Overview

Chapter 1 gives a game-theoretic basis for models of collective bargaining. It starts by introducing general concepts of two-person strategic, extensive and repeated games. It is assumed, for simplicity, that the two parties in bargaining have a constant discount rate and that they make an arbitrarily large number of alternating offers. It is shown that in such a case, the equilibrium of the game is obtained through the maximization of some weighted geometric average of the objectives of the parties. As either of the parties becomes more patient (or quicker when responding to the opponent's offers) relative to the other, the geometric weight of its objective approaches unity, and as it becomes more impatient (or slower when responding to the opponent's offers), the geometric weight of its objective approaches zero. Finally, it is shown that in the absence of uncertainty, the outcome of the game takes the simple form that either of the parties proposes the equilibrium offer and then the other immediately accepts this.

Chapter 2 gives microfoundations for models of collective bargaining when there is no investment. The same analysis also holds when there is no adjustment cost for investment, since in this case the firm will always hold its capital input at the optimal level. We start by introducing the monopoly-union model and extend this model for the case of profit-sharing. In the ordinary-wage system, only the basic wages are used as instruments of bargaining and the workers do not receive any share of profits, while in the profit-sharing system, the basic wages and the workers' profit share are determined simultaneously in bargaining. It is shown that if there is no investment or no adjustment cost for investment, then the behaviour of the monopoly union does not qualitatively differ in the two systems; also, in the case of profit-sharing, the monopoly union chooses its optimal wage–employment combination on the labour demand curve.

Finally, it is theoretically proven that either highly centralized systems with bargaining at the level of the whole economy, or highly decentralized systems with bargaining at the level of small industries or firms, seem to perform well in terms of employment, while lower levels of employment are found in systems where bargaining is carried out at some intermediate level of centralization. The starting point is that since firms produce different commodities and purchase intermediate inputs from each other, the degree of centralization has opposing impacts on wages: one of these operates through the macroeconomic effects of a single union's wage policy, while the other operates through the elasticity of the labour demand that the single union faces. It follows that a union facing the whole productive sector of the economy and a union facing a very small part of that sector both set low wages, but for different reasons: the former because it can internalize the macroeconomic effects of its wage policy, and the latter because it observes a high elasticity of labour demand.

Chapter 3 examines the prospects for public policy when the response of the government is internalized in wage-setting. We assume that the government uses some taxes or subsidies to correct the distortions of the economy, but that it must balance its budget by other 'revenue-raising' taxes. In such a case, the tax incidence on the workers has an impact on wages. Standard results based on the assumption of exogenous wages suggest that if wages are fixed arbitrarily high in some part of the economy, it is desirable to provide a subsidy to counteract the distortion. We show that when collective bargaining is properly incorporated into the model, this result holds only for very decentralized bargaining but otherwise, it is reversed; then the effect through the government budget on the workers' tax burden will outweigh the direct effect of the subsidies, so that a tax is preferable for this purpose.

While chapter 3 focuses on public policy from the viewpoint of setting small distortion-correcting taxes and subsidies, chapter 4 examines optimal taxation and public production when the government can set its instruments at any level. It is shown that optimal taxation and public production must change the unions' choice-sets so that (with a utilitarian social welfare function) the union wages will be uniform. Since the subsidies create a gap between consumer and producer wages, production and consumption decisions are independent and aggregate production efficiency is desirable. An interesting result is that although it is possible to maintain full employment by public policy, this is not necessarily socially optimal. When jobs cannot be divided and wage-fixing is non-competitive, an equilibrium with unemployment is possible. Then, with decreasing returns to scale in aggregate production, it can be optimal to employ only some of the workers and to pay benefits to the rest of them rather than to attempt to employ them all.

In chapter 5, the static model of bargaining is extended so that there exist sunk costs in investment. It is shown that if the union is strong, then there exists a reputational equilibrium. In the presence of *credible* contracts, the firm can, when making its plans, take the union's pay parameters as given, but in the absence of credible contracts, the employer and the union bargain after the former announces its investment plan. In the absence of credible contracts, the union has an incentive to renege and reap the benefits of investment, so that the firm has less incentive to invest than in the presence of credible contracts. If the union is powerful enough, the equilibrium with credible contracts is stable. If the employer does not trust the union, then the latter has an incentive to deprive the employer of profits. Consequently, the employer loses nothing if it trusts a strong union.

It is shown that credibility is an issue only at medium levels of union power: with a weak union, the pay parameters are competitively determined; with a strong union, there is a reputational equilibrium with credible contracts; and with a union of medium strength, there is unemployment in the absence of credible contracts. Consequently, any marginal attempt to undermine the power of a strong union causes a loss of credibility of contracts and, consequently, a fall in investment and welfare.

Chapter 6 considers a situation where the game is repeated continuously in time. For technical reasons, we consider only the case of a monopoly union. It is shown that if there is some investment going on, then there exists a reputational equilibrium where the union has no incentive to renege on its announced pay parameters. The interpretation is the same as in chapter 5: if the employer does not trust the union, then the latter can take all the profits by using two-part tariffs; so the firm loses nothing in trusting the union.

Chapter 7 extends the model of chapter 6 to the case of several unions. It is shown that a union can increase its members' income in two ways: by raising its members' real basic wage relative to the other workers, as above; or by extracting part of capital rent. If a union is small, it attempts to benefit at the expense of the other unions by raising the basic wage and ensures high capital stock and high employment in future by giving up any claim on capital income. When a union is big so that its basic wage considerably increases the price level, there is no incentive to rival the other unions and rent extraction is chosen. We conclude that at high levels of centralization, bargaining ends up with claims on capital income, while at low levels of centralization, it ends up with the use of ordinary wages. The substitution between labour and intermediate inputs only increases the likelihood of profit-sharing among the unions of medium size but it does not change the outcome.

Chapter 8 considers the effect of union power on economic growth. This is done by examining balanced growth in a closed (and fully unionized) economy. There are two categories of labour termed 'skilled' and 'unskilled', but the occupation of the workers is assumed to be flexible. It is assumed that when unskilled workers transform themselves into skilled workers, an increasing amount of unskilled labour is needed to produce one unit of skilled labour. The unions and the firms bargain simultaneously over the wages for skilled and unskilled labour and possibly over the workers' profit share. It is furthermore assumed that research employs only skilled labour, and that the producers of intermediate inputs are subject to monopolistic competition while those of final goods are subject to oligopolistic competition.

The first finding is that because an increase in R&D increases aggregate labour income, a union does not accept any agreement causing unemployment for its skilled members. If there were unemployment for both labour inputs, then both labour income and profits could be increased by producing more final goods, until either of the inputs became fully employed. This motivates a labour union and the corresponding firm to agree only on such wages for which either skilled or unskilled labour is fully employed. If skilled labour were less than fully employed, then employing more of this in research would increase the level of labour income. Consequently, the union has no incentive to start bargaining when the expected outcome of bargaining would yield full employment for unskilled, but unemployment for skilled labour. So in the case of growth, skilled labour must be fully employed.

Second, it is shown that union power speeds up growth: higher wages for unskilled labour increase research through decreased final output and the transfer of skilled labour from the production of final goods to research. The increase in the union's relative bargaining power increases both unemployment and the balanced growth rate. If the strengthening of union power increases the wage for unskilled labour so that there is unemployment for unskilled labour, then the final-goods sector employs less skilled labour. This fall in the demand for skilled labour decreases the wage for skilled labour and the unit cost of a new design. With a lower unit cost, the production of new designs expands, thereby speeding up economic growth.

Finally, it is shown that unemployment can be socially desirable: if a high growth rate is socially optimal, then the maintenance of it requires so much skilled labour in research that with the remaining skilled labour, only part of unskilled labour can be employed in ordinary production.

Chapter 9 examines the effect of union power on international specialization in a world where one economy is unionized but the rest of the world has competitive labour markets. Alternatively, the analysis holds for specialization in a closed economy which has both a unionized and a non-unionized sector. It is assumed that all economies produce both primary and refined goods, that technical change is based on international (or inter-sectoral) brand proliferation for refined goods, and that technology and preferences are everywhere the same. In other respects, the model is more or less similar to that in chapter 8.

Since there is perfect international competition in the market for the designs of new refined goods and since this sector employs only skilled labour, the wage for skilled labour is uniform all over the world. Consequently, the increase of union power in any economy decreases ordinary production and transfers resources to research in that economy. This means that countries with relatively high (low) union power export refined (primary) and import primary (refined) products. Brand proliferation increases the output of refined goods in all economies. Because the production of refined goods constitutes a relatively large share of economies with relatively high union power, it follows that real output growth is faster in countries with relatively high union power.

Finally, it is also shown that in an open economy unemployment can be socially desirable. When a large amount of skilled labour is needed to develop new designs for refined goods, such an amount must be taken from ordinary production. Then, in the production of the primary good, unit labour cost must be increased by so much that only part of unskilled labour is employed.

1 Basic concepts of game theory

1.1 Introduction

In order to obtain an extensive treatment of collective bargaining, one has to take game theory as a starting point. This chapter presents the elements of game theory that are needed in the rest of the book. The basic references are Nash (1950), Ståhl (1972), Rubinstein (1982), Binmore, Rubinstein and Wolinsky (1986), Sutton (1986) and Osborne and Rubinstein (1990, 1994).

In game theory the decision-makers, who are called *players*, pursue well-defined objectives (i.e. they are rational) and take into account their knowledge of other decision-makers' behaviour (i.e. they reason strategically). A *game* is a description of strategic interaction that includes the players' interests as well as the constraints on the actions that the players can take. The game does not specify the actions that the players do take. A *solution* of a game is a systematic description of the outcomes that may emerge. To find an equilibrium in a game, one must identify the patterns of each player's behaviour which are stable against selfish deviations by the other participants in the game. In this study, we ignore uncertainty, restrict ourselves to two-player situations and consider only games that are used in the later chapters. For convenience, the players are called 'the union' and 'the firm'.

1.2 The application of games to labour economics

In a (*non-cooperative*) *strategic game*, each player chooses its plan of action once and for all, and these choices are made simultaneously. A classical example of this is when the players must split a cake of fixed size knowing that the situation will not be repeated. The common solution concept in strategic games is a *Nash equilibrium,* which requires that no player can deviate and gain if the other sticks to its equilibrium behaviour.

Section 1.3 shows that a Nash equilibrium can be solved by the maximization of a simple function called the *Nash product* of the game. This function is the product of the players' gains in the equilibrium outcome over those in the outcome that corresponds to disagreement.

Many useful games in economics involve a sequential structure where the players have to take actions in some specified order. These are called *extensive games*, and in them each player considers its plan of action not only at the beginning of the game but also whenever it has to make a decision. In most extensive games, the players can make incredible threats that they themselves would prefer not to carry out. Section 1.4 eliminates this defect using the solution concept known as *subgame perfect equilibrium*. This says that the players' strategies must be the best responses not only at the beginning of the game but also in all parts of the game starting later.

An extensive game where the players take actions in two stages (and not simultaneously) is called a Stackelberg game. The player who acts first is called the (Stackelberg) leader and the one who reacts later is called the (Stackelberg) follower of the game. For instance, the common form of wage-bargaining, where the union sets the wage while the employer determines employment taking the wage as given, can be modelled as a Stackelberg game where the union's wage-setting is carried out strategically before the employment decision.[1] The outcome of such a game is that the union chooses its optimal wage–employment combination on the labour demand curve. The firm could warn that if the union increases the wage above the level corresponding to full employment, then it will stop production for good. Since everybody knows that in the event of this threat being implemented the firm will lose its profit, such a warning cannot be a relevant strategy in the game.

In economic applications, two special forms of extensive game are of special interest. First, when the same strategic game is repeated and the players have some sort of memory, we have a *repeated game*. This concept was created to explain the nature of long-term relationships. For instance, in the case where the firm is subject to adjustment costs in investment, the formation of reputation in collective bargaining can be modelled as a repeated game in which the firm will remember the union's cheating in the later stages of the game.[2] In such a game, it may be in the union's best interests to cheat, in which case wage-setting will be 'non-credible', or not to cheat, in which case it will be 'credible'. Since in the 'credible' case the wages are expected to be lower and the profits higher than in the

[1] This case is examined in section 2.2.
[2] This case is considered in chapters 6 and 7.

'non-credible' case, the credibility of wage-setting will encourage the firm to invest in capital.

A repeated game is *finite* if the bargaining is repeated only a fixed number of times, and *infinite* if it is repeated indefinitely. These two versions lead to different results. A model with an infinite horizon is appropriate if after each period the players believe that the game will continue for an additional period, while the model with a finite horizon is appropriate if the players clearly perceive a well-defined final period.[3] In the applications of this book, the fact that the players' lifetime is finite need not be important. If the game is played frequently so that the horizon approaches very slowly, then the players ignore the existence of the horizon entirely until its arrival is imminent. On the basis of this, we prefer the game with an infinite horizon to that with a finite horizon as the better approximation of reality for wage-bargaining. Infinitely repeated games are introduced in section 1.5.

In the second useful form of an extensive game, the players try to solve the conflict of their interests by committing themselves voluntarily to a course of action that is beneficial to both of them. This can be specified as an *alternating-offers game*: the players take turns to call out proposals for splitting a cake and the other party can decide whether or not to accept the offer as a basis for the agreement. A delay in agreement means welfare loss for both parties, so that in the long run they must end up with a solution. An example of this game is wage-bargaining in which the negotiators could in principle make each other a large number of offers in a very short time.

Section 1.6 shows that the outcome of the alternating-offers game is the following. Because of the losses associated with delays, one of the players immediately offers the final agreement and the other one accepts it.[4] If the time interval between successive offers is small, the outcome of any alternating-offers game can be approximated by the outcome of some strategic game. Given this result, any alternating-offers game can be solved through the maximization of the Nash product of the corresponding strategic game, i.e. through the maximization of the product of the players' gains over the outcome that corresponds to disagreement.

Section 1.7 generalizes the alternating-offers game to economically more interesting cases where the players are in an asymmetric position. Then the players share the cake in proportions that correspond to their

[3] See, for example, Osborne and Rubinstein (1994), p. 135.
[4] This is true only because we assume that the parties know perfectly the environment as well as each other's preferences. If, for example, the players were uncertain about each other's preferences, then there would be some 'learning' time without any agreement before the final offer was made.

relative bargaining power in the game. It is shown that this generalization can be transformed into the symmetric case so that the relative bargaining power of a player takes the form of a parameter. Consequently, the outcome of the game can be solved through the maximization of some weighted geometric average of the players' gains over the outcome with disagreement. This average is called a *generalized Nash product* of the game and its weights approximate the relative bargaining power of the parties. As an application of this property, it is possible to examine the problem of how the relative bargaining power of the union affects the general equilibrium of the economy.[5]

1.3 Strategic games

1.3.1 Bargaining problems

It is assumed that the union chooses its *action* x_u from a set $\mathcal{X}_u$ and the firm chooses its action x_f from a set $\mathcal{X}_f$. Then the pair

$$x = (x_u, x_f) \in \mathcal{X} = \mathcal{X}_u \times \mathcal{X}_f$$

of the players' actions can be called the *action of the game*. We denote the union's utility function by $u_u = U_u(x) \in \mathcal{R}$ and the firm's utility function by $u_f = U_f(x) \in \mathcal{R}$, where x belongs to set $\mathcal{X}$ and $\mathcal{R}$ is the set of real numbers. Game theory uses von Neumann–Morgenstern utility functions that were originally defined over lotteries.[6] One property of these functions is that the behaviour of an agent having such a utility function must be independent of the units in which we measure utility. This property can be formally presented as follows:

Assumption 1.1: Let U_u (U_f) be the utility function that is generated by the preferences of the union (firm). Then for any strictly increasing linear transformation Λ, the utility function $\Lambda(U_u)$ ($\Lambda(U_f)$) is generated by the same preferences of the union (firm).

Each player has to take into account the fact that the other player's behaviour may cause negotiations to break down. Therefore, in line with Nash (1950), we assume that the union and the firm either reach an *agreement* in some set X or fail to reach an agreement, in which case the *disagreement event* D occurs. It is furthermore assumed, for simplicity, that event D is unique. It follows that the set of the union's actions is

[5] This case is considered in chapters 5, 8 and 9.
[6] von Neumann and Morgenstern (1944).

given by $\mathcal{X}_u \doteq X_u \cup \{D\}$, and the set of the firm's actions is given by $\mathcal{X}_f \doteq X_f \cup \{D\}$.

We call the pair (u_u, u_f) of the players' utilities the *outcome of bargaining*. The set of the outcomes $(U_u(x), U_f(x))$ that are associated with possible agreements $x \in X$ is given by

$$S \doteq \cup_{x \in X} \{(U_u(x), U_f(x))\} \subset \mathcal{R}^2.$$

We assume that the set S is compact (i.e. closed and bounded) and convex, and that it is possible to make an agreement that yields the same utility for the players as the disagreement event D does. This latter assumption means that the disagreement outcome belongs to set S:

$$d = (\bar{u}_u, \bar{u}_f) = (U_u(D), U_f(D)) \in S.$$

When there exists some agreement $(u_u, u_f) \in S$ that is preferred by both players to the disagreement outcome, $u_u > \bar{u}_u$ and $u_f > \bar{u}_f$, a pair $\langle S, d \rangle$ that consists of both the set S of possible agreements and the disagreement point d is called a *bargaining problem*. Denoting the set of all bargaining problems by $\mathcal{B}$, we define a *bargaining solution* as a function $\theta: \mathcal{B} \to \mathcal{R}^2$ that assigns to each bargaining problem $\langle S, d \rangle \in \mathcal{B}$ a unique outcome $(\theta_u, \theta_f) \in S$. Since the players can agree to disagree, $d \in S$, and there is some agreement preferred by both of them to the disagreement outcome, they have a mutual interest in reaching an agreement.

1.3.2 Nash axioms

Later on, we will find that the following definition is very useful in proofs:

Definition 1.1: If the disagreement utilities are the same for both players, $\bar{u}_u = \bar{u}_f$, and if for any agreement $(u_u, u_f) \in S$ there exists a reversed agreement $(u_f, u_u) \in S$ so that the players' places are switched, then the bargaining problem $\langle S, d \rangle$ is termed symmetric.

Nash imposed three axioms concerning a bargaining solution $\theta : \mathcal{B} \to \mathcal{R}^2$.[7] The first of these is the following:

Axiom 1 (Symmetry)**:** In the symmetric case, switching the players' places does not affect the solution, $\theta_u(S, d) = \theta_f(S, d)$.

[7] There was also a fourth axiom in Nash (1950) but this was the same as assumption 1.1 above.