Economics Letters 152 (2017) 36–40

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

Quantitative overeducation and cooperative game theory

Tobias Hiller

University Leipzig, Germany

HIGHLIGHTS

- We use coalition structure games to model the bargaining after the training.
- A production function with a flat increase is accompanied by quantitative overeducation.
- Public training programs have a higher impact in branches with high marginal productivity.

ARTICLE INFO

Article history:
Received 20 September 2016
Received in revised form 28 November 2016
Accepted 8 December 2016
Available online 23 December 2016

JEL classification:
C71
J24
M53

Keywords:
Quantitative overeducation
Cooperative game theory
χ value
Shapley value

ABSTRACT

Overeducation is an empirical phenomenon in two dimensions: qualitative and quantitative. Quantitative overeducation addresses a firm's decision, to train more employees than needed. One explanation for this decision is modeled in this article—that of classical bargaining power. The main idea is that after investing in human capital the employer uses employees outside the firm to raise the bargaining power when he negotiates with the employees within the firm on how to share the profit of the firm. To model this, we use cooperative game theory for the first time. The labor market is modeled by a coalition structure and the payoffs are determined by the χ value (Casajus, 2009).

1. Introduction

Overeducation is an empirical phenomenon in two dimensions: qualitative and quantitative. Qualitative overeducation can be defined as the discrepancy between employees' educational attainments and the skills requirement of jobs. Some initial empirical findings for the U.S. labor market are presented by Rumberger (1981) and Duncan and Hoffman (1981). For comprehensive overviews of the literature see Groot and van den Brink (2000), Hartog (2000), and McGuinness (2006), among others. There are two main explanations for this qualitative discrepancy. The first explanation focuses on the potential trade-off between educational (formal) knowledge and on-the-job training. Some employees (e.g. young professionals) have to compensate for their lack of working experience with formal education apart from the job profile. The second explanation is based on the career mobility of employees. For a limited period, employees may work in jobs with lower or fewer educational requirements since these jobs provide them with skills to be used later in higher-level jobs.

Quantitative overeducation addresses the decision of firms to train more employees than needed. Empirically, this fact is very well documented for the German labor market. Bellmann and Wahse (2006) report that 35% of apprenticeships are in excess of internal requirements of firms. The analysis of sectors reveals that the public sector has the highest rate: 60%. Neubäumer (1993) arrived at a similar conclusion. In addition, the difficulties of young employees to obtain a permanent employment after training (see Bellmann and Hartung (2010), for example) indicate that firms train more employees than needed.

There are several explanations for this behavior (see Harhoff and Kane (1997), Niederalt (2004), Bellmann and Wahse (2006), and Zwick (2007) for alternative literature reviews). One reason may be collective agreements with unions that codify a certain quantitative level of training. In large firms and the public sector, social responsibility could mandate training in excess of internal requirements. Some firms may overeducate for their current needs, when they expect future growth. Public subsidy programs could also cause quantitative overeducation (Dolton, 1993). Receiving an information advantage over other firms in the period of training on

E-mail address: hiller@wifa.uni-leipzig.de.

http://dx.doi.org/10.1016/j.econlet.2016.12.010
0165-1765/

the specific apprentice's skills is another explanation (Acemoglu and Pischke, 1998). Yet another reason for quantitative overeducation are negative net costs of apprenticeship (i.e., the employees' training pays for itself within the training period). Empirically, findings for this explanation are offered by Wolter et al. (2006) for the Swiss labor market and Neubäumer (1993), Büchel and Neubäumer (2001), Zwick (2007), Wenzelmann et al. (2009), and Pollmann-Schult and Mayer (2010) for Germany. A common outcome is that low training costs are observed in the craft sector and, hence, quantitative overeducation is most likely. Other vulnerable branches based on low or negative net costs of training are trade and services. The explanation for quantitative overeducation that is modeled in this article is that of classical bargaining power. Training in excess of internal requirements causes an excess of supply in the future. Hence, the firm has a good bargaining position and could capture a higher part of the profit generated by the engaged employees.

We model this problem by using the framework of human capital theory. In his seminal paper, Becker (1962) uses a simple model to answer the question who benefits from investments in human capital: the employee or the employer. He distinguishes two types of human capital: general and specific. General human capital is equally productive in all firms. Investments in specific human capital increase only the employee's productivity in the current firm. We focus here on specific human capital. Our contention is that the employer uses employees outside the firm to raise the bargaining power when he negotiates with employees within the firm on how to share the profit of the firm.

To model the bargaining, we use cooperative game theory. The best-known solution concept is the Shapley value (Shapley, 1953). It assumes that all players work together. In the labor market, this assumption is not true. There are, on the contrary, many small units called firms. To consider this structure, coalition structures are used. These structures divide players into disjointed components. A component with one employer and employees is considered a firm. The most popular value for games with a coalition structure (CS games) was introduced by Aumann and Drèze (1974). According to these authors, components are active groups as in our understanding of firms.[1] The Aumann–Drèze value assumes component efficiency, meaning that the worth of the component – the profit of the firm – is divided among the players of the component. However, the outside options of players have no bearing on their payoffs. This is not very realistic. With this idea in mind, Wiese (2007) introduced the Wiese value. This value is component efficient, reflecting the outside options of the players on the market. Inspired by the Wiese value, Casajus (2009) presented the χ value. The main advantage of the χ value with respect to the Wiese value is a "nicer" axiomatization and a more intuitive definition of the players' payoffs (Casajus, 2009). The Wiese value and the χ value are the most important values for CS games that interpret components as active groups and account for outside options of the players.[2] In Hiller (2013), the χ value was used to replicate the standard results of human capital theory: The employees receive the additional profit after an investment has been made in their general human capital. After an investment in specific human capital, the employer and the employee participate in the additional profit.

This article is the first to apply CS games and the χ value to the problem of quantitative overeducation in human capital theory. Fig. 1 illustrates the underlying idea—a two stage non-cooperative game. In the first step, the employer decides on the number of apprentices (employees with specific human capital training). After the apprenticeship, the employer decides how many apprentices are engaged at the firm, in other words, how many employees are in his component. Finally, the χ payoffs of the employer and the employees are determined. These payoffs represent how the employer and the employees divide the additional profit after the investment in specific human capital. We focus on the second stage and answer the question: Given a number of trained employees, how many employees will be engaged at the firm to maximize the employer's share of the profit?

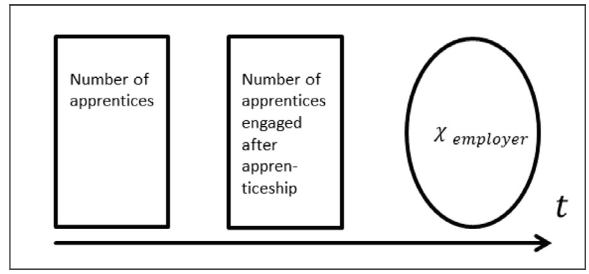

Fig. 1. Non-cooperative game.

The remainder of the article considers the basic notations of cooperative game theory in Section 2. In Section 3, the main results are presented. Section 4 concludes.

2. Basic definitions and notation

In cooperative game theory, a game is a pair (N, v). $N = \{1, 2, \ldots, n\}$ is the player set; in this article employees and employers. The coalition function v specifies for every subset K of N a certain worth $v(K)$ reflecting the economic ability of K, i.e. $v : 2^N \to \mathbb{R}$ such that $v(\emptyset) = 0$.

Using (N, v), the Shapley value computes the players' payoffs. For this purpose, rank orders ρ on N are used. They are written as $(\rho_1, \ldots, \rho_n)$ where ρ_1 is the first player in the order, ρ_2 the second player, etc. The set of these orders is denoted by $RO(N)$; $n!$ rank orders exist. The set of players before i in rank order ρ including i is called $K_i(\rho)$. For player i, the Shapley payoff is determined by Shapley (1953):

$$\mathrm{Sh}_i(N, v) = \frac{1}{n!} \sum_{\rho \in RO(N)} v(K_i(\rho)) - v(K_i(\rho) \setminus \{i\}). \quad (1)$$

Since we will analyze a firm with a twice differentiable production function, we have to introduce infinite games.[3] The space of players is represented by a measurable space (N, C). Members of N are players and members of C are coalitions. We assume that (N, C) is isomorphic to $([0, 1], \mathcal{B})$, where $\mathcal{B}$ stands for the Borel subsets of $[0, 1]$. The coalition function v is a real-valued function on C such that $v(\emptyset) = 0$. A infinite game is a triple (N, C, v). The set of all infinite games forms a linear space over the field of real numbers, denoted $\mathfrak{G}$. The Shapley payoff for $i \in N$ is determined by Aumann and Shapley (1974):

$$\mathrm{Sh}_i(N, C, v) = \int_0^1 \left(\frac{\partial v(C)}{\partial i} \cdot t(n) \right) dt. \quad (2)$$

One assumption of the Shapley value is that all players work together and that the total worth of the set of players, $v(N)$, is divided among them. On the labor market, however, this assumption is not true. There, employers with employees constitute small units

[1] In contrast, the Owen (1977) value interprets components as bargaining unions.

[2] Another value for CS games was developed by Alonso-Meijide et al. (2015), for example.

[3] For definitions and notation see Billera et al. (1978) and Neyman (2002), for example.