Working Paper

Inequality, market power, and product diversity

Author(s):
Föllmi, Reto; Zweimüller, Josef

Publication Date:
2003

Permanent Link:
https://doi.org/10.3929/ethz-a-004517907

Rights / License:
In Copyright - Non-Commercial Use Permitted
Inequality, Market Power, and Product Diversity
Reto Foellmi and Josef Zweimueller
March 2003
Inequality, Market Power, and Product Diversity

Reto Foellmi, University of Zurich
Josef Zweimüller, University of Zurich, CESifo, IZA, and CEPR

March 4, 2003

Abstract

We analyze a macroeconomic model of monopolistic competition in which consumers earn unequal incomes. When preferences are non-homothetic, the distribution of income affects equilibrium mark-ups and equilibrium product diversity.

JEL: D30, D42, E25

Keywords: inequality, mark-ups, monopolistic competition

*University of Zurich, Institute for Empirical Research in Economics, Bluemlisalpstrasse 10, CH-8006 Zürich, Tel: +41-1-634 37 26, Fax: +41-1-634 49 07, e-mail: rfoellmi@iew.unizh.ch, zweim@iew.unizh.ch.
†We thank Josef Falkinger, Lars Ljungqvist, and Manuel Oechslin for valuable discussions.
1 Introduction

In this paper we analyze the role of the personal distribution of income for macroeconomic outcomes when firms have market power. While the recent macroeconomic literature has extensively studied the role of income inequality when *capital markets* are imperfect (see e.g. Bertola, 1999, for a recent survey) this literature has been almost entirely silent about the role of income distribution when there are imperfections in *product markets*.\(^1\)

This question, however, is both theoretically interesting and empirically relevant. In the theoretical literature, any impact of inequality transmitted by product market power is typically ruled out by the assumption of homothetic preferences and/or a representative consumer. From an empirical point of view, numerous studies have shown that homothetic preferences are a hopelessly unrealistic description of actual consumer behavior (see e.g. Deaton and Muellbauer, 1980). Hence exploring the implications of non-homothetic preferences sheds light on a neglected, but empirically relevant issue.

Our starting point is a variant of the popular model of Dixit and Stiglitz (1977) that has been widely applied to macroeconomic questions. We keep their assumption of symmetric preferences and technologies but allow for utility functions that are non-homothetic.\(^2\) Keeping the symmetry assumption highlights the role of consumer heterogeneity. Deviating from the homotheticity assumption makes the firms’ market demand functions dependent on the distribution of income and allows us to study the role of income inequality for equilibrium product diversity and mark-ups.

The paper is organized as follows. Section 2 describes the set-up of the model and derives individual and market demand functions. In Section 3 we discuss existence and uniqueness of the general equilibrium and how this equilibrium is affected by changes in the distribution of resources across consumers.

---

\(^1\)Macroeconomic models in which income distribution plays a role because it affects demand functions of monopolistic producers include Murphy, Shleifer, and Vishny (1989), Falkinger (1994), Zweimüller (2000), and Saint-Paul (2002). However, none of these papers consider the role of income distribution for mark-ups and pricing decisions of monopolistic producers.

\(^2\)In their original work, Dixit and Stiglitz (1977) consider not only CES-preferences but also VES-preferences (“variable elasticity of substitution”) over the differentiated products. In that part of their analysis, however, they make the implicit assumption that all consumers are identical. Distributional issues are not addressed.
2 The Set-Up

Technology, preferences, and endowments Consider an economy with a continuum of products indexed by $j$. All goods are produced with the same technology that requires a fixed set-up of $a$ units of labor to run a firm and one unit of labor to produce one unit of output. The labor market is competitive and the wage rate equals $w$. Hence the marginal cost of production are also equal to $w$, the same for all goods.

All consumers have the same preferences. Their objective function is defined over an infinite, continuous range of potentially producable products $j \in [0, \infty]$. From this set of differentiated goods an endogenous range $N$ is produced in equilibrium. We assume symmetry and separability of the various products. Moreover, we denote by $v(c(j))$ the utility gained from consuming good $j$ in quantity $c(j)$ and normalize the utility from not consuming a good to zero, $v(0) = 0$. Then consumer’s objective function can be written as

$$v(c(j)) = \int_0^N v(c(j)) dj.$$ 

The function $v(\cdot)$ satisfies the usual assumptions $v' > 0$ and $v'' < 0$. Furthermore we assume $v'(c)c/v(c) < 1$ for all $c \geq 0$.

There is a population of consumers of mass 1. Consumers are heterogenous with respect to their labor endowment $\theta$. The endowment distribution has support over the interval $[\underline{\theta}, \bar{\theta}]$, $0 < \underline{\theta} < \bar{\theta} < \infty$, and cumulative density $F(\theta)$. Average endowment is normalized to unity.

Individual consumption and market demand The optimal consumption of good $j$ is given by the first order condition

$$v'(c(j)) = \lambda(\theta)p(j),$$

where $\lambda(\theta)$ is the marginal utility of income for a consumer with endowment $\theta$. Equation (1) implicitly defines the optimal demand for product $j$ as a function of its price and the endowment level $\theta$. For further use we denote the individual demand function by $c(p(j), \theta)$. By implicit differentiation of equation (1) it is straightforward to verify that the price elasticity of

---

3 Concavity of the $v(\cdot)$-function and the normalization $v(0) = 0$ imply that $v'(c)c/v(c) \leq 1$. The assumption in the text requires this latter inequality to hold strictly. This precludes degenerate equilibria.
individual demand, which we denote by $\eta(\cdot)$, is given by

$$\eta(c(p(j), \theta)) \equiv -\frac{\partial c(p(j), \theta)}{\partial p(j)} \frac{p(j)}{c(p(j), \theta)} = -\frac{v'(c(p(j), \theta))}{c(p(j), \theta) \cdot v''(c(p(j), \theta))}.$$  

(2)

Thus $\eta(\cdot)$ is determined by the curvature of the utility function $v(\cdot)$ and, in general, varies with consumption level $c$.

Market demand, which we denote by $x$, can be calculated by horizontal aggregation of individual demand curves. From equation (1), market demand for good $j$ is

$$x(p(j)) \equiv \int_{\theta}^{\theta} c(p(j), \theta) dF(\theta).$$  

(3)

By symmetry, the above demand function depends on $j$ only via the price $p(j)$, but is otherwise independent of $j$.

3 Equilibrium product diversity and mark-ups

Equilibrium conditions  The equilibrium is characterized by symmetry.\footnote{The assumption that ensures symmetric outcomes is $v'(c)/v(c) < 1$ for all $c \geq 0$ which implies $v'(0) = \infty$. This means all consumers purchase all available products. (With $v'(0) < \infty$, asymmetric equilibria would be possible in which poor consumers are excluded from certain markets, see Foellmi and Zweimueller, 2003).} Therefore we have $p(j) = p$, $c(p(j), \theta) = c(p, \theta)$, and $x(p(j)) = x(p)$.

Producers have monopoly power on their respective markets and set prices to maximize profits. A single firm is small and cannot influence aggregate variables. Formally, each monopolist solves the problem $\max_p [p x(p) - w x(p)]$. The solution to this problem can be written in the familiar form

$$\frac{p - w}{p} = \frac{1}{\varepsilon(p)}, \text{ with } \varepsilon(p) = \int_{\theta}^{\theta} \frac{c(p, \theta)}{x(p)} \eta(c(p, \theta)) dF(\theta).$$  

(4)

where $\varepsilon(p)$ denotes the price elasticity of market demand. Equation (4) states that profits are maximized where the relation between the profit margin (price minus marginal cost) and the price, the ”Lerner index” is equal to the inverse of the price elasticity of demand. This price elasticity is a weighted sum of the individual price elasticities, the weights being individuals’ relative consumption levels $\frac{c(p, \theta)}{x(p)}$.\footnote{The assumption that ensures symmetric outcomes is $v'(c)/v(c) < 1$ for all $c \geq 0$ which implies $v'(0) = \infty$. This means all consumers purchase all available products. (With $v'(0) < \infty$, asymmetric equilibria would be possible in which poor consumers are excluded from certain markets, see Foellmi and Zweimueller, 2003).}
There is free entry for firms. In equilibrium, the marginal firm just breaks even and, by symmetry, all other firms also make zero profits. In equilibrium we must have
\[(p - w)x = wa,\] where \(a\) is the fixed labor input necessary to operate a firm, and \(x = x(p)\) denotes market demand when firms charge the monopoly price.

The economy-wide resource constraint requires that labor demand cannot exceed labor supply which is equal to unity (a population of mass 1 that supplies on average 1 unit of labor). Aggregate labor demand in the production of final output equals \(xN\) (\(N\) is the mass of firms that breaks even) and aggregate labor demand necessary to cover the fixed cost is \(aN\). A perfect labor market ensures that in equilibrium labor supply equals labor demand
\[1 = (x + a)N.\]

In equilibrium, the distribution of income is identical to the endowment distribution. Firms make zero profits, all income accrues from labor, and each household gets the same wage per labor unit. Consumers spend all income and spread expenditures equally across goods. Hence a consumer with labor endowment \(\theta\) purchases exactly \(\theta x\) units on each variety
\[c(\theta, p) = \theta x.\]

**Uniqueness versus multiplicity of equilibria** The above system of four equations can easily be reduced to a single equation with the degree of product diversity \(N\) as the unknown. Using equations (5) and (6) we can write \((p - w)/p = aN\). The right-hand-side of (4) can be rewritten using (7) and (6). Taken together this yields
\[aN = \left(\int_{\theta}^{\bar{\theta}} \theta \eta \left(\theta \frac{1 - aN}{N}\right) dF(\theta)\right)^{-1} \quad \text{where } N \in (0, 1/a) .\] The left-hand-side relates feasible values of product diversity \(N\) to values of the Lerner index \((p - w)/p\) that ensure zero profits (ZP-curve in Figure 1). The right-hand-side relates values of \(N\) to values of \((p - w)/p\) that guarantee profit maximization (PM-curve in Figure 1).

**Proposition 1** a) There exists at least one equilibrium with \(N \in (0, 1/a)\). b) When the price elasticity of individual demands \(\eta(c) = -v'/v''(c)\) is non-increasing in \(c\), this equilibrium is unique. When \(\eta(c)\) is non-monotonic in \(c\) there may (but need not) be multiple equilibria.
Proof. a) We argue graphically (Figure 1). Both PM- and ZP-curve are continuous. The ZP-curve starts at the origin, slopes upward and stops at \((p - w)/p = 1\) when \(N = 1/a\). The PM-curve starts at \((p - w)/p = 1/\varepsilon(\infty)\) when \(N = 0\), and stops at \((p - w)/p = 1/\varepsilon(0)\) when \(N = 1/a\). At least one intersection exists when \(\varepsilon(\infty) < \infty\) and \(\varepsilon(0) > 1\). To see that this is actually the case recall that \(0 < \varepsilon'(c)/v(c) < 1\). Using l'Hôpital's rule we may write \(0 < \lim_{c \to 0} \varepsilon'(c)/v(c) = \lim_{c \to 0} [\varepsilon''(c)c + v'(c)]/v'(c) = \lim_{c \to 0} [1 + \varepsilon''(c)c/v'(c)] = \lim_{c \to 0} [1 - 1/\eta(c)] < 1\) from which it follows that \(1 < \eta(0) < \infty\). When for all consumers \(c = 0\), we have \(\varepsilon(0) = \eta(0) > 1\). By similar arguments, we have \(1 < \varepsilon(\infty) < \infty\).

b) If \(\eta(c) = -v'(c)/(cv''(c))\) decreases in \(c\), it increases in \(N\). Then the market price elasticity \(\varepsilon(x) = \int_0^\theta \eta \left(\theta - \frac{aN}{N}\right) dF(\theta)\) also increases in \(N\). Thus the PM-curve is downward sloping and we have a unique equilibrium (Figure 1a). If \(-v'(c)/(cv''(c))\) increases in \(c\), the PM-curve is upward sloping. Then, the equilibrium is either unique (\(PM^A\)) or there may be multiple equilibria (\(PM^B\)) (Figure 1b).

Figure 1a,b

The proposition says that the equilibrium is unique if a larger number of firms is associated with lower mark-ups (PM-curve is downward sloping). One might consider such a situation as "realistic" as it is consistent with the intuition that an increase in the number of competitors tends to cut profits margins. However, the proposition also says that there are utility functions where a larger number of competitors is associated with higher profit-margins. This is a necessary (but not sufficient) condition for multiple equilibria. The intuition for multiplicity is this: When many firms enter, production per good is low, elasticities of substitution are small and mark-ups are high, which supports an equilibrium with high entry. When few firms enter, elasticities of substitution are high and mark-ups are low. This in turn supports an equilibrium with a low number of firms.

The impact of inequality on product diversity and mark-ups We now turn to our question of primary interest: How does inequality affect product diversity and mark-ups? The following proposition follows directly from our previous analysis.

Proposition 2 Consider a unique equilibrium. When \(-v'(c)/v''(c)\) is concave (convex) in \(c\), a more unequal distribution of \(\theta\) increases (decreases) product diversity and the mark-up, and
decreases (increases) the real wage. Only when $v'(c)/v''(c)$ is affine-linear in $c$, macroeconomic aggregates are unaffected by the endowment distribution.

**Proof.** Consider two distributions $F_0(\theta)$ and $F_1(\theta)$, such that $F_0(\theta)$ is less unequal than $F_1(\theta)$ (that is, $F_0(\theta)$ second order stochastically dominates (SSD) $F_1(\theta)$). Using equation (2) we rewrite $\theta \eta(\theta x) = -v'(\theta x)/(x v''(\theta x))$. When $-v'(c)/v''(c)$ is concave (convex), SSD implies $\int_{\underline{\theta}}^{\theta} -v'(\theta x)/v''(\theta x)dF_1(\theta) < (>) \int_{\underline{\theta}}^{\theta} -v'(\theta x)/v''(\theta x)dF_0(\theta)$. Concavity implies, for given $x$ (and, by equation (6), for a given $N$), more inequality decreases the price elasticity of market demand and increases the Lerner index. In Figure 1a, the PM-curve shifts up. In the new equilibrium, both product diversity and the Lerner index are higher. ■

To understand the intuition, consider the effect of inequality on the shape of market demand functions. An individual’s demand reaction to a price change is given by $\partial c(\theta)/\partial p = (1/p) \left[ -v'(\theta x)/v''(\theta x) \right]$ (use equation (1)). The sensitivity of market demand to a price change is just the sum of these individual demand changes. When $-v'(\theta x)/v''(\theta x)$ is concave, an increase in inequality decreases the price sensitivity of market demand. Hence the price elasticity of the new market demand function is smaller. As a consequence, both equilibrium product diversity and the Lerner index increase.5

Obviously, when $-v'(\theta x)/v''(\theta x)$ is convex, analogous arguments lead to the conclusion that a mean preserving spread in the endowment distribution makes demand more sensitive to changes in prices. The price elasticity of the new market demand function is now larger. Thus, in the new equilibrium, mark-ups and product diversity are smaller, and the real wage is higher. Only in the special case, when the utility function $v(\cdot)$ is such that $-v'(c)/v''(c)$ is affine-linear in $c$, changes in the endowment distribution have no effect on aggregate outcomes. Only in that case, macroeconomic outcomes can be viewed as if they were generated by decisions of a representative consumer.6

---

5 Note that the effect on the elasticity of the market demand depends on how changes in inequality affect the distribution of changes in individual demands. It is not relevant whether the rich or the poor have the higher demand elasticities: $\eta(\theta c)$ could be increasing, decreasing, or non-monotonic in $\theta$.

6 Utility functions that feature linearity of $-v'(\theta c)/v''(\theta c)$ belong to the HARA-class. In that case we have $v'(c) = (\beta c - \bar{c})^{-1/\beta}$ and $-v'(c)/v''(c) = \beta c - \bar{c}$ and the equilibrium (market) demand elasticity is $\beta - \bar{c}N/(1 - aN)$ which is independent of the distribution of income. In the even more special case when $\bar{c} = 0$, $v(\cdot)$ is a CES-utility function (Dixit-Stiglitz, 1977) where the Lerner index equals $aN = 1/\beta$. 

7
References


Figures 1a, 1b – Existence of an equilibrium

\[
\begin{align*}
\text{Lerner Index} & \\
\frac{1}{\varepsilon(\infty)} & \quad \text{PM} \\
\frac{1}{\varepsilon(0)} & \quad \text{ZP} \\
N^* & \quad 1/a \quad N
\end{align*}
\]

\[
\begin{align*}
\text{Lerner Index} & \\
\text{PM}^A & \quad \text{PM}^B \\
\text{ZP} & \quad 1/a \quad N
\end{align*}
\]
Working Papers of the Institute for Empirical Research in Economics

No.

Ralf Becker, Urs Fischbacher and Thorsten Hens: *Soft Landing of a Stock Market Bubble. An Experimental Study*, January 2002


Bruno S. Frey and Matthias Benz: *Ökonomie und Psychologie: eine Übersicht*, Oktober 2001

Reto Schleining: *Money Illusion and the Double Dividend in the Short Run*, October 2001


Ernst Fehr and Armin Falk: *Psychological Foundations of Incentives*, November 2001

Takeshi Momi: *Excess Demand Functions with Incomplete Markets – A Global Result*, January 2002


Lars P. Feld and Bruno S. Frey: *Trust Breeds Trust: How Taxpayers are Treated*, January 2002

Aleksander Berentsen and Guillaume Rocheteau: *Money and Information*, January 2002

Aleksander Berentsen and Guillaume Rocheteau: *Money and the Gains from Trade*, January 2001


Bruno S. Frey and Stephan Meier: *Selfish and Indoctrinated Economists?*, January 2002


Ernst Fehr and Urs Fischbacher: *Third Party Punishment*, February 2002

Bruno S. Frey and Stephan Meier: *Pro-Social Behavior, Reciprocity or Both?*, February 2002


Anke Gerber and Marc Oliver Bettzüge: *Evolutionary Choice of Markets*, March 2002

Rafael Lalive, Jan C. van Ours and Josef Zweimüller: *The Effect of Benefit Sanctions on the Duration of Unemployment*, March 2002

Reto Föllmi and Josef Zweimüller: *Structural Change and the Kaldor Facts of Economic Growth*, March 2002

Rafael Lalive and Josef Zweimüller: *Benefit Entitlement and Unemployment Duration: The Role of Policy Endogeneity*, April 2002


Simon Gächter and Ernst Fehr: *Fairness in the Labour Market – A Survey of Experimental Results*, April 2002


Bruno S. Frey and Stephan Meier: *Museums between Private and Public - The Case of the Beyeler Museum in Basle*, June 2002

Bruno S. Frey: *Publishing as Prostitution? Choosing Between One’s Own Ideas and Academic Failure*, June 2002


Matthias Benz and Alois Stutzer: *Are Voters Better Informed When They Have a Larger Say in Politics?*, June 2002

Ernst Fehr, Urs Fischbacher and Elena Tougareva: *Do High Stakes and Competition Undermine Fairness? Evidence from Russia*, July 2002

Enrico De Giorgi: *Reward-Risk Portfolio Selection and Stochastic Dominance*, August 2002

Enrico De Giorgi: *A Note on Portfolio Selections under Various Risk Measures*, August 2002

Klaus Reiner Schenk-Hoppé: *Resuscitating the Cobweb Cycle*, July 2002

Alois Stutzer: *The Role of Income Aspirations in Individual Happiness*, August 2002
<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Authors</th>
<th>Publication Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>Do Workers Work More if Wages are High? Evidence from a Randomized Field Experiment</td>
<td>Ernst Fehr and Lorenz Götte</td>
<td>July 2002</td>
</tr>
<tr>
<td>126</td>
<td>Rational Investor Sentiment</td>
<td>Anke Gerber, Thorsten Hens and Bodo Vogt</td>
<td>December 2002</td>
</tr>
<tr>
<td>127</td>
<td>Do Workers Enjoy Procedural Utility?</td>
<td>Matthias Benz and Alois Stutzer</td>
<td>September 2002</td>
</tr>
<tr>
<td>128</td>
<td>An Application of Evolutionary Finance to Firms Listed in the Swiss Market Index</td>
<td>Thorsten Hens, Klaus Reiner Schenk-Hoppé and Martin Stalder</td>
<td>August 2002</td>
</tr>
<tr>
<td>129</td>
<td>Introducing Procedural Utility: Not only What, but also How Matters</td>
<td>Bruno S. Frey, Matthias Benz and Alois Stutzer</td>
<td>October 2002</td>
</tr>
<tr>
<td>130</td>
<td>Limited Rationality and Strategic Interaction, The Impact of the Strategic Environment on Nominal Inertia</td>
<td>Ernst Fehr and Jean-Robert Tyran</td>
<td>November 2002</td>
</tr>
<tr>
<td>131</td>
<td>The Success of Job Applications: A New Approach to Program Evaluation</td>
<td>Armin Falk, Rafael Lalive and Josef Zweimüller</td>
<td>November 2002</td>
</tr>
<tr>
<td>132</td>
<td>Indirect Reciprocity and Strategic Reputation, Building in an Experimental Helping Game</td>
<td>Dirk Engelmann and Urs Fischbacher</td>
<td>November 2002</td>
</tr>
<tr>
<td>133</td>
<td>Fairness and the Power of Competition</td>
<td>U. Fischbacher, Christina M. Fong and Ernst Fehr</td>
<td>January 2003</td>
</tr>
<tr>
<td>134</td>
<td>The Hidden Costs and Returns of Incentives – Trust and Trustworthiness among CEOs</td>
<td>E. Fehr and John A. List</td>
<td>November 2002</td>
</tr>
<tr>
<td>135</td>
<td>Being Independent is a Great Thing: Subjective Evaluations of Self-Employment and Hierarchy</td>
<td>Bruno S. Frey and Matthias Benz</td>
<td>November 2002</td>
</tr>
<tr>
<td>136</td>
<td>Terrorism: Deterrence May Backfire</td>
<td>Bruno S. Frey and Simon Luechinger</td>
<td>December 2002</td>
</tr>
<tr>
<td>137</td>
<td>How To Fight Terrorism: Alternatives To Deterrence</td>
<td>Bruno S. Frey and Simon Luechinger</td>
<td>December 2002</td>
</tr>
<tr>
<td>138</td>
<td>Markets Do Not Select For a Liquidity Preference as Behavior Towards Risk</td>
<td>Thorsten Hens and Bodo Vogt</td>
<td>December 2002</td>
</tr>
<tr>
<td>139</td>
<td>Markets Do Not Select For a Liquidity Preference as Behavior Towards Risk</td>
<td>Thorsten Hens and Klaus Reiner Schenk-Hoppé</td>
<td>December 2002</td>
</tr>
<tr>
<td>140</td>
<td>Is Strong Reciprocity a Maladaptation?</td>
<td>Ernst Fehr and Joseph Henrich</td>
<td>January 2003</td>
</tr>
<tr>
<td>141</td>
<td>A Nation-Wide Laboratory Examining trust and trustworthiness by integrating behavioral experiments into representative surveys</td>
<td>Ernst Fehr, Urs Fischbacher, Bernhard von Rosenbladt, Jürgen Schupp and Gert G. Wagner</td>
<td>January 2003</td>
</tr>
<tr>
<td>142</td>
<td>Who Gains From Non-Collusive Corruption?</td>
<td>Reto Foellmi, Manuel Oechslin</td>
<td>January 2003</td>
</tr>
<tr>
<td>143</td>
<td>Does Marriage Make People Happy, Or Do Happy People Get Married?</td>
<td>Alois Stutzer and Bruno S. Frey</td>
<td>January 2003</td>
</tr>
<tr>
<td>144</td>
<td>Clean Evidence on Peer Pressure</td>
<td>Armin Falk and Andrea Ichino</td>
<td>January 2003</td>
</tr>
<tr>
<td>145</td>
<td>Inequality, Market Power, and Product Diversity</td>
<td>Reto Foellmi, Josef Zweimüller</td>
<td>March 2003</td>
</tr>
</tbody>
</table>