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The "Average" Within-Sector Firm Heterogeneity in General Oligopolistic Equilibrium*

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Abstract

This paper builds a general oligopolistic equilibrium model to investigate how within-sector firm heterogeneities affect wage rate, country-wide profits, and welfare. Using linear inverse demands, I consider asymmetric sectors, each involving n Cournot oligopolists producing horizontally differentiated varieties with constant, though asymmetric, costs. I link a measure of the average within-sector firm heterogeneity with the economy-wide, endogenously determined, and competitive wage rate. For interior equilibriums, the higher the "average" the lower the wage rate. Once general equilibrium feedbacks from wage rate are considered, the "average" has an unclear impact on country-wide profits and welfare, depending on moments of the technology distribution as well as demand parameters. The findings have implications to better understand antitrust and related policies.

Keywords: Cournot Competition; General Oligopolistic Equilibrium (GOLE); Asymmetric Oligopoly; Horizontal Differentiation; Market Concentration; Antitrust

JEL Codes: D43; D51; L11; L13

1 Introduction

Firm heterogeneity in productivity has been playing an increasingly prominent role both theoretically and empirically in economics.[1] New and richer micro-level (trade) data on firms

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[1] For review of theoretical and empirical literature, see Syverson (2011) on productivity differences in general. For an example of subfield literature, see Bernard et al. (2007), Redding (2011), and Tybout (2003) on firm heterogeneity and international trade.

and plants, regarding several developed and developing countries and years, have progressively become available since the late 1980s, allowing to explore new features.

Mayer and Ottaviano (2008) have summarized the empirical evidence on internationalized firms in a subset of European countries by stating that

> *"[They] are superstars. They are rare and their distribution is highly skewed, as a handful of firms accounts for most aggregate international activity.*
>
> *[They] belong to an exclusive club. They are different from other firms. They are bigger, generate higher value added, pay higher wages, employ more capital per worker and more skilled workers and have higher productivity"* (p. 14, emphasis added).

These stylized facts also hold for narrowly defined sectors. Firms within their internationalized sectors differ in efficiencies and thus in their own market shares. This evidence also highlights the well-known asymmetric (or heterogeneous) efficiencies among firms within their domestic markets. I believe that these stylized features of data call for general equilibrium models to account for both heterogeneous efficiencies and strategic interaction among rival firms. On the one hand, heterogeneous firm efficiencies have been widely considered by scholars. On the other hand, there exists a lack of theoretical models to *also* account for strategic interaction in general equilibrium.

The following simple observation offers a sufficient motivation in adopting a model with strategic interaction. Consider the U.S., one of the largest and most diversified economies in the world, and look at the four-firm and eight-firm concentration ratios (CR4 and CR8, respectively), namely the aggregate market share of the four and eight largest firms in a (disaggregate) sector. As common in literature, let us focus on manufacturing sectors (NAICS 31-33). Beyond the well-known textbook examples,[2] a simple overall valuation of market concentration over sectors can better set the scene. There are 181 out of 471 sectors (total number of sectors at six-digit 2007 NAICS codes) with a CR4 higher than 50% and 292 sectors with a CR8 higher than 50%. Yet, only 19 sectors have a CR4 lower than 10%.[3] It would be easy for the reader to find similar evidences on strong market concentrations for other countries, especially for the developing ones. Putting aside questions on the accuracy on concentration ratios as proxies

[2]Such as the "Automobile manufacturing" (NAICS 336111) with a CR4 equal to 67.6%, or the "Tire manufacturing"(NAICS 32621) with a CR4 equal to 72.8%,

[3]Data are from the 2007 U.S. Economic Census Concentration Ratios. Market shares are relative to the value of shipments. Author's own calculations.

for market power and competitiveness, this sketchy observation highlights how many (manufacturing) markets are far to be represented by perfect or monopolistic competition because oligopolistic rents are likely to be positive and large.

Hence, analyzing the implications of several sectors composed by a small number of large firms having heterogeneous productivities and most likely engaging in a strategic competition within their sectors, is far from being a theoretical curiosity but it is a worthwhile question that needs further consideration. Surprisingly, so far this has not been done in any general equilibrium framework. The aim of this paper is to meet this theoretical need by investigating the following research question: what is the role of within-sector firm heterogeneities in affecting wage rate, country-wide aggregate profits (henceforth simply aggregate profits), and social welfare in a general equilibrium model under oligopoly? This paper achieves its purpose by building on the Neary (2003b;c)'s framework of general oligopolistic equilibrium (henceforth GOLE), and by augmenting it to allow for situations in which sectors may be asymmetric in terms of average productivity requirements and they are composed by n Cournot oligopolists producing horizontally differentiated varieties with constant, though asymmetric, costs. This framework is able to generate a measure of the average within-sector firm heterogeneity, which I use to derive new theoretical insights.

The main theoretical contribution of this paper is to link the first uncentred moment of the cross-sector distribution of within-sector firm heterogeneities — measured as within-sector variances of production costs — and the endogenous wage rate. This link permits to obtain general equilibrium feedbacks on aggregate profits and social welfare. The findings of this paper are summarized as follows. On the one hand, the first uncentred moment of the cross-sector distribution of within-sector firm heterogeneities unambiguously and negatively affects the wage rate. The economic intuition for this finding relies on standard partial equilibrium models of oligopoly without free entry. It is well-known that market power is indirectly linked to the market concentration, which is positively and closely related to the variance in firms' production costs. In a framework with a continuum of sectors as that presented here, the first uncentred moment of the cross-sector distribution of within-sector firm heterogeneities measures the "average" within-sector firm heterogeneity. Hence, the lower this "average" the more likely that incumbents engage in a stronger competition in their sectors, and they would be more disposed to pay a higher wage rate, putting pressure on labor demand. On the other hand, the endogenous determinacy of the wage rate, together with the moments of the technology distribution of unit labor requirements (henceforth simply technology distribution) and demand parameters, contribute in obtaining unclear findings of the impact of the "average" within-sector firm heterogeneity on aggregate profits and social welfare, depending on specific structure of the whole economy.

My approach provides a new viewpoint on antitrust and related policies (e.g., those helping minor firms) in comparison with those implied from standard partial equilibrium models, which only focus on single sectors. The model qualifies the standard vision on competition policies deriving from partial equilibrium works. Specifically, applying the intuitions from partial equilibrium approaches to the economy as a whole might bring misleading results, as the effects on aggregate profits and social welfare depend on features of all sectors in a country and on how these sectors interact with factor markets. The bottom line for policy implications is the following. Antitrust or, more generally, governmental authorities aiming to maximize social welfare ought to posses an economy-wide standpoint on their policies, without overlooking potential general equilibrium feedbacks from factor markets.

This paper is organized as follows. The next section briefly discusses the background, which motivates and justifies my formulation, and it presents an overview of the theoretical contribution as well as the related literature. In Section 3 I build a model of within-sector firm heterogeneities in the GOLE framework. Section 4 provides exercises of comparative statics, states theoretical findings, and discusses them. Finally, in Section 5 I give some concluding remarks and I suggest policy implications as well as some promising extensions of the model.

2 Background, overview, and related literature

Monopolistic competition is the standard tool in many strands of economic literature, such as international trade, economic geography, macroeconomics, or economic growth. The reason is that this market structure permits to have a highly tractable framework to embed imperfect competition in general equilibrium.[4] Literature on firm heterogeneity has not been prevented from this approach.[5] However, in a world characterized by the presence of a handful of large firms in

[4]For further discussion on monopolistic competition and its use on various economic fields, see the survey of the literature by Chang (2011).

[5]For example, New New Trade Theory considers firm heterogeneity in general equilibrium by sticking with the conventional use of monopolistic competition of Dixit and Stiglitz (1977) to explain selection process in international markets. This closes the strategic interaction channel. Firm heterogeneity has been also embedded in the Eaton and Kortum (2002)'s Ricardian trade model by Bernard et al. (2003), in which Bertrand competition is among firms producing the same variety, with markups endogenously determined. Holmes et al. (2012) consider a

many (disaggregated) sectors, models relying on monopolistic competition, usually with constant elasticity of substitution (CES) preferences, are not adequate, or at best incomplete, given the empirical evidence. Firms differ in size and the largest ones (that are also able to go to international markets) are most likely to engage in strategic behavior because their weights within their sectors are far from zero. Moreover, with monopolistic competition and CES demand, firms' prices are not affected by firms' market shares because markups are assumed to be a constant multiple of marginal cost.[6] Hence, the omnipresent skewness of firm productivity in real-world economic activity, in which few large firms dominate markets, is blunt by considering – using Neary (2009b)'s words (p. 241, emphasis added) – *"atomistic firms of monopolistic competition, which never earn profits in equilibrium, take the demand functions they face as given, and do not interact strategically with their competitors."* The importance of oligopoly is highlighted in standard theory of industrial organization, and its relevance becomes greater as firms's efficiencies are not only heterogeneous but also skew.

Motivated by the empirical evidence and by the lack of theoretical models to account for it in general equilibrium, I propose a simple model of strategic interaction and within-sector firm heterogeneities, by building on a framework characterized by a continuum of asymmetric sectors, each involving n firms having asymmetric costs of production and competing on quantity (i.e., à la Cournot). As in standard frameworks of monopolistic competition, and as widely observed in most sectors, I also consider horizontally differentiated goods in order to have a model that advances the realism, and it is more justifiable in a non-cooperative interaction environment without collusion, as good differentiation helps to hold market power. Large firms in a sector most likely remain active for a long time, therefore I work up with an exogenously fixed small number of active firms within each sector. The exogenous asymmetries across sectors in average productivities overcome in a simple way the assumption that each sector is composed by the same number n of active firms, permitting to consider differences in degree of competition across sectors. This paper is not the first study that considers firm heterogeneity in oligopoly. This setting has been intensively analyzed in past partial equilibrium literature (e.g., Lahiri and Ono (1988), and Kimmel (1992)). However, to my knowledge, no

version of the Bernard et al. (2003)'s model with a finite number of firms. See also Grossman and Rossi-Hansberg (2010) for a model of industry-level external economies of scale and trade, assuming Bertrand competition with a continuum of sectors and wage as numéraire. In general, (homogeneous-product) Bertrand competition with its undercutting process is more akin to monopolistic competition with free entry than to Cournot competition, which easily permits to take into account oligopolistic rents in equilibrium instead.

[6] Melitz and Ottaviano (2008) have partially overcome this limiting feature by using monopolistic competition with quasi-linear preferences. Yet, strategic interaction has been put aside.

paper has studied the implications for wage rate, aggregate profits, and social welfare of within-sector firm heterogeneities together oligopolistic competition in a full general equilibrium, yet simple, framework with many asymmetric sectors in term of average firm productivity.

As firms in each sector have different productivities as well as sectors differ in their average productivities, this is likely to affect factor rewards, once one aggregates over all sectors, because the competition within sectors influences the demand from firms for the same *scarce* input, by means of the strategic interaction. Most of theoretical literature on firm heterogeneity, however, does not consider the implication from factor markets.[7] To address factor markets, a general equilibrium approach is needed. Neary (2003b;c) offers a theoretically consistent framework overcoming the difficulties to embed oligopoly in general equilibrium. The Neary's key assumption is that *firms are large in their own sector, but small for the economy as a whole*. In what follows, I build on his (GOLE) approach, which relies on a continuum of sectors and an exogenous and small number of firms competing à la Cournot within their sectors. Hence, firms have sectoral market power, which permits them to affect the price of their output, so that they strategically act only with respect to their direct rivals within their sectors, but they take factor prices, other goods prices, and national income as given (viz., there exist neither monopsony power nor Ford effect). Differently from Neary (2003b;c), who assumes homogeneous products and symmetric costs among firms within sectors, I augment his framework by considering both firm heterogeneity in productivities within sectors and differentiated products. It is reasonable to expect that these two extensions are more likely to be fulfilled in reality. In a theoretical framework that encompasses both within-sector firm heterogeneities and strategic interaction, I show how the wage rate plays a pivotal role because it affects all firms in the same way, via the perfectly competitive labor market and its general equilibrium feedbacks.

The key difference between most of literature on firm heterogeneity in general equilibrium and my paper relies on the market structure, because I work with Cournot competition, therefore the framework presented in this paper can be seen as complementary to models that consider monopolistic or Bertrand competition. I have sought to show how the interaction among labor market, oligopolistic market structure and firm heterogeneity in productivity can also have an important role to better understand antitrust (or competition) policy outcomes. To keep the analysis simple and to improve both understanding and intuition of the model, I assume that demand and cost functions are linear, permitting to work up with closed-form

[7] For example, by normalizing factor reward to unity assuming a sector under perfect competition and constant returns to scale, whose good acts as numéraire (viz., one unit of input produces one unit of numéraire good).

equations. These key features allow for providing a fairly general, yet highly tractable, model, to my knowledge the first theoretical study with these characteristics, and it can be used for exercises of comparative statics. The model generates testable predictions on the link between a measure of the average of within-sector firm heterogeneities and the wage rate, and once the technology distribution is plausibly parametrized and calibrated (this step is left to future research), the model would also give indications on the sign variations in aggregate profits and social welfare due to a rise in the "average" within-sector firm heterogeneity.

This paper relates to the economic literature and extends it in several ways, showing how my model is able to unify a fairly broad set of research. Firstly, from a methodological viewpoint it is related to the recent stream of literature using the Neary (2003b;c)'s GOLE framework. This literature focuses on various topics, primarily linked to international trade issues.[8] Bastos and Straume (2012) build a GOLE model considering endogenous (horizontal) product differentiation whereas Neary and Tharakan (2012) deal with an exogenous differentiation. However, these papers consider only two varieties of a good in an international duopoly approach, without focusing on the role of within-sector firm heterogeneities in general equilibrium. Egger and Koch (2012) also set up a GOLE model with exogenous product differentiation to analyze the implications on employment issues. As the previous two papers, no room is given to within-sector firm heterogeneities. Partial exceptions dealing with different firm productivities can be found in Eckel and Neary (2010) and Eckel et al. (2011) in studying multi-product firms. Both studies consider an extension of their original models to allow for firm heterogeneity but they go to another directions, as the authors are mainly interested in analyzing both scale and scope intra-firm adjustments due to various shocks among multi-product firms in partial equilibrium, and the consequent link with labor market. Yet, a full general equilibrium account of the effects of within-sector firm heterogeneities is not offered. My paper analyses yet another topic, by proposing in an unified framework asymmetric sectors composed by n firms with different productivities in producing horizontal differentiated varieties, by giving closed-form solutions for wage rate, aggregate profits, and social welfare. Hence, my findings and the mechanisms behind them lead to new insights. Given the increasing importance of the GOLE framework in theoretical literature, the research question on the role of firm heterogeneity, which is a key

[8]See, for example, Neary (2003a;b) and Neary (2009a) for Ricardian trade models; Eckel and Neary (2010), Eckel et al. (2011) and Egger and Koch (2012) for multi-product firms; Bastos and Straume (2012) and Neary and Tharakan (2012) for wage inequality and skill-premium; Neary (2007) for cross-border mergers; Basile and De Benedictis (2008), Bastos and Kreickemeier (2009), Egger and Etzel (2012), Egger and Koch (2012), Egger and Meland (2011), and Kreickemeier and Meland (2011) for unions and unemployment.

feature for most of sectors in many countries, is worth being analyzed. I aim to mitigate this theoretical void.[9]

Secondly, this paper is theoretically related to, but differs from, the IO literature focusing on the link between asymmetric costs in oligopoly and both sectoral total profits and welfare. Partial equilibrium models of oligopoly with firms having heterogeneous productivities permit to analyze market concentration issues, by means of the positive relationship between price-marginal cost margins and market shares. It is a common wisdom that market concentration is negatively related to welfare. However, comparative statics on the rise in cost dispersion has showed that welfare-enhancing effects may also be derived. For asymmetric-costs Cournot competition in different theoretical contexts, Long and Soubeyran (1997; 2001) and Salant and Shaffer (1999) have showed that there exists a positive link between a rise of marginal cost dispersion between firms and both sectoral total profits and welfare when the average marginal cost of firms in the sector is not affected and all firms continue to be active after that their costs change.[10] All these studies focus on the effects of a cost variation within a single sector. They do not consider, however, any link with factor markets, therefore they cannot account for the effect of a country-level measure of within-sector firm heterogeneities and general equilibrium feedbacks from factor rewards. Hence, all this literature leaves an open question on the formal assessment of changes in welfare and aggregate profits in general equilibrium. Considering these additional features leads to unclear results for the economy as whole, as this paper will show.

Finally, the paper is also linked to another strand of research in IO. An established theoretical finding, addressed in an asymmetric-costs oligopoly, derives from the argument that helping minor (i.e., inefficient) firms may reduce welfare, since the seminal work by Lahiri and Ono (1988). This partial equilibrium literature has focused on several related issues: for example, the effect of an exogenous variation in the sector-wide cost component on profits of single firms (e.g., Kimmel (1992)) or the effect of an exogenous variation in a single firm's production cost on sectoral total profits and welfare (for models with linear demand see, e.g., Zhao (2001) for an homogeneous good, and Wang and Zhao (2007) for a differentiated good). These works have provided conditions on single firms' market shares to assess the impact on sectoral total profits and welfare due to changes in production costs. These and many other akin issues have

[9]Neary (2002) uses the n-firm asymmetric-costs differentiated-good in a partial equilibrium analysis of strategic investments. He suggests in passing that future research should address a possible extension by using the GOLE framework.

[10]See the seminal work by Bergstrom and Varian (1985a;b) for the insight.

been investigated via partial equilibrium frameworks. Shedding some light on these topics, by adopting an extended version of the GOLE framework, it would permit a better understanding of antitrust and related policy outcomes.

3 Model

Before building the model in detail, I briefly describe the model features. The model strategy nests two key distinct characteristics. On the demand side, I assume a representative consumer having preferences over horizontally differentiated goods in a linear demand structure, a framework widely used in IO literature, like in Dixit (1979) and extended by Vives (1985) to allow for n firms producing a single variety each. On the supply side, I consider a linear technology with constant, though asymmetric, marginal costs among firms within their own sector (e.g., as in partial equilibrium studies by Lahiri and Ono (1988) and Long and Soubeyran (1997; 2001)).[11] I set up a simple and static Cournot oligopoly model, by presenting equilibrium outcomes for a single representative sector. The model considers labor as the sole factor of production, whose market is perfectly competitive. I use this framework to extend the GOLE model by Neary (2003b;c) by giving an equilibrium closed-form solution to the wage rate. The wage rate allows for deriving closed-form solutions, in term of exogenous variables only, for aggregate profits and social welfare in general equilibrium. On these two variables I conduct exercises of comparative statics in the next section. Continuity and differentiability in relevant arguments will be assumed for the introduced functions up to the necessary order. I present the model only for a closed (or autarky) economy. Generalization to an open-economy case, in which domestic firms engage in strategic competition with their foreign rivals in each sector, can be achieved with a heavier notation. Further discussion and implications on extending the model to an open-economy case are provided in Section 5.

3.1 Demand side

The country is populated by a representative consumer endowed with L units of labor, inelastically supplied (for a positive wage rate) to a perfectly competitive labor market.[12] Preferences

[11] This partial equilibrium setting of oligopoly with a representative consumer having linear demand is well-know in literature since Vives (1985). For the sake of the reader, I briefly sketch the standard derivations for the basic setup for the supply side and partial equilibrium from which I depart.

[12] A perfectly competitive labor market is plausible if a continuum of sectors compete for labor supply.

are given by an utility function additively separable over a continuum of sectors[13] of unit mass, indexed by $z \in [0,1]$, strictly increasing and strictly concave, given by

$$U[\{x(z)\}] = \int_0^1 u[x(z)]dz\,, \tag{1}$$

assuming $u'[\cdot] > 0$ and $u''[\cdot] < 0$. Let the sub-utility functions be quadratic, involving $n \geq 2$ symmetrically[14] and horizontally differentiated varieties of each good z, given by

$$u[x(z)] = a\sum_{i=1}^{n} x(i,z) - \frac{b-\gamma}{2}\sum_{i=1}^{n}[x(i,z)]^2 - \frac{\gamma}{2}\left(\sum_{i=1}^{n} x(i,z)\right)^2\,, \tag{2}$$

with $a > 0$ and $b > \gamma \geq 0$. Let $x(z)$ and $x(i,z)$ in Eq. (2) denote the consumption of good produced in sector z and the consumption of the variety $i \in \{1, 2, \ldots, n\}$ produced in sector z, respectively. I additionally assume that the good produced in each sector is not substitutable with those of any other sector.[15]

The interpretation of the demand parameters is borrowed by Ottaviano et al. (2002). The higher a the higher maximum willingness to pay. The parameter a is constant both across any two varieties in each sector and across sectors. Hence, the model considers only horizontal differentiation, to focus on heterogeneity among firm productivities, abstracting from product quality (or vertical differentiation), implying that all inverse demand functions share the intercept.[16] The higher b the more the consumer is bias towards a dispersed consumption of varieties (i.e., love of variety). As usual in most studies on oligopoly, I abstract from complementarity, by setting $\gamma \geq 0$. To have love of variety I have set $\gamma < b$ (Ottaviano et al., 2002). These assumptions guarantee strictly concave sub-utility functions and interior solutions. The γ-to-b ratio measures the degree of horizontal differentiation (or substitutability) between any two

[13]From an empirical viewpoint, in a GOLE setting, sectors can be interpretable as corresponding to a high level of disaggregation of commodities applied in economic censuses, such as five-digit NAICS codes, or even more.

[14]Here symmetry means that all varieties of any good enter into each sub-utility function in the same way. Note that I have assumed a bounded set of varieties for each good.

[15]These preferences have the advantage to give closed-form outcomes with linear demands in own prices and quantities, so that they can approximate market outcomes in the neighborhood of their equilibriums. Moreover, these preferences guarantee existence and uniqueness of the equilibrium in any sector, with downward-sloping reaction functions of firms in quantity space, namely the outputs are strategic substitutes, as required by Cournot competition. Quadratic preferences are quasi-homothetic (viz., they are a case of Gorman (1961)'s polar form), and they can be aggregated across individuals with different incomes, as long as they share the demand parameter b, implying linear and parallel Engel curves (Neary, 2003c; 2009a). This feature allows for adopting the representative consumer approach.

[16]The model is isomorphic to that in which one allows for different values of a for any variety of each good, as it can be easily brought back to the present case by deviating any *small* quality effect on production cost as long as all firms are active (viz., isomorphism holds for sufficiently small differences among product qualities).

varieties, ranging from zero ($\gamma = 0$: independent) to approximately one ($\gamma \approx b$: almost homogeneous or perfect substitutes). To keep mathematical simplicity, I assume that, as for the parameter a, the parameter γ is constant for any pair of varieties of a good in each sector and invariant across sectors. This is done to avoid including another source of heterogeneity.

The representative consumer maximizes the utility function in Eq. (1) subject to the budget constraint:

$$\max_{\{x(z)\}\in\mathbb{R}^n_+,\, i\in\{1,\dots,n\},\, z\in[0,1]} U[\{x(z)\}] \quad s.t. \quad \int_0^1 \sum_{i=1}^n p(i,z)x(i,z)dz \leq I\,, \tag{3}$$

with I the income (or total expenditure) in the economy, and $p(i,z)$ the price of variety $x(i,z)$. Solving the problem[17] in Eq. (3) gives the linear inverse demand function for the interior optimal consumption of $x(i,z)$:

$$\lambda p(i,z) = a - bx(i,z) - \gamma \sum_{\substack{j=1 \\ j\neq i}}^{n} x(j,z)\,, \quad i = 1,\dots,n\,, \tag{4}$$

with λ the Lagrangian multiplier of the budget constraint (or the marginal utility of income). I assume throughout that $p(i,z) > 0$ for $i \in \{1,\dots,n\}$, and non satiation (that is, $\lambda > 0$). This guarantees a strictly positive demand for each variety produced, meaning that all varieties are essential at any (finite) positive price. As $\gamma < b$, the inverse demand functions in Eq. (4) can be inverted as

$$x(i,z) = A - \lambda B p(i,z) + \lambda C \sum_{\substack{j=1 \\ j\neq i}} p(j,z)\,, \quad i = 1,\dots,n\,, \tag{5}$$

where $A = \frac{a}{b+\gamma(n-1)}$, $B = \frac{b+\gamma(n-2)}{(b+\gamma(n-1))(b-\gamma)}$, and $C = \frac{\gamma}{(b+\gamma(n-1))(b-\gamma)}$.

For sake of completeness, before concluding the demand side of the model, I derive the closed-form expression for the marginal utility of national income. I rewrite the direct demand functions in Eq. (5) as

$$x(i,z) = A - \lambda(B+C)p(i,z) + \lambda C n\bar{p}(z)\,, \quad i = 1,\dots,n\,, \tag{6}$$

[17] The first order conditions for utility maximization are both necessary and sufficient given the strict concavity of sub-utility functions.

with $\bar{p}(z) = n^{-1}\sum_{i=1}^{n} p(i,z)$. By multiplying each direct demand function in Eq. (6) for its price, $p(i,z)$, yields

$$x(i,z)p(i,z) = Ap(i,z) - \lambda(B+C)[p(i,z)]^2 + \lambda Cn\bar{p}(z)p(i,z)\,. \tag{7}$$

Eq. (7) is the expenditure on the variety i of good z. Then, by summing up Eq. (7) for all varieties produced in sector z, and integrating over all sectors, it gives the total expenditure in the economy as a whole, which has to equal the national income, I, by assuming the saturation of the budget constraint in Eq. (3):

$$\int_0^1 \left\{\sum_{i=1}^{n} x(i,z)p(i,z)\right\} dz = An\mu_1^{\bar{p}} - \lambda(B+C)n\mu_1^{\sigma_p^2} - \lambda(B+C)n\mu_2^{\bar{p}} + \lambda Cn^2\mu_2^{\bar{p}} = I\,, \tag{8}$$

where

$$\mu_1^{\bar{p}} \equiv \int_0^1 \bar{p}(z)dz\,, \quad \mu_2^{\bar{p}} \equiv \int_0^1 [\bar{p}(z)]^2 dz\,, \quad \mu_1^{\sigma_p^2} \equiv \int_0^1 \sigma_p^2(z)dz\,, \tag{9}$$

and $\sigma_p^2(z) = \left\{\left(\sum_{i=1}^{n}[p(i,z)]^2\right)/n - [\bar{p}(z)]^2\right\}$, which is the price variance in sector z. The first two terms in Eq. (9) are the first and the second uncentred moments of the distribution across sectors of the average price in each sector, respectively. The third term is the first uncentred moment of the distribution across sectors of the price variance in each sector.

I can now solve Eq. (8) for the marginal utility of national income, λ, as

$$\begin{aligned} \lambda[\{p(z)\}, I] &= \frac{An\mu_1^{\bar{p}} - I}{n\left\{(B+C)\mu_1^{\sigma_p^2} + \mu_2^{\bar{p}}(B - C(n-1))\right\}} \\ &= \frac{\left[a\mu_1^{\bar{p}} - I\frac{b+\gamma(n-1)}{n}\right](b-\gamma)}{(b+\gamma(n-1))\mu_1^{\sigma_p^2} + (b-\gamma)\mu_2^{\bar{p}}}\,. \end{aligned} \tag{10}$$

The marginal utility of national income is endogenous in general equilibrium and it does not depend on sector-level variables but on the economy-wide variables only: price distribution and national income (and, of course, demand parameters and the exogenous number of varieties, which is common across all sectors). The marginal utility of national income in Eq. (10) is negatively related, all other things being equal, with a rise in national income, a rise in the second uncentred moment of the distribution across sectors of the average price in each sector, $\mu_2^{\bar{p}}$, a rise in the first uncentred moment of the distribution across sectors of the price variance in each sector, $\mu_1^{\sigma_p^2}$, and a fall in the first uncentred moment of the distribution across sectors of the average price in each sector, $\mu_1^{\bar{p}}$.[18] I move now to analyze firms' behaviors, technology, and the partial equilibrium.

3.2 Supply side and partial equilibrium

As in the traditional literature on oligopoly models, I assume that each sector is composed by an exogenously fixed and small number n of firms,[19] and, for analytical tractability, each firm in any sector produces a distinct variety, namely there exists a bijective (i.e., one-to-one) relation between firms and varieties.[20] Hence, each firm faces a positive demand for its produced variety. Focusing on oligopolistic market structure and competition among incumbents, I keep any firm entry-and-exit process out from the study, therefore this framework can be used for short and medium run analyses or, more generally, for situations in which changes in variables are not enough to permit any firm entrance or exit. The lack of free entry in the model can be motivated with the evidence that in many markets there are few large firms that for long periods of time have positive profit margins (see, e.g., Cubbin and Geroski (1987), Friedman (1993) and Leahy and Neary (2010)) and for the high entry barriers or the difficulty faced by new entrants in surviving long as argued by Geroski (1995), who also highlights how firm entry has a modest effect in eroding average industry profits.[21] Moreover, the exit may not occur if firms

[18]Note that if $\mu_1^{\sigma_p^2} = 0$ (i.e., no heterogeneity within any sector) and γ tends to b (i.e., goods almost perfect substitutes) then

$$\lim_{\gamma \to b} \left(\lambda[\{p(z)\}, I] \Big|_{\mu_1^{\sigma_p^2}=0} \right) = \frac{a\mu_1^{\bar{p}} - bI}{\mu_2^{\bar{p}}} .$$

Thus the marginal utility of national income degenerates to that of the baseline model by Neary (2003b;c), in which within every sector each firm charges the same price.

[19]The assumption of an equal number n of firms in each sector might seem strong, not allowing for different competition levels across sectors. I continue, however, to represent different competition levels within sectors by considering cross-sector asymmetries in terms of average firm productivities, given the strategic environment in each sector.

[20]For the paper's purpose, I abstract from multi-product (or multi-variety) firms, focusing on the scale changes in firm productions as a whole. There exists empirical evidence showing that large firms tend to have power-law distributed business lines, with only some key products composing most of sale shares (see, e.g., Sutton (2002) for a general discussion).

[21]Free entry condition allows for sectors with many (or an infinite number of) firms, driving profits to zero (ignoring the integer problem), and equilibrium outcomes converge to those of monopolistic or perfect competition. See Zhou (2010) for a model of homogeneous-good oligopoly and international trade, focusing on the entry-and-exit process of heterogeneous firms à la Melitz (2003). In his model, free entry leads expected profits to zero, and the opening up to trade leads inefficient firms out of the market, like in a model of monopolistic competition, although this entry-and-exit process is not due to the increase in the number of varieties supplied by the most efficient firms, but to a decrease in prices while the set of varieties is not changed. On a similar research line, see also Bekkers and Francois (2008), who extend the Brander and Krugman (1983)'s segmented-market model to a general equilibrium framework, by allowing for a finite number of sectors, offering also an interesting solution to

were to pay sunk costs, excluding drastic economic situations, which can be put aside as I work "around" the equilibrium (Negishi, 1961), in order to justify the use of the GOLE. I appeal also to the robust empirical evidence that big firms have a higher probability to remain active in the medium run.

I assume away any capacity constraint. Firms play a static one-stage game with complete information. They compete à la Cournot in their respective sectors, by choosing their own profit-maximizing outputs, taking the rivals' aggregate output as given. The GOLE approach relies on the assumption that *firms are large in their own sector but small with respect to the economy as a whole* (Neary, 2003b;c), so that firms take λ as given in their production decisions because they are not able to affect national income, wage rate, and firms' prices in the other sectors. Hence, the *perceived* inverse demand functions are linear within a neighborhood of the equilibrium (Negishi, 1961). This assumption avoids the problem of monopsony power in build model of oligopoly in general equilibrium.[22]

Labor, L, is the only factor of production. Labor can freely move across all sectors with no cost, therefore all firms in the country face the same wage rate. Firms are heterogeneous in their productivities and operate under a technology with constant returns to scale, therefore each cost function is linear in the output. As the number of firms is exogenously given, the fixed (sunk) costs have no role (provided firms gain positive profits). Thus, I set the fixed costs equal to zero. Each firm requires a different amount of labor to produce one unit of output, therefore firms differ in their marginal costs $c(i, z)$ for $i = 1, \ldots, n$, and $z \in [0, 1]$. Each firm maximizes its own profits subject to the *perceived* inverse demand function in Eq. (4), taking the direct rivals' outputs as given:

$$\max_{y(i,z)\in\mathbb{R}_+\,,\, i=1,\ldots,n\,,\, z\in[0,1]} \pi(i, z) \equiv [p(i, z) - c(i, z)]y(i, z)\,, \tag{11}$$

with $y(i, z)$ the output of firm i in sector z. Linear cost and demand functions guarantee stability and uniqueness of Cournot–Nash equilibrium in pure strategies, where firms do not deviate unilaterally from the equilibrium.

the integer problem for small-group models. Both papers emphasize reallocation effects due to the firm entry-and-exit process. However, they do not derive any link with the labor market, by normalizing the wage rate as well as no implication is derived from the nexus between with-sector firm heterogeneities and welfare. Neary (2010) puts forward some suggestions to embed firm entry-and-exit process in oligopolistic models.

[22] There are, of course, some real-world cases in which firms are able to influence the national-wide variables. The GOLE approach abstracts from such cases. This approach is justified as many modern developed economies are well diversified, so that sectors are relatively small with respect to the economy as a whole.

As standard in studies using the GOLE approach, I set $\lambda = 1$. This does not affect the model implications (in reality the absolute value of λ is not determined).[23] Hence, in general equilibrium nominal variables are measured in terms of the inverse of the marginal utility of national income (i.e., *real at the margin*).[24] As variables at the margin behave like the real ones, this setting can provide theoretical insights.

By imposing market clearing condition for each variety, the first order conditions for the firm's problem in Eq. (11) give the best response function for each firm in sector z:

$$y(i,z) = \frac{1}{2b}\left[a - \gamma \sum_{\substack{j=1 \\ j\neq i}}^{n} y(j,z) - c(i,z)\right], \quad i = 1,\ldots,n\,. \tag{12}$$

It can be checked that the second order conditions for interior solutions are satisfied. By using the usual trick to sum up all first order conditions in Eq. (12) over $i = 1,\ldots,n$, one obtains $2bQ(z) = na - \gamma(n-1)Q(z) - \sum_{i=1}^{n} c(i,z)$, with $Q(z) = \sum_{i=1}^{n} y(i,z)$. Solving for $Q(z)$ yields the Cournot–Nash equilibrium sectoral total production $Q(z)^{CN}$:[25]

$$Q(z)^{CN} = \frac{n(a - \bar{c}(z))}{2b + \gamma(n-1)}\,, \tag{13}$$

with $a > \bar{c}(z)$ and $\bar{c}(z) = n^{-1}\sum_{i=1}^{n} c(i,z)$. The superscript CN refers to Cournot–Nash equilibrium outcomes.

The Cournot–Nash equilibrium supply of each firm is obtained as solution of simultaneous equations derived by each firm's best response function in Eq. (12):

$$y(i,z) + \frac{\gamma}{2b}\sum_{\substack{j=1 \\ j\neq i}}^{n} y(j,z) = \frac{a - c(i,z)}{2b}\,, \quad i = 1,\ldots,n\,.$$

[23] Real variables are homogeneous of degree zero in the wage rate and $1/\lambda$. This fact provides a solution to the well-known numéraire problem. See Neary (2003b;c) and Neary (2009a) for further discussion.

[24] See Gabszewicz and Vial (1972) on the numéraire problem for oligopoly models in general equilibrium.

[25] Sectoral total output only depends on $\bar{c}(z)$, not on the distribution of costs among firms in the sector. Hence, a mean-preserving cost change (e.g., a productivity shock) is not able to affect $Q(z)^{CN}$. This is a well-known result, which dates back to Dixit and Stern (1982). See also the widely cited work by Bergstrom and Varian (1985a;b) and Katz (1986). This result is valid if, as here, all firms have the same "conjectural variations" (viz., for Cournot competition, zero conjectural elasticity for each firm) and an interior equilibrium is considered.

Hence, the supply of firm i in sector z in Cournot–Nash equilibrium is given by

$$(14) \qquad y(i,z)^{CN} = \frac{a - c(i,z)}{2b-\gamma} - \frac{\gamma n(a - \bar{c}(z))}{(2b-\gamma)(2b+\gamma(n-1))}\,, \quad i = 1, \ldots, n\,.$$

Differently from models of monopolistic competition, firms in each sector consider the sectoral total output in Eq. (13) in taking their own decisions. I assume throughout only interior solutions in equilibrium, in which all firms have strictly positive supplies (as I have assumed that each firm faces a positive demand), namely all firms are active in equilibrium, that is $y(i,z) > 0$ for $i = 1, \ldots, n$ and $z \in [0,1]$.[26] This is equivalent to the following assumption.

Assumption 1.

$$c(i,z) < a - \frac{\gamma n(a - \bar{c}(z))}{2b+\gamma(n-1)}\,, \quad i = 1, \ldots, n\,, \quad \text{for each } z \in [0,1]\,.$$

Assumption 1 means that unit labor requirements of firms in any sector are not too large. In this specification, every firm in any sector is able to charge a distinct price for its produced variety, having a potential positive demand even though it does not charge the lowest price (in case it faces a relatively high production cost). The corresponding Cournot–Nash equilibrium price, $p(i,z)^{CN}$, can be obtained by plugging Eq. (14) into Eq. (4), and by imposing $y(i,z)^{CN} = x(i,z)$:

$$(15) \qquad p(i,z)^{CN} = by(i,z)^{CN} + c(i,z) = \frac{ba + (b-\gamma)c(i,z)}{2b-\gamma} - \frac{b\gamma}{2b-\gamma}Q(z)^{CN}\,.$$

The Cournot–Nash equilibrium profits of any firm are given by the standard result in Cournot competition: $\pi(i,z)^{CN} = b\left[y(i,z)^{CN}\right]^2$.[27] Firm i's profit function ($i = 1, \ldots, n$) is strictly

[26] This is a standard assumption in literature on asymmetric-costs oligopoly, abstracting from inactive firms. Considering both active and inactive firms would extremely complicate the analysis.

[27] To see this, note that

$$y(i,z)^{CN} = \frac{1}{2b-\gamma}\left(a - c(i,z) - \gamma Q(z)^{CN}\right)\,,$$

from Eq. (13). Therefore one can write the profit margin in Eq. (15) as $p(i,z)^{CN} - c(i,z) = by(i,z)^{CN}$, and by using the expression for the inverse demand function in Eq. (4) as

$$\begin{aligned} by(i,z)^{CN} &= a - \frac{b}{2b-\gamma}\left(a - c(i,z) - \gamma Q(z)^{CN}\right) - \gamma Q(z)^{CN} + \frac{\gamma}{2b-\gamma}\left(a - c(i,z) - \gamma Q(z)^{CN}\right) - c(i,z) \\ &= \left(1 - \frac{b}{2b-\gamma} + \frac{\gamma}{2b-\gamma}\right)\left(a - c(i,z) - \gamma Q(z)^{CN}\right) = \frac{b}{2b-\gamma}(2b-\gamma)y(i,z)^{CN}\,. \end{aligned}$$

Profit margins are proportional to firm outputs, not to firm marginal costs as in monopolistic competition: the more market share the more market power, which is directly linked to production costs. Operating profits equal decreasing in the direct rivals' sectoral total output, $\sum_{j\neq i}^{n} y(j,z)$ for $y(i,z) > 0$, showing the well-known competitive effect among incumbents.

I assume that any firm's marginal cost depends on the wage rate, $w > 0$, and on a firm-specific unit labor requirement $\beta(i,z) \geq 1$.[28] Thus I can simply write any firm unit cost as $c(i,z) = w\beta(i,z) > 0$. This completes the supply side of the model. In the next subsection I consider the labor market as well as the general equilibrium.

3.3 Labor market and general equilibrium

Total wage income and aggregate profits are costlessly distributed to the representative consumer, who uses them for the current consumption. This does not affect the generality of the model. The national income is given by $I = wL + \Pi$, with $\Pi \equiv \int_0^1 \sum_{i=1}^{n} \pi(i,z)dz$ the aggregate profits. The model is closed by deriving the wage rate as a function of exogenous variables. Full employment yields

$$L = \int_0^1 \sum_{i=1}^{n} \beta(i,z)y(i,z)dz\,. \tag{16}$$

Plugging into Eq. (16) the Cournot–Nash equilibrium production of each firm from Eq. (14), then the firm unit cost, $c(i,z) = w\beta(i,z)$, and solving for wage rate, w, by evaluating the integral in Eq. (16), yields

$$w = \frac{\left[a\mu_1^{\bar{\beta}} - L\frac{2b+\gamma(n-1)}{n}\right](2b-\gamma)}{(2b+\gamma(n-1))\,\mu_1^{\sigma_\beta^2} + (2b-\gamma)\mu_2^{\bar{\beta}}}\,, \tag{17}$$

where

$$\mu_1^{\bar{\beta}} \equiv \int_0^1 \bar{\beta}(z)dz\,, \quad \mu_2^{\bar{\beta}} \equiv \int_0^1 \left[\bar{\beta}(z)\right]^2 dz\,, \quad \mu_1^{\sigma_\beta^2} \equiv \int_0^1 \sigma_\beta^2(z)dz\,.$$

The first two terms are the first and the second uncentred moments of the distribution across sectors of the average of firm-level unit labor requirements in each sector, respectively. The third term is the first uncentred moment of the distribution across sectors of the variance of

net profits because of zero fixed costs. Hence, more efficient firms (viz., those with lower unit labor requirements) have larger both markups and outputs.

[28] I normalize the smallest unit labor requirement to unity.

firm-level unit labor requirements in each sector, with

$$\sigma_\beta^2(z) = \left[\frac{\sum_{i=1}^n [\beta(i,z)]^2}{n} - \left[\bar{\beta}(z)\right]^2 \right] \quad \text{and} \quad \bar{\beta}(z) = n^{-1} \sum_{i=1}^n \beta(i,z) \, .$$

The variable of interest is $\mu_1^{\sigma_\beta^2}$ and plays a crucial role in deriving all exercises of comparative statics for the paper's purpose.[29] The reader can think of a series of productivity shocks affecting firms within any sector, changing firm market shares and, thus, the within-sector variances of unit labor requirements. Thus via aggregation across sectors, these shocks are able to affect $\mu_1^{\sigma_\beta^2}$. In doing so, I am not concerned about the origin of these shocks, however, throughout the paper I refer to them as technology changes, in the understanding that they may come from any other plausible sources as, for example, the management.[30] I aim to explore what happens to wage rate, aggregate profits, and social welfare when $\mu_1^{\sigma_\beta^2}$ changes. In the following exercises of comparative statics, in order to isolate the effects of $\mu_1^{\sigma_\beta^2}$, I take as given the other two moments of the technology distribution. Furthermore Assumption 1 continues to hold after that marginal cost dispersion in any sector changes (viz., no shock is able to drive any firm out of the sector).

In the remaining of the paper, I also refer to $\mu_1^{\sigma_\beta^2}$ as the *"average" within-sector firm heterogeneity*. This measure can be seen as complementary to what Lerner (1934) called "the degree of monopoly" across all sectors. By using his words, one can see the "average" within-sector firm heterogeneity as the "*average* degree of monopoly" *within* sectors.

Using the solution for the wage rate, it is possible to give closed-form solutions to the endogenous variables of interest (i.e., aggregate profits and social welfare) in term of exogenous variables. This is what I do in the next section in carrying out comparative statics.

[29] Neary (2003b;c) and Neary (2009a) looks also at the competition policy by increasing the number of *symmetric-costs* firms within all sectors of the economy. The present framework is not suited for studying competition policy because firms have heterogeneous productivities, therefore one cannot simply differentiate the variables with respect to n (by ignoring the integer problem) because in my model the efficiencies of entrant firms would matter.

[30] See Syverson (2011) for further discussion on the sources of productivity differences.

4 The impact of the "average" within-sector firm heterogeneity

In this section I carry exercises of comparative statics of how the "average" within-sector firm heterogeneity affects wage rate, aggregate profits, and social welfare. For the last two variables of interest, I provide results with the wage rate treated as both exogenous (i.e., a parameter) and endogenous (viz., the wage rate is a decreasing function of the "average" within-sector firm heterogeneity). The findings are discussed and related to the partial equilibrium literature.

4.1 Wage rate

It is immediate to calculate comparative statics effects on the equilibrium wage rate. From Eq. (17), as in Neary (2003b;c), the equilibrium wage rate is, all other things being equal, decreasing in L and in $\mu_2^{\bar{\beta}}$ whereas it is increasing in $\mu_1^{\bar{\beta}}$. The key feature of the model is that the wage rate is unambiguously and negatively related to $\mu_1^{\sigma_\beta^2}$, the "average" within-sector firm heterogeneity. From this new feature I derive theoretical insights of potential importance. The following proposition formally states the effect of a rise in the "average" within-sector firm heterogeneity on the wage rate.

Proposition 1. *In a GOLE framework with firm heterogeneity within sectors, all other things being equal, the higher the "average" within-sector firm heterogeneity the lower the wage rate.*

The economic intuition for Proposition 1 can be easily explained as follows. For Cournot competition without free entry in a partial equilibrium framework, it is well-known that the aggregate market power, as measured by the Lerner Index, is indirectly linked to the market concentration, as measured by the Herfindahl-Hirschman Index. This last index is positively and closely related to the heterogeneity (i.e., the variance) in firms' production costs (see, e.g., Long and Soubeyran (1997; 2001) and Salant and Shaffer (1999)).[31] Hence, in a multi-sector framework, the lower the "average" within-sector firm heterogeneity the more likely the incumbents engage in a stronger competition within their sector, and they would be more

[31] Let $\mathcal{L}$ the (average) Lerner index (weighted by market shares) for an industry, $\mathcal{H}$ the Herfindahl-Hirschman Index of the same industry, and $\mathcal{E}$ the own price elasticity of market demand (in absolute value). For an homogeneous Cournot competition it holds that $\mathcal{L} = \mathcal{H}/\mathcal{E}$. In case of a linear set up, $\mathcal{L}$ is directly linked to $\mathcal{H}$. Note that, however, for markets with horizontally differentiated goods, the interpretation of the sum of the squared market shares as Herfindahl-Hirschman Index is not straight because of the potential differences in equilibrium prices of varieties of the same good, so that preferences matter as well.

disposed to pay a higher wage rate, putting pressure on labor demand. Stated in this simple form, the economic intuition is clear even though it seems that the debate about antitrust and related policies, by focusing on single-sector issues, has not carefully taken in consideration such theoretical result.

It can be easily shown that the total labor demand in Eq. (16) is negatively related to the "average" within-sector firm heterogeneity. This means that the more concentrated the markets the less total labor demand coming from all sectors. Hence, the "average "within-sector firm heterogeneity can be interpreted as a *country-level* proxy for the average concentration within sectors. Two additional corollaries to Proposition 1 are in order.

Corollary 1. *In case all sectors are composed by firms with the same productivity in each sector (i.e., within-sector firm homogeneities), then* $\mu_1^{\sigma_\beta^2} = 0$ *because there exists no dispersion among firm-level unit labor requirements within each sector. Hence, the wage rate is lower when one considers within-sector firm heterogeneities.*

Note furthermore that Proposition 1 holds for any degree of horizontal differentiation among good varieties. For the limiting case where varieties of goods are almost perfect substitutes, one has the following result.[32]

Corollary 2. *In case within-sector firm heterogeneities are not considered (that is,* $\mu_1^{\sigma_\beta^2} = 0$*), and goods are almost perfect substitutes (that is,* $\gamma \approx b$*), then the wage rate tends to that in the Neary (2003b;c)'s model.*

4.2 Aggregate profits

I next move on analyzing the Cournot–Nash equilibrium aggregate profits. They are given by

$$\Pi^{CN} = \int_0^1 \left\{ \sum_{i=1}^{n} b \left[y(i,z)^{CN} \right]^2 \right\} dz = \frac{b}{(2b-\gamma)^2(2b+\gamma(n-1))^2} \Phi \,, \tag{18}$$

with

$$\Phi = \int_0^1 \left\{ \sum_{i=1}^{n} \left[a(2b-\gamma) - w\beta(i,z)(2b+\gamma(n-1)) + \gamma n w \bar{\beta}(z) \right]^2 \right\} dz \,. \tag{19}$$

[32] It is worthwhile to note, however, that the result in Corollary 2 is purely notional as one cannot invert the inverse demand functions for $\gamma = b$. This remark also applies to the already discussed limiting case for the marginal utility of national income in footnote 18 as well as to the following limiting cases for aggregate profits and social welfare in footnotes 34 and 39, respectively.

It is sufficient to focus on Eq. (19) as the first factor on the right hand side of Eq. (18) is a positive constant. Straightforward calculations in Eq. (19) and rearranging[33] yield

$$\begin{aligned}\Phi = {} & na^2(2b-\gamma)^2 + w^2 n\left\{(2b+\gamma(n-1))^2\mu_1^{\sigma^2_\beta} + (2b-\gamma)^2\mu_2^{\bar{\beta}}\right\} \\ & - 2wna(2b-\gamma)^2\mu_1^{\bar{\beta}}\,.\end{aligned} \tag{20}$$

Now I am able to calculate the effect of the "average" within-sector firm heterogeneity on aggregate profits. The exercise of comparative statics is based on partially differentiating Eq. (20) with respect to $\mu_1^{\sigma^2_\beta}$.[34]

Consider firstly the effect of the "average" within-sector firm heterogeneity on aggregate profits when the general equilibrium feedback, which relies on the endogenous wage rate, is not considered. Namely, let us parametrically treat the wage rate, considering it as exogenous and, thus, constant. It is easy to see that

$$\frac{\partial\left(\Phi\big|_{w \text{ exogenous}}\right)}{\partial\mu_1^{\sigma^2_\beta}} = w^2 n(2b+\gamma(n-1))^2 > 0\,. \tag{21}$$

Hence, as long as one takes the wage rate as given, aggregate profits are a linear and increasing function of the "average" within-sector firm heterogeneity. I call the derivative in Eq. (21) as the *direct* effect of the "average" within-sector firm heterogeneity on aggregate profits. This result relates to partial equilibrium literature on Cournot competition (e.g., Long and Soubeyran (1997; 2001) and Salant and Shaffer (1999)). The economic intuition relies on the fact that each firm's profit function is convex decreasing in the *exogenous* marginal cost of production, and in doing the exercise of comparative statics a mean-preserving variation in cost dispersion in each sector has been considered. This fact is indirectly reflected in the assumed constancy of the other two moments of the technology distribution.[35] In all above papers, authors work with a single-sector framework and an exogenous wage rate, and my model, when one con-

[33] For the derivation of Φ, a computational file is available from the author upon request.

[34] As for the wage rate, if $\mu_1^{\sigma^2_\beta} = 0$ and γ tends to b, then the aggregate profits degenerate to those of the Neary (2003b;c)'s baseline model:

$$\lim_{\gamma\to b}\left(\Pi^{CN}\Big|_{\mu_1^{\sigma^2_\beta}=0}\right) = \frac{n}{b(n+1)^2}\left(a^2 + w^2\mu_2^{\bar{\beta}} - 2wa\mu_1^{\bar{\beta}}\right)\,.$$

[35] This finding relies on the Bergstrom and Varian (1985a;b)'s intuition: a mean-preserving increase in marginal cost dispersion between Cournot oligopolists shrinks the sectoral production costs, and thus sectoral total profits will strictly increase, whereas sectoral total output will not change, as long as all firms will continue to be active after costs change.

siders the wage rate as exogenous, can be simply seen as a continuum-of-sectors extension of those partial equilibrium frameworks. This is the case as the production cost of any firm is exogenous as both the wage rate and unit labor requirements (viz., the technology of any firm is exogenous). Hence, even in a continuum-of-sectors general equilibrium framework, there exists a positive link between the "cross-sector average market concentration" — as proxied by the "average" within-sector firm heterogeneity — and the (country-wide) aggregate profits, as expected by antitrust authorities, as long as the wage rate is exogenously taken.

I turn next to consider the general equilibrium feedback. By treating the wage rate as endogenous, I obtain the following derivative:[36]

$$\frac{\partial\left(\Phi|_{w \text{ endogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} = 2w\frac{\partial w}{\partial\mu_1^{\sigma_\beta^2}}n\left\{(2b+\gamma(n-1))^2\mu_1^{\sigma_\beta^2}+(2b-\gamma)^2\mu_2^{\bar{\beta}}\right\} + w^2 n(2b+\gamma(n-1))^2 - 2na(2b-\gamma)^2\mu_1^{\bar{\beta}}\frac{\partial w}{\partial\mu_1^{\sigma_\beta^2}}\,. \tag{22}$$

The second term at the right hand side of Eq. (22) is the (positive) *direct* effect of the "average" within-sector firm heterogeneity on aggregate profits, as I have just seen in Eq. (21). From Proposition 1 it follows that at the right hand side of Eq. (22), both the first and third terms are negative. In general the sign of the derivative in Eq. (22) is indeterminate.

I can say a little bit more on this point. To better see the why of this unclear result on the aggregate profits and trying to disentangle what generates it once the wage rate is treated as endogenous, one can proceed as follows. Let us explicit L from Eq. (17):

$$L = \left[a\mu_1^{\bar{\beta}} - w\frac{2b+\gamma(n-1)}{2b-\gamma}\mu_1^{\sigma_\beta^2} - w\mu_2^{\bar{\beta}}\right]\frac{n}{2b+\gamma(n-1)}\,, \tag{23}$$

then it must be the case that the quantity within the square brackets at the right hand side of Eq. (23) is positive for any $L > 0$. Then one can rewrite the first and third term in Eq. (22) as

$$\frac{\partial\left(\Phi|_{w \text{ endogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} - w^2 n(2b+\gamma(n-1))^2 \equiv Z$$

[36] In order to economize the notation, I simply apply the Leibniz's chain rule on the derivation of composed functions.

with

$$Z = \underbrace{-2n\frac{\partial w}{\partial \mu_1^{\sigma_\beta^2}}(2b-\gamma)^2}_{(+)} \underbrace{\left[a\mu_1^{\bar{\beta}} - w\left(\frac{2b+\gamma(n-1)}{2b-\gamma}\right)^2 \mu_1^{\sigma_\beta^2} - w\mu_2^{\bar{\beta}}\right]}_{(+/0/-)} . \tag{24}$$

The product of the terms outside the square brackets is positive from Proposition 1. It is easy to compare the quantities within the square brackets at the right hand side in Eqs. (23) and (24). The indeterminacy of the sign of Eq. (22) is due to the coefficient multiplying $w\mu_1^{\sigma_\beta^2}$ within the square brackets at the right hand side of Eq. (24): $[(2b+\gamma(n-1))/(2b-\gamma)]^2 > 1$. This coefficient is similar to that in Eq. (23) except it is raised to the power two. Hence, $Z \geq 0$ if and only if

$$a\mu_1^{\bar{\beta}} \geq w\left(\frac{2b+\gamma(n-1)}{2b-\gamma}\right)^2 \mu_1^{\sigma_\beta^2} + w\mu_2^{\bar{\beta}} .$$

I formally state this result.

Proposition 2. *Consider the wage rate as endogenous in a GOLE framework with firm heterogeneity within sectors. If*

$$a\mu_1^{\bar{\beta}} \geq w\left(\frac{2b+\gamma(n-1)}{2b-\gamma}\right)^2 \mu_1^{\sigma_\beta^2} + w\mu_2^{\bar{\beta}} ,$$

then, all other things being equal, a rise in the "average" within-sector firm heterogeneity has a positive effect on aggregate profits.

If

$$w\left(\frac{2b+\gamma(n-1)}{2b-\gamma}\right)^2 \mu_1^{\sigma_\beta^2} + w\mu_2^{\bar{\beta}} > a\mu_1^{\bar{\beta}} > w\left(\frac{2b+\gamma(n-1)}{2b-\gamma}\right) \mu_1^{\sigma_\beta^2} + w\mu_2^{\bar{\beta}} ,$$

then $Z < 0$ and, all other things being equal, a rise in the "average" within-sector firm heterogeneity has an unclear effect on aggregate profits, depending on the sign of the difference $w^2 n(2b+\gamma(n-1)) - |Z|$.

In principle it can be shown under what exact value combinations of economic structure the impact on aggregate profits would be either positive, negative, or zero, but this exercise would lead to somewhat cumbersome findings. Hence, I am not able to determine a clear-cut finding for the effect of the "average" within-sector firm heterogeneity on aggregate profits because the sign of the derivative relies on the specific values of the moments of the technology distribution as well as demand parameters. This is a striking and new finding. I formally state this theoretical indeterminacy as follows.

Corollary 3. *In a GOLE framework with firm heterogeneities within sectors and wage rate treated as endogenous, all other things being equal, a rise in the "average" within-sector firm heterogeneity has not a clear-cut effect on aggregate profits, depending on the specific values of the moments of the technology distribution as well as demand parameters.*

As for the IO literature on the effect of cost changes on sectoral total profits (i.e., Kimmel (1992), Zhao (2001), and Wang and Zhao (2007)), which depends on the firms' market shares, the analysis so far cannot establish any monotonic relationship. The indeterminacy of the sign in Eq. (24) vanishes in case the "average" within-sector firm heterogeneity is zero, namely in every sector firms have the same productivity, so that the effect of a rise in the "average" within-sector firm heterogeneity on aggregate profits would be positive.

Although I have not a clear quantitative finding, I may derive from Eq. (22) an additional qualitative insight of some interest for the national income distribution. As long as there exist value combinations of the moments of the technology distribution and demand parameters for which the derivative in Eq. (22) is positive, a rise in the "average" within-sector firm heterogeneity is able to play a potential role on the distribution of national income between total wage income and aggregate profits given the finding in Proposition 1. Note that this distributional role of the "average" within-sector heterogeneity on the national income is clearly played when the wage rate is treated as exogenous. I formally state this result in the following corollary.

Corollary 4. *If there exist value combinations of the moments of the technology distribution as well as demand parameters such that the derivative in Eq. (22) is positive, then, all other things being equal, a rise in the "average" within-sector firm heterogeneity can shrink the share of total wages (or, equivalently, it can expand the share of aggregate profits) in the national income.*

A final comment is worthwhile. The value of Z in Eq. (24) is clearly positive if valued at $\mu_1^{\sigma_\beta^2} = 0$. In this case the second term within the square brackets at the right hand side disappears, by implying that Eq. (22) is positive as well. This shows how in a situation in which there exists homogeneity in firm efficiencies in each sector, a marginal rise in the "average" within-sector firm heterogeneity will increase aggregate profits even when the wage rate is treated as endogenous. However, as already stated, for positive values of the "average" within-sector firm heterogeneity is no longer clear if a marginal rise in $\mu_1^{\sigma^2_\beta}$ has a positive impact on aggregate profits. The next subsection is devoted to take into account the normative side of the model, by calculating the effect of the "average" within-sector firm heterogeneity on social welfare.

4.3 Social welfare

As I have used the assumption of a representative consumer and the preferences are quasi-homothetic, social welfare can be derived by means of the indirect utility function, by plugging the direct demand functions for the varieties produced in each sector in Eq. (5) into the sub-utility functions in Eq. (2), and by integrating over all sectors.[37] Thus the indirect utility function is given by

$$\mathcal{U} = K - \lambda^2 \frac{n}{2} \left(\frac{\mu_2^{\bar{p}}}{b + \gamma(n-1)} + \frac{\mu_1^{\sigma_p^2}}{b - \gamma} \right), \tag{25}$$

where $K = na^2/2(b + \gamma(n-1))$ is a positive constant.

As before, I set $\lambda = 1$.[38] Hence, I can focus on a monotonically transformed form of the indirect utility function of Eq. (25) as given by

$$\mathcal{V} \equiv (\mathcal{U} - K)\frac{2}{n} = -\left(\frac{\mu_2^{\bar{p}}}{(b + \gamma(n-1))} + \frac{\mu_1^{\sigma_p^2}}{(b - \gamma)} \right). \tag{26}$$

The indirect utility function in Eq. (26) is negatively related not only to $\mu_2^{\bar{p}}$, as in Neary (2003b;c), but also to $\mu_1^{\sigma_p^2}$. Hence, the representative consumer dislikes both differences in prices across sectors and, as expected, differences in prices within sectors. I state formally this result.

Proposition 3. *In a GOLE framework with firm heterogeneities within sectors, the representative consumer dislikes both differences in prices across sectors and differences in prices within sectors.*

[37] For the derivation of the indirect utility function, a computational file is available from the author upon request.

[38] Hence, the marginal utility of national income is hold constant when I analyze the social welfare. This assumption may sound strong because of its meaning of no income effect. However, by recalling that the GOLE framework relies on the Negishi (1961)'s perceived demand function, which gives a good approximation around the equilibrium, this assumption is plausible and also convenient permitting to economize on the mathematical notation. In calculating the indirect utility function, this simplification is standard in GOLE literature dealing with welfare issues. See Bastos and Kreickemeier (2009), Bastos and Straume (2012), Egger and Etzel (2012), Egger and Meland (2011), Kreickemeier and Meland (2011), and Neary (2003b;c).

An additional observation is worthwhile. It is straightforward to see how the second term within the parentheses at the right hand side of Eqs. (26) tends to increase when γ becomes larger. This fact means that as varieties become more homogeneous, there exists a stronger negative effect on social welfare of the within-sector price heterogeneities as proxied by $\mu_1^{\sigma_p^2}$. For completeness, I formally state this result.[39]

Proposition 4. *In a GOLE framework with firm heterogeneities with sectors, as varieties become more homogeneous, there exists a stronger negative effect on social welfare of the within-sector price heterogeneities.*

The rationale for this result derives from the assumption that all varieties of any good are essential. As varieties become more homogeneous, the willingness to pay different prices for close varieties have a larger cost in terms of utility.

Before proceeding further, it is useful to derive explicitly the two moments of the price distribution in Eq. (26), in terms of the moments of the technology distribution. The closed-form solutions for the moments of the price distribution will come in handy for the exercises of comparative statics on social welfare. To do so, I use the formulation for the Cournot–Nash equilibrium price in Eq. (15) to calculate the Cournot–Nash equilibrium average price in any sector as

$$\bar{p}(z)^{CN} = b\frac{Q(z)^{CN}}{n} + w\bar{\beta}(z) = b\frac{a - w\bar{\beta}(z)}{2b + \gamma(n-1)} + w\bar{\beta}(z)\,. \tag{27}$$

Thus I apply the definitions of price moments given in Eq. (9) to the equilibrium (sector-z) average price in Eq. (27). The second uncentred moment of the distribution across sector of the average price in each sector in term of the moments of the technology distribution is equal to

$$\mu_2^{\bar{p}} = \frac{(ba)^2 + 2ba(b+\gamma(n-1))w\mu_1^{\bar{\beta}} + (b+\gamma(n-1))^2 w^2 \mu_2^{\bar{\beta}}}{(2b+\gamma(n-1))^2}\,. \tag{28}$$

For the first uncentred moment of the distribution across sectors of the price variance in each

[39] Note that if $\mu_1^{\sigma_p^2} = 0$ and γ tends to b, then the indirect utility function in Eq. (25) degenerates to that of Neary (2003b;c)'s baseline model:

$$\lim_{\gamma\to b}\left(\mathcal{U}\Big|_{\mu_1^{\sigma_p^2}=0}\right) = \lim_{\gamma\to b}\mathcal{U} = \frac{1}{2b}\left(a^2 - \lambda^2\mu_2^{\bar{p}}\right)\,,$$

where $\mu_2^{\bar{p}}$ is defined in Eq. (28) with γ tending to b.

sector in term of the moments of the technology distribution, I use Eq. (15) together with the definition of any firm's Cournot–Nash profits. Firstly, I can write the Cournot–Nash equilibrium price variance in any sector as

$$\begin{aligned}(29)\quad \sigma_p^2(z) &= \frac{\sum_{i=1}^n \left[p(i,z)^{CN}\right]^2}{n} - \left[\bar{p}(z)^{CN}\right]^2 = \frac{\sum_{i=1}^n \left[by(i,z)^{CN} + c(i,z)\right]^2}{n} - \left[\bar{p}(z)^{CN}\right]^2 \\ &= \frac{b}{n}\sum_{i=1}^n \pi(i,z)^{CN} + w^2\sigma_\beta^2(z) + w^2\left[\bar{\beta}(z)\right]^2 + \frac{2bw}{n}\sum_{i=1}^n y(i,z)^{CN}\beta(i,z) - \left[\bar{p}(z)^{CN}\right]^2,\end{aligned}$$

then, by integrating over all sectors both sides of Eq. (29) and using Eq. (16), I obtain

$$(30)\qquad \mu_1^{\sigma_p^2} = \frac{b}{n}\Pi^{CN} + w^2\mu_1^{\sigma_\beta^2} + w^2\mu_2^{\bar{\beta}} + \frac{2bw}{n}L - \mu_2^{\bar{p}},$$

where $\mu_2^{\bar{p}}$ has been defined in Eq. (28).[40]

Having these preliminary results at hand, I can go on in analyzing social welfare. As for aggregate profits, when the wage rate is exogenously treated, it is easy to show that a rise in the "average" within-sector firm heterogeneity negatively affects social welfare because $\mu_1^{\sigma_\beta^2}$ is positively related to only $\mu_1^{\sigma_p^2}$ in Eq. (30) but not to $\mu_2^{\bar{p}}$ in Eq. (28). But $\mu_1^{\sigma_p^2}$ has an negative impact on the indirect utility function as I have already noted above in discussing Eqs. (25) and (26). Hence, for any $\mu_1^{\sigma_p^2} > 0$ it holds that

$$(31)\qquad \frac{\partial\left(\mathcal{V}\big|_{w\text{ exogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} = \underbrace{\frac{\partial\mathcal{V}}{\partial\mu_1^{\sigma_p^2}}}_{(-)}\underbrace{\frac{\partial\left(\mu_1^{\sigma_p^2}\big|_{w\text{ exogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}}}_{(+)} < 0,$$

with

$$(32)\qquad \frac{\partial\left(\mu_1^{\sigma_p^2}\big|_{w\text{ exogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} = \frac{b}{n}\frac{\partial\left(\Pi^{CN}\big|_{w\text{ exogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} + w^2 > 0,$$

[40] Note that, after some routine calculations, $\mu_1^{\sigma_p^2} = 0$ when goods are almost homogeneous (that is, γ tends to b) and $\mu_1^{\sigma_\beta^2} = 0$ (i.e., no within-sector firm heterogeneity in any sector). The motive is clear: in any sector, without both firm heterogeneity and good differentiation, firms will charge the same price.

by considering Eqs. (21), (28), and (30).[41]

The negative effect of the "average" within-sector firm heterogeneity on the indirect utility function in Eq. (31), when the wage rate is treated as exogenous, is what one can observe from the common perception on market power, which decreases competitiveness and therefore it would distort allocation of resources deteriorating social welfare. This means that, for example, if a rise in market concentration happens across all sectors of the economy (as measured by the "average" within-sector firm heterogeneity), this has a negative effect on social welfare, without considering general equilibrium feedback from the wage rate. Note that this result is in contrast with partial equilibrium literature on the link between mean-preserving rise in cost dispersion and welfare (e.g., Long and Soubeyran (1997; 2001) and Salant and Shaffer (1999)), in which an increase in market concentration has a positive impact on welfare as it improves sectoral total profits without affecting consumer surplus.

I turn now to calculate the impact of the "average" within-sector firm heterogeneity on social welfare when the wage rate is treated as endogenous. This adds complexity to the analysis. I proceed by steps as follows. By differentiating the indirect utility function in Eq. (26) with respect to $\mu_1^{\sigma_\beta^2}$, I can write

$$\frac{\partial\left(\mathcal{V}\Big|_{w \text{ endogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} = \underbrace{\frac{\partial\mathcal{V}}{\partial\mu_1^{\sigma_p^2}}}_{(-)} \underbrace{\frac{\partial\left(\mu_1^{\sigma_p^2}\Big|_{w \text{ endogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}}}_{(+/0/-)} + \underbrace{\frac{\partial\mathcal{V}}{\partial\mu_2^{\bar{p}}}}_{(-)} \underbrace{\frac{\partial\left(\mu_2^{\bar{p}}\Big|_{w \text{ endogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}}}_{(-)}, \tag{33}$$

with

$$\frac{\partial\left(\mu_2^{\bar{p}}\Big|_{w \text{ endogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} = \frac{\partial w}{\partial\mu_1^{\sigma_\beta^2}}\left(\frac{2ba(b+\gamma(n-1))}{(2b+\gamma(n-1))^2}\mu_1^{\bar{\beta}} + \frac{2w(b+\gamma(n-1))^2}{(2b+\gamma(n-1))^2}\mu_2^{\bar{\beta}}\right), \tag{34}$$

by using Eq. (28). From Proposition 1 follows that the term outside parentheses at the right hand side of Eq. (34) (i.e., the partial derivative) is negative whereas both terms within parentheses are positive. Hence, the partial derivative in Eq. (34) is negative. This means that the

[41] By using Eqs. (18) and (21), one can express Eq. (32) as

$$\frac{\partial\left(\mu_1^{\sigma_p^2}\big|_{w \text{ exogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} = w^2\left(\frac{b^2}{(2b-\gamma)^2}+1\right) > 0\,.$$

second term on the right hand side of Eq. (33) is positive being the product of two negative factors.

It remains to analyze the sign of the second factor in the first term at the right hand side of Eq. (33). Differentiating Eq. (30) with respect to $\mu_1^{\sigma_\beta^2}$ yields

$$
\frac{\partial\left(\mu_1^{\sigma_p^2}\Big|_{w \text{ endogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} = \frac{b}{n}\frac{\partial\left(\Pi^{CN}\Big|_{w \text{ endogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}} + w^2 + 2w\left(\mu_1^{\sigma_\beta^2} + \mu_2^{\bar{\beta}}\right)\frac{\partial w}{\partial\mu_1^{\sigma_\beta^2}} + \frac{2bL}{n}\frac{\partial w}{\partial\mu_1^{\sigma_\beta^2}} - \frac{\partial\left(\mu_2^{\bar{p}}\Big|_{w \text{ endogenous}}\right)}{\partial\mu_1^{\sigma_\beta^2}}. \tag{35}
$$

It is sufficient to note that, like the right and side of Eq. (22), the first term at the right hand side of Eq. (35) has an undetermined sign. Hence, the impact of the "average" within-sector firm heterogeneity on social welfare, when the wage rate is treated as endogenous, may be either positive, negative, or zero. This result is formally stated in the next proposition.

Proposition 5. *In a GOLE framework with firm heterogeneities within sectors and wage rate treated as endogenous, all other things being equal, a rise in the "average" within-sector firm heterogeneity has not a clear-cut impact on social welfare, depending on the specific values of the moments of the technology distribution as well as demand parameters.*

The indeterminacy on the sign of the impact of a rise in the "average" within-sector firm heterogeneity on the social welfare has potential implications for various strands of literature. Firstly, I want to highlight how this result is not in any sense a suggestion against antitrust policy in general, rather, it sheds more light on possible ambiguous outcomes of these policies, which need to be sophisticated and implemented with caution, by taking into account possible negative effects from a social point of view due to general equilibrium feedbacks from the endogenous wage rate. Thus, my paper can provide, for its feature of linking market concentrations and firm heterogeneities to social welfare, a first attempt to a GOLE extension of antitrust issues.[42]

Secondly, since the seminal work by Lahiri and Ono (1988), there has been a growing research on the helping minor firms (see, e.g., Wang and Zhao (2007) for a welfare comparison

[42]For example, by moving from the considerations by Bork (1978) on the welfare-maximizing role of antitrust policy, Brock and Obst (2009) develop a simple theoretical general equilibrium model in which market concentration directly enters in the utility function of consumers. The authors show, via traditional trade-off conditions on both marginal rate of transformations and substitutions, the Pareto optimal level of concentration towards the antitrust authority should aim to maximize welfare.

between Cournot and Bertrand competition with horizontal product differentiation). Lahiri and Ono (1988), by adopting an asymmetric Cournot duopoly, have showed that to help a minor firm by means of the reduction in its production cost, is harmful for social welfare, when the cost difference between firms is sufficiently large. This result happens because the help would decrease the efficient firm's output whereas, via the standard effect of strategic interaction, it would increase the minor firm's output, making the total output less convenient. Even though the help to the minor firm would decrease the market concentration and, thus, increase the competition, it also has a contrasting impact on welfare, by increasing the average cost of production in the sector. If the minor firm's market share were sufficiently small, the net impact would be welfare-enhancing. As my model shows, this result does not generalize to a GOLE framework encompassing within-sector firm heterogeneities. My model qualifies this theoretical literature, by putting in evidence that unclear outcomes may happen once general equilibrium feedbacks can play a role via the endogenous wage rate.

Finally, the model presented here sheds also some light on literature on the link between asymmetric-cost oligopoly and welfare (e.g., Long and Soubeyran (1997; 2001), and Salant and Shaffer (1999)). This strand of literature has showed how a mean-preserving rise in the cost dispersion can have welfare-enhancing effects as long as all firms continue to be active. In my GOLE framework, this result does not immediately apply.

5 Concluding remarks and some possible extensions

The aim of this paper has been to give for the first time a fairly general, though simple, theoretical contribution in which within-sector firm heterogeneities and oligopolistic competition are considered together in general equilibrium. This is done without normalizing the wage rate, which endogenously leads to the key findings via its general equilibrium feedbacks. Specifically, I have built a general oligopolistic equilibrium model augmented with within-sector firm heterogeneities and product differentiation. The paper has analyzed the impact of a rise in a measure of the average within-sector firm heterogeneity on wage rate, (country-wide) aggregate profits, and social welfare. In the light of the empirical evidence on heterogeneous and highly skewed firm productivities, the model presented here offers an important and interesting theoretical tool to conduct exercises of comparative statics as well as to better understand linkages between market concentrations and welfare effects. I have presented and solved the model for an arbitrary (small) number of heterogeneous firms producing horizontal differentiated varieties of a good in each of “finely disaggregated” sectors. I have obtained unique equilibrium outcomes, bringing in evidence some testable theoretical predictions that future empirical studies should address.

Standard IO and antitrust literature, adopting partial equilibrium settings, has abstracted from general equilibrium feedbacks. This paper has overcome this limiting feature by using the GOLE approach. The theoretical contribution allows for obtaining new findings that can be summarized as follows. I have derived a link between the first moment of the distribution of firm heterogeneity (as measured by the within-sector variance of production costs) across sectors and wage rate, aggregate profits, and social welfare. On the one hand, the “average” within-sector firm heterogeneity unambiguously and negatively affects the wage rate. On the other hand, the effect of the “average” on aggregate profits and social welfare has unexpectedly been ambiguous because it crucially depends on the nature of the technology distribution and demand parameters. Even though sharp policy prescriptions cannot be offered, implications of these results are manifold. The possibility of a negative link between (economy-wide) market concentrations and aggregate profits helps to explain unexpected findings in empirical research. In addition, the research outcomes mean that antitrust policies aiming to affect competition and market power within sectors, ought to be sophisticated, by considering not only the market structure of single sectors, but also its effects on the economy as a whole, via the general equilibrium feedbacks coming from labor market, and more in general from factor markets.

Finally, this paper has also offered a first step to better understand possible counterproductive policy outcomes, which can contrast with conventional wisdoms on welfare-enhancing effects of antitrust and akin policies, as provided by standard partial equilibrium oligopoly theory (e.g., the welfare-reducing effect due to the helping of minor firms).

A caveat is in order. The exercises of comparative statics throughout the paper and the main findings are based on the assumption that the other moments of the technology distribution (of unit labor requirements) remain fixed while the variable of interest (i.e., the “average” within-sector firm heterogeneity) is free to vary. This assumption may overlook possible links among the moments of the technology distribution, which might be interconnected to each other, depending on specific functional forms of technology distribution. The reader should bear in mind this fact for the interpretation of findings of the impact of the “average” within-sector firm heterogeneity. The full comparative statics analysis on the other moments of the technology distribution goes beyond this paper's purpose.

I close this section by suggesting some possible extensions of the model that future research agenda should consider in more detail. Firstly, in the interest of analytical tractability, the results admittedly rest on stylized model specifications of demand and cost functions. Although I expect the findings would survive in more sophisticated models as long as inverse demand functions are linear and production exhibits constant return to scale in order to guarantee decreasing best reply functions, further investigations are needed to fully establish conditions for policy analysis. More general settings, however, are likely to not solve directly the ambiguous effect of the "average" within-sector firm heterogeneity on aggregate profits and social welfare. Nonetheless, I believe that my model has provided interesting insights to better understand the role of firm heterogeneity and market concentration in general equilibrium, hoping that scholars working on related topics would find them useful for their research.

Secondly, I have assumed a perfectly competitive labor market. This is a strong simplifying assumption. Given the growing literature on GOLE studying labor market imperfections (e.g., unemployment and unions), it would be interesting to address those issues in a framework like that presented here.

Thirdly, in order to obtain clear-cut results on aggregate profits and social welfare, one might also put more structure to the model. Setting a parametrized distribution for firms' productivities, and therefore for firms' production costs, is a natural extension. This would require a specified technology, which may be parametrized by using a statistical distribution function, such as the widely used Pareto or Fréchet.

Finally, I have presented the model for a closed economy only. An open economy version is worth being developed to further analyze the role played by firm heterogeneity and market concentration, however, the key mechanisms of my model should be preserved. A question should look at a generalization allowing for the case in which firms in a country compete with those ones of the same sector localized in another country. This can be achieved with a slightly heavier notation. Although industrial concentration within sectors is likely to decrease with more competing (active) firms with asymmetric costs becoming more close to each other, the effect of trade liberalization is not straightforward. As long as one allows for the firm entry-and-exit process, trade liberalization effects also depend on the level of within-sector firm heterogeneities in the trade partners and, more generally, on the knowledge of both economic structures, which might also widen the productivity dispersions in internationalized sectors.

A further open economy extension might allow for cross-country-industry differences in technology distributions, by analyzing the implications for wage rates, and therefore for gains for trade and trade patterns. Cross-country differences in economy-wide wage rates can play an important role in affecting international competitiveness of firms, and via general equilibrium, shape international competitiveness of countries. The model can be also applied to analyze strategic trade policies with firm heterogeneity, an issue that has been addressed only by using either partial equilibrium framework or a normalized wage rate. As I have argued, carrying out open economy extensions would increase in many ways our understanding on the consequences of globalization on welfare changes. The model presented here might also be used as a complementary setting in analyzing other issues, which have been considered by means of the monopolistic competition approach.

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