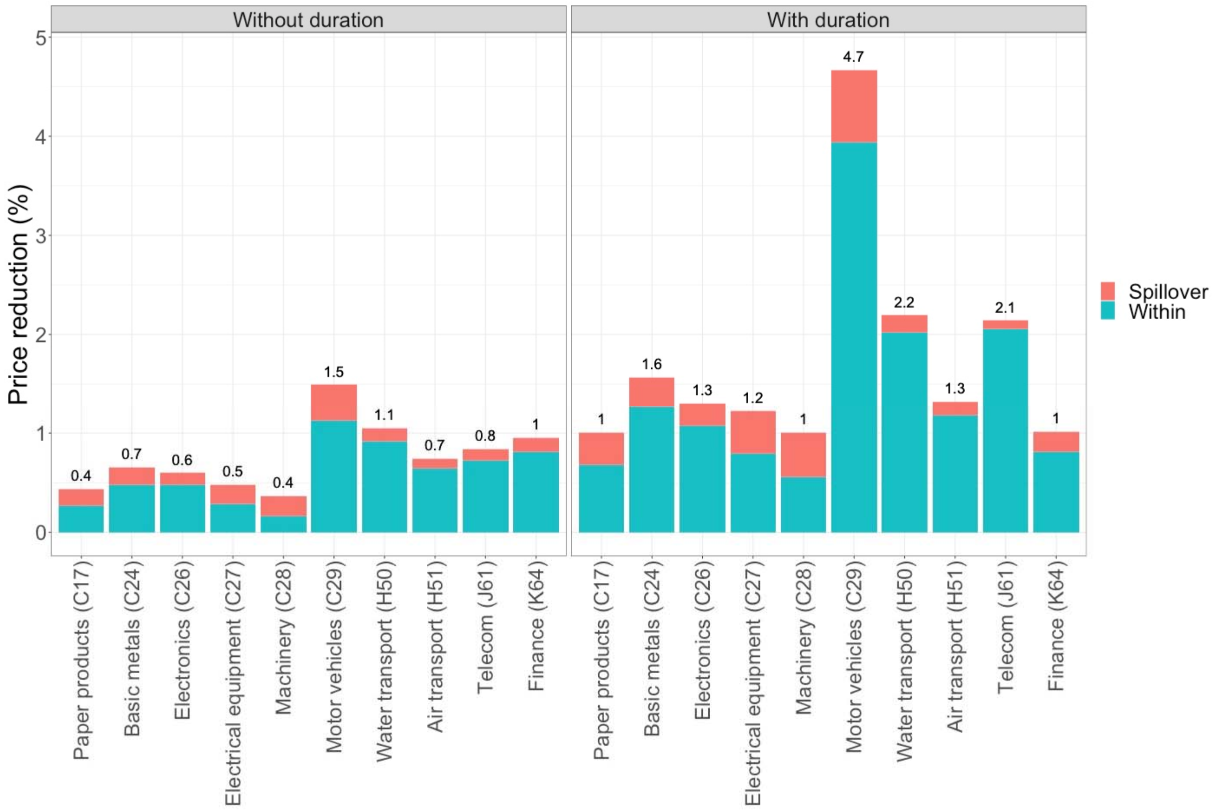
Factoring in duration dampens the dynamics of the spillover ratios over time, as years with high- and low-spillover decisions blend together. It is also worth noting that, because of the large volume of low-spillover, long-duration cases in 2016 (e.g. the TRUCKS cartel), spillover ratios tend to remain relatively low in subsequent years.

Figure 5.2 displays the results at the industry level and reports the grand averages over the entire period covered by the analysis. The bars represent the percent price change in the industries where the most significant impacts are observed, with a breakdown between within-industry and spillover effects. Analogous results for 2019, the most recent year for which data are available, can be found in annex A.3 (Table A.3.1).

It is clear that the largest price reductions are found in those industries in which the European Commission made its most significant decisions. In fact, the total effect in these industries is always dominated by the within-industry effect. When case duration is ignored, the greatest effects are observed in motor vehicles (1.5%), water transport (1.1%), finance (1%), telecoms (0.8%), basic metals (0.7%) and air transport (0.7%). In general, these results are driven by cases that are large in an absolute sense: they affect large markets. This applies for example to several merger cases brought in the telecom industry between 2016 and 2018 (including Hutchison's acquisition of sole control over Wind Tre, the Hutchison H3G WIND joint venture and the Hutchison 3G UK acquisition of Telefónica UK) or in the basic metal industry (the Glencore takeover of Xstrata in 2012 and the Tata Steel/ThyssenKrupp merger in 2019). In some instances, however, sizable industry-specific price reductions are the result of cases that are large not in absolute terms, but relative to the industry in which they take place. This is the case, for example, of the Maritime Car Carriers (MCC) cartel of 2018 or the CMA CGM/NOL merger of 2016 in the water transport industry.

In qualitative terms, the main conclusions remain relatively unaffected whether or not duration is taken into account. In quantitative terms, as one would expect, accounting for duration leads to larger calculated price impacts, particularly in the motor vehicles (4.7%), water transport (2.2%) and telecoms services (2.1%).

Figure 5.2 Industry-level price changes, 2012-2019 average, selected industries



6. FURTHER DEVELOPMENTS IN DATA ANALYSIS AND MODELLING

This section discusses further developments in data analysis and modelling. Section 6.1 focuses on the use of the logistic function to model the within-sector diffusion of deterrent effects of competition policy interventions, while Section 6.2 highlights the main novelties in this year's input-output analysis. Section 6.3 describes the on-going collection of data on antitrust interventions other than cartels. Finally, Section 6.4 discusses the possible application of a TFP shock to the QUEST macro-model, in addition to the mark-up shock currently being applied.

6.1 The logistic approach to deterrence

Our analytical framework posits that European Commission decisions in cartel and merger cases exert their effects beyond the firms and markets directly targeted. This is because they deter anticompetitive behaviour in neighbouring markets. The deterrent effects of competition policy consist in discouraging companies from engaging in anticompetitive behaviour, even though they might not have been directly affected by a competition policy intervention. The size of such effects is influenced by the awareness that an anticompetitive activity would trigger a reaction of the European Commission similar to what was already signalled by its earlier competition policy enforcement actions.[8] It is reasonable to think that important merger or cartel decisions have deterrent effects on companies active in the sector concerned. Therefore, we assume that each competition policy intervention by the European Commission changes company behaviour not only in the directly affected market(s), but also in the remainder of the sector (defined at the NACE four-digit level) concerned.

We model deterrence as a gradual process, where the diffusion of deterrent effects at the sector level depends on the size of the affected market relative to the size of the corresponding four-digit sector. Modelling deterrence as a process of sector diffusion allows imposing limits on the overall importance of deterrent effects in line with information from business surveys (see footnote 3 in section 3.1), while at the same time allowing for a non-linear relationship between direct and deterrent effects at the sector level. Indeed, many mathematical models used to describe diffusion processes, exhibit the S-shaped pattern: at the beginning diffusion proceeds at slow pace; after some time it accelerates; and in the last phase, it slows down due to saturation. Similarly, we assume that two opposite forces are at work in shaping the diffusion of the deterrent effects. First, the marginal increase in the deterrent effects is positively linked to the level of deterrence already achieved.[9] The reason is that larger interventions receive more attention due to their higher fines and market impact. Second, the marginal increase in the deterrent effects declines when the market size approaches the size of the NACE four-digit sector potentially deterred, i.e. when deterrence reaches its saturation level. The logistic link between direct and deterrent effects stems from these two mechanisms.

The logistic function was originally introduced to model population growth (Verhulst, 1838), and it has been employed in many scientific fields such as biology, physics, probability, statistics and economics. Indeed, in many applications the sigmoidal shape provides a good description of the phenomenon under study. In economics, the logistic function is employed, for example, to model the diffusion of innovations (Griliches, 1957, Metcalfe, 2004). Indeed, it has been widely recognized by the literature that the temporal dynamics of technology adoption follows a logistic path (Baptista, 1999, Comin and Mestieri, 2013). Another field of application of the logistic curve is the spread of information. For example, Dodd and McCurtain (1965) show that diffusion of information follows the prediction of the logistic model if there are no barriers to the diffusion process itself. More recently, Wang et al. (2012) model the diffusion of information across online social networks through a logistic function. The applications mentioned so far have employed the sigmoidal function to model the diffusion of a phenomenon over time. We present here a novel application of the function, which proposes modelling the diffusion of deterrence effects within the sectoral 'space'.

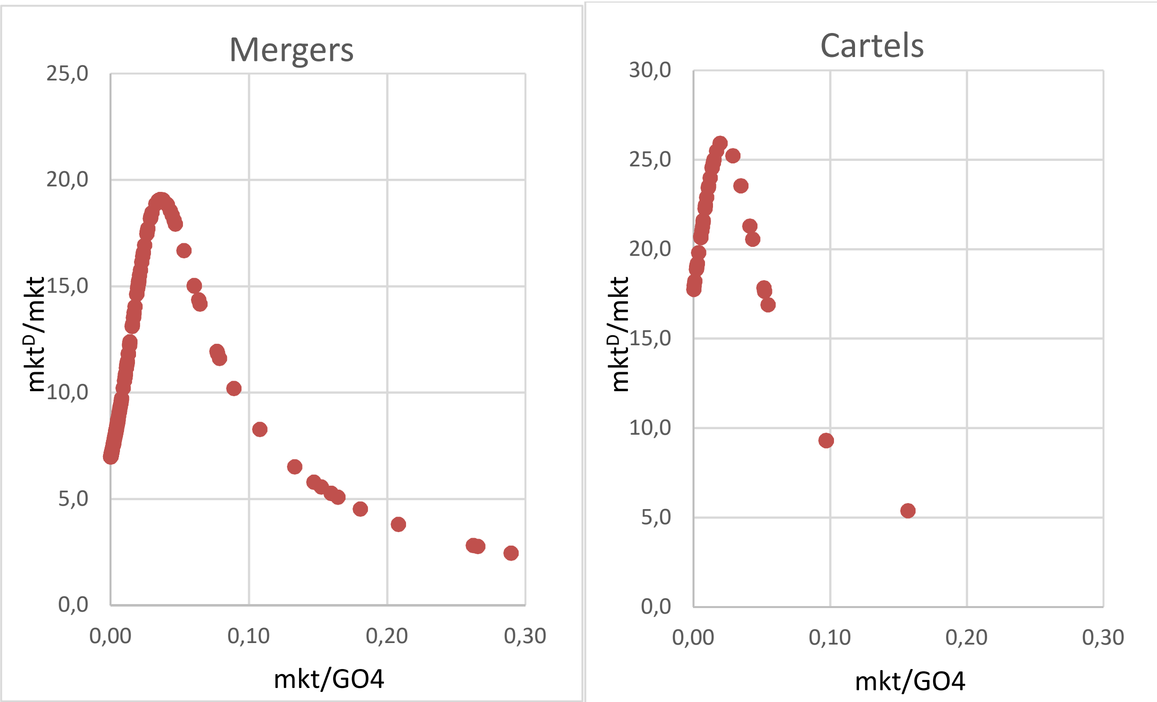
Figure 6.1 illustrates the empirical distribution of the deterrence multipliers under the baseline scenario. In this scenario, the parameters of the logistic functions are calibrated in such a way that the average merger multiplier equals 10 and average cartel multiplier equals 20. Note that for most cases, the ratio of the size of the affected market over the size of the corresponding four-digit sector (on the x-axis) remains below 5%. From Figure 6.1 we observe a hump shaped pattern of the deterrence multipliers (on the y-axis), which results from the two opposite forces shaping the diffusion of the deterrent effects. For decisions with a relatively low market over sector ratio, the multiplier increases rapidly (as the marginal increase in deterrence is positively linked to the level of deterrence already achieved), until a maximum value of around 18 and 25 is reached for mergers and cartels, respectively. As the market over sector increases

[8] More broadly, deterrent effects depend on: (i) the perceived probability of detection of the anticompetitive behaviour; (ii) the expected punishment after detection; and (iii) the reputation of the competition authority (see Dierx et al. (2020)).

[9] The assumption that the growth of the process is positively linked to its starting point is standard in a variety of mathematical models describing the temporal, spatial or situational path of diffusion processes.

further, potential deterrence decreases (as the market size approaches the size of the NACE four-digit sector potentially deterred), which forces a progressive reduction in the deterrence multipliers.

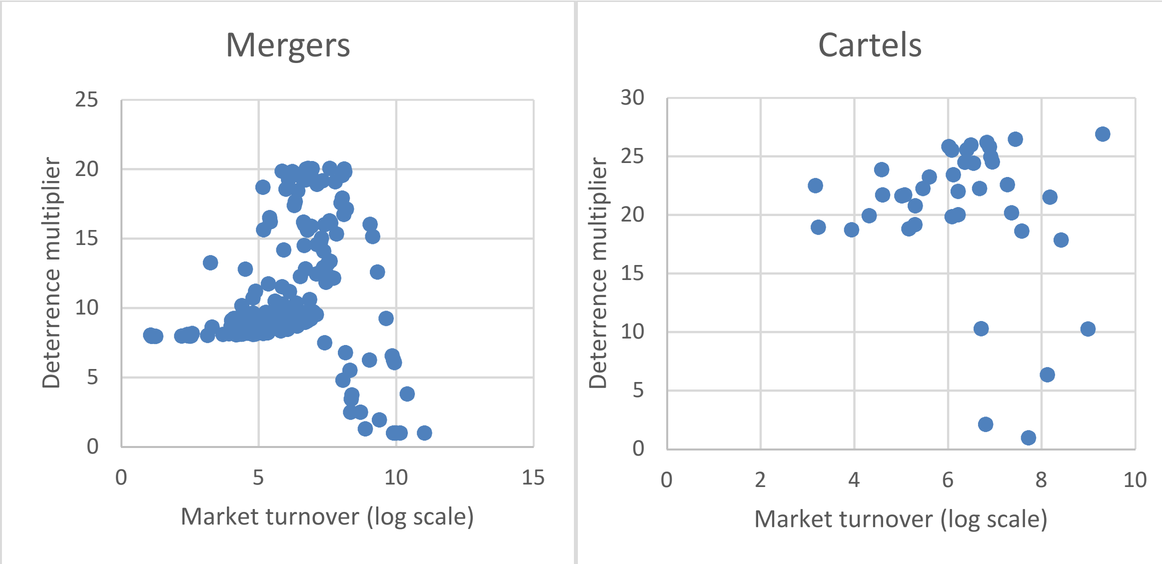
Figure 6.1 - Deterrence multiplier



The deterrent effects resulting from this calibration of the logistic function can be appreciated from Figure 6.2, which plots the deterrence multiplier against the size of the market(s) affected by each individual merger intervention and cartel prohibition over the period 2012-2019. In general, deterrent multipliers are the largest for competition policy interventions affecting markets of a medium size. By contrast, very large and very small cases tend to have smaller associated deterrent multipliers. This can be explained intuitively by the fact that small cases do not attract a lot of attention.[10] For larger cases, on the other hand, the size of the affected market accounts for a large share of the four-digit sector to which it belongs, which leaves less room for further deterrence within that same sector.

10 Exceptionally though, small cases can have a large deterrent effect if they serve as a precedent indicating that the competition authority intends to pursue similar cases in the future.

Figure 6.2 Deterrent effects associated with cartel and merger cases



6.2 Input-output model

In our analytical framework, competition policy enforcement reduces prices (or prevents them from increasing) in the markets and sectors targeted. However, these price reductions have a limited duration. One area in which we have expanded our analysis concerns the handling of duration in our input-output model of price spillovers.

The European Commission estimates the duration associated with its decisions on a case-by-case basis (Dierx and Ilzkovitz, 2020). For cartels, this involves assessing the stability of the collusive agreement: cases assessed to be unsustainable, fairly sustainable and very sustainable are assigned durations of one, three and six years, respectively. For mergers, duration is determined by an evaluation of barriers to entry: two years for significant barriers, three years for very significant barriers, and five years for extremely significant barriers.

In earlier versions of the input-output analysis, information about case duration was largely ignored. Effectively, European Commission decisions were assumed to produce their price reducing effects only in the year in which they were adopted. Now, such results ('without duration') are complemented by an additional set of results ('with duration') in which each cartel and merger case keeps producing its effect in the years following the decision until its duration runs out.

In addition to being interesting in and of themselves, the results with duration make it easier to relate the findings of the input-output analysis to those of the QUEST-based analysis, as the latter do account for duration. Taking duration into account and averaging over the entire 2012-2019 period, the input-output calculations imply that competition policy enforcement reduces the EU's overall price level by about 0.5 percent. In the QUEST analysis, a comparable result is represented by the long-term impact on the GDP deflator, which reflects the new price level after adjustments have taken place. In the baseline scenario, that amounts to a 0.4 percent decrease. As QUEST is a lot more flexible than an input-output model in the ways it allows economic agents to adjust their behaviour in response to a shock, it makes intuitive sense that it would predict a less pronounced price response. Overall, however, while the two models differ radically in scope and economic logic, it is encouraging to see that the results are broadly in agreement. A more extensive discussion of case duration and of the relationship between input-output and QUEST-based analyses can be found in annex A.3.

6.3 Collection of data on antitrust interventions other than cartels

In the work programme for 2021, it is planned to extend the modelling effort to include the European Commission's antitrust interventions under Articles 101 and 102 of the Treaty on the Functioning of the European Union (TFEU). The impact of antitrust decisions would complement that of the merger interventions and cartel prohibitions currently modelled. Doing so would allow making a more comprehensive assessment of the socio-economic benefits from competition policy.

The study team intends to conduct the model simulations according to the same methodology described above, with an avoided price increase in the range of 5-10% for both Article 101 and 102 cases and an expected duration of the price effect in the absence of an intervention of three years, which is in line with the OECD (2014) guidance. Information on the annual turnover (i.e. the annual value of sales) in the affected market(s) by the companies under investigation is taken from the decision itself (in case of a prohibition decision) or if available, from the case file (in case of a commitment decision).

In order to conduct the antitrust simulations for the years 2012-2019 (i.e. the same period covered by corresponding cartel and merger simulations), data on the annual value of sales in the affected market(s) by the companies under investigation is being collected. Annex A.5 provides a descriptive analysis of the antitrust interventions concerned.

6.4 Application of an additional productivity shock to the QUEST model

Competition policy interventions can spur productivity by inducing markets to operate more competitively (see Syverson, 2011 and Nicodème et al., 2007). Theoretical studies identify three main channels through which competition can affect productivity. Firstly, competition can encourage a reallocation of capital and labour inputs toward those firms that use these resources most productively at the margin (allocative efficiency). This "cleansing" mechanism improves the sector's allocative efficiency, leading to higher productivity growth. Secondly, competition may increase managerial effort and improve efficiency of the production process, for instance by optimising the use of resources (productive efficiency). Lastly, competition incentives can encourage firms to innovate and lagging firms to adopt the more efficient existing technologies in order to stay in the market (dynamic efficiency).[11]

In the QUEST III model, a rise in competition (as reflected in lower mark-ups) will increase the capital over labour ratio (capital intensity) due to lower prices for investment goods and higher real wages. This increase in labour productivity does not reflect a true increase in the efficiency of production, as in the case of a TFP shock, but simply a relative increase in the amount of capital used in the production process.

To evaluate the impact of competition on productive efficiency, alternative measures of productivity need to be used, such as total factor productivity or labour augmenting productivity. As in many other macroeconomic models, in QUEST III productivity has been modelled as a labour augmenting (or Harrod-neutral) increase in productivity: as a consequence of the increased efficiency of production, labour input becomes more productive (i.e. the output over labour ratio increases), while capital productivity (i.e. the output over capital ratio) remains unchanged.

However, in QUEST III a mark-up shock does not affect total factor productivity (TFP) because: (1) technology is exogenous and hence there is no effect on innovation (dynamic efficiency); and (2) firm dynamics are not modelled and hence the distribution of firms by productivity is not affected (allocative efficiency). Therefore, in order to capture the productivity effect of the increase in the level of competition, an empirically estimated labour augmenting productivity

11 This last channel is more disputed (see e.g., Cohen (2010) and De Bondt et al. (2012) for a survey of the literature).

shock would need to be introduced in the model. This exercise would allow giving a more comprehensive quantification of the macroeconomic impact of competition policy enforcement using the QUEST macro-model, because it would allow taking into account the direct effect of mark-up shocks on productivity growth. Ignoring this channel would underestimate the macro-impact of competition policy interventions in our model simulations.

There is some empirical evidence linking a higher degree of market competition to productivity growth (see, among others, Syverson, 2011; CMA, 2015; and Holmes and Schmitz, 2010 for reviews of evidence). Few papers assess the overall impact of competition on productivity in the European Union (see Weyerstrass and Jaenicke, 2008; Ospina and Schiffbauer, 2010; Carvalho, 2018; Breda et al., 2019). It should be also noted that the impossibility of directly observing competition necessitates the adoption of indirect measures, such as market concentration, market shares or mark-ups. Their estimations may give rise to some measurement and data quality issues (see Syverson, 2011).

Based on the existing empirical evidence, we have calibrated a reduced-form equation making an explicit link between changes in mark-ups and labour augmenting productivity, implicitly including the above-mentioned effects of changes in mark-ups on the productivity-enhancing process. In addition to the mark-up shock, this elasticity would be inserted into the QUEST model to quantify the effect of competition policy on productivity growth. Annex A.4 discusses in depth how competition policy can contribute to economic growth by stimulating productivity and surveys the existing empirical literature, highlighting the limitations of such analysis. It also provides preliminary macroeconomic simulations, taking into account the additional contribution of such a shock.

7. CONCLUSION

This report presents the annual update of the macroeconomic simulations of the impact of competition policy interventions by the European Commission. This year's dataset includes 40 cartel prohibitions and 165 merger interventions covering the period 2012-2019. For next year's report, we are considering taking into account a further 50 antitrust interventions under Articles 101 and 102 TFEU, beyond the cartel prohibitions already included in the present report. However, this is conditional on the availability of the data required. More broadly speaking, the present model simulations do not consider: (i) antitrust interventions other than cartel prohibitions by the European Commission; (ii) the decentralised enforcement of EU antitrust rules by national competition authorities; (iii) national merger control; and (iv) EU State aid control. Therefore, the actual impact of EU competition policy will likely be well above the outcomes presented in this report.

The annual number of competition policy interventions (cartel prohibitions and merger interventions) by the European Commission is relatively stable at around 26 decisions per year. By contrast, the total size of markets affected by such interventions varies from a low of 18 billion euro in 2013 to a high of 140 billion euro in 2016. Important decisions taken in 2016 concern mergers in the beer and telecoms markets, as well as the trucks cartel prohibition. However, the overwhelming majority of Commission interventions concern smaller markets, as illustrated by a median market size of around 0.5-0.6 billion euro. Each intervention offers economic benefits in terms of a reduction in prices for customers of the different products concerned and an increase in competition as reflected in a decline of mark-ups.

The price and mark-up shocks used in the model simulations include a proxy for the deterrent effects of competition policy interventions. It is assumed that each merger intervention and cartel prohibition not only has an impact on the relevant market directly affected by the Commission's intervention but also has a deterrent effect spread across the remainder of the NACE four-digit sector concerned by this intervention. A logistic function is used to model deterrence as a gradual process where the diffusion of deterrent effects at the sector level depends on the size of the affected market relative to the size of the corresponding four-digit sector.

In the macro-model simulations, a permanent negative mark-up shock is applied to the QUEST III model, reflecting the increase in competition caused by the Commission's competition policy interventions. This permanent shock reflects companies' expectations that the European Commission will continue to enforce EU competition policy at the same pace into the foreseeable future. Under the baseline scenario, the mark-up decreases by 0.6 percentage points resulting in an increase in real GDP of 0.3% after five years, reaching 0.5% in the long run. In the input-output model simulations, a negative price shock is applied at the industry level in line with the sector distribution of the European Commission's interventions, with the manufacturing, communication and finance industries being most affected. These within-industry price effects then spill-over along the supply chain to downstream industries. Such spill-over price effects may reach up to one half of the total price effect, depending on the year. If duration is taken into account, competition policy enforcement lowers price levels by around 0.5% on average over the period 2012-2019, with particularly large price reductions in the motor vehicles, water transport and telecoms sectors.

This year, two main changes have been made in the data analysis and modelling of the macro-economic impact of EU competition policy. First, the calibration of the logistic function has been improved by better taking into account information about the affected market size as a share of the corresponding four-digit sector with the deterrence multiplier being larger for interventions located around the median of market size distribution. Second, the input-output analysis has been extended by taking into account information about the duration during which the impact of the Commission's interventions is being felt. This has allowed a comparison of the total price reduction in the input-output model with that in the QUEST III model, showing that both price reductions are of the same order of magnitude.

Finally, steps have been taken with a view to providing a more comprehensive assessment of the impact of EU competition policy. More in particular, the collection of data on antitrust interventions other than cartel prohibitions has been launched. If successful, next year's model simulations could take into account such interventions as well. Moreover, we are considering whether it would be appropriate to apply a productivity shock to the QUEST III model, in addition to the mark-up shock currently being applied. Such a shock would reflect the productivity effects of competition policy enforcement in terms of improved allocative (entry/exit), productive (better use of internal resources) and dynamic (innovation) efficiency.

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A. TECHNICAL ANNEXES[12]

A.1. THEORETICAL FOUNDATION AND CALIBRATION OF THE LOGISTIC FUNCTION USED TO MODEL THE DETERRENT EFFECTS OF COMPETITION POLICY INTERVENTIONS[13]

In this annex we describe the equations defining the mathematical foundation of the logistic approach chosen to model deterrence, and we discuss possible alternative approaches.

We denote by $x = \frac{mkt}{GO4}$ the share of the direct market impact of a competition authority's intervention to the size of the NACE 4-digit sector to which this market belongs, and by $\mathrm{h} = \frac{mkt^D}{(GO4-mkt)}$, the deterrent effect of the intervention.

Deterrence effects are not observable, thus we need to conjecture a functional form linking x to h, which we denote as the generic function $\mathrm{h} = \mathrm{h}(x)$. Given its largely recognized empirical validity in explaining a wide range of phenomena, we choose a logistic-type link. One can obtain the logistic function from the two following assumptions: the marginal increase in deterrence is proportional to its starting value; the marginal increase in deterrence is proportional to the distance from the saturation point of the market (where $\mathrm{h} = 1$). These two hypotheses lead to the following differential equation, describing the diffusion of deterrence into a given market as a function of the size of the market directly affected by the competition policy intervention:

$$\frac{\mathrm{dh}}{\mathrm{d}x} = \chi \mathrm{h}(1-\mathrm{h})$$

where χ is a constant. Rearranging, and integrating both sides, we get:

$$\int \frac{1}{h(1-h)} \mathrm{dh} = \chi \int \mathrm{d}x$$

Computing the indefinite integrals up to a constant, and denoting by F the inflection point of the curve, we obtain:

$$\mathrm{h}(x) = \frac{1}{1+e^{-\chi(x-F)}} \qquad x \epsilon [0, 1)$$

Lastly, in order to impose the passage of this function through the points [0,0] and (1,1), we apply the following transformation, which corresponds to a stretching of the original logistic link:

$$\mathrm{y}(x) = \frac{\mathrm{h}(x) - \mathrm{h}(0)}{\mathrm{h}(1) - \mathrm{h}(0)}$$

This is the function used in the simulations presented in this report to model the deterrent effects of competition policy interventions.

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12 These technical annexes have been written under the sole responsibility of the authors and do not necessarily represent the views of the European Commission.

13 Prepared by Filippo Pericoli (DG JRC).

The proposed formulation is justified by our a priori knowledge of the economic problem at hand, as we assume that deterrent effects are absent $(y = 0)$ if there are no competition policy measures $(x = 0)$, and that deterrent effects should spread in the limit to the whole 4-digit market $(y = 1)$ as the size of the intervention becomes big enough $(x \to 1^-)$. This implies that the logistic function must pass through the point of coordinates [0, 0] and should approach the point (1, 1).

The parameter χ is a measure of the steepness of the stretched logistic curve. It reflects the speed of the diffusion: the higher this parameter, the faster is the speed of diffusion of information about a competition policy intervention amongst companies active in the NACE four-digit sector concerned by this intervention. *F* is the inflection point, where the growth of the diffusion effects start to decline. An increase (decrease) of the parameter F shifts the function to the right (left).

In order to calibrate the logistic function, we fix the inflection point F at values such that the average ratio between the adjusted market and the directly affected market $\left(\frac{mkt^D}{mkt}\right)$ is equal to 10 for mergers and to 20 for cartels. We choose these values based on a review of the empirical literature on deterrence effects (see footnote 2 in section 3.1).[14]

Lastly, we choose the parameter χ in such a way to fulfil these additional criteria:

1. The maximum ratio of the deterrence multiplier $\left(\frac{mkt^D}{mkt}\right)$ is not too high in relation to the average multipliers.
2. The deterrence multiplier approaches zero forhigh values of the independent variable $\left(\frac{mkt}{GO_4}\right)$.

After some numerical experiments, we obtained a satisfactory logistic shape, by choosing a value for χ equal to 100 that corresponds to a relatively slow diffusion in the area where cases are mainly concentrated. We prefer a curve with a low steepness, as there are no theoretical arguments in favour of the introduction of strong discontinuities in the diffusion process.

The popularity of the logistic function has recently surged, as witnessed by a wide number of contributions dealing with modelling the diffusion of COVID-19 (see amongst others Wang et al., 2020). After a review of the literature of diffusion processes, we conclude that, it would be worthwhile to explore other possible approaches to model deterrence effects, with the ultimate aim of understanding to what extent the simulated macroeconomic impact of competition policies is sensitive to this functional choice. In detail, it might prove worth it to explore three alternative approaches to model deterrence effects: a non-stretched logistic function; a Beta distribution function; and the mixed-influence model developed by Bass.

First, one possible modification might consist in relaxing the assumption that the function should pass through the points of coordinates [0, 0] and [1, 1]. Indeed, this last transformation of the h function generates a divergence with respect to the standard logistic function, especially for small values of the independent variable. From a theoretical point of view, a non-stretched solution would have the advantage that the resulting diffusion process would correspond to the solution of the standard differential equation, which generates the logistic function. In this setting, the value of deterrence corresponding to a zero value in the independent variable could be interpreted as the amount of deterrence that is attributable to

[14] Table 2 in Dierx et al. (2017) summarizes the results on surveys on deterrent effects.

the mere existence of the competition authority, or to the deterrent effects of interventions in other sectors of the economy.

Second, a suitable solution might be that of relying on a Beta distribution. Indeed, this is the distribution function generally employed to model processes where the domain is bounded in the interval [0, 1]. Moreover, it is a highly flexible function, which can assume a sigmoidal shape for some choice of its parameters. This option would just require to model jointly the direct and the deterrence effects $\frac{mkt+mkt^D}{GO4}$ rather than deterrence effect only $\frac{mkt^D}{GO4}$.

Third, one might rely on alternative theoretical frameworks for modelling the process of diffusion, and in particular, on the mixed-influence model introduced by Bass (1969). Indeed, the logistic function belongs to the class of internal-influence diffusion models, as it describes the diffusion of information in a context where there is already an initial amount of information. The internal-influence model thus explains the evolutionary pattern of a diffusion process starting from an initial value of diffusion, which remains unexplained. A possible refinement could consist in relying on a more general diffusion scheme such as a mixed-influence model, where the diffusion depends on two components: an external influence, which emanates from outside a social system, and an internal component, which is driven by interactions occurring within a social system. The first component is appropriate to model formalised and hierarchical communication, while the second component is appropriate to model the diffusion of information in cases where the social system is composed of relatively small and homogeneous agents. This approach originates a general diffusion trajectory, which nests the logistic diffusion as a particular case. A detailed review of the theoretical foundations of these approaches and their comparative empirical performances are reviewed by Geroski (2000), and Kijek and Kijek (2010).

A.2. DEVELOPMENTS OF MARK-UP LEVELS IN EU MANUFACTURING AND SERVICE SECTORS – FURTHER WORK[15]

Policy makers have been actively debating the evolution of corporate market power (see for instance the debates at Jackson Hole 2017 or Sintra 2017) and the associated implications for innovation, growth, and income inequality, in light of growing – but also conflicting evidence made available by the research community. For instance, De Loecker and Eeckhout (2020) use firm level data from the Worldscope database and find that the aggregate global mark-ups rose from 1.15 in 1980 to 1.6 above marginal cost in 2016 – mostly driven by the US and the EU.[16] However, not all studies find mark-ups to have increased in the EU, and on the US findings there is some debate as well. Cavalleri et al. (2019), for example, find that in the four big countries of the euro area (Germany, France, Italy and Spain) mark-ups have been marginally trending downwards since the late 1990s.

The conclusions of recent studies as regards the evolution of market power over the past 20 years fall into three broad categories. The first and most influential group documents an increase in market power limited to a small group of the most efficient “super-star” firms. De Loecker and Eeckhout (2017) find that in the US average mark-ups rose from 18% above marginal cost in 1980 to 67% in 2016 and that this rise was driven by an increase in the market share of top-income firms – also referred to as "superstar" firms (see for example van Reenen

[15] Prepared Maria Garrone (DG ECFIN) and Anna Thum-Thysen (DG ECFIN).
[16] The authors use a methodology developed in De Loecker and Warsinski (2012) for the calculation of aggregate average mark-ups.

(2018) and Autor et al. (2017)). Most recent results by De Loecker and Eeckhout (2020) confirm the rise of mark-ups and the superstar firm phenomenon in the US, but report no evidence of this reallocation phenomenon in Europe. Calligaris et al. (2018) analyse the digital transformation and evolution of market power between 2001 and 2014 for 26 countries.[17] In line with De Loecker and Eeckhout (2017), their study reveals that mark-ups have increased by between 4% and 6% over the period considered and confirms that this increase is mainly driven by firms belonging to the top decile of the mark-up distribution. They also find that digital-intensive sectors[18] report higher mark-ups than less-digitally intensive sectors and that this gap in mark-up between the two has increased significantly over time. A very recent paper by Diez et al. (2020) analyses firm-level data from Bureau van Dijk's Orbis database[19] on 19 countries[20] for the period 2000-2015 and follows the methodology of De Loecker and Warsinski (2012). The paper finds that average mark-ups increased by about 6% in 2000-2015, mostly for firms from advanced economies, and that the increase is driven by the high-mark-up firms at the top of the mark-up distribution, whose mark-ups increased by 40 % during the sample period.

The second group of studies argues that this increase in market power has been broadly based. Weche and Wamback (2018) use micro-level data from Bureau van Dijk's Orbis database to analyse the development of market power in EU countries over the period 2007-2015. Following the approach by De Loecker and Eeckhout (2017), the results show a sharp drop in mark-ups during the crisis, followed by a post-crisis increase, which, however, did not fully recover in 2015. The after-crisis trend in average mark-ups does not appear to be driven exclusively by industry restructuring, but also by a within firm increase of mark-ups. In contrast with De Loecker and Eeckhout (2017), the increase in average mark-ups is driven by the entire upper half of the mark-up distribution, implying that not only firms with already high mark-ups increased their mark-ups further but the median mark-up has also increased in recent years.

The third group finds no evidence of an increase in mark-ups and nuances the findings by arguing that this increase in market power is sensitive to the method used to measure market power or to the factors included in the analysis. Gutiérrez and Philippon (2017a and b, 2019a and b) find that in the US market power (measured as higher concentration rates) is rising but they argue this seems to be rather a US phenomenon, which could be potentially explained by differences in the role of antitrust authorities. They do not find evidence of declining competition in Europe. They argue that the findings by De Loecker and Eeckhout (2018), which point to a decline in competition, are heavily influenced by technological change and the shift to intangible capital (see also Traina (2018)). Lopez-Garcia et al. (2018) calculate mark-ups based on the Compnet firm-level database for euro area countries from 2000 to 2015 (with coverage differing across countries). The authors assume intermediate goods to be the variable input. They observe an increase in mark-ups, but find that mark-up levels can be quite sensitive to different intermediate input variable definitions. Therefore, they normalise median mark-ups to 1 in the year 2011. Abraham et al. (2020) use a method allowing to estimate aggregate price-cost margins in the presence of fixed factors of production and exploiting

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[17] Australia, Austria, Belgium, Bulgaria, Denmark, Estonia, France, Finland, Hungary, Germany, Indonesia, India, Ireland, Italy, Japan, Republic of Korea, Luxembourg, the Netherlands, Portugal, Romania, Slovenia, Spain, Sweden, Turkey, the United Kingdom, United States.

[18] The authors interact the estimated markups with a digital intensity taxonomy by sector.

[19] Unlike the Worldscope database used by De Loecker and Eeckhout (2017), Orbis BVD is not restricted to only publicly traded firms. This difference may help explain the greater mark-up variation and the higher mark-up level on average.

[20] Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Italy, Japan, Korea, Latvia, Portugal, Romania, Russia, Spain and the U.S. The alternative sample includes, in addition, Austria, China, Hungary, Ireland, Netherlands, Poland, Slovakia and Slovenia.

properties of the primal and dual (revenue- and cost-based) Solow residuals. Based on firm-level data for Belgium, they find a moderate decline in price-cost margins once fixed factors of production are taken into account in the estimation and argue that ignoring fixed costs underestimates price-cost margins while it overestimates firms' profitability.

A multiplicity of explanatory factors has been put forward to make sense of the rise in corporate market power. On the positive side, technological developments and globalisation may have increased market size and profitability of the high fixed costs – low variable costs firms, resulting in increased market concentration, higher allocative efficiency, enhanced product differentiation, and improved product quality. Toughness of competition led to the emergence of super-star firms, market power being rather "a strength, than a weakness".

Yet, even in this positive view of market power developments, caution is advised in evaluating the macroeconomic implications of these dynamics. In particular, these novel influential market players may have an incentive to stifle further competition and use their firepower to buy out potential rivals, thereby reducing market dynamism (i.e. firm exit and entry). Other macroeconomic implications could include slower technological diffusion, falling labour shares and rising income inequality, as the bargaining power of these very big firms in input and labour markets affects the distribution of surplus. Hence, a policy response may be needed to ensure market contestability and stimulate the process of creative destruction.

A less positive view of market power developments considers that flawed policies are at least in part responsible for increased market concentration whereby barriers to firm entry, growth, and exit have resulted in too little competition and excessive rent-seeking behaviour. Examples of such policies include the lack of international coordination in corporate taxation leading to profit-shifting, more lax anti-trust policies (US), and weakened social dialogue policies that may have failed to address the loss of bargaining power of relatively more atomised economic agents (employees, self-employed).

The above-mentioned studies differ in multiple ways. The indicators used to measure market power are quite diverse (market concentration, price-cost margins, business dynamics, mark-ups). The granularity of the data (sectoral, firm-level), the type of firms included in the study (listed firms, big firms, full population), and the methodology used to estimate mark-ups also vary.

In the future, we aim to provide a comprehensive assessment of the evolution of corporate market power in the EU Member States over the last 15 to 20 years, while focussing on the mainstream indicator of market power, namely the mark-up. The evolution of mark-ups needs to be analysed together with the evolution of the fixed costs of operation, as in a highly competitive market one would expect firms to operate in proximity to the break-even point where their revenue just enables them to cover their total costs (see Abraham et al. (2019) on this). Our objective is therefore to evaluate whether there has been an increase in market power, defined as the situation in which firms are increasingly able to generate profits beyond a normal margin needed to recoup the fixed costs of operation, i.e. a situation where mark-ups go up above and beyond the possibly increasing overhead costs.

We plan to not only provide a comprehensive assessment of the evolution of market power – by combining information on the evolution of mark-ups with information on the evolution of fixed costs – but also to pin down the impact of methodological heterogeneity. For the latter, we plan to evaluate the sensitivity of results to the approach taken to assess the evolution of market power. By carrying out this work, we expect to be able to argue that results obtained with a particular methodology are relatively more credible in view of the intrinsic features of the structural approach.

A.3. INTRODUCTION OF DURATION IN A STATIC INPUT-OUTPUT MODEL AND LINK BETWEEN MACRO-SIMULATION AND INPUT-OUTPUT ANALYSIS[21]

This annex provides additional information on the handling of duration in the input-output analysis of section 5 and on the relationship between that analysis and the macro-simulations of section 4.

A.3.1 Duration

In our sectoral analysis of competition policy enforcement, cartel prohibitions and merger interventions cause price reductions that in turn propagate from the markets directly affected to the rest of the economy. But how long do these effects last? Until last year's final report, we paid little attention to the fact that a case's economic repercussions may protract beyond the year in which the decision was adopted. What's more, the duration of those consequences is likely to vary from one case to another. With this year's report, such issues are factored into the analysis. Now, in addition to results 'without duration' of the kind found in previous years' final reports, we also report a full set of results 'with duration'.

To do so, we use information about how long the price reductions associated with a cartel prohibition or merger intervention are likely to last (a case's 'duration' for short) supplied by DG COMP. To assess case duration, DG COMP uses different criteria for cartels and mergers. The (likely) duration of a cartel is determined using an aggregate score of cartel stability that reflects a range of indicators such as number of participant firms, overall market share and trends in demand. Mergers, on the other hand, are assigned a (likely) duration based on an evaluation of how difficult it is for a competitor to enter or expand in the relevant market. This is assessed through several indicators, including churn rate, imports, fixed costs and economies of scale. For the details, the interested reader is referred to Dierx and Ilzkovitz (2020).

Equipped with this information, in any given year we are able to construct price effects 'with duration' that reflect not only the decisions adopted in that very year – i.e. those that contribute to the calculation 'without duration' – but also earlier decisions whose effects, according to DG COMP's calculations, have not yet waned.

Unsurprisingly, taking duration into account results in larger price impact estimates. The repercussions on the magnitude of our results can be very significant. To appreciate this, consider for example the within-industry effect for the motor vehicle industry (C29) in 2019. In the analysis without duration, there is only one relevant decision, the occupant safety systems cartel case. Once we recognize the role of duration, on the other hand, our calculations must consider nine additional cases: two cartels and one merger from 2018 that have durations in excess of one year; three cartels and two mergers from 2017 with duration greater than two years, and; one cartel from 2016 with six year duration. As a consequence, the within-industry effect increases from less than 1% without duration to more than 8% with duration. As can be seen in Figure A.3.1, a similar – though not as dramatic – pattern can be observed in other industries (most notably, water transport and telecoms). Furthermore, such wide gaps between within-industry effects with and without duration are amplified when these are fed to the input-output model to compute the spillover effects.

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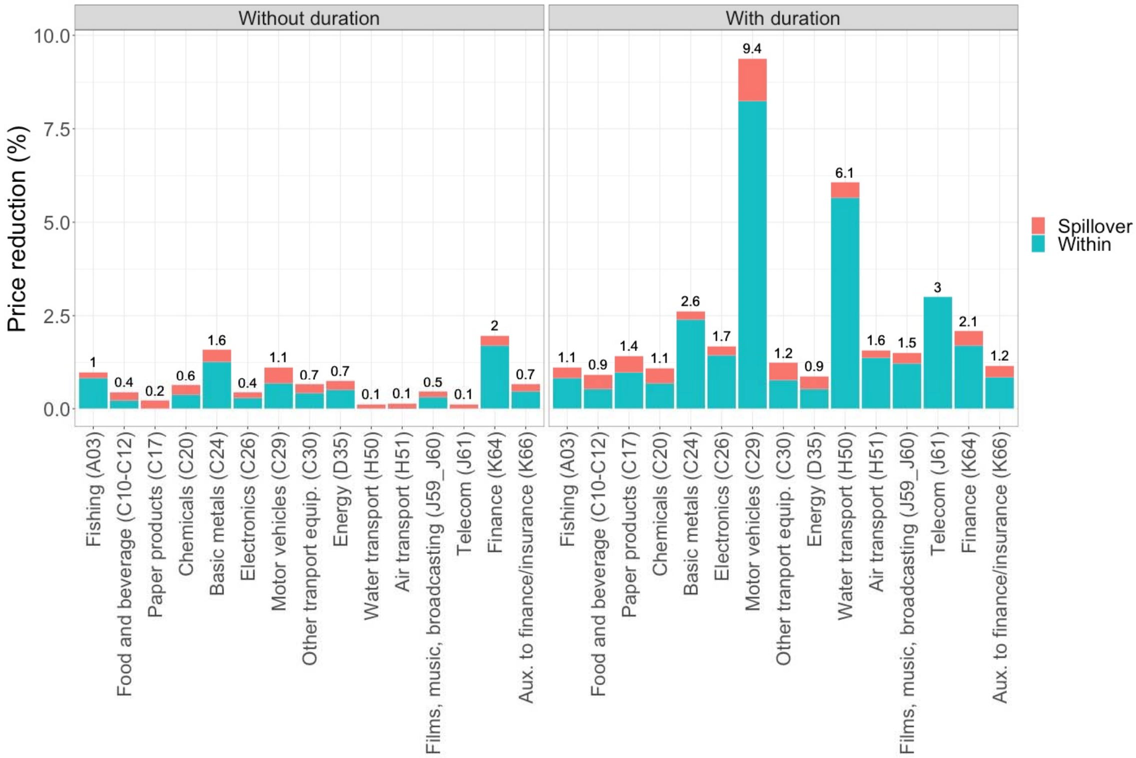
[21] Prepared by Mattia Cai (DG JRC).

Figure A.3.1 Industry level price changes, 2019, selected industries



A.3.2 Relationship with the macro-simulation analysis

The macro-simulations of section 4 and the input-output analysis of section 5, although carried out in parallel, are closely connected. The link between the two is provided by equation 3.2. This equation combines case-level data and macroeconomic statistics to obtain a vector of industry-specific price changes associated with competition policy enforcement. In turn, those price changes provide the basis for computing, on one hand, the exogenous mark-up shocks that set the macro-simulations in motion and, on the other, the within-industry effects from which the input-output model calculates the spill-over effects.

This link is not broken by the fact that the macro-simulations and input-output analysis treat the time dimension in very different ways. By nature, the input-output analysis relies on a static framework. Effectively, the time span of interest collapses into a single period and all relevant events (e.g. any relevant cartel of merger cases) are implicitly assumed to occur together. By contrast, the QUEST model underlying the macro-simulations is dynamic. Consequently, a time path must be specified for the mark-up shock that feeds into QUEST. As discussed in box 1, this entails predicting a plausible future scenario for competition policy enforcement over the entire period covered by the simulations. In practice, the mark-up shocks for future time periods are constructed from historical data. In particular, a prominent role in the macro-simulation analysis is played by the so-called permanent shock. The permanent shock is computed entirely by averaging historical data over the period 2012-2019. In this sense, the permanent mark-up shock underlying the macro-simulation results of section 4 is intimately related with (and conceptually analogous to) the average within-industry effects represented by the light blue bars in Figure 5.2. (In particular, given that that the mark-up shocks used with the QUEST model take case duration into account, the appropriate comparison is with the right-hand side panel.)

As a word of caution, one should be wary of interpreting the input-output results of Figure 5.2 as permanent effects. Doing so requires much stronger assumptions than those underlying the QUEST permanent shock. Loosely speaking, the permanent mark-up shock calculations are justified as long as the overall level of competition policy enforcement in the near future resembles that observed in the recent past. On the contrary, generalizing the input-output results presupposes that the industry distribution of that enforcement activity will also remain stable over time.

A.4. APPLICATION OF AN ADDITIONAL PRODUCTIVITY SHOCK TO THE QUEST MACRO-MODEL: EMPIRICAL FOUNDATION AND INITIAL RESULTS[22]

In the macro-simulations presented in Section 4 there is no direct effect between a variation of mark-up and productivity, because in the QUEST model technology is assumed to be exogenous and firm dynamics is not modelled. It has been decided to apply a reduced-form equation making an explicit link between changes in mark-ups and labour augmenting productivity, implicitly including the effects of competition policy interventions on productivity-enhancing process to be applied to the QUEST model in addition to the mark-up shock.

The following Section A.4.1 introduces the economic logic behind the link among competition policy interventions, mark-up and productivity. Section A.4.2 summarises briefly the empirical evidence regarding the relationship between market competition and productivity, using firm-level micro or sectorial level data;[23] while Section A.4.3 provides macroeconomic-simulations with the QUEST model, which incorporate a productivity shock, based on the discussed empirical evidence.

A.4.1 The theoretical foundation

There is a consensus on the fact that market competition can drive increases in productivity, and thus that competition policy interventions can spur productivity by improving the functioning of the market (see Syverson, 2011, Nicodème et al., 2007, and Competition and Markets Authority, 2015, to survey the literature).

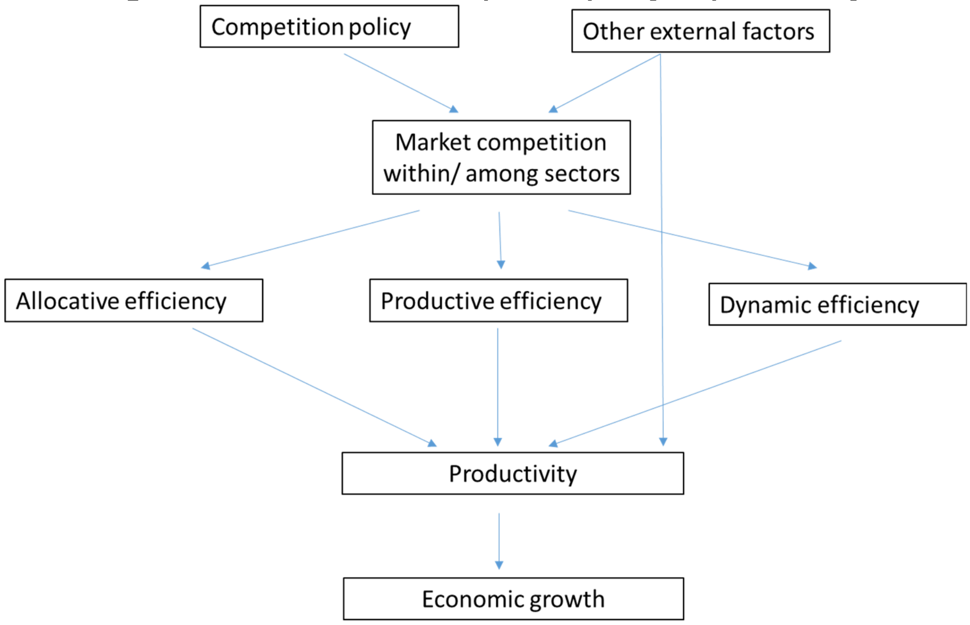
Competition authority's interventions generate directly a decrease in mark-up by improving the conditions of competition in the markets. However, such interventions have also an indirect impact on productivity growth by three main channels, summed up in Figure A.4.1: by reallocating efficiently the scarce resources (allocative efficiency), by improving the utilization of the production factors by firms (productive efficiency) and, finally, by encouraging firms to innovate and move to the technological frontier (dynamic efficiency).[24]

22 Prepared by Roberta Cardani (DG JRC) and Marco Ratto (DG JRC).

23 See Cai et al. (2020) for a survey of the empirical literature on the link between productivity and competition policy interventions, taking into account the mechanism by which market competition affects productivity and on the link between competition authority intervention and productivity.

24 The term "static efficiency" builds on the two above-mentioned concepts: productive and allocative efficiency. It refers to the extent in which total surplus is maximized in the short run, using the current technology and its inputs combination. On the contrary, the term "dynamic efficiency" refers to the efficiencies that arise in the long run via innovation.

Figure A.4.1 The effect of competition policy on productivity



More in details, the ***allocative efficiency*** is reached by increasing market contestability. Among firms, competition acts as a disciplining device: it ensures that the more productive firms increase their market share at the expense of the less productive. The low-productivity firms may then exit the market, to be replaced by higher productivity firms. In this sense, competition policies have a substantial impact on the churn rate. A competitive environment not only forces high-costs firms out of the market, it also raises the productivity cut-off that any potential entrant must meet to enter successfully. Examples of theoretical model that take into account the allocation channel are due to Melitz (2003), Rossi (2019) and Casares et al. (2020), who introduce the entry-exit channel in an otherwise standard New Keynesian model. In such a framework, low productivity firms exit and high productivity firms produce more, which results in an increase in the aggregate productivity.

The increase in competition can also be associated with an increase in the technical or ***productive efficiency***, forcing firms to optimise the use of resources and reducing various forms of *X-inefficiency* (like, for example, managerial or worker slack and bureaucratic inertia). Note that by raising producers' own productivity levels, market competition can boost the aggregate productivity of the economy. This channel is generally analysed in a principal-agent framework with asymmetric information, where managers and workers can partially capture monopoly rents in the form of higher wages or reduced effort (see Ahn (2001), Bloom and Van Reenen (2007; 2010) for a survey on this topic). Such studies conclude that competition lessens information asymmetries by means of appropriate incentives to monitor the worker performance or by linking wages to effort.

Lastly, competition policies potentially affect ***dynamic efficiency***. Market competition may drive firms to innovate and differentiate their products in order to gain market shares. In this sense, innovation enhances productivity through technological improvements of production processes or the creation of new products. However, the link between market competition and productivity is a debated issue in the literature and empirical results are mixed. On the one hand, industrial organization literature argues that competition may be detrimental for innovations ("*discouragement effect*"). Schumpeter (1942) argues that monopolistic firms can fund R&D expenditure more easily as the market structure allows them to capture all the gains from their innovations. Consequently, the monopolist can achieve higher rates of innovation and thus growth. The same conclusion is obtained by the early endogenous growth models, such as Aghion and Howitt (1992), who conclude that an increase in market competition between producers reduces expected future profits from innovations and therefore the rate of technical change ("*rent dissipation effect*"). In addition, more intense competition will lower the expected durability of innovations ("*creative destruction*") and hence the incentive to innovate.

On the other hand, some economists observe that a monopolist has less incentive to innovate than a competitive firm, because he would only replace his existing rent bearing the cost of innovation, whereas competitive firms would take over the market while before they would just cover their production costs. (Arrow's *replacement effect*).[25] Other studies, rooted in the distance-to-frontier theoretical tradition, show that potential or actual competition can induce an incumbent leader to react to the competition threat and innovate in order to maintain its leadership ("*escape competition effect*").

To reconcile these two possible channels, Aghion et al. (2005 and 2009) come up with an inverse U-shaped non-linear relation between competition and innovation: both a positive and negative effect of competition on innovation may arise depending on the initial level of competition. An environment with too low or too high competition is least conducive to innovation, while the incentives to undertake innovative activity are highest at intermediate levels of competition intensity. Under low competition, firms have a weak incentive to innovate in order to escape competition, while under high competition, innovation is discouraged as prospective rents are lowered.[26]

A.4.2 Empirical literature on the effect of market competition on productivity

The empirical evidence based on aggregate and firm/sector-level data establishes a positive relationship between market competition and productivity.[27]

Using panel data on 700 British manufacturing sector companies, Nickell (1996) demonstrates that a 10% increase in price mark-ups implies a 1.1 to 1.67% loss in aggregate total factor productivity (TFP) growth, depending on which competition measure is taken into account (e.g. market share at the firm level or measures of concentration). Firms subject to an intense competition have more incentives to improve their own efficiency because their market share, and ultimately their own survival, depends on it. The paper also finds that the number of competitors has a positive impact on productivity.

25 Papers showing that companies sheltered from competition are less likely to innovate and are therefore less productive are due to Porter (1990, 2001), Lewis (2004), Syverson (2004, 2011), Holmes, Levine, Schmitz (2012), Holmes and Schmitz (2010) and Bloom and van Reenen (2010).

26 Empirical evidence on the dynamic channel is mixed. The inverted-U relationship has been documented by empirical work of Aghion (2005) based on industry-level US data, with innovation measured by the number of citation-weighted patents and competition by a Lerner index. Other empirical work include Polder and Veldhuizen (2012) based on Dutch National Accounts and micro-data and Klein and Bouis (2009) who find an inverted-U relationship between mark-ups and productivity using sectoral data for the EU from EUKLEMS. Polder and Veldhuizen (2012) raise several caveats for the estimation of the inverted-U relationship.

27 See, among others, Syverson, 2011, CMA, 2015 and Holmes and Schmitz, 2010 for reviews of evidence. In this section, we do not pinpoint the mechanisms through which competition impacts on productivity, because we are interested in the overall impact of market competition on productivity.

Table A.4.1 Empirical studies on the link between productivity and market competition

Study	Country	Time span	Estimation method	Productivity measure	Mark-up measure	Impact of mark-up on TFP
Nickell (1996)	UK	1975-1986	First difference dynamic panel regression with fixed effect	Aggregate TFP: log of value added and log sales.	Market shares (proxied by total sales)	Elasticity: a 1% increases in price mark-ups implies a 0.11% to 0.167% loss in TFP growth
Weyerstrass and Jaenicke (2008)	9 Euro Area countries (Austria, Belgium, Finland, France, Netherlands, Germany, Ireland, Italy, Spain)	1976-2004	OLS fixed effect	Aggregate TFP: Solow residual from GDP; labour productivity: GDP per employee.	Estimation based on Lerner index calculation (Roeger, 1995)	Elasticity: a 1% reduction of the EA mark-up would boost TFP growth by 0.057 p.p. and labour productivity growth by 0.015 p.p..
Ospina and Schiffbauer (2010)	Eastern European and Central Asian countries	2001-2004	OLS, IV estimations	Aggregate TFP: log of value added and log sales. Labour productivity: ratio of firm sales to human capital	1) Log of Sales over operating costs; 2) competition cost from Survey question.	Elasticity: firms that have 20% higher mark-ups, have, on average, 1.2% lower TFP level
Carvalho (2018)	Portugal	2010-2015	OLS fixed effect, two-stage OLS regression	Aggregate TFP: log of value added and log sales; labour productivity: ratio of gross value added at factor cost per employee	Log of Herfindahl-Hirschman Index	Elasticity: markets that have a 1% higher Herfindahl-Hirschman Index have firms with 1.12-1.3% lower TFP level and 1.7% labour productivity level.
Breda et al. (2019)	US	2000-2016	Panel OLS, IV regression	Log TFP is the residual of a regression of log membership on log assets and log of number of employees.	Log of Herfindahl Index	Point estimates: a change from no competition at all to very high competition increases TFP by 0.2 to 0.3 log points
Siedschlag et al. (2019)	EU 20	2002-2014	Two stages IV regression	Log of labour productivity level: value addedd	1) Market share of top-10 firms (CR10); 2)Herfindahl-Hirschman Index (HHI)	Semi-elasticity: an increase in CR10 (HHI) by one unit is associated with a decline in labour productivity by 21.7%.(174.9%).
Ganglmair, et al. (2020)	Germany	2006-2016	OLS regression with year and industry fix effect	Log of TFP: log of net sales; log of labour productivity level log revenues per employee	Log of mark-ups measured as firms' cost-price margins	Elasticity: a 1% increase in price mark-ups lowers productivity by 1.3 p.p. (labour productivity) to 1.5 p.p (TFP).

Focusing on a subset of Euro Area countries, Weyerstrass and Jaenicke (2008) analyse the influence of mark-up on productivity over the period 1976-2004 at the aggregate level. Using fixed country effects, they estimate that a reduction of the mark-up in the Euro Area by around 10% would raise average TFP growth in the Euro Area by 0.57 p.p. The effect ranges from 0.5 p.p. in Finland and the Netherlands to 0.75 p.p. in Italy. Moreover, a reduction of the mark-up in the Euro Area by 10% would raise the growth rate of trend labour productivity by 0.15 p.p. (within bounds of 0.13 p.p. in the Netherlands to 0.2 p.p. in Italy). Ospina and Schiffbauer (2010) identify the effects of competition on firm-level productivity in Eastern European and central Asian countries, using the World Bank Enterprise Survey database. They find that having a 20% higher mark-up leads to a 1.2% lower TFP level and 8% lower labour productivity level. Moreover, countries that deregulated during the period have experienced a more pronounced increase in competition. The contribution to productivity growth due to competition spurred by these reforms is around 12–15%.

Using a firm-data panel database, Carvalho (2018) finds that Portuguese firms operating in a market with 10% higher Herfindahl index experience, on average, an 11.2-13% lower TFP and 17% labour productivity.

Breda et al. (2019) exploit US trade union data, which contains both prices and quantity of the service sold by all providers in the sector. They conclude that entrants into the sector have initially greater TFP and lower prices than those set by incumbents. Subsequently, incumbents respond to the increased competition through reductions in their prices. Consequently, aggregate TFP increases. In particular, they find that a change from "no competition at all" (the Herfindahl index is equal to one) to very high competition (the Herfindahl index is close to zero) increases TFP by 0.2 to 0.3 log points.

Using CompNet and WIOD data, Siedschlag et al. (2019) investigate the effect of the Single market in the EU by assessing the responsiveness of competition and productivity to trade integration. They conclude that an increase in Top 10 firm (Herfindahl-Hirschman, HHI) concentration index by one unit is associated with a decline in labour productivity by 21.7% (174.9%). Given that the average value of the Top 10 firm (HHI) index is 0.45 (0.053), this implies that an increase in 1% of Top 10 firm (HHI) concentration index would decrease the labour productivity by 9.76% (9.27%).

Finally, Ganglmair et al. (2020) study the role of firm's competition on their productivity in Germany. To this end, they estimate firm-level price-cost margins in the form of price mark-ups as a proxy for a firm's pricing power and the degree of competition that it is exposed to. They conclude that, when the lagged mark-up is also taken into account, a 1% increase in price mark-ups lowers the productivity level by 1.3% (labour productivity) to 1.5% (TFP). The effects are stronger for the trade sector (with a 4 % decrease) than in manufacturing (with a 2% decrease). On the contrary, for firms in service-related sectors an increase in price mark-ups has a small but positive effect on firm-level productivity.[28]

From Table A.4.1 it is evident that in the literature there is a wide range of productivity measures and, particularly, of competition environment, as these variables cannot be observed directly.

For example, at the aggregate and sectorial level, productivity may be measured in terms of labour productivity (output per unit of labour) or of TFP (output per unit of combined inputs). On the contrary, at the firm level it is calculated by measuring the number of units produced relative to employee labour hours or by measuring a company's net sales relative to employee labour hours. As these variables are unobserved, their estimations may give rise to some measurement and quality data issues (see Syverson, 2011). For example, the firm-level TFP series mix up genuine TFP (TFPQ) and mark-ups, as firm-level prices are not observables. Analogously, the strength of competition may be proxied by different measures: mark-up estimation, concentration indexes, market shares or by survey indicators describing the perceived intensity of competition by managers. However, only those studies who focus on the link between mark-up and productivity are of interested here. This is because, even if all the

[28] The authors consider also the indirect effect of price mark-ups on productivity via innovation. However, here we are interested only in the on the overall effect, so we do not take into account that part of the analysis.

indexes of concentrations (different from mark-ups) are directly and positive correlated to the mark-up level of the economy/sector or industry, they should be combined to elasticity between such indicators and mark-ups.

For geographical and temporal span reasons, we choose the labour elasticity proposed by Weyerstrass and Jaenicke (2008). This is because the estimation of TFP elasticity relies on additional assumptions on production, capital and labour markets that are unknown, while labour productivity is easier to map with the QUEST model assumptions. Therefore, in the following, we can prudentially assume that due to a 1% decrease in mark-up, labour productivity growth increases by 0.015 p.p.

A.4.3 Macroeconomic simulations

To better understand the implications of adding an additional productivity shock to the baseline macro-simulation, it is useful to discuss the propagation mechanisms of productivity shock in the QUEST model. This shock has been modelled as a temporary shock to the labour augmenting productivity growth, resulting in a permanent level increase.

A positive labour augmenting productivity shock level has a negative impact on the marginal costs of production. Consequently, firms lower their prices, the GDP deflator is reduced, while real wages rise. The increase in real wages stimulates consumption, which leads firms to produce more. Expected higher returns increase private investment. In the short run the productivity shock has a negative impact on employment due to the nominal and real rigidities.[29] In the medium-long run the effect is positive, in light of the increase in the supply capacity and higher aggregate demand.

Table A.4.2 Macroeconomic impact of productivity level (+0.6 p.p.)

	1	5	10	50
GDP	0.279	0.378	0.429	0.476
GDP deflator	-0.140	-0.104	-0.112	-0.091
Agg. Employment	-0.060	0.023	0.047	0.008
Labour productivity	0.339	0.355	0.382	0.468
Agg. Consumption	0.466	0.556	0.598	0.632
Consumption Savers	0.515	0.58	0.616	0.66
Consumption Liq. Constr.	0.209	0.428	0.505	0.483
Investment	0.164	0.284	0.342	0.415
Wage income high skilled	0.226	0.621	0.766	0.658
Wage income low skilled	0.221	0.574	0.695	0.621
Profits high skilled	0.591	0.116	0.271	0.599

Note: Numbers are expressed as percentage deviation from the equilibrium un-shocked values. Columns report the impact after 1,5,10, and 50 years.

Table A.4.2 reports the results of the macroeconomic impact simulated due to the permanent productivity shock of the same magnitude of the mark-up shock used in the baseline scenario (0.6 p.p.). Comparing the results with those presented in Table 4.2, it is worth noting that productivity shock has a greater impact on the macroeconomic variables. When the economy is hit by the mark-up shock, firms do not fully adjust their prices downward to the new lower level of marginal costs because of the presence of price stickiness. On the contrary, the productivity shock influences directly the productive function, expanding their productive possibilities.

[29] This is a very standard result in the New Keynesian literature.

Based on the empirical evidence reported in the previous section, we can cautiously assume that a 1% decrease in mark-up leads to labour productivity growth increase by 0.015 p.p., as in Weyerstrass and Jaenicke (2008). However, we cannot apply directly this elasticity value, η, to the QUEST model, but we need to translate it into a labour augmenting productivity shock, taking into account the specification of the production function used in our macro-model.

In QUEST model, the production function takes the form of Cobb-Douglas production function with constant return of scale, specified as follows:

$$Y = (AY \cdot L)^{\alpha} K^{1-\alpha} \quad \text{(A.4.1)}$$

The production function links the total output obtained by firms to the factor inputs used in the production (in our case, capital, K, and labour, L). α is the output elasticity of labour input, while AY is the labour augmenting productivity shock.

By definition, labour productivity is defined as output in terms of labour input, Y/L. This measure can be easily obtained dividing equation (A.4.1) by L:

$$\frac{Y}{L} = (AY)^{\alpha} \left(\frac{K}{L}\right)^{1-\alpha} \quad \text{(A.4.2)}$$

Keeping an ex-ante capital intensity (K/L) constant, the empirical elasticity of labour productivity growth over mark-up, η, can be translated into a shock to labour augmenting productivity (AY) using the following formula:

$$\frac{\eta}{\alpha} \Delta \text{MUP} \quad \text{(A.4.3)}$$

where the ΔMUP represents the percentage variation in the mark-up level of 4.6%. The QUEST parameter α is calibrated to be 0.65, as in Havik et al. (2014). This implies that the size of the labour augmenting productivity shock induced by the decrease in mark-up is 0.11 p.p.

Table A.4.3 Macroeconomic impact of MUP (-0. 6 p.p.) and productivity (+0.11 p.p.) shocks in the baseline scenario

	1	5	10	50
GDP	0.211	0.346	0.448	0.619
GDP deflator	-0.141	-0.171	-0.23	-0.362
Agg. Employment	0.114	0.201	0.246	0.24
Labour productivity	0.097	0.145	0.201	0.378
Agg. Consumption	0.261	0.358	0.456	0.612
Consumption Savers	0.25	0.292	0.38	0.54
Consumption Liq. Constr.	0.316	0.708	0.864	0.994
Investment	0.467	1.079	1.309	1.462
Wage income high skilled	0.279	0.57	0.7	0.917
Wage income low skilled	0.529	1.198	1.49	1.634
Profits high skilled	0.481	1.117	1.355	1.503

*Note: Numbers are expressed as percentage deviation from the equilibrium un-shocked v*alues. Columns report the impact after 1,5,10, and 50 years

Table A.4.3 reports the baseline scenario macroeconomic impact of a decrease in mark-up by 0.6 p.p. combined with a temporary shock to the labour productivity growth (resulting in a permanent level increase of productivity by 0.11 p.p.). As expected, the inclusion of a labour productivity shock in addition to the mark-up shock produces a higher increase in GDP with respect to our baseline scenario (Table 4.2). In particular, the impact on GDP is equal to 0.35 p.p. after five years.

A.5. DESCRIPTIVE ANALYSIS OF ANTITRUST INTERVENTIONS (OTHER THAN CARTELS) BY THE EUROPEAN COMMISSION OVER THE PERIOD 2012-2019[30]

A.5.1 Introduction

This annex provides a descriptive analysis of antitrust interventions by the European Commission over the period 2012-2019. Section A.5.2 considers the number of interventions aimed at stopping anticompetitive behaviour, while section A.5.3 reports on the fines imposed in the case of prohibition decisions. Section A.5.4 considers whether there is sufficient scope for the collection of the data required for the conduct of simulations of the macroeconomic impact of antitrust interventions. Section A.5.5 concludes and discusses a possible follow-up of the present exercise.

A.5.2 Development over time of the Commission's antitrust interventions

Over the period 2012-2019, the European Commission took 50 decisions aimed at stopping anticompetitive behaviour under Articles 101 (excluding cartels), 102 and 106 of the Treaty on the Functioning of the European Union (TFEU). Often the European Commission starts a case investigation in response to a formal complaint. Such an investigation may ultimately lead to a prohibition or commitment decision. Then again, the Commission may conclude that there are insufficient grounds for conducting a further investigation into the alleged infringement(s) and consequently reject the complaint pursuant to Article 7(2) of Regulation No. 773/2004. In this case, the Commission adopts a rejection decision. Actually, complaint rejection decisions occur quite frequently. In the period 2012-2019, the Commission adopted 58 complaint rejection decisions in addition to its 50 antitrust decisions. Complaint rejection decisions are no further considered here since they are unlikely to have immediate customer benefits. In the discussion below, we will therefore abstract from the rejection decisions and focus on the 50 prohibition and commitment decisions.

Figure A.5.1 illustrates the changes over time in the number of antitrust decisions taken by the European Commission. There is a significant variation from year to year, with ten or more decisions being taken in 2018 and 2019 and only two decisions taken in 2015. This dip in the number of decisions taken in 2015 coincides with the arrival of the Juncker Commission. The annual average number of antitrust decisions taken is 6¼, which is just above the average number of cartel prohibitions (5), but well below the average number of merger interventions (more than 20).

[30] Prepared by Adriaan Dierx (DG COMP) and Fabienne Ilzkovitz (ULB)

Figure A.5.1: Number of antitrust decisions (2012-2019)

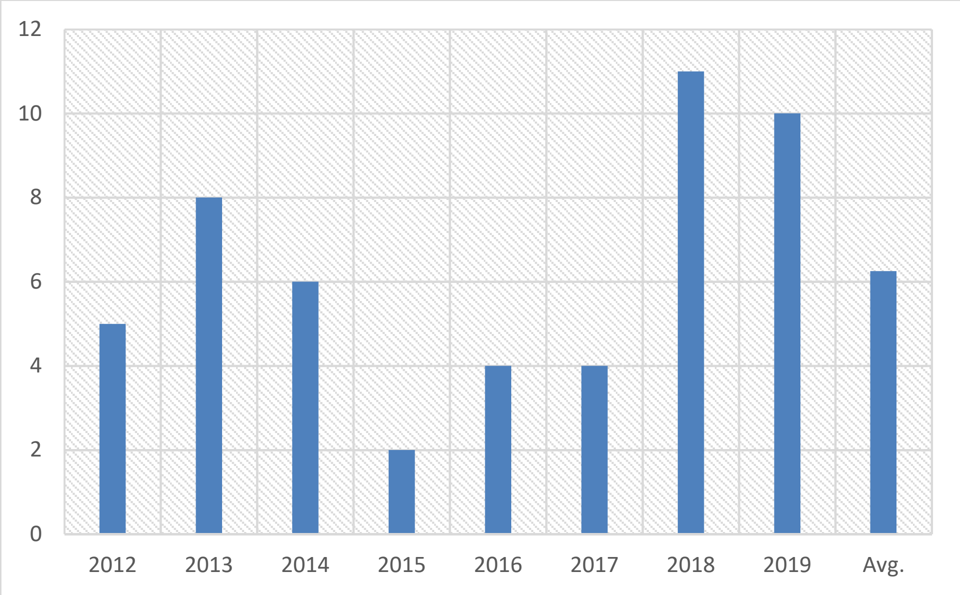
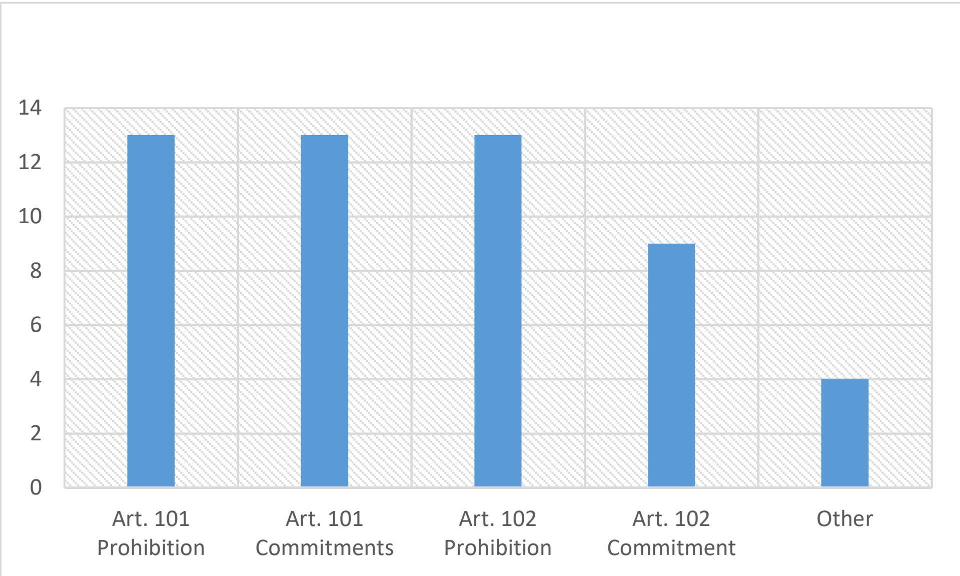


Figure A.5.2 makes a distinction between the types of decision taken. Decisions under Article 101 TFEU target agreements and concerted practices between companies, which prevent, restrict or distort competition within the EU internal market. Decisions under Article 102 TFEU are aimed at stopping abusive behaviour by companies that have a dominant position in a particular market. Two decisions, i.e. the Rio Tinto Alcan decision of 2012 and the Perindopril (Servier) decision of 2014, used both Article 101 and 102 as a legal base, which explains why the total number of decisions in Figure A.5.2 adds up to 52. The 'Other' decisions include a decision making the Hellenic Republic's commitments under Art.106 TFEU in the Greek lignite case legally binding as well as three procedural decisions under Art.8 and Art.23 of Council Regulation (EC) No 1/2003.

Figure A.5.2: Types of antitrust decisions (2012-2019)



A case investigation by the European Commission may result in a decision prohibiting (under Article 7 of Regulation 1/2003) the identified infringement of Article 101 or 102 of the TFEU. Alternatively, the companies involved may suggest commitments addressing the European Commission's competition concerns. Under Article 9 of Regulation 1/2003, the European Commission can take the decision to make the proposed commitment legally binding. Table A.5.1 summarises the information available on the number of decisions of different types taken between 2012 and 2019.

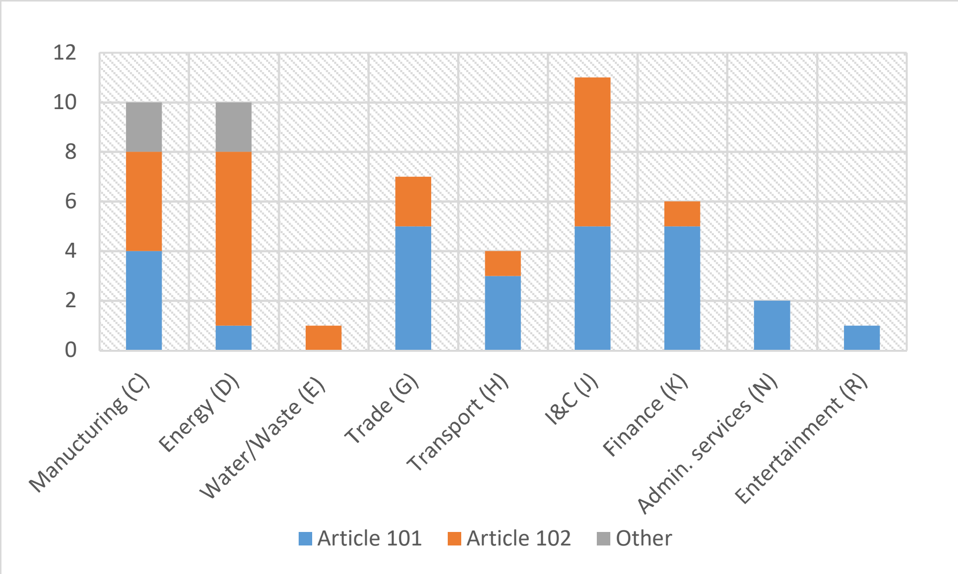
Figure A.5.2 and Table A.5.1 show that 26 decisions concern anticompetitive agreements under Article 101 and 22 decisions address abuses of a dominant position under Article 102. Exactly half of Article 101 cases were resolved by commitments of the companies involved, while for the other half the Commission had to issue a prohibition decision. For Article 102, the situation rather similar with 13 prohibition decisions and 9 commitment decisions. As already mentioned, two decisions are double counted because they concern infringements of both Article 101 and 102.

Figure A.5.3 describes the sector distribution of the 50 antitrust decisions taken over the period 2012-2019. Almost two thirds of the decisions taken concern the manufacturing (NACE classification C), energy (D) and information and communication (J) sectors. Other sectors with a significant number of cases are the wholesale and retail trade (G), transport (H) and finance (K) sectors. In manufacturing and information and communication (I&C) decisions are about equally divided between Art. 101 and 102. In energy most decisions concern anticompetitive agreements under Article 101, while in trade, transport and finance most decisions concern the abuse of dominance under Article 102.

Table A.5.1: Number of antitrust decisions (2012-2019)

	Art. 101		Art.102		Other
Year	**Prohibition**	**Commitments**	**Prohibition**	**Commitment**	
2012	*0*	*3*	*0*	*2*	*1*
2013	*3*	*2*	*0*	*2*	*1*
2014	*1*	*1*	*4*	*1*	*0*
2015	*0*	*1*	*0*	*1*	*0*
2016	*0*	*3*	*1*	*0*	*0*
2017	*1*	*0*	*2*	*1*	*0*
2018	*5*	*0*	*3*	*2*	*1*
2019	*3*	*3*	*3*	*0*	*1*
Total	***13***	***13***	***13***	***9***	***4***

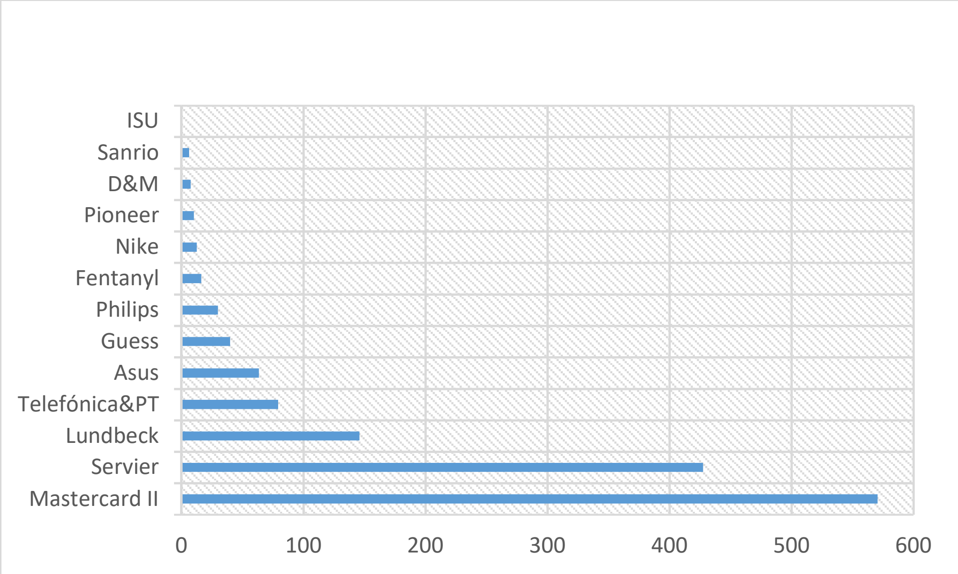
Figure A.5.3: Sector distribution of Article 101 and 102 decisions (2012-2019)



A.5.3 Fines imposed for infringements of antitrust rules

A company that has participated in an anticompetitive agreement and so infringed competition law under Article 101 may have to pay a fine. The level of the fine depends on the company's annual sales of the product concerned by the infringement as well as the gravity and duration of the infringement. Figure A.5.4 illustrates the total amount of fines levied on companies being the object of the different prohibition decisions under Article 101. The figure illustrates the large variation in the levels of fines imposed, varying from 571 million euro in the Mastercard II case to zero in the case brought against the International Skating Union (ISU), where the European Commission decided not to levy a fine because of the unique nature of the infringement by the sport's governing body. Moreover, the offending ISU rules that determined whether skaters could participate in international speed skating events had been publicly known since their adoption in 1998. Other notable decisions are the Perindopril (Servier), Lundbeck and Fentanyl decisions in the pharmaceutical sector, which concern 'pay-for-delay' patent settlements blocking competition from generic drugs, as well as the Commission's decision to fine Telefónica and Portugal Telecom for an illegal non-compete contract clause. In addition, in 2018 the Commission fined four consumer electronics manufacturers (Asus, D&M, Philips and Pioneer) for fixing online resale prices. The decisions in the Sanrio, Nike and Guess cases concerned illegal restrictions on cross-border sales.

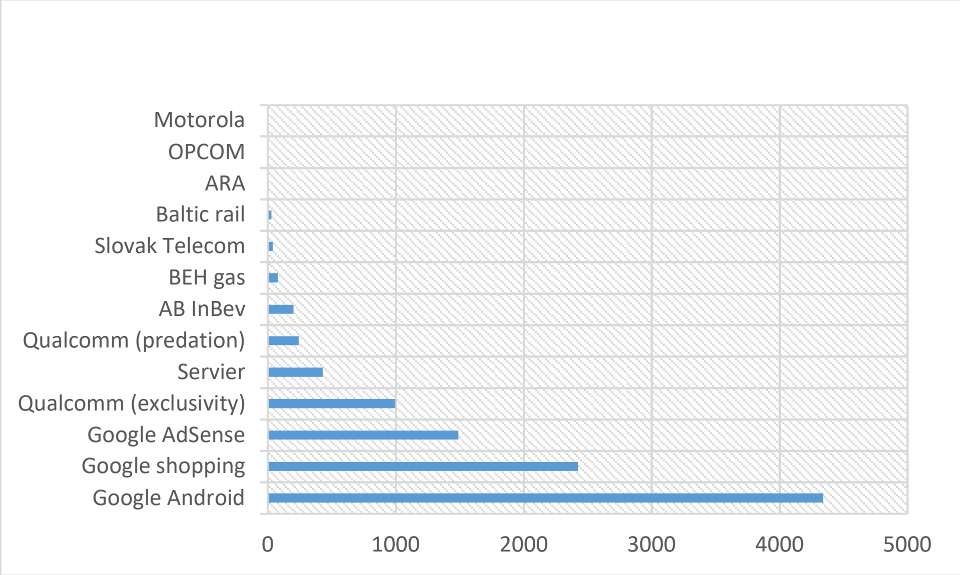
Figure A.5.4: Fines levied (in millions of euro) in prohibition decisions under Article 101



Under Regulation 1/2003, the Commission may also levy fines on companies having abused their dominant position in the market, as part of its Article 102 prohibition decision. The starting point for the fine is the percentage (up to 30%) of the company's annual sales of the product concerned in the infringement. This is then multiplied by the number of years and months that the infringement lasted. Depending on the circumstances of the infringement the fine can be increased or decreased, with the maximum level of the fine being capped at 10% of the overall annual turnover of the company. The fines reported here are the fines charged by the European Commission in its initial case decision. They do not reflect possible reductions imposed by Court reviews.

Figure A.5.5 illustrates the total amount of fines levied on companies being the object of the different prohibition decisions under Article 102. The top fines are significantly larger than those applied in prohibition decisions made under Article 101. Once more, one can observe a large variation in the level of fines imposed, with the fine imposed in the Google Android case topping the list at more than 4.3 billion euro, followed by the Google search (shopping) and the Google AdSense cases. The Android case addressed the illegal restrictions imposed by Google on Android device manufacturers and mobile network operators with the aim of strengthening the dominance of its search engine. The search (shopping) case concerned the abuse of Google's dominance as a search engine to give an illegal advantage to its own comparison shopping service, and in its AdSense decision the European Commission prohibited Google's abusive practices in online advertising. Other substantial fines were levied on Qualcomm for its predatory behaviour in forcing a competitor out of the market and for making payments to a key customer in order to remain the exclusive supplier. The Perindopril (Servier) case, which concerned a series of deals aimed at protecting Servier's bestselling blood pressure medicine, perindopril, from price competition by generics, was brought under both Article 101 and 102. AB InBev was fined 200 million euro for restricting cross-border sales of beer. In the Motorola case, the European Commission decided not to impose a fine because of a lack of case law on the misuse of standard essential patents. The fines of 1 million euro on OPCOM and of 6 million euro on ARA are relatively small, making them invisible in the graph.

Figure A.5.5: Fines levied (in millions of euro) in prohibition decisions under Article 102



If the Commission takes a commitment decision under Article 9 of Regulation 1/2003, it accepts the commitments offered by the companies involved, without having established that an infringement of competition law has occurred. This therefore implies that a fine is imposed only if the company concerned does not obey the commitments made legally binding by the Commission decision. For example, in 2013 Microsoft was fined 561 million euro for its failure to comply with its 2009 commitment to offer users a browser choice screen enabling them to easily choose their preferred web browser.

A.5.4 Availability of indicators used for macro-modelling purposes

This section considers whether there is sufficient scope for the collection of the data required for the conduct of simulations of the macroeconomic impact of antitrust interventions. Since 2012, the JRC in close collabouration with DG COMP and DG ECFIN has carried out simulations of the impact of the European Commission's merger interventions and cartel prohibitions. The data used for this exercise are collected by DG COMP for the purpose of calculating the customer savings resulting from its competition policy interventions and include: (1) the price increase avoided; (2) the size of the market affected; and (3) the expected duration of the price effect in the absence of an intervention. While DG COMP does not calculate the customer savings from antitrust interventions other than mergers and cartels, other competition authorities, including those in the US, the UK and Japan, do so. The OECD (2014) has prepared guiding principles on how to calculate customer savings resulting from interventions in abuse of dominance cases (covered under EU legislation by Art.102 TFEU). No such guidance exists for agreements and concerted practices (other than cartels) under Art. 101 TFEU. Nevertheless, we would propose following the OECD guidance as a point of departure for the data values to be used in the model simulations, with some slight modifications to reflect the realities of EU antitrust policy (see Table A.5.2).

Table A.5.2: Assumptions and data sources for antitrust simulations

	OECD suggestion for Art.102 cases		Proposed approach for Art. 101 and 102 cases	
	Assumption	**Source**	**Assumption**	**Source**
Avoided price increase	*Price increase of 5%*	*Whenever possible use case specific information*	*Price increase of 5-10%*	*Empirical literature and practice of other competition authorities*
Affected turnover	*Ex-ante turnover of the companies under investigation in the affected market(s)*	*Whenever possible use case specific information*	*Annual turnover of the companies under investigation in the affected market(s)*	*Case-specific information*
Duration	*3-years*	*Whenever possible use case specific information*	*3-years*	*Whenever possible use case specific information*

We can safely assume that the avoided price increase due to a prohibition decision under Article 101 or 102 TFEU is equivalent to the price increase attributed to the corresponding antitrust infringement. Measurement of this price increase "requires a measure of the counterfactual price which would have prevailed 'but for' the infringement".[31] Oxera (2009) describes the different economic methods and models that can be used to measure the price effects of antitrust infringements, and on that basis the European Commission (2013) published a practical guide on how to quantify the harm from antitrust infringements. This guide makes no distinction between infringements under Article 101 and 102 TFEU. However, it distinguishes the immediate harm to customers due to the rise in prices resulting from anticompetitive behaviour from the indirect harm to customers associated with the exclusion or 'foreclosure' from the market of competitors. However, no estimates of the size of the direct and indirect price effects are given. This is an issue which merits further discussion, especially if the indirect effects of foreclosure are felt primarily in an adjacent market (as in the Qualcomm predation case).

To our knowledge there are very few empirical studies quantifying the direct price effects of infringements of Article 101 and 102 TFEU. Two recent studies[32] for the European Commission provide relevant evidence in abuse cases under Article 102 TFEU. The Telekomunikacja Polska (TP) study reports that DSL broadband "prices charged by the Polish incumbent were 9.8 percentage points higher than what they would have been without the abuse" (see Page 189). The E.ON study shows an 'economically relevant' reduction of peak wholesale electricity prices because of E.ON's commitment to divest 5,000 MW of generation capacity (see Page

[31] See page v, RBB Economics et al. (2016).
[32] See chapters 5 and 6, respectively, in Ilzkovitz and Dierx (2020).

229). Both results indicate that the 5% avoided price increase suggested by the OECD for abuse cases is a rather conservative assumption. Both the ACM and the CMA have adopted a price effect of 10% (see Table 3 in OECD (2014)). We would therefore propose adopting a price effect in the range[33] of 5-10%, not only for abuse cases under Article 102 but also for cases concerning agreements and concerted practices under Article 101.[34]

For the measurement of the affected turnover, we propose following the OECD guidance. Information on the annual turnover of the companies under investigation in the affected market(s) can be obtained from the case file. For prohibition decisions, we would suggest simply using the value of sales used for the calculation of the fine. For commitment decisions, a more in-depth investigation of the case file will likely be necessary. However, as the average number of yearly commitment decisions remains well below three, this effort should be manageable.

Similarly, we would suggest following the OECD in adopting a 3-years duration, at least initially. At a later stage, we could investigate whether there is any case-specific information showing that the duration of the price effect of the Commission's decision is shorter or longer than the 3-year standard.

These assumptions, in all their simplicity, allow exploiting case-specific information, where available, while referring to the literature/practice of other competition authorities, otherwise.

In addition to this data collection effort, each case needs to be attributed to a NACE four-digit sector. For most cases, a single four-digit sector is provided on the DG COMP website. For the limited number of cases assigned to two or more four-digit sectors, an assignment to a single four-digit sector has been made, to be verified with the case team.

A.5.5 Conclusion and follow-up

A descriptive analysis of antitrust enforcement by the European Commission shows that over the period 2012-2019 25 prohibition decisions, 22 commitment decisions and 3 procedural decision were taken. The annual number of decision taken fluctuated between five and eleven, with the exception of 2015 when the incoming Juncker Commission adopted only two commitment decisions. Articles 101 and 102 were used as a legal basis for the decisions taken in almost equal measure. The decisions covered a wide range of sectors, including manufacturing, energy, retail and wholesale trade, transport, information and communication, and finance.

Prohibition decisions often impose a fine on the companies that have infringed on the EU's competition rules. The level of such fines depend on a number of factors, including the company's annual sales of the product concerned in the infringement. This explains to some extent, the large variation in the level of fines imposed in the different decisions.

This technical annex also considers whether there is sufficient scope for the collection of the data required for the conduct of simulations of the macroeconomic impact of antitrust interventions: (1) the price increase avoided; (2) the size of the market affected; and (3) the

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[33] To be compared with a price effect for cartel prohibitions in the range of 10-15% and for merger interventions in the range of 3-5%.

[34] For cartel cases, the OECD (2014) recommends basing the customer savings calculations on a price overcharge of 10%, which implies that the proposed range of 5-10% for other infringements of Article 101 represents a rather conservative assumption.

expected duration of the price effect in the absence of an intervention. It proposes following the OECD guidance to use case-specific information whenever possible, as an ultimate goal. However, as no such information is immediately available for the price increase avoided nor for the duration of this effect, we suggest adopting a gradual approach.

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KD-04-21-012-EN-N
doi: 10.2763/473550