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INSTITUTIONAL SHAREHOLDING, COMMON OWNERSHIP AND PRODUCTIVITY: A CROSS-COUNTRY ANALYSIS

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By Maria Bas, Lilas Demmou, Guido Franco and Javier Garcia-Bernardo

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ABSTRACT/RÉSUMÉ

Institutional shareholding, common ownership and productivity: a cross-country analysis

The increase in institutional ownership, the shift towards passive portfolio management and the rise of common ownership have transformed OECD countries financial markets in the last decades. The paper investigates the potential consequences of these transformations on firm's productivity, using granular data on firms financial and ownership structure as well as a variety of econometric methods. The analysis suggests that the rise of institutional investors is overall not a major concern from a productivity standpoint: firms displaying higher institutional ownership tend to have higher productivity levels and growth rates compared to their peers, though the positive relationship tends to vanish when institutional investors' time horizon is short. Moreover, inter-industry common ownership is related to higher firm-level productivity and this positive relation is stronger for firms operating in intangible-intensive and digital sectors, potentially hinting to an easing of vertical relationships and/or technological spillovers when firms operating in different sectors are owned by the same equity holders. On the contrary, the correlation with intra-industry common ownership appears negative, though not always significantly, potentially due to lower competition.

JEL codes: D22, D24, G32.

Keywords: productivity, institutional ownership, common ownership.

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Investissement institutionnels, structure commune de la propriété d'entreprise et productivité

L'essor de l'investissement institutionnel, de la gestion passive de portefeuille et de structures de propriété commune entre les investisseurs ont transformé les marchés financiers des pays de l'OCDE au cours des dernières décennies. L'article étudie les conséquences potentielles de ces transformations sur la productivité des entreprises, en utilisant des données granulaires sur la structure financière et de propriété des entreprises ainsi qu'une variété de méthodes économétriques. L'analyse suggère que la montée des investisseurs institutionnels n'est globalement pas une préoccupation majeure du point de vue de la productivité : les entreprises affichant une propriété institutionnelle plus élevée ont tendance à avoir des niveaux de productivité et des taux de croissance plus élevés par rapport à leurs pairs. Cependant, cette relation positive tend à disparaître lorsque l'horizon temporel des investisseurs institutionnels est court. De plus, une structure de propriété commune entre les investisseurs institutionnels au niveau inter-industriel est liée à une productivité plus élevée au niveau de l'entreprise et cette relation positive est plus forte pour les entreprises opérant dans les secteurs à forte intensité en actifs immatériels et numériques, suggérant que lorsque les entreprises opèrent dans des secteurs différents mais qu'elles sont détenues par les mêmes actionnaires, les relations verticales sont assouplies et/ou les retombées technologiques favorisées. Au contraire, une structure de propriété commune entre les investisseurs institutionnels au niveau intra-industriel est associé a une moindre productivité, potentiellement du fait d'une moindre concurrence, mais ce résultat n'est pas toujours significatif.

Classification JEL: D22, D24, G32.

Mots-clés: productivité, investissement institutionnel, structure de propriété commune.

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Institutional shareholding, common ownership and productivity: a cross-country analysis

By Maria Bas, Lilas Demmou, Guido Franco and Javier Garcia-Bernardo[1]

1. Introduction

1. Financial markets in OECD countries have undergone significant transformations over the past decades. The role of institutional investors in equity markets has grown, contributing to a shift in the investment strategy of equity holders towards passive portfolio management (i.e. investment vehicles that mimic the performance of a market index such as the S&P 500) and an increase in common ownership across competing companies.

2. The objective of this study is to investigate the potential consequences of the rising importance of institutional investors on listed firm's productivity, given their role in allocating private savings across firms and influencing firms' investment decisions. We focus on two main channels: a governance channel, looking at the institutional owners' business model (e.g. engagement, time horizon etc.); and a common ownership channel, analysing simultaneous ownership of shares in competing firms (i.e. intra-industry) or potentially vertically integrated firms (i.e. inter-industry). Previous studies linking ownership structure to economic performance have mostly focused on specific countries, sectors or firms, and looked predominantly at profitability or innovation (Aghion et al., 2013; Brossard et al., 2013). To the best of our knowledge, this paper is the first attempt to understand the productivity implications of financial market transformations for a larger number of countries and industries.

3. The analysis relies on a rich firm-level dataset (Orbis) covering financial and ownership information of firms located in 18 countries and operating both in manufacturing and non-financial services industries,

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over the period 2007-2019.[2] The empirical strategy horse-races a set of alternative econometric methods, including fixed effects panel data models, propensity score matching and catch-up growth models. Further, based on recent advancements in the literature (Azar et al., 2018; Azar and Vives, 2021b), the paper relies on the computation of innovative measures to capture the extent to which firms are owned by the same equity holders within and across sectors as well as whether they are at the core of investors networks.

4. Our main findings suggest a positive relationship through the governance channel: firms displaying higher institutional ownership tend to have higher productivity levels and growth rates compared to their peers. The positive correlation tends to vanish when institutional investors' horizon shortens, while it appears larger the higher the shares of large diversified owners. The implication of common ownership critically depends on whether the simultaneous ownership of shares occurs intra- or inter-industry: inter-industry common ownership is related to higher firm-level productivity, potentially due to technological spillovers over the value chain and a more efficient network of vertical relationships; conversely, the consequences of intra-industry common ownership appears negative, though not always significant, potentially due to lower competition. As a result, the analysis delivers insights with respect to two potential risks and related policy areas: i) investors' short-termism and hence a role for policy to encourage long-term investment; ii) potential adverse competition implications of intra-industry common ownership and hence a hypothetical role for anti-trust policies.

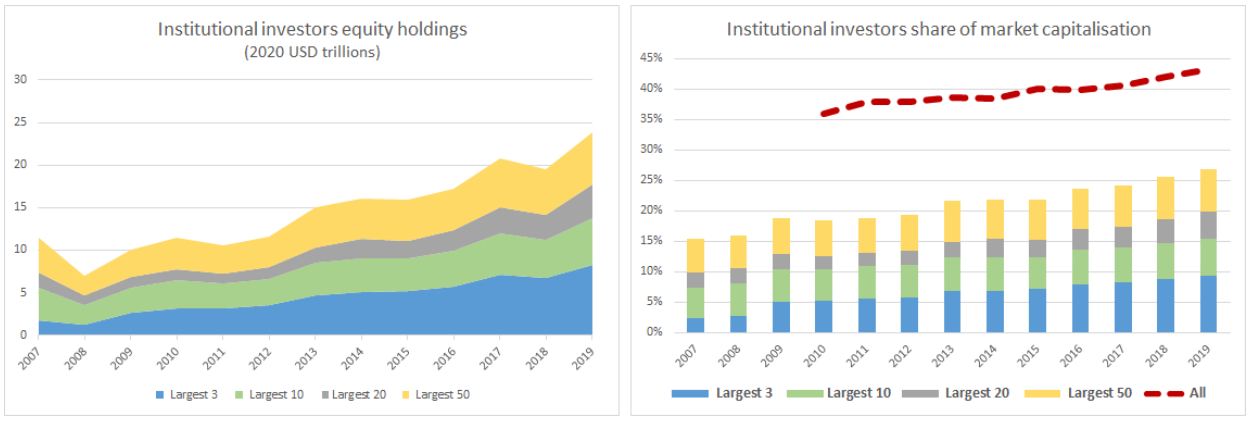
5. The paper proceeds as follows. Section 2 documents the recent developments in equity markets. Section 3 overviews the main channels through which changes in equity markets, and in particular the rise of institutional owners, could affect productivity. In Section 4, we describe the data and the main variables used in the analysis. Section 5 and 6 present the methodological framework and the main findings with respect to both the governance and the common ownership channels, respectively. Section 7 concludes and discusses the policy implications of the analysis.

2. Equity markets have experienced significant changes

6. The importance of institutional investors has steadily increased over time, both in terms of the amount of assets they manage and the share of equity market capitalization they hold. According to a recent OECD paper (Medina et al., 2022), global assets under management by the top 50 institutional investors reached USD 24 trillion in 2019, a twofold increase compared to 2007 (Figure 1, left panel). As a result, the percentage shares held by the top 50 institutional investors displayed a substantial increase, approximately 70% during the 2007-2019 period (Figure 1, right panel), modifying the equity market landscape. Overall, institutional owners accounted for approximately 43% of global market capitalisation at the end of 2019 (Figure 1, right panel, dashed line) – a relevant percentage compared to the 11% held by corporations, 10% by the public sector, 9% by strategic individuals and 27% by a variety of other entities in 2020 (e.g. direct retail investors, institutional holdings that are below the disclosure thresholds).

[2] We purposedly exclude 2020 in order to abstract from the specific features characterising the pandemic period.

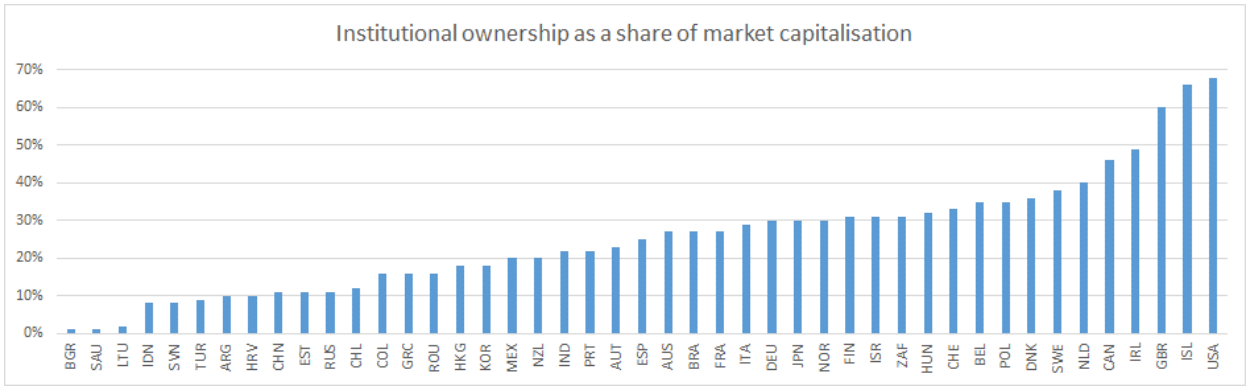
Figure 1. The rise of institutional investors



Source: Medina et al. (2022) – Figure 4.1. Global holdings by the largest 50 institutional investors -- based on OECD-ORBIS Corporate Finance dataset, Refinitiv, as well as OECD calculations based on the OECD-Orbis Productivity dataset.

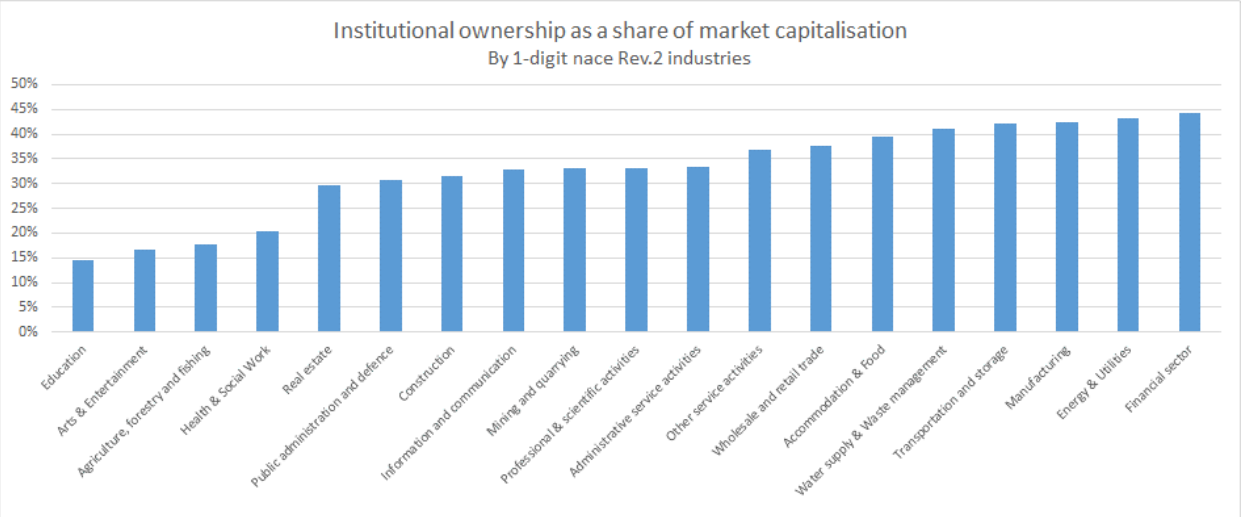
7. While the role of institutional owners has grown in many jurisdictions, cross-country differences remain large. Institutional investors account for more than 20% of market capitalisation in many countries, but varying from negligible percentages in Bulgaria, Saudi Arabia and Lithuania to more than 60% in the UK, Iceland and the U.S. (Figure 2). Large European economies such as France, Germany, Italy and Spain are in the middle of the distribution, with institutional holdings ranging between 20% and 30% of market capitalisation. Moreover, considerable heterogeneity prevails also across sectors, with manufacturing, the financial and the energy sectors featuring the higher average share of institutional ownership (Figure 3).

Figure 2. Institutional ownership across countries, end of 2020



Source: Medina et al. (2022) based on OECD-ORBIS Corporate Finance dataset, Refinitiv.

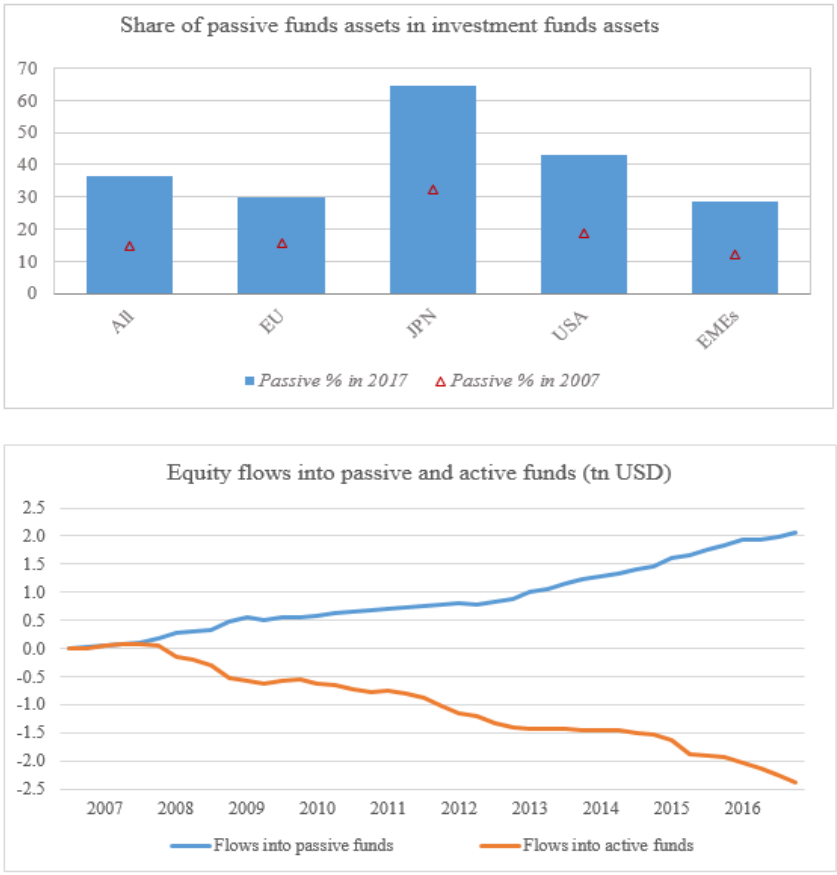
Figure 3. Institutional ownership across sectors, 2010-2019 average



Source: OECD calculations based on Orbis® data.

8. The increasing savings worldwide channelled through institutional owners has contributed to the growth of passive portfolio management, i.e. an investing strategy that tracks a free-float market-weighted index, such as the S&P 500 or MSCI Global Index. The underlying idea is to mimic the performance of the market with minimal management expenses. The shift towards passive management has occurred for three main reasons. First, retirement assets have significantly grown across markets, increasing the demand for diversified and long-term oriented portfolios that do not require very active management. Second, the introduction of index funds as well as of exchange traded funds (ETFs) has provided practical options for investors looking to reduce firm-specific risk exposures at low cost. Third, the ability of active fund management to beat an appropriate passive benchmark investing vehicle has been amply debated, creating incentives for passive investment (French, 2008; Fama and French, 2010; Ibbotson, Chen, and Zhu, 2011; Jurek and Stafford, 2011). In the United States, passive investment accounted for approximately 40% of stock assets in 2017, twice the share observed 10 years before, though the exact percentage is still debated. A similar evolution has been observed worldwide (Figure 4, top panel). Accordingly, BIS data show large equity inflows into passively managed funds and, symmetrically, substantial outflows from active funds (Figure 4, bottom panel). Overall, following this trend, the amount of funds managed via passive index funds and ETFs reached 48% of total equity investment via funds in 2020 (Investment Company Institute, 2021).

Figure 4. Passive investment style has crowded-out active investment style



Note: Top panel. Passive funds' share of investment fund assets, in percent, by geographical focus. Bottom panel. Cumulative equity fund flows towards active and passive funds in trillion USD.
Source: OECD calculations based on BIS data and Sushko and Turner (2018).

9. Related to the increase in passive (or more generally, index) investment is the recent rise in the extent of common ownership, i.e. the tendency of institutional investors to own sizeable holdings in a number of different companies, either within industry (intra-industry common ownership) or across industries (inter-industry common ownership).[3] The high values of the average combined holdings of the largest institutional investors at the firm level in many countries is a first indication of this trend (Figure 5). The combined ownership of the top 3 institutional investors represents circa 23% of the listed equity in *each firm* in large markets as the United States and the United Kingdom (Medina et al., 2022).

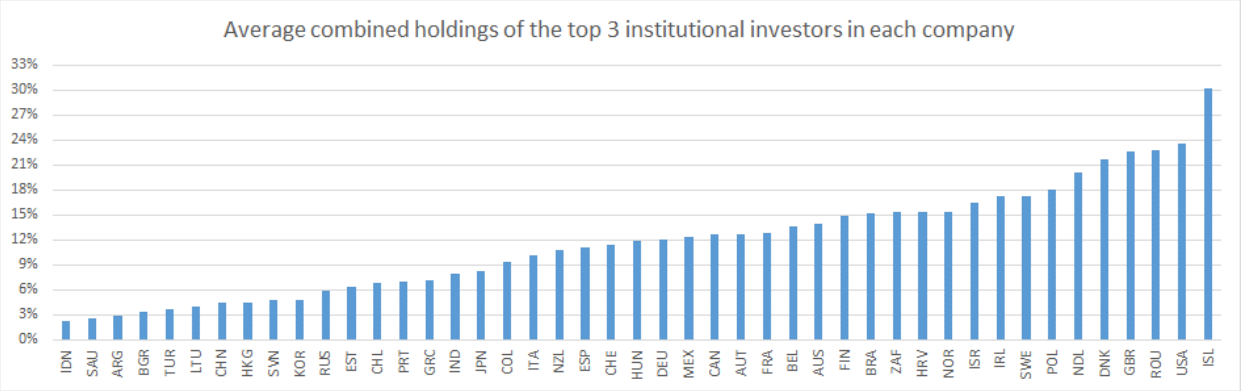
10. To gauge a more immediate intuition of the relevance of intra-industry common ownership, one might think at the following examples: the share of U.S. public firms held by institutional investors that simultaneously hold at least 5% of companies in the same industry has increased from 10% in 1980 to about 60% in 2014 (He and Huang, 2017); similarly, in 2016, institutional investors held more than 60% (45%) of the shares of firms operating in chemical (electronic equipment) sectors in Germany, while pension funds held more than 50% (45%) of the shares in telecommunication (real estate) companies in Iceland (Mancini and Nyeso, 2017).[4] Yet, common ownership is not only an industry specific phenomenon, but rather an economy-wide one, with high levels and increasing trends in simultaneous shareholding

[3] The decreasing competition in the financial industry could be another factor related to the rise in common ownership.

[4] Further details on common ownership at the country-industry level could be found in De La Cruz et al. (2019).

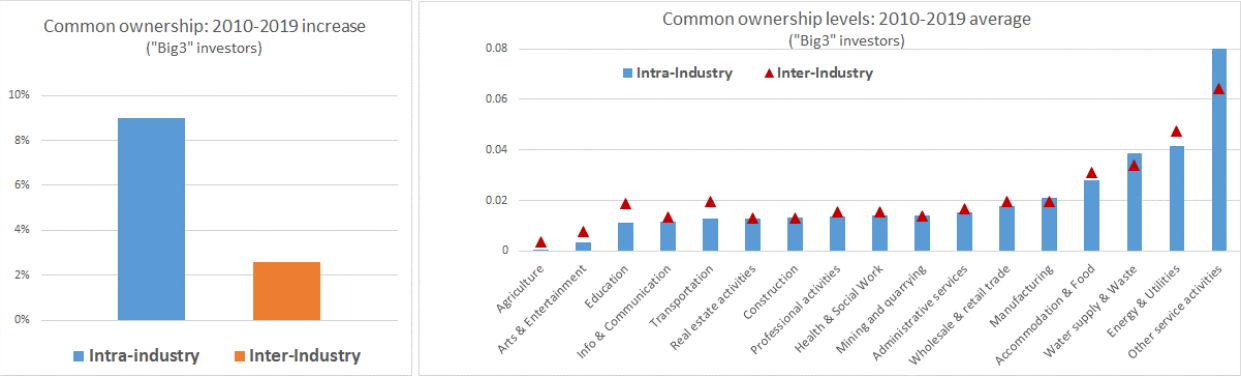
across industries (Azar and Vives, 2021b). These trends are robust to the use of alternative measures for common ownership (see Section 4 for a description of the measures); according to the most conservative one (i.e. displaying the smallest increase), intra-industry common ownership increased by 9%, while inter-industry common ownership by almost 3% from 2010 to 2019 in the whole economy (Figure 6, left panel). The level of common ownership is also heterogeneous across sectors (Figure 6, right panel): other services activities and the energy sector display the highest levels, while common ownership is very low in the agriculture and Arts & Entertainment sectors.

Figure 5. Ownership concentration by institutional investors is high in many countries



Source: Medina et al. (2022) based on OECD-ORBIS Corporate Finance dataset, Refinitiv.

Figure 6. Common ownership over time and across sectors

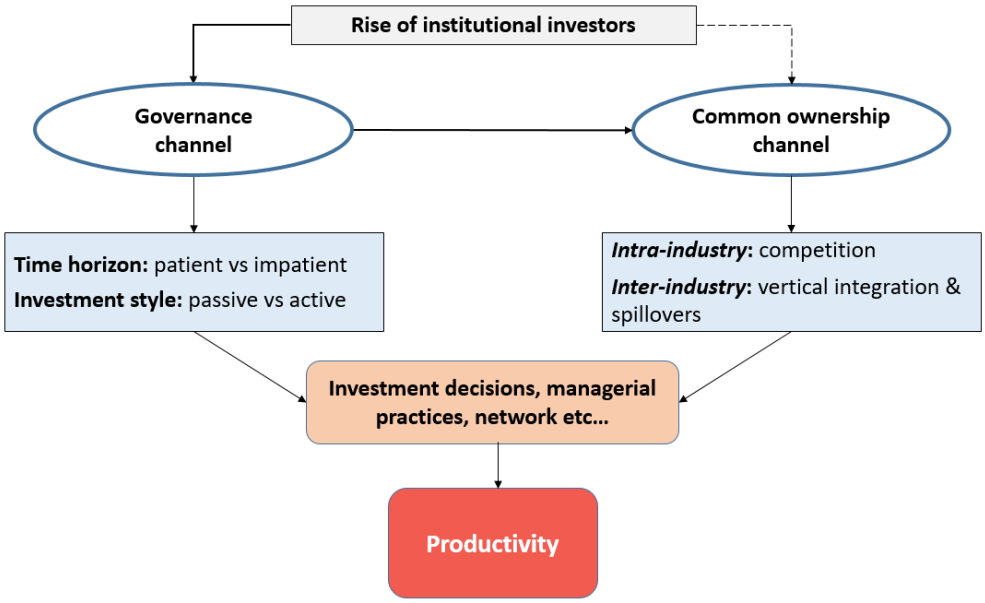


Note: Common ownership is computed according to the measure developed by Azar et al. (2018) and Azar and Vives (2021b), focusing on the so-called "Big 3" investors (BlackRock, Vanguard, and State Street). Details are reported in Section 4 as well as in Annex B.
Source: OECD calculations based on Orbis® data.

3. The ownership-productivity linkage: theoretical framework and literature

11. The recent rise of institutional investors is changing the equity ownership landscape and may entail productivity effects through two main channels (Figure 7): i) a governance channel, and ii) a common ownership channel.

Figure 7. Implications for productivity: the main channels



Source: OECD

3.1. The governance channel

12. Equity owners can help improve a firm's performance through governance by providing better guidance and/or specialised knowledge of the sector in which the firm operates, steering the firm towards new managerial techniques, and easing access to additional funds (Hansen and Hill, 1991; Bond et al., 2012).[5] The business model of institutional owners, which significantly differ from those of corporate or individual investors, have been recently the subject of intense policy debate in two main areas: their time horizon and their investment style.[6]

13. The time horizon of equity holders may affect the type of investment a firm undertakes. Long-term oriented owners might be more supportive of investment in innovative activities and human capital-intensive projects, the benefits of which take time to materialise. On average, portfolio turnover tends to be higher for institutional owners than for corporate owners; thus, the rise of institutional investors with a shorter time horizon might lead to a lower focus on long-term outcomes (Davies et al, 2014; Kang and Kim, 2017). In a survey of 400 executives run by Graham et al. (2005), most financial executives acknowledged being prepared to sacrifice long-term value if it allowed them to meet the current quarter's earnings forecast. Similarly, Terry (2015), in a sample of U.S firms, detects a discontinuity in R&D spending between firms barely meeting earnings targets and firms that fail to meet them, and Bushee (1998) finds that this effect is more pronounced for firms owned by institutional investors with high portfolio turnover. More generally, Asker et al. (2015) find that publicly listed companies are four times less responsive to

[5] The size of the stewardship teams of institutional investors is essential to drive their impact via governance. See Medina et al. (2022) to find estimates of the size stewardship teams.

[6] For a detailed discussion on the way institutional owners engage in firms' management, see Çelik and Isaksson (2014). The effects of institutional ownership through governance has received considerable attention in the corporate finance literature, mainly investigating the impact of Boards of directors' composition or voting rights on firms' financial returns (Schmidt and Fahlenbrach, 2017; Edmans and Holderness, 2017). Yet, very little is known about the impact on productivity and, while correlated, the two dimensions do not necessarily overlap.

investment opportunities than private companies, particularly so in industries where stock prices are more sensitive to earnings announcements and investors are more impatient.

14. The increasing reliance on passive investment styles creates a new wrinkle in the relationship between institutional owners and productivity through the governance channel. On the one hand, passive investment is associated with a relatively longer time horizon. On the other hand, it is associated with lower monitoring and thus potentially increasing agency costs via the misalignment of interests between shareholders and managers (Epps and Ismail, 2009). Importantly, a passive investment style is often the outcome of the preference of institutional investors for a diversified portfolio. While a relatively smaller equity stake in many firms may reduce investors capacity and willingness to engage in firms' managerial decisions and/or increase their reliance on proxy voting (Baysinger et al., 1991; Francis and Smith, 1995), diversification may allow them to be more supportive of R&D activities, especially if they are long-term oriented (Brossard et al., 2013). Indeed, diversification could attenuate idiosyncratic risks associated with investment in innovation (Aghion et al., 2013). Finally, large and diversified investors can still have a strong influence and a pivotal role in firm decisions due to the relevance of their actions to the market (Azar and Vives, 2021b).

3.2. The common ownership channel

- Intra-industry common ownership.

15. Firms operating in the same industry and belonging to the same investor's portfolio may, in the interest of their common shareholders, compete less intensively on product markets, with detrimental consequences for productivity (*competition channel;* Rotemberg, 1984; O'Brien and Salop, 2000). Commonly owned firms could charge higher prices, for instance by colluding more easily, as investors that are highly diversified in a given industry have enough ties across companies to facilitate communication and eventually enforce collusive agreements. Moreover, common ownership, can create perverse incentives for managers. This is exacerbated when ownership is dispersed, as managers could be induced to take decisions in the interest of certain shareholders even if detrimental to the firm. For instance, incentives to gain market shares could be lower when bonuses are set based on the performance of the whole industry rather than of the individual firm. Indeed, a recent strand of literature on the effects of the rise in common ownership finds that the implied new layer of conflicts of interest has led to higher product prices and weaker governance. For instance, Azar, Schmalz, and Tecu (2018) show that competing firms in the U.S. airline industry are held by a small group of institutional investors and that increased common ownership induces higher prices; similar findings are reported for the banking and seed industries (Azar, Raina and Schmalz, 2021; Torshizi and Clapp, 2021).

16. At the same time, however, the overall effect of intra-industry common ownership on innovation and productivity could turn positive when inter-firm coordination is explicit (e.g. joint ventures or strategic alliances) and firms cooperate in their R&D efforts and share knowledge (*cooperation channel*). Indeed, common owners' interest in the combined valued of their holdings may mitigate frictions arising from incomplete contracting, by moderating the risk of being expropriated when collaborating with rivals. Moreover, common owners may facilitate the development of new profitable collaboration opportunities by reducing information asymmetries among competitors, which arise from the natural tendency to conceal information to rivals. Along those lines, commonly-owned firms are found to exhibit higher future market share growth, thanks to a higher number of patents per dollar spent in R&D and higher profit margins (He and Huang, 2017), as well as higher product prices, thanks to superior product quality achieved by improved governance or more efficient pricing strategies (Edmans, Levit and Reilly, 2019).

17. While evidence is not yet conclusive and the effect on productivity has not been investigated, there is an active policy debate about the necessity to update anti-trust regulation in order to consider common ownership issues (Mancini and Nyeso, 2017; Posner et al., 2017; Rock and Rubinfeld, 2017), especially in industries where product market concentration is high.

- Inter-industry common ownership.

18. Simultaneous shareholding across industries makes common owners' incentives more complex, due to externalities arising when firms operate in vertically related industries (Azar and Vives, 2021a). From a general equilibrium perspective, the potential gains stemming from price collusion are indeed more uncertain: the attempt to increase profits through higher prices and lower competition is not immune to a backlash for common owners, as they risk ending up with lower profits in downstream industries due to higher inputs costs that could not always be passed-off on customers (KPMG, 2020). Azar and Vives (2021b) empirically corroborate this theoretical prediction by showing that, for the case of the airline industry, increases in inter-industry common ownership are associated with lower prices, especially when focusing on the so-called Big 3 investors, which are close to "universal owners".[7]

19. Common ownership along the value chain may also lead to stronger business relationships among vertically integrated firms, (*vertical integration / spillover channel*; Schmaltz, 2018), by attenuating hold-up problems when information asymmetries are high, which is especially the case for innovative projects (Freeman, 2021). In particular, Geng et al. (2015) shows that overlapping ownership mitigates hold-up problems arising from patent complementarities, resulting in higher R&D investment and patent success, and this attenuation effect is stronger when the common owners is a long-term oriented and engaged institutional investor. Similarly, Anton et al. (2021) provide evidence that, in the presence of technological spillovers, common ownership could increase ex-ante incentives to innovate for technologically related firms by mitigating potential issues related to surplus appropriability.

20. In sum, the literature is in its early stage and existing indirect evidence is mixed. As a consequence, the potential effect of institutional and/or common ownership on productivity remains uncertain from a theoretical standpoint, making an empirical investigation all the more relevant.

4. Data and main variables

21. Empirically investigating the link between institutional ownership and productivity requires a substantial data construction effort that combines information on both ownership linkages and financial indicators at the firm level. Combining the Orbis Ownership and the Orbis Financials databases, both provided by Moody's Analytics, allows a granular description of firms' equity ownership structures to be generated and related to firms' multifactor productivity estimates. The matched sample provides information for around 50,000 firm-year observations over the 2007-2019 period; it covers firms located in 18 countries and operating in both manufacturing and non-financial services industries.[8]

4.1. Ownership data

22. The Orbis Ownership database reports equity holdings of firms worldwide, covering direct and indirect firm-owner relationships from 2007 to 2019. The complexity of the raw data entails an extensive set of cleaning procedures to ensure data consistency, with two main challenges. First, the removal of custodians and nominees, who do not hold shares or voting rights. Second, the type of entity in Orbis (e.g.

[7] The Big 3 are three largest passive asset managers -- namely BlackRock, Vanguard, and State Street. Combined together, representing the overall largest share owner in S&P500 companies (Fichtner et al., 2017), with on average 25% of the voting rights (Bebchuk and Hirst, 2019).

[8] Countries covered: Austria, Australia, Canada, Germany, Denmark, Spain, Finland, France, UK, Greece, Ireland, Italy, Japan, Netherlands, Poland, Romania, Sweden and the United States. Sectors included: all industries whose two-digits codes are within the 10-82 range according to Nace Rev.2 classification, excluding the 64-66 financial industries. The COVID-19 period is excluded on purpose in order to abstract from the very specific shock affecting both firms productivity and financial markets, potentially introducing noise in the estimations.

institutional investor, strategic investor) often does not reflect the investment profiles of the companies (e.g. Vanguard was classified as a corporate investor instead of an institutional investor). A complete description of the challenges faced in building a ready-to-use dataset and the solutions adopted is reported in Annex A.

23. For the purpose of this project, detailed data on owners' characteristics constitute a valuable source of information to capture firms' equity structure. In particular, owners are distinguished according to their legal type and country of origin, as well as by their investment time horizon (proxied by the average shares turnover over the sample period) capturing the average investment preferences of equity holders. Moreover, the so-called Big 3 investors, whose relevance is increasing within the institutional investors landscape, combine diversified portfolios and most often a passive investment style, making them a natural candidate to study the impact of these characteristics of institutional investors business model on productivity. In sum, we are able to associate to each firm-year the percentage shares held by different groups of equity holders with similar characteristics (e.g., the shares held by institutional investors or the shares held by institutional investors that are tendentially long-term oriented) and investigate their impact on productivity via the governance channel.

24. With respect to common ownership, the baseline measure is computed using the method developed by Azar et al. (2018) and Azar and Vives (2021b). First, we calculate the weight that firm *j* puts on firm *k* as:

$$\lambda_{jk} = \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}} \quad (1)$$

25. where γ_{ij} is the control of investor *i* in firm *j* and β_{ik} is the ownership stake of investor *i* in firm *k*. The notion of control is operationalized using the Banzhaf dispersed index -- Annex B provides the technical details.[9] In a nutshell, λ_{jk} reflects whether firms *j* and *k* have the same investors: for instance, it takes the value 1 if an investor owns 100% of the shares in both firms *j* and *k*, while 0 if the *j* and *k* do not display any common investor. Second, the λ_{jk} are aggregated at the firm level by computing an intra-industry common ownership (λ_j^{intra}) and an inter-industry common ownership (λ_j^{inter}) measure. Operationally:

$$\lambda_j = \frac{\sum_k S_k \lambda_{jk}}{\sum_k S_k} \quad (2)$$

26. where the sales of other firms, S_k, are used as weights for the load of each common ownership linkage.[10] For the case of λ_j^{intra}, the average is calculated over all firms $k \neq j$ in the same sector as *j;* for the case of λ_j^{inter}, this average is calculated over all firms *k* in different sectors as *j*.

27. We also compute two extra measures of common ownership at the firm level, both from an intra-sector and inter-sector perspective. The first is the so-called degree centrality: for each investor, we compute the share of revenues owned in each company; next, the common ownership of a given firm is obtained as the aggregated degree centrality of the investors (minus the contribution of the firm itself to that aggregated centrality). The second measure is the betweenness centrality, which measures the number of shortest paths in the ownership network passing through each investor of a given company and thus tends to capture the extent of information flows across firms via owners.

[9] In a nutshell, the Banzhaf index measures the number of coalitions in which the shareholder would be pivotal in a corporate election. For instance, as control is not simply proportional to the shares held, the Banzhaf index would ensure that a shareholder with 51% of the share is reported to have full control on the firm.

[10] To test the robustness of our measures, we also compute the unweighted versions of the above measures.

28. For all measures, our baseline common ownership estimates will focus on the Big 3 passive investors. This allows us to strongly reduce concerns about missing ownership relationships (i.e. the coverage of the Big 3 is close to complete) affecting our computations, while at the same time covering the most relevant common owners across sectors. A detailed explanation of the common ownership measures and worked examples can be found in Annex B, where we also show that all measures are highly correlated among each others.

4.2. Productivity data

29. We use the historical vintage of the Orbis Financials dataset to obtain firm-level productivity estimates as well as firm-specific financial characteristics for listed companies worldwide. To ensure firms' comparability across countries and sectors, we adopt the data cleaning procedures routinely applied at the OECD, which are based on the methodology described in Gal (2013), Kalemli-Ozcan et al. (2015). We retain non-financial firms with available information to calculate the value added based multi-factor productivity and rely exclusively on consolidated accounts.[11]

30. The logarithm of multi-factor productivity, estimated through the GMM Wooldridge (2009) value added based procedure, is our baseline measure for firms' productivity. The main advantage of applying this methodology is that it overcomes the OLS simultaneity bias, given that inputs' choices are not independent from unobserved shocks.[12] We proxy the capital input with the deflated value of fixed assets, the labor input with the number of employees and adopt intermediate inputs (e.g., material costs) as an instrument for unobserved productivity. In the robustness checks, we also rely on (log) labor productivity, calculated as the logarithm of value added per employee, and results are qualitatively unchanged. Finally, it is worth noticing that, as we do not observe firm level prices but only 2-digits industry deflators, all the productivity measures employed are revenue based.

5. Methodology and findings

5.1. Governance channel

31. This section tests the governance channel by investigating the relationship between institutional ownership and firm-level multi-factor productivity. To start, we estimate the following simple baseline static model:

$$MFP_{icst} = \gamma_0 + \gamma_1 Institutional\ Ownership_{i,t-1} + \gamma_2 \boldsymbol{X}_{ics,t-1} + \delta_{ct} + \delta_{st} + \epsilon_{icst} \quad (3)$$

where the subscripts *i*, *c*, *s*, *t* stand for firm, country, sector and time, respectively, *MFP* for the logarithm of firm level multi-factor productivity, while *Institutional Ownership* is the share of institutional ownership over total ownership of the firm. The vector *X* includes a set of firm level controls - namely, firms' size, proxied by the number of employees, the leverage ratio (also accounting for the structure of finance) measured as total liabilities over total assets and the profitability ratio, measured as the ratio of EBIT over total assets. All explanatory variables are lagged to reduce potential simultaneity bias. The country by

[11] The choice of consolidated accounts sidesteps issues related to tax shifting by multinationals. Further, given that our sample includes (mostly large) listed firms, unconsolidated accounts may represent better firms' choices with respect to taxation rather than true productivity. Productivity measures based on unconsolidated accounts may be misleading and difficult to interpret for holding companies, which are often the only listed entity in a conglomerate. Finally, mixing consolidated and unconsolidated accounts can generate double-counting concerns.

[12] It also internalizes the Ackerberg, Caves and Frazer (2015) critique on the identification of the labor coefficient in both Olley and Pakes (1996) and Levinsohn and Petrin (2003) semi-parametric approaches.

time dummies (δ_{ct}) account for differences in macroeconomic developments across countries, while industry by time dummies (δ_{st}) account for sector specific shocks (e.g. technological developments) that are common across countries. The model is estimated by OLS, clustering standard errors at the firm-level (e.g., the unit of the panel). $\gamma_1$is the coefficient of interest, which is expected to be positive (negative) if institutional ownership is associated with higher (lower) firm productivity.

32. Results are presented in Table 1. Our findings suggest that firms with a higher share of institutional ownership tend to have higher productivity compared to firms with a lower share of institutional owners (column 1). The inclusion of a battery of firm level observable characteristics as controls does not alter the significance of the relationship between institutional ownership and productivity, while it only slightly reduces the magnitude of the coefficient of interest (column 2). Moreover, these correlations are robust when we use longer lags (e.g. 3 years)[13] for institutional ownership or rely on alternative definitions of institutional ownership, using an indicator variable equal to one if the share of institutional owners within the firm is above the median in the sample (25% of shares held by institutions; column 4) or above a 10% threshold (column 5). The checks suggest that our findings are not driven by outliers or the choice of a specific institutional ownership measure or lag structure. Finally, all results are qualitatively and quantitatively unaffected when employing an even richer fixed effects structure, controlling for any shock occurring at the country-sector level (i.e. including country by sector by year fixed effects).[14]

33. A natural extension of the previous model consists in adding firm fixed effects, thus focusing exclusively on within-firm variation by controlling for all firm-specific time invariant characteristics – hence evaluating the role of changes in institutional ownership on productivity changes at the firm level. While the point estimates always remain in the positive domain, they are not significant in the majority of specifications and thus are not reported. There could be two main potential explanations for this outcome. First, within-firm variation in institutional ownership is not large enough to induce changes in firms' governance. Second, institutional investors may invest ex-ante in firms which are more productive and, despite employing lagged explanatory variables, the findings in Table 1 could be driven by reverse causality: we deal with this risk in the next section.

Table 1. The governance channel – static baseline estimates

Dependent Variable: MFP levels					
Model	(1)	(2)	(3)	(4)	(5)
Explanatory ownership variable	Cont.	Cont.	Cont. t-3	Above median	Above 10%
Lagged Institutional Ownership	**0.434*** **	**0.305*** **	**0.257*** **	**0.193*** **	**0.285*** **
	(0.033)	**(0.029)**	**(0.035)**	**(0.016)**	**(0.016)**
Observations	54,122	54,122	30,992	54,122	54,122
R-squared	0.422	0.522	0.533	0.523	0.527
Firm Controls (Size, Profitability, Leverage)	NO	YES	YES	YES	YES
Sector * Year Fixed Effects	YES	YES	YES	YES	YES
Country * Year Fixed Effects	YES	YES	YES	YES	YES

[13] The in-sample average portfolio turnover for institutional investors is approximately 50%, indicating that institutions display an average holding period of 2 years. Hence, the choice of a 3-year lag for the share of institutional ownership is expected to decrease endogeneity concerns.

[14] See Table C.1 in Appendix. We opted for not fully saturating the model in the baseline for two reasons. First, in light of the necessarily limited number of firms in our sample (given the focus on listed companies), we preferred to avoid our results being fully based on the residual variation remaining once comparing just few firms within a given country-sector-year cell. Second, the country by sector dimension is theoretically not fully appropriate to capture the playing field of large listed corporations.

Note: Standard errors in parentheses; standard errors clustered at the firm level. Significance Level: *10%, **5%, *** 1%.
Lagged institutional ownership stands for the percentage shares held by institutional investors in each firm at t-1 in model (1) and (2) and at t-3 in model (3), while for a binary variable taking value 1 for firms with institutional ownership above the median level in model (4) or for firms in which institutional investors hold more than 10% of the shares in model (5).
Source: OECD calculations based on Orbis® data.

34. Another extension consists in introducing some simple dynamics in our econometric modelling, by estimating a model of firm productivity growth based on the Neo-Schumpeterian growth approach to technology diffusion and innovation by Aghion and Howitt (1997) and Acemoglu et al. (2006), which has already been implemented in several firm-level empirical studies (e.g. Adalet McGowan et al., 2017; Gal et al. 2019). Analytically, we estimate the following equation:

$$\Delta MFP_{icst} = \gamma_0 + \gamma_1 Institutional\ Ownership_{i,t-1} + \gamma_2 GapToFrontier_{ics,t-1} + \gamma_3 \boldsymbol{X}_{ics,t-1} + \delta_{ct} + \delta_{st} + \epsilon_{icst} \quad (4)$$

where notation is consistent with that of equation 3. ΔMFP is now the change in the logarithm of firm level multi-factor productivity, while *GapToFrontier* stands for the lagged distance to the sector-year specific productivity frontier.[15]

35. Results are presented in Table 2 and confirm the baseline findings (columns 1 and 2): a higher share of institutional ownership is positively related to firm yearly productivity growth, independently of whether firm level controls are included in the equation. The positive correlation remains significant also when looking at the cumulative growth over a longer 3-year time horizon (column 3). In line with theoretical predictions and previous analyses, the coefficient of the gap to the frontier is also positive and statistically significant, suggesting that that firms below the frontier benefit from a catch-up effect. [16]

Table 2. The governance channel – dynamic baseline estimates

Dependent Variable: MFP growth			
Model	(1)	(2)	(3)
Growth over	1-year	1-year	3-years
Lagged Institutional Ownership	**0.059*** **	**0.036*** **	**0.044*** **
	(0.009)	**(0.009)**	**(0.016)**
Gap with respect to MFP Frontier	0.155***	0.156***	0.197***
	(0.006)	(0.006)	(0.009)
Observations	48,739	48,739	31,211
R-squared	0.124	0.136	0.166
Firm Controls (Size, Profitability, Leverage)	NO	YES	YES
Sector * Year Fixed Effects	YES	YES	YES
Country * Year Fixed Effects	YES	YES	YES

Note: Standard errors in parentheses; standard errors clustered at the firm level. Significance Level: *10%, **5%, *** 1%.
Lagged institutional ownership stands for the percentage shares held by institutional investors in each firm at t-1. In columns (1) and (2), MFP growth stands for the yearly growth rates, while in column (3) the dependent variable is the 3-years cumulative MFP growth.

[15] The gap to the frontier is computed as follows: $Gap_{ics,t-1} = MFPFrontier_{s,(t-1)} - MFP_{ics,(t-1)}$. The sectoral frontier is defined as the average MFP of the 5% most productive firms in a given sector and time, across countries. To avoid endogeneity concerns, the frontier firms are excluded from the estimating sample.

[16] Results are again confirmed when using an even more demanding fixed effects structure, controlling for any shock occurring at the country-sector level (i.e. including country by sector by year fixed effects). See Table C.2.

Source: OECD calculations based on Orbis® data.

5.1.1. Dealing with endogeneity concerns

36. The results described in previous section show a positive correlation between the share of institutional owners and firm productivity (growth). However, our simple baseline model, even when augmented with several controls and a relatively rich fixed effect structure, does not allow us to infer that institutional ownership is beneficial for productivity, as these findings might suffer from reverse causality concerns. i.e. institutional investors may target firms that are more productive or have better growth prospects ex-ante.

37. To obtain a set of more refined correlations, we rely on propensity score matching techniques, which allow to compare firms which are very similar in all respects but differ in the degree of institutional ownership. Analytically, we proceed as follows. First, we estimate a probit model of the probability of having a share of institutional ownership above the in-sample median conditional on firm' age, size, profitability and financial health (measured by the leverage ratio), as well as industry-year and country-year fixed effects. These estimations are run for three different subsample periods (2008-2011, 2012-2015 and 2016-2019).[17] Next, we recover the predicted institutional ownership probability and we rely on matching techniques (e.g., method of the nearest neighbour) to select a pair of firms displaying common characteristics (i.e., a close propensity score) but a different level of institutional ownership (i.e., below/ above the median share). This results in a group of matched treated firms (high-institutional ownership) and a control group (low-institutional ownership firms), a setting that will allow us to considerably attenuate reverse causality concerns.

38. Table 3 presents the results from the propensity score matching estimation. The impact of institutional ownership on productivity remains positive and significant. Moreover, comparing the coefficients in columns (1) to (3) on the treatment group, the effect appears to be increasing over time. Overall, these findings show evidence confirming that the governance channel is at play and that institutional ownership could be productivity enhancing.

Table 3. The governance channel – alternative specifications

	PSM: Step 2		
Model	(1)	(2)	(3)
Dependent variable	MFP Lev.	MFP Lev.	MFP Lev.
Sample period	2008-2011	2012-2015	2016-2019
Treatment assignment	0.078***	0.223***	0.449***
	(0.019)	(0.019)	(0.018)
Observations	13,550	16,903	22,206
R-squared	0.002	0.004	0.019

[17] All results are consistent if using a pooled sample over time.

PSM: Step 1			
Model	(1)	(2)	(3)
Sample period	2008-2011	2012-2015	2016-2019
Lagged size	0.137***	0.136***	0.142***
	(0.007)	(0.006)	(0.006)
Lagged Liabilities to Assets ratio	-0.169***	-0.241***	-0.159***
	(0.043)	(0.037)	(0.031)
Lagged ROA	-0.188**	-0.352***	-0.217***
	(0.078)	(0.082)	(0.073)
Age	-0.060***	-0.021	-0.032**
	(0.014)	(0.014)	(0.013)
Industry by Year Fixed Effects	YES	YES	YES
Country by Year Fixed Effects	YES	YES	YES
Observations	13,550	16,903	22,206

Note: Standard errors in parentheses; standard errors clustered at the firm level. Significance Level: *10%, **5%, *** 1%.
Lagged institutional ownership stands for the percentage shares held by institutional investors in each firm at t-1.
Source: OECD calculations based on Orbis® data.

5.1.2. Channels of transmission

39. Up to now, the analysis focused on institutional owners as if they were a unique and homogeneous class of investors, while, as discussed in Section 3, their business model may vary substantially. In this section, we expand our baseline framework to account for their different characteristics and, in particular, their time horizon and investment style.

40. Table 4 summarises the main findings. In the first specification, we check whether the estimated relations vary depending on investors patience. Institutional owners are defined as being impatient (patient) if they belong to the top (bottom) 25% of the turnover distribution and, for each firm, we distinguish whether impatient or patient owners are prevalent among its institutional investors. The negative and statistically significant coefficient on the interaction term between institutional ownership and the prevalence of impatient owners suggests that the positive association between institutional investors and productivity tends to vanish when they are short-term oriented. This is in line with theoretical prediction that long-term oriented owners might be more supportive of investment in innovative activities.

41. Next, we use the shares held by the Big 3 as a proxy to investigate the potential role of investors with a passive but diversified investment style (Fichtner et al., 2017). A higher presence of the Big 3 is associated with higher productivity (Column 2) and even more so when combined with an overall high share of institutional investors (Column 3). These findings may be indicative of the ability of large and diversified owners to attenuates idiosyncratic risks associated with investment in innovation and, at the same time, may hint that the potential lack of direct monitoring could be compensated by the intrinsic ability of systemic investors to have a strong influence due to signalling effects (e.g., the exit of large investors from a company could be interpreted as a negative signal from the market).

Table 4. The governance channel – time horizon and investment styles

Dependent Variable: MFP levels			
Model	(1)	(2)	(3)
Channel under scrutiny	Time horizon	Passive/Big3	Passive/Big3
Lagged Institutional Ownership	0.327***	0.125***	0.017
	(0.030)	(0.034)	(0.034)
Lagged Institutional Ownership * Lagged Impatient Ownership	**-0.250*** **		
	(0.076)		
Lagged Share of Big3 over Institutional Ownership		**0.721** **	**0.311** **
		(0.298)	**(0.142)**
Lagged Share of Big3 over Institutional Ownership * Lagged Institutional Ownership			**4.743*** **
			(0.419)
Observations	54,122	43,029	43,029
R-squared	0.522	0.517	0.532
Firm Controls (Size, Profitability, Leverage)	YES	NO	YES
Main effect for Impatient Ownership	YES	NO	NO
Sector * Year Fixed Effects	YES	YES	YES
Country * Year Fixed Effects	YES	YES	YES

Note: Standard errors in parentheses; standard errors clustered at the firm level. Significance Level: *10%, **5%, *** 1%.
Lagged institutional ownership stands for the percentage shares held by institutional investors in each firm at t-1. Lagged share of Big 3 over institutional ownership measures the share of Big 3 investors' holdings over all institutional holdings in each firm at t-1. Lagged impatient ownership is a binary variable that takes value 1 if the share of institutional impatient owners is larger than the share of institutional patient owners, while 0 otherwise.
Source: OECD calculations based on Orbis® data.

5.2. The common ownership channel

42. This section tests the common ownership channel by investigating the relationship between the extent of simultaneous shareholding with and across sectors and firm-level multi-factor productivity. To start, we estimate the following simple static baseline model:

$$MFP_{icst} = \beta_0 + \beta_1 CO\_inter_{ics,(t-1)} + \beta_2\, CO\_intra_{ics,(t-1)} + \beta_3\, \boldsymbol{X}_{ics,(t-1)} + \delta_{ct} + \delta_{st} + (\delta_i) + \epsilon_{icst} \quad (5)$$

where notation is consistent with that of equation 3. *CO_inter* and *CO_intra* capture firm-level common ownership inter-sector and intra-sector, respectively, computed according to the methodology developed by Azar et al. (2018) and Azar and Vives (2021b). The vector *X* includes the same set of firm level controls as in equation (1). All explanatory variables are again lagged one period to reduce potential simultaneity bias. As in previous analyses, the country-year (δ_{ct}) and the sector-year fixed effects control for any shock occurring respectively at the country or sector level. We run the model both with and without firm fixed effects (δ_i): when included, they subsume country by sector fixed effects and allow to control for all firm-specific time invariant characteristics, thus moving from a cross-sectional estimation in levels to a within-firm estimation looking at productivity changes over time. The model is estimated by OLS, clustering standard errors at the firm-level (e.g., the unit of the panel). β_1 and β_2 are the coefficients of interest, which we expect to be negative (positive) if higher common ownership is associated with lower (higher) productivity.

43. Table 5 presents the results from the estimation of Equation 5. Columns (1) to (3) show the cross-sectional results, while Columns (4) to (6) show the within-firm estimations. Firms in different industries but sharing the same common owner have a higher productivity than their peers and also display higher productivity increases over time. A potential explanation for this finding is that a vertical integration (i.e.,

closer business relationships among vertically integrated firms) and/or a spillover channel (i.e., technological spillovers) could be at play with respect to inter-sector common ownership. The estimates with respect to intra-sector common ownership are not always significant, but a negative relationship appears to prevail when they are (columns 3 and 5), hinting that the competition channel may slightly outweigh the cooperation channel.

44. Next, we test the robustness of these findings in two ways. First, we rely on an alternative measure of common ownership, namely the degree centrality measure described in Section 4. Results in Columns (7) and (8) of Table 5 confirm in both the cross-section and within-firm estimation the existence of a positive relationship between inter-industry common ownership and productivity, while the intra-industry relationship is non-significant.[18] Second, we again rely on the dynamic model of firm productivity growth described in Equation 4 and results in Columns 9 and 10 once again confirm that firms in different industries but sharing the same owner (in the same industry and sharing a common owner) tend to have higher (lower) productivity growth, even after controlling for catch-up effects.

Table 5. The common ownership channel – baseline estimates

	Dependent Variable: MFP levels or growth									
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable: MFP	Levels	Levels	Levels	Levels	Levels	Levels	Levels	Levels	Growth	Growth
Common ownership at time	t-1	t-1	t-3	t-1	t-1	t-3	t-1	t-1	t-1	t-3
Lagged CO, Inter Big 3	4.491***	1.097**	1.924***	0.821***	0.781***	0.279			0.379**	0.656**
	(0.626)	(0.486)	(0.526)	(0.273)	(0.259)	(0.273)			(0.156)	(0.287)
Lagged CO, Intra Big 3	-0.765	-0.205	-1.015**	-0.353	-0.438*	-0.312			-0.300**	-0.571*
	(0.605)	(0.450)	(0.509)	(0.256)	(0.243)	(0.285)			(0.151)	(0.299)
Lagged Centrality, Inter Big 3							0.143*	0.100**		
							(0.077)	(0.039)		
Lagged Centrality, Intra Big 3							0.039	-0.050		
							(0.068)	(0.035)		
Gap with respect to MFP Frontier									0.236***	0.301***
									(0.010)	(0.015)
Observations	40,825	40,825	29,802	41,027	39,779	28,909	40,849	39,804	36,538	25,456
R-squared	0.426	0.654	0.662	0.896	0.901	0.912	0.654	0.901	0.163	0.204
Firm Controls (Size, Profitability, Leverage)	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES
Country * Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry * Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effects	NO	NO	NO	YES	YES	YES	NO	YES	NO	NO

Note: Standard errors in parentheses; standard errors clustered at the firm level. Significance Level: *10%, **5%, *** 1%.
Common ownership is computed at the firm-level according to the measure developed by Azar et al. (2018) and Azar and Vives (2021b) in models (1) to (6) and (9) to (10); lagged CO intra stands for intra-industry common ownership at time t-1, while lagged CO inter stands for inter-industry common ownership. In models (7) and (8), common ownership is proxied by the degree centrality measure. In all cases, the measures focus on the so-called "Big 3" investors (BlackRock, Vanguard, and State Street).
Source: OECD calculations based on Orbis® data.

[18] However, our findings turn not significant when using a third measure, betweenness centrality, to capture the extent of common ownership at the firm-level.

5.2.1. Dealing with endogeneity concerns

45. Column 9 of Table 5 already reduces concerns about the possibility that common owners tend to acquire the most productive firms ex-ante. However, we still cannot rule out that they target firms with the best growth prospects. Therefore, to further address residual endogeneity concerns, we replace our firm-level measures of common ownership with country-sector-year measures. Indeed, it is plausible to assume that the productivity of a single firm could not influence the extent of common ownership in an entire industry. Analytically, we estimate the following equation:

$$MFP_{icst} = \beta_0 + \beta_1 ACO\_inter_{cs,(t-1)} + \beta_2\ ACO\_intra_{cs,(t-1)} + \beta_3\ \boldsymbol{X}_{ics,(t-1)} + \delta_{ct} + [\delta_s] + [\delta_i] + \epsilon_{icst} \quad (6)$$

46. where notation is consistent with that of Equation 5, and A*CO_inter* and A*CO_intra* capture aggregate inter- and intra-industry common ownership, respectively.[19] The fixed effect structure includes country by time fixed effects, controlling for any shock at the country-level, and either sector or firm fixed effects to obtain cross-sectional (across firms within sectors) and within-firm estimates respectively. Also notice that the estimation is carried on the whole sample of listed firms with productivity data available, given that the use of an aggregated measure of common ownership does not require to match firms with both productivity and ownership information available.

47. Results are presented in Table 6. Columns (1), (2) and (3) show the cross-sectional estimations, while columns (4), (5) and (6) present the within-firm estimations. With respect to inter-industry common ownership, its positive impact through the vertical integration and spillover channels is confirmed in all specifications, as firms in sectors characterised by high inter-industry common ownership tend to have higher productivity and higher productivity growth. Moving to intra-industry common ownership, the relationship is again negative but turns statistically significant, suggesting that firms producing in industries with high intra-industry common ownership have lower productivity than firms in industries with lower intra-industry common ownership (Columns 1 to 3) and that high intra-industry common ownership could have a negative effect on within firm productivity changes (Columns 3 to 6), potentially due to lower competition among rival firms (competition channel). Cross-sectional results are confirmed when relying on betweenness centrality, but within-firm estimations turn non-significant (Columns 7 and 8, respectively).[20]

[19] The aggregation is performed in three steps, building on a sample with all listed firms with available ownership information: i) compute, for each country-sector-year cell, the share of firms with non-zero common ownership; ii) compute the median share of firms with non-zero common ownership in each country-year; iii) assign value one to observations above the median and otherwise zero.

[20] Results are not significant also when using the degree centrality measure of common ownership in this setting.

Table 6. The common ownership channel – tackling endogeneity

Dependent Variable: MFP Levels								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Common ownership at time	t-1	t-1	t-3	t-1	t-1	t-3	t-1	t-1
High Aggregate Inter-Industry CO	0.038***	0.022***	0.068***	0.009*	0.009+	0.030***		
	(0.011)	(0.008)	(0.011)	(0.005)	(0.006)	(0.006)		
High Aggregate Intra-Industry CO	-0.024**	-0.036***	-0.044***	-0.013***	-0.014**	-0.021***		
	(0.011)	(0.009)	(0.011)	(0.005)	(0.006)	(0.006)		
High Aggregate Inter-Betweenness Centrality							0.169***	0.001
							(0.046)	(0.024)
High Aggregate Intra-Betweenness Centrality							-0.140***	0.003
							(0.047)	(0.024)
Observations	272,732	272,732	228,626	263,788	263,788	211,878	264,622	256,096
R-squared	0.328	0.578	0.336	0.884	0.887	0.896	0.589	0.888
Firm Controls (Size, Profitability, Leverage)	NO	YES	YES	NO	YES	YES	YES	YES
Country * Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	Subsumed	Subsumed	Subsumed	YES	Subsumed
Firm Fixed Effects	NO	NO	NO	YES	YES	YES	NO	YES

Note: Standard errors in parentheses; standard errors clustered at the firm level. Significance Level: *10%, **5%, *** 1%.
Common ownership is measured both intra- and inter-industry at the country-sector-year level; in all models, the regressors of interest are binary 0-1 variables that take value 1 for observations above the median and 0 otherwise. Common ownership is a computed at the firm-level according to the measure developed by Azar et al. (2018) and Azar and Vives (2021b) in models (1) to (6), while using the betweenness centrality measure in models (7) and (8). In all cases, the measures focus on the so-called "Big 3" investors (BlackRock, Vanguard, and State Street).
Source: OECD calculations based on Orbis® data.

5.2.2. Channels of transmission

48. This section expands the baseline framework to test the heterogeneity of the relation between common ownership and productivity across different type of sectors and firms as well as the potential mechanisms through which it operates.

49. First, we compare innovative and traditional sectors. This distinction also allows us to obtain indirect evidence on the existence of the knowledge spillovers and the competition channels: if common ownership inter-industry enhances firm productivity due to knowledge transfer across firms producing in different sectors, we should expect this relation to be stronger in technology-intensive industries; similarly, as innovative sectors are usually characterised by higher economies of scale and by a leading role of superstar firms, we would expect them to be more exposed to potential reductions in competition via intra-industry common ownership.

50. To proxy for sectors' innovativeness, we rely on the intangible intensity and digital intensity measures developed at the OECD and interact them with our common ownership variables.[21] Column 1 of Table 7 shows that the relation between inter-industry common ownership and firm productivity is higher for firms operating in intangible-intensive sectors, while it tends to vanish for traditional ones, thus suggesting that a knowledge spillover channel could be at play. Conversely, the interaction term between common ownership intra-industry and intangible asset intensity is negative and significant at the 10%

[21] Intangible intensity is measured, following Demmou et al. (2019), as the median ratio (across firms within industries) of intangible over total assets; it takes into account a wide range of intangible assets – including databases, copyrights, designs, trademarks, and organisation and distribution networks, and it is based on data for U.S. listed firms during 1990-2006 period. Digital intensity is built as in Calvino et al. (2018) and encompasses several dimensions, such as the share of ICT tangible and intangible (i.e. software) investment, the share of purchases of intermediate ICT goods and services, the stock of robots per hundreds of employees, the share of ICT specialists in total employment, and the share of turnover from online sales.

confidence level, hinting to a stronger association in intangible intensive sectors and further corroborating the potential existence of a competition channel. A potential reason could be that intangible-intensive industries tend to be more concentrated -- intangibles disproportionately benefit large firms and enable them to scale up, increasing market shares (Bajgar et al., 2021); as a consequence, the combination of high product market concentration and high common ownership may reinforce anti-competitive behaviours. These findings are confirmed when classifying industries based on their digital intensity (Column 2): the positive (negative) relationship between inter- (intra-) industry common ownership and productivity is significant exclusively in digital intensive industries.

51. Finally, Column 3 shows that the consequences of common ownership inter and intra industry on within-firm productivity are smaller for the largest firms.[22] With respect to inter-industry common ownership, results suggest that relatively smaller firms tend to benefit more from potential technology and knowledge transfers across sectors (spillover channel). On the contrary, the finding that the negative correlation with respect to is lower for larger firms could reinforce the idea that a competition channel could be at play, favouring large incumbents relatively more.

Table 7. The common ownership channel – Heterogeneity across type of sectors and firms

Dependent Variable: MFP			
Model	(1)	(2)	(3)
Dependent variable type	Levels	Levels	Levels
Lagged CO, Inter Big 3	-0.450		7.840***
	(0.463)		(2.912)
Lagged CO, Intra Big 3	0.572		-6.399**
	(0.651)		(2.786)
Gap with respect to MFP Frontier			
Lagged CO, Inter Big 3 * Intangible Intensity	**2.718****		
	(1.128)		
Lagged CO, Intra Big 3 * Intangible Intensity	**-2.194***		
	(1.259)		
Lagged CO, Inter Big 3 * High digital intensity (s)		**1.177*****	
		(0.371)	
Lagged CO, Inter Big 3 * Low digital intensity (s)		**0.376**	
		(0.371)	
Lagged CO, Intra Big 3 * High digital intensity (s)		**-0.691****	
		(0.343)	
Lagged CO, Intra Big 3 * Low digital intensity (s)		**-0.228**	
		(0.361)	
Lagged CO, Inter Big 3 * Initial Size Levels			**-0.322****
			(0.127)
Lagged CO, Intra Big 3 * Initial Size Levels			**0.271****
			(0.122)
Observations	35,704	39,779	39,772
R-squared	0.887	0.901	0.901
Firm Controls (Size, Profitability, Leverage)	NO	YES	NO
Country * Year Fixed Effects	YES	YES	YES
Industry * Year Fixed Effects	YES	YES	YES
Firm Fixed Effects	YES	YES	YES

Note: Standard errors in parentheses; standard errors clustered at the firm level. Significance Level: *10%, **5%, *** 1%.
Common ownership is computed at the firm-level according to the measure developed by Azar et al. (2018) and Azar and Vives (2021b), focusing on the so-called "Big 3" investors (BlackRock, Vanguard, and State Street); "lagged CO intra" stands for intra-industry common ownership at time t-1, while "lagged CO inter" stands for inter-industry common ownership. Intangible intensity is a sector level (country and time invariant) variable computed as in Demmou et al. (2019). Digital intensity is also a sector level (country and time invariant) variable, computed as in Calvino et al. (2018).
Source: OECD calculations based on Orbis® data.

[22] Notice that we use the initial size of the firm in the first year the firm appears in the sample as common ownership might also affect firm size changes over time.

6. Concluding remarks and policy implications

52. The increasing importance of institutional owners in equity markets, and its corollary, the rise of passive-style investment and common ownership, has generated intense policy and academic debate. This paper attempts to take the debate further by exploring the potential implications of these changes for firm-level productivity.[23]

53. Our findings point to a differentiated relation between institutional ownership and productivity depending on investors' time horizon and on whether the rise of common ownership occurs predominantly within or across industries. First, while the rise of institutional owners is associated with positive productivity performance (growth) at the firm level, the correlation tends to vanish when institutions' time horizon is short. Second, the impact of common ownership is positively associated with productivity when common shares are held across industries, but can have negative consequences for productivity when they are held intra-sector.

54. Further research is needed in order to i) obtain causal estimates of the impact of institutional and common ownership on productivity (growth), and ii) to have a more complete understanding of the transmission channels underlying the ownership-productivity linkages and thus to develop specific policy recommendations aimed at increasing institutional investors contribution to productivity growth.[24] Still, while showing that institutional investors appear overall not to be a major concern from a productivity perspective, our paper delivers relevant insights with respect to two potential risks and related policy areas: i) the detrimental impact of investors' short-termism and hence a potential role for policy to encourage long-term investment; ii) the negative effects (materialising under certain conditions) of intra-industry common ownership and hence a potential role for anti-trust policies.

6.1. Encouraging long-term investments

55. The increasingly complex structure of equity markets worldwide creates a new set of challenges for policy makers. In particular, the rising number of intermediaries in the investment chain may have increased incentives for trading compared to engagement, with undesirable consequences for innovation. While intermediaries are supposed to provide advice, they often face conflicts of interests given their compensation arrangement, which is often structured as a commission on sales. Thus, they may tend to privilege quantity over quality and focus on the economic sentiments of other participants in the market rather than on investigating companies' fundamental value (Stoughton et al., 2011). Increasing the transparency of the investment chain, as set in the new EU directive for Shareholders Rights Directives and in line of the OECD Principles of Corporate Governance, remains an ongoing challenge.

56. A potential policy lever to increase the provision of patient capital is the tax regime. Several OECD countries have already introduced a tax structure on capital gains which increases the shorter the holding period as an incentive to long-term investment (Reese, 1998; Cici, 2012; Sialm and Starks, 2012). For instance, He et al. (2022) find that a five-percentage points decrease in the tax rate on long-term capital gains compared to that on short-term gains results in a 2% increase in the annual innovation output three years after the tax break. This finding suggests that tax policy could be effective at curbing short-termism,

[23] Importantly, the primary objective of an institutional owner is not to improve firms' productivity and therefore this angle may be viewed of secondary importance for policy makers. For instance, pension and mutual funds aim first at ensuring adequate retirement income to individuals and policy makers tend to rightly examine their performance and take actions toward this criteria and not productivity.

[24] For instance, institutional investors are quite a heterogeneous category, ranging from pension funds to hedge funds and insurers, and digging into the potentially different effects on productivity of specific institutional investors could deliver more targeted insights.

and the wide cross-country variations in capital gains taxation leave room for more governments to harness this instrument.[25]

57. In this respect, a highly debated policy recommendation is to implement the so-called Financial Transaction Tax (FTT), which is a small levy on financial transactions of assets such as stock, bonds, futures or currency. Variations of FTTs are used in Belgium, Brazil, France, India, Italy and South Korea, among other countries. The objective is to make transactions costlier for shorter holding periods, potentially decreasing intra-day (computer-based) trading volume as well as speculation and volatility caused by excessive trading (Stiglitz, 1989). Adversaries of the FTT point to the need for short-term trading to support an efficient price discovery process (Schulmeister et al., 2008).

58. Establishing a market environment that align the interests of managers and shareholders may be also favourable to long-term investment. To this end, policy makers may combine action on several policy areas:

- First, fiercer competition in the product market could be fostered as a way to discipline managers and owners, reducing their ability to extract higher short-term profits at the expense of long-term performance. However, in certain instances, higher competition may also amplify short-termism, and an option to fully harness its benefits could be to include clawback provisions in mangers contracts, allowing firms to get back previously paid bonusses in case of unsatisfactory long-term performance.
- Second, employees' involvement in managerial decisions may also be a way to monitor managerial decisions and curb short-termism, as they have inside knowledge of the firm and a clear interest in its long-term performance. For instance, Fauvera and Fuerst (2006) report a positive effect on investment of the presence of employees' representatives on the Board, especially in industries where competition is weak.[26]
- Third, compensation schemes designed to share longer-term returns with managers could provide them with further incentives to undertake valuable long term innovation projects (Rong et al., 2017). For example, economic rent extraction by managers in the short run could be taxed at higher tax rates at the individual level. More generally, while compensation practices are decided at the firm level on a discretionary basis, policy makers can also have an influence by setting guidelines for responsible management, for instance through codes of managerial best practices ("stewardship" codes) that institutional owners are invited to sign on a voluntary basis.[27]

6.2. Anti-trust policies

59. A range of policy responses to address potential competition issues associated with intra-industry common ownership have been debated in the literature and policy circles. However, no consensus has yet emerged on the need for intervention and on the most appropriate tools to eventually intervene. Indeed, the academic literature, as described in section 3.2, is still unconclusive on the extent to which intra-industry common shareholding could hamper competition and underlines that the anti-competitive effects of common ownership may be country and context dependent, making it difficult to adopt a systematic approach.

[25] On the downside, policy makers need to pay attention to the risks of distortions implied by complex tax regimes.

[26] An example is the German model of corporate governance which relies on a two-tier structure, with a supervisory board, including shareholders and employees, and a management board, including executives.

[27] Several countries have already established codes of managerial best practices and international organisations such as the OECD, for instance through the publication of OECD Principles of Corporate Governance (e.g., see Principle III.A and III.C), have an important role to play to identify and encourage these best practices.

60. The debate on the anti-trust policy actions that are needed to potentially confront the issue is characterised by two main opposing views (Mancini and Nyeso, 2017): [28]

- Leveraging existing legislation allowing competition authorities to take legal action in common ownership cases. This would allow to detect and eventually sanction exclusively large acquisitions or explicit collusion fostered by common owners, but not cases where several funds have similar patterns of relatively smaller multiple holdings, potentially still generating competition concerns.
- Imposing hard limits on the amount of common ownership permitted by a given investor in concentrated markets. Yet, defining the boundaries of its application could be contentious and this approach could more generally impose large costs to investors and competition authorities.

61. The conditional nature of the potential anti-competitive effects of intra-industry common ownership allows policy makers to act also indirectly through policy levers affecting the context features that facilitate their emergence. The major of these features is product market concentration, as the implications of common ownership are strictly related to the extent of product market rivalry (Ederer and Pellegrino, 2022). As shown in the empirical analysis, this is particularly true in innovative sectors, which tend to be more and increasingly concentrated. Ex-ante regulatory policies, fostering contestability and fair trade in digital markets, may be warranted to avoid competition being stifled in these markets (Nicoletti et al., 2023), with a negative impact on productivity and innovation. More generally, a competition-friendly regulatory framework, addressing market failures but removing barriers to enter the market, could indirectly neutralise the negative consequences of intra-sector common shareholding.

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Annex A. Ownership data cleaning process

Pre-processing of the Orbis Ownership data

1. For each firm-owner relationship, the raw Orbis dataset reports its type, which allows to understand whether the link is direct or indirect as well as whether the equity holder is the ultimate owner of the company. To the purpose of our project, we retain exclusively relationships that are labelled as "single shareholder of first level" (SHH according to Bureau van Dijk notation), which avoids the risk of double counting while at the same time being able to account for missing direct ownership. For each relationship, the dataset displays either the direct percentage of shares held by the owner in the firm and/or the total percentage (i.e. direct plus indirect). The total percentage share is never provided by combining information from several shareholding relationships, in order to avoid double counting and the potential inconsistencies arising from the fact that indirect ownership could be reconstructed reliably only if all existing links are reported in the data – something that Bureau van Dijk cannot assert for certain. Rather, direct and/or total ownership (or none of them) are provided by the source of information.

2. The main alternative option would have been to keep only relationships labelled as "immediate shareholder" (ISH according to Bureau van Dijk notation); however, this solution would have not allowed us to account for indirect ownership, which is especially relevant in the case of institutional investors – and asset managers specifically – as they own securities indirectly through their funds.

3. We use the type of entity provided by Orbis to differentiate between institutional investors and strategic investors. In particular, Orbis reports the investors categories displayed in Table A.1:

Table A.1. Type of owners in Orbis

Code	Description
A	Insurance company
B	Bank
C	Industrial company
D	Unnamed private shareholders, aggregated
E	Mutual & Pension fund/Trust/Nominee
F	Financial company
H	Self ownership
I	Individual(s) or family(ies)
J	Foundation/Research Institute
L	Other unnamed shareholders, aggregated
M	Employees/Managers/Directors
P	Private Equity firms
Q	Branch
S	Public authorities, States, Governments
V	Venture Capital
Y	Hedge Fund
Z	Public

Source: OECD based on Orbis® data.

4. The following Orbis types were matched into the following broad categories:

- *Institutional investors*: 'A': Insurance, 'B': Bank, 'F': Financial company, 'J': Foundation/Research Institute, 'P': Private equity, 'V': Venture capital and 'Y': Hedge fund. Type 'E': Mutual and pension fund/Nominee/Trust/Trustee was also matched to Institutional investors after the correction for nominees (detailed in the next paragraph).
- *Strategic investors*: 'C': Corporate, 'I': Individual, 'Q': Branch.
- *Public, dispersed ownership*: "Z": Public, 'D': Unnamed private shareholders, aggregated, 'L': Other unnamed shareholders, aggregated, and 'M': Emplyees/Managers/Directors.
- *Government* Type 'S': Public authorities, states, governments can act as both strategic investor (e.g. China ownership of Syngenta) and institutional investors (e.g. pension funds or most wealth funds). Governments' entities were linked to either institutional or strategic investment using the procedure detailed in section "Consistency checks with respect to owners' type".

Data cleaning

Resampling versus interpolation

5. The subsidiary-shareholder level panel dataset could be resampled by adding missing years (e.g., adding an observation for year Y if Y-1and Y+1 are known) and/or interpolated (i.e. backward interpolation, to a maximum of three years). The resampling increases the number of observations from 12,355,166 to 12,804,355 (3.6%). The interpolation would increase the number of observations of direct ownership from 4,065,777 to 4,272,381 (5.1%), and the number of observations of total ownership from 7,759,798 to 7,952,465 (2.5%). At this stage, we proceeded with the resampling but we do not interpolate, as further checks on interpolated data revealed that the interpolation increases the risk of double counting ownership stakes.[29] Finally, in order to compare our database with other frequently used ownership datasets with the aim to test its accuracy and completeness, we also collected and merged information on market capitalisation from Worldscope data, which allows to compute the monetary value of the assets managed by investors.

Custodian and nominees

6. We corrected the dataset for nominees and custodiams. These are entities whose names are used to facilitate transactions, but who do not own the underlying shares (neither the voting rights) and thus are not of interest for the analysis. Nominees could represent a non-negligible share of market capitalisation if not properly accounted for. To deal with the issue, we treat "Nominees" or "Custodian" as dispersed ownerships.

7. The number of observations and corresponding value of the adjustments are as follows:

- Change of shareholders with the words "custodian" or "nominee" in their name: 197,672 observations with a weighted value (during the full period) of 10,012 billion.
- Change of State Street Bank And Trust Company (a large custodian bank): 3,201 observations with a weighted value (during the full period) of 655 billion..
- Change of GUOs with custodians or nominee in their name: 1,289 observations with a weighted value (during the full period) of 32 billion.

[29] Results available on request

Consistency checks with respect to owners' type

8. The information of the largest investors was manually checked and corrected in case of inconsistencies. For instance, the information on the Global Ultimate Owner (GUO) of BNY Mellon for the years 2009, 2010 and 2011 is incorrect in the raw Orbis, as it points to "Flamel Technologies" instead of "The Bank Of New York Mellon Corp".

9. We also more generally checked for the consistency between the Orbis classification of shareholders in different owners types and shareholders' actual investment profile. In particular, we aim to correct for cases when institutional investors have been misclassified as strategic investors and reversely. For example, we identified that subsidiaries of a well-known Mutual Fund were classified as corporate owners, while they were owing billions of dollars in dispersed investment and should be matched to institutional investors type.

10. We corrected systematically for these cases in the following way:

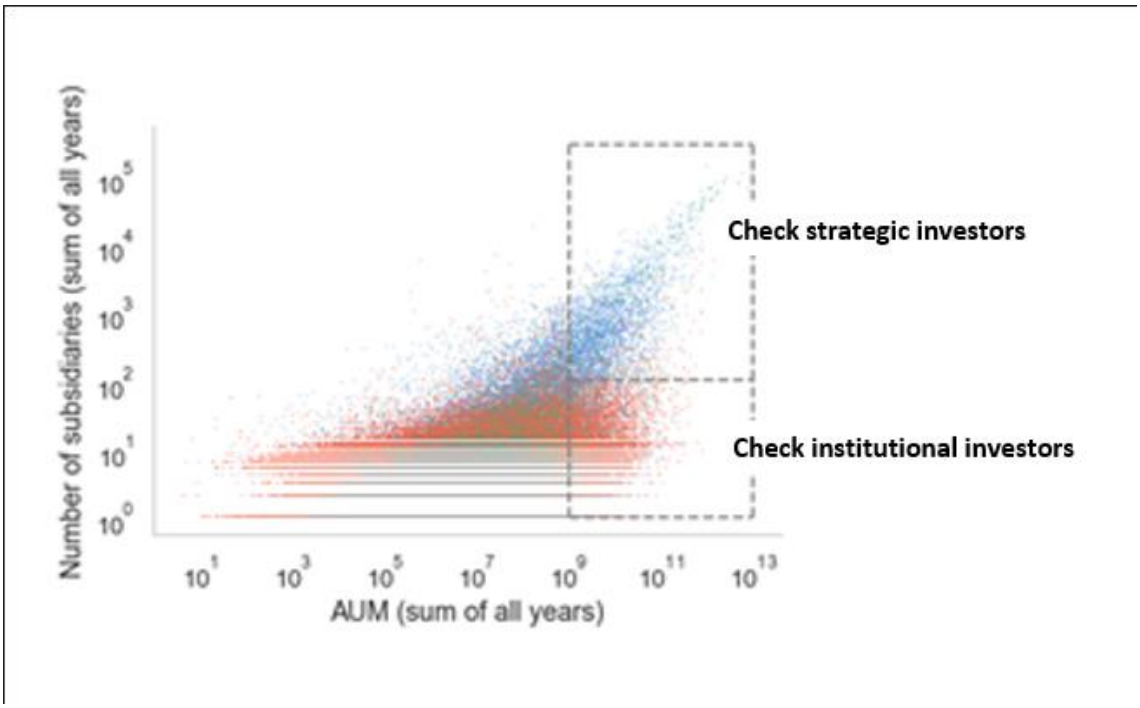
- First, we systematically analysed whether strategic shareholders have been misclassified. In particular, we looked at the 670 shareholders (0.07% of the total) classified as strategic investors with at least 1 billion of aggregated assets under management (AUM; summing all the years) and owning dispersed shares (i.e., having a stake in at least 100 companies). Among those 670, 430 shareholders had a weighted average ownership in all subsidiaries below 10% and, after a manual check, are reclassified as institutional investors.[30]
- Similarly, we analyzed shareholders classified as institutional investors with at least 1 billion of aggregated AUM (summing all the years) and owning concentrated shares – i.e., shares in *less than* 100 observations.. Among the shareholders satisfying these requirements, those with a weighted average ownership above 25% are reclassified as strategic investors. [31]

11. Figure A.1 provides a graphical visualisation of the above checks, reporting assets under management and number of subsidiaries for all shareholders and highlighting into squares the observations that were checked with respect to the consistency between the Orbis classification and their investment profile.

[30] The original type of those investors is "C" (corporate) in 354 observations, "S" (state) in 50 observations, "I" (individual) in 25 observations and "M" (groups of directors/employees) in 1 case. The cases where the type was "I" corresponded to investment companies owned by an individual.

[31] Notice that, since private equity, venture capital often have weighted ownerships above 25%, and since the type "E" (mutual funds) is usually correctly classified, we restricted the reclassification to the types "F" (financial, 704 companies), "J" (foundation, 60 companies) and "A" (insurance, 62 companies).

Figure A.1. Checking the consistency of owners' type classification



Note: The x-axis display the assets under management of each shareholder, while the y-axis the number of subsidiaries the shareholder had shares in. Entities originally labelled as strategic investors are colored in red, institutional investors are colored in blue, banks are colored in green, and all other entities are colored in gray.
Source: OECD based on Orbis® data.

12. As an additional check, we also exploited the fact that usually the type of a first level shareholder matches the type of the global ultimate owner; in other words, a discrepancy may signal a potential mis-reporting of one of the types. Figure A.2. compares the correlation between the types of owners. Overall, we found a very high correlation between the types of entity of shareholders and those of GUO.

13. When the type of entity of the GUO did not match the type of entity of the shareholders, we reclassified the type of entity of the GUO. For instance, 100% of the AUM of Vanguards were held by shareholders of labelled as institutional investors, while Vanguard itself was classified as a strategic investor. We then reclassified Vanguard as an institutional investor. Applying this correction to the entire dataset, it resulted in 1,262 changes of the 955,635 GUOs (0.13%) which have been manually checked ex-post.

Figure A.2. Correlation between GUO's type and first level shareholders type

Type of shareholders		*Type of GUO*			
	Institutional	0	0.047	0.04	0.91
	Strategic	0	0.018	0.94	0.043
	Banks	0	0,96	0.011	0.028
	Dispersed	1	0	0	0
		Dispersed	Banks	Strategic	Institutional

Note: Correlation between the type of entity of the direct shareholder and global ultimate owner.
Source: OECD based on Orbis® data.

Direct, total ownership, double counting

14. Next, we checked the relation between the information on direct and total ownership, in order to best identify how to exploit both variables to increase coverage while avoiding double counting. For each combination of GUO (owning one or more shareholders) and subsidiary, we calculated the sum of direct ownership for all shareholders and compared it with the maximum of total ownership. Figure A.3 shows the difference between the sum of direct investment and the maximum total ownership for each company. Reassuringly, 68% of the companies have a similar direct and total recorded ownership when allowing for a small discrepancy interval (i.e., 10 percentage points).

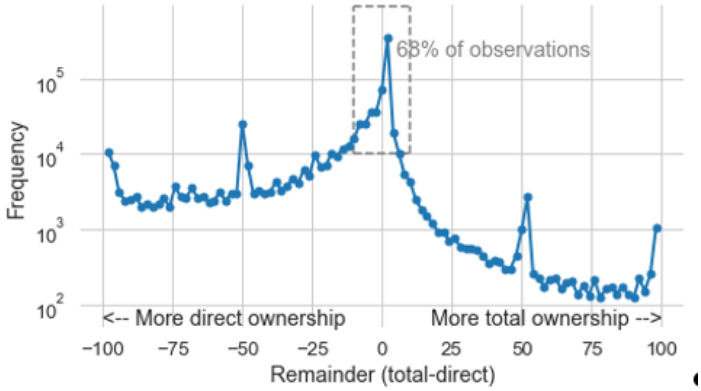
15. We used direct and total ownership information as follows:

- When the sum of direct ownership was equal or higher than the max of total ownership, we kept only the direct ownership.
- When the max of total ownership was higher than direct ownership, we included the unaccounted ownership (total-direct) in the shareholder with the maximum total ownership. If there was a tie, the unaccounted ownership was given to the shareholder corresponding to the GUO. If the tie did not include the GUO, the unaccounted ownership was given to the largest shareholder (in total AUM).

16. Additionally, the sum of ownership stakes in a company sometimes exceeds 100% in Orbis. This is often the case when the ownership information is obtained by Orbis from different sources and is not merged accurately, resulting in a duplication of investment at different levels of ownership. These cases account for less than 1% of the sample and were adjusted by fixing the overall ownership to 100% and rescaling the ownership of each investor.

17. Finally, we build two cleaned files. First, we retain just first-level shareholdings and obtain a subsidiary-shareholder-year level panel dataset. Second, we aggregated the results to create a second file, at the subsidiary-GUO-year level.

Figure A.3. Direct ownership vs total ownership for each company in the dataset



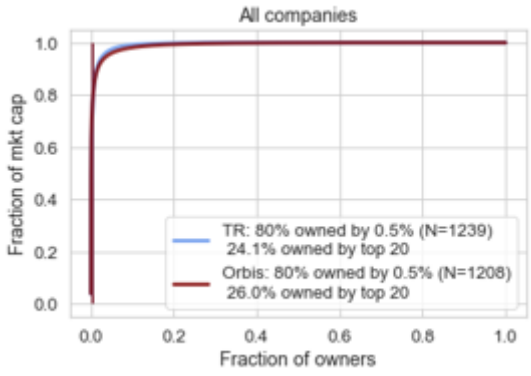
Note: Histogram showing the number of companies as a function of the difference between total ownership reported and the sum of direct ownership.
Source: OECD based on Orbis® data.

External validation of the dataset

Comparison of the distribution of ownership in Orbis and Thomson Reuters

18. First, we compared the distribution of owners of the two most used databases in the analysis of firms' ownership structures: Orbis and Thomson Reuters. The comparison shows that they have a similarly concentrated ownership structure, with 80% of the assets owned by 0.5% of the investors Figure A.4). Similarly, the top 20 owners (once manually merged) own approximately 25% of the assets, reflecting the large concentration of ownership and the fact that data quality is better for large companies.

Figure A.4. Concentration of ownership in Orbis and Thomson Reuters



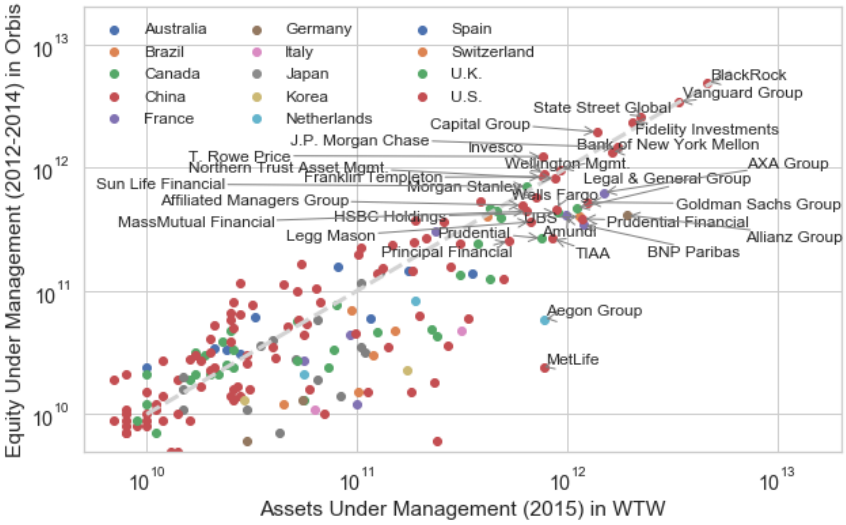
Source: OECD based on Orbis® and Thomson Reuters data.

Comparing Orbis with Willis Towers Watson

19. Second, we compared the value of assets under management in Orbis with Willis Towers Watson, which produces each year a list of the top 500 asset managers. Willis Towers Watson data do not distinguish between assets under management and equity under management; to overcome this limitation, consistent with the literature, we assume approximately 40% of the assets to be in equity and compared

the sum of managed equity during 2012-2014 in Orbis/TR with the WTW report of 2015. We used string matching (using TF-IDF at the trigram + cosine similarity) to match the Orbis and WTW datasets. We were able to match 80% of the value with the Orbis dataset. The correlation between Orbis and WTW is 86%, so quite high and especially so for U.S. firms (Figure A.5).

Figure A.5. Correlation between Orbis and Willis Towers Watson



Source: OECD based on Orbis® and Willis Towers Watson data.

Annex B. Common ownership measures

20. We calculate common ownership based on the network of ownership, where nodes are firms (either companies or investors) and edges are ownership relationships.[32] We compute three main different measures to proxy common ownership: Azar's lambda, following Azar et al. (2018) and Azar & Vives (2021) methodologies; degree centrality; betweenness centrality. Each measure displays several variants and it is calculated for the entire world, for the EU28, and for each country independently.

Measuring the owners' degree of control

21. First of all, our measures of common ownership require to operationalize the degree of control that an investor can exercise on the firm. We use three alternative measures of control:

- *Percentage of ownership*. Investors cast votes proportionally to the ownership in the company -- at least when only a single type of shares is available.
- *Banzhaf power index concentrated***.** An investor owning 51% of a firm has full control over the firm, but this control is not fully captured when using percentage of ownership as a proxy. A more accurate way to operationalize control is to use the Banzhaf power index, which is proportional to the number of times an investor is a critical voter (i.e., can decide the election with its vote) amongst all possible coalitions of shareholders. This measure is used by Azar & Vives (2021), who only consider investors with more than 0.5% of the shares -- we use instead a lower threshold of 0.05%, which should increase accuracy. Moreover, the Banzhaf index requires integer numbers as inputs for the computation and thus we multiply ownership stakes by 10, again with the aim to increase the accuracy of the results even if at the expense of computational time.
- The index is highly dependent on missing investors. If information on only two investors is available, for instance owner A with 15% and owner B with 10% of the shares, the Banzhaf power index will assign all power to investor A. To reduce this issue, we use the percentage of ownership when less than 10% of the ownership is known and not the Banzhaf index.
- *Banzhaf power index dispersed*. A second way to reduce the impact of missing investors is to impute them. To do so, we modify the Banzhaf power index concentrated index by distributing missing ownership in 1% stakes. For this measure, we only consider investors with ownership stakes above 0.5%, to avoid that the imputed ownership stakes can be higher than some known investors.

Azar's lambda

22. Azar et al. (2018) and Azar & Vives (2021) calculate the weight that firm j puts on firm k as:

[32] Notice that for common ownership calculations, we removed dispersed ownership (categories ZZ) as their inclusion would artificially increase the common ownership in the sample.

$$\lambda_{jk} = \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}}, \tag{7}$$

where γ_{ij} is the control of investor i in firm j and β_{ik} is the ownership stake of investor i in firm k. λ_{jk} reflects if firms *j* and *k* have the same investors. It takes the value 1 if one investor owns 100% of the shares of both firms, and 0 if the firms have no common investors. Control is operationalized using the three methods described in the previous paragraph.

23. Azar et al. (2018) then calculates two measures: λ_j^{intra} and λ_j^{inter}. These measures could be seen as the common ownership intra-sector and inter-sector, weighted by the sales, *S*, of other firms:

$$\lambda_j = \frac{\sum_k S_k \lambda_{jk}}{\sum_k S_k}, \tag{8}$$

For the case of λ_j^{intra}, this weighted average is calculated over all firms k ≠ j in the same sector as j. For the case of λ_j^{inter}, the weighted average is calculated over all firms k in different sectors as j. It is also possible to compute their unweighted versions using simple averages.

24. Algebraically, the matrix Λ, containing the elements λ_{jk}, is the product of

$$\Lambda = \frac{\Gamma \cdot \mathrm{B}'}{d(\Gamma \cdot \mathrm{B}')}, \tag{9}$$

where Γ is the matrix of control stakes $\gamma_{ij,}$ B is the matrix of ownership stakes β_{ik}, and d($\Gamma \cdot$ B) represent the diagonal. Moreover, the diagonal of Λ should be set to zero. The intra-sector and inter-sector vectors are calculated by multiplying parts of Λ by the weights (the sales of firms *j*) and dividing it by a normalizing constant. For Λ^{intra} this normalizing constant is the sales of other firms in the sector. For Λ^{inter} this normalizing constant is the sales of firms in all other sectors.

25. Finally, Azar et al. divides λ_{jk} into two components, the weight due to the Big 3 passive investors (Blackrock, Vanguard and State Street), and the weight due to other investors:

$$\lambda_{jk} = \frac{\sum_{i \in B3} \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}} + \frac{\sum_{i \in I \setminus B3} \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}} \tag{10}$$

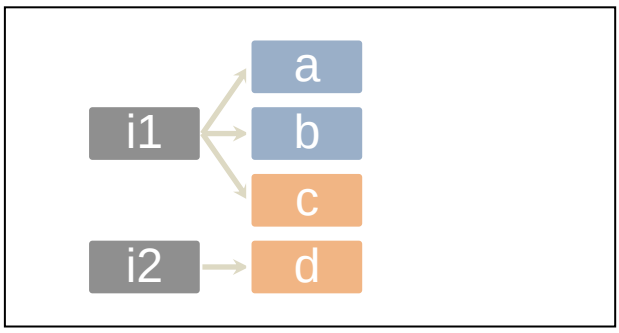
We decompose λ_{jk} into three components: the weight due to the Big 3, the weight due to other institutional investors, and the residual.

26. To summarise, we calculate 36 measures of common ownership based on Azar et al. (2018) and Azar and Vives (2021), resulting from the combination of the following choices: intra vs inter-industry common ownership; all owners vs Big 3 investors vs all other institutional investors; weighted vs unweighted averages; ownership stakes vs Banzhaf concentrated vs Banzhaf dispersed index to operationalise control.

Worked example

27. Two investors fully own four firms: firms *a* and *b* in sector blue, and *c* and *d* in sector orange (Figure B.1).

Figure B.1. Firms ownership structure: an example



Source: OECD

28. Firms *a* and *c* have sales equal to 2, firms *b* and *d* have sales equal to 1.

$$\Gamma = \mathrm{B} = \begin{bmatrix} 1 & 0 \\ 1 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}, W = \begin{bmatrix} 2 \\ 1 \\ 2 \\ 1 \end{bmatrix}, \Lambda = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

29. Given that firms *a* and *b* share the same owner, and have a weight of 1 on each other, while firms *c* and *d* have different owners, the unweighted lambdas are:

$$\Lambda_{unw}^{intra} = \begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \end{bmatrix} \text{ and } \Lambda_{unw}^{inter} = \begin{bmatrix} 0.5 \\ 0.5 \\ 1 \\ 0 \end{bmatrix}$$

30. The weighted lambdas are:

$$\Lambda_{w}^{intra} = \begin{bmatrix} 1/1 \\ 2/2 \\ 0/1 \\ 0/2 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \end{bmatrix}, \Lambda_{unw}^{inter} = \begin{bmatrix} 2/3 \\ 2/3 \\ 3/3 \\ 0 \end{bmatrix} = \begin{bmatrix} 0.67 \\ 0.67 \\ 1 \\ 0 \end{bmatrix}$$

Degree centrality

31. Compared to previous measures taking into account only the numbers of network edges, the degree centrality measure also looks at the total revenue owned directly by an investor. In particular, the higher this share of revenues, the more central is the investor. It is calculated as:

$$D_i = \sum_k \beta_{ik} R_k \tag{11}$$

where β_{ik} is the ownership stake of investor *i* in firm *k* and R_k the revenue of firm *k*.

32. The common ownership at firm j is then given by the aggregated degree centrality of the investors (minus the contribution of firm j to that aggregated centrality) and adjusted by the control of investor *i* in firm *j* (γ_{ij}). The degree centrality of firm *j* (D_j) is also taken into account for the cases where firm *j* is an investor.

$$DCr_j = \sum_i \gamma_{ij}(D_i - \beta_{ij} R_j) + D_j \tag{12}$$

This measure is then normalized by the total revenue in the network, adjusted by the known ownership. DC_j is hence defined as the share of revenue owned by the investors of company *j*, weighted by the ownership of the investors in company *j*.

$$DC_j = \frac{DCr_j}{\sum_{k!=j} \sum_i \beta_{ik} R_k} \quad (13)$$

The degree centrality is broken down in two components; the intra-sector, which can be calculated simply as the D_i , DCr_j, and DC_j for each sector independently, and the inter-sector component, calculated as:

$$DCr_j^{inter} = DCr_j - DCr_j^{intra} \quad (14)$$

$$DC_j^{inter} = \frac{DCr_j^{inter}}{\sum_{k!=j} \sum_i \beta_{ik} R_k - \sum_{k \in s\, !=j} \sum_i \beta_{ik} R_k} \quad (15)$$

An unweighted version is also calculated by setting R to one for all companies. Finally, the contribution of the Big 3 passive investors and the contribution of all institutional investors was also calculated by limiting the calculation of DCr_j to those groups of investors.

33. To summarize, we calculate 54 measures of degree centrality per firm, resulting from the combination of the following choices: total vs intra vs inter-industry; weighted vs unweighted; all owners vs Big 3 investors vs all other institutional investors; ownership stakes vs Banzhaf concentrated vs Banzhaf dispersed index to operationalise control.

Worked example:

Considering the same example as above (see Figure B.1), degree centrality can be computed as:

$$\Gamma = \mathrm{B} = \begin{bmatrix} 1 & 0 \\ 1 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}, W = \begin{bmatrix} 2 \\ 1 \\ 2 \\ 1 \end{bmatrix}$$

The degree centrality of the investors (D_i) is hence 5 for i1 and 1 for i2. Next, the different measures of centrality at the firm level are given by:

$$DCr_j = \begin{bmatrix} 3 \\ 4 \\ 3 \\ 0 \end{bmatrix}; DCr_j^{intra} = \begin{bmatrix} 1 \\ 2 \\ 0 \\ 0 \end{bmatrix}; DCr_j^{inter} = \begin{bmatrix} 2 \\ 2 \\ 3 \\ 0 \end{bmatrix}$$

The normalized intra and inter-sector measures are then obtained by dividing by the revenue of other firms in the sector (or other firms in other sectors):

$$DC_j^{intra} = \begin{bmatrix} 1/1 \\ 2/2 \\ 0/1 \\ 0/2 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \end{bmatrix}; DC_j^{inter} = \begin{bmatrix} 2/3 \\ 2/3 \\ 3/3 \\ 0/3 \end{bmatrix} = \begin{bmatrix} 2/3 \\ 2/3 \\ 1 \\ 0 \end{bmatrix}$$

Betweenness centrality

34. Ownership relations can also serve to spread information, for example via shareholder meetings. If this is the case, investors with a brokerage function will have a more prominent effect on the productivity of the company. This is captured well by betweenness centrality, which is defined as the number of shortest paths in the network passing through each investor. Since information can travel independently of the ownership stake in the firm, the values are calculated without weighting the network by ownership. Similarly, since the information can be spread in both directions (towards investor and towards the firm), this network is not directed.

35. The raw betweenness centrality of firm j is defined as the sum of the betweenness centralities of the investors i:

$$BCr_j = \sum_i B_i \tag{16}$$

Where B_i is the betweenness centrality value of the investor, defined as the number of shortest paths between all companies in the ownership network passing through the investor.

36. This measure is then normalized by the total number of shortest paths in the network:

$$BC_j = \frac{BCr_j}{(N-1)(N-2)} \tag{17}$$

where N is the number of nodes in the network.

37. We can then separate the degree centrality in intra-sector component, simply by calculating B_i , BCr_j, and BC_j for each sector independently, and inter-sector component:

$$BC_j^{intra} = \frac{BCr_j^{intra}}{(N_s-1)(N_s-2)} \tag{18}$$

$$BCr_j^{inter} = BCr_j - BCr_j^{intra} = \frac{BCr_j^{inter}}{(N-1)(N-2)-(N_s-1)(N_s-2)} \tag{19}$$

Finally, the contribution of the Big 3 passive investors and the contribution of all institutional investors was also calculated by limiting the calculation of BCr_j to those groups of investors.

38. We calculate 9 measures of betweenness centrality per firm, resulting from the combination of the following choices: total vs intra vs inter-industry; all owners vs Big 3 investors vs all other institutional investor.

Annex C. Additional tables

Table C.1. The governance channel – static baseline estimates -- robustness

Dependent Variable: MFP levels					
Model	(1)	(2)	(3)	(4)	(5)
Explanatory ownership variable	Cont.	Cont.	Cont. t-3	Above median	Above 10%
Lagged Institutional Ownership	**0.442*** **	**0.297*** **	**0.248*** **	**0.193*** **	**0.281*** **
	(0.034)	**(0.030)**	**(0.037)**	**(0.017)**	**(0.017)**
Observations	50,981	50,981	28,720	50,981	50,981
R-squared	0.526	0.615	0.634	0.616	0.620
Firm Controls (Size, Profitability, Leverage)	NO	YES	YES	YES	YES
Country * Sector * Year Fixed Effects	YES	YES	YES	YES	YES

Note: Standard errors in parentheses; standard errors clustered at the firm level. Significance Level: *10%, **5%, *** 1%.
Lagged institutional ownership stands for the percentage shares held by institutional investors in each firm at t-1 in model (1) and (2) and at t-3 in model (3), while for a binary variable taking value 1 for firms with institutional ownership above the median level in model (4) or for firms in which institutional investors hold more than 10% of the shares in model (5).
Source: OECD calculations based on Orbis® data.

Table C.2. The governance channel – dynamic baseline estimates -- robustness

Dependent Variable: MFP growth			
Model	(1)	(2)	(3)
Growth over	1-year	1-year	3-years
Lagged Institutional Ownership	**0.065*** **	**0.039*** **	**0.045** **
	(0.010)	**(0.010)**	**(0.018)**
Gap with respect to MFP Frontier	0.174***	0.181***	0.224***
	(0.006)	(0.007)	(0.011)
Observations	45,608	45,608	28,708
R-squared	0.247	0.258	0.312
Firm Controls (Size, Profitability, Leverage)	NO	YES	YES
Country * Sector * Year Fixed Effects	YES	YES	YES

Note: Standard errors in parentheses; standard errors clustered at the firm level. Significance Level: *10%, **5%, *** 1%.
Lagged institutional ownership stands for the percentage shares held by institutional investors in each firm at t-1. In columns (1) and (2), MFP growth stands for the yearly growth rates, while in column (3) the dependent variable is the 3-years cumulative MFP growth.
Source: OECD calculations based on Orbis® data.