The Enigma of Medieval Craft Guilds: A Model of Social Inertia and Technological Change[*]

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1. Introduction

It is widely recognised by economists that the main force underlying economic growth processes is technological change. However, it is equally acknowledged that technological change generally represents a serious threat to the economic, political and social interests of many individuals and many institutions (consumers, workers, firms, artisans, professionals) which are therefore organised to seek, in various ways, at times even using violence, to impede it.

Schumpeter (1934), for example, considered social resistance to change one of the greatest difficulties encountered by entrepreneurs in introducing new combinations of means of production. Such resistance, noted Schumpeter, essentially consists in the existence of legal or political impediments and is expressed by groups threatened by the innovation. Simon Kuznets (1972, p. 446) was even more explicit: "there may be, and there have been cases where the resistance [to the competitive and destructive effects of technological innovations] was so great, and the price of overcoming it so high, that economic growth did not proceed at an adequate pace"[1]. However, the author who perhaps most decisively underlined the checking effect that interest groups may have on the process of technological innovation and growth was Mancur Olson (1982, p. 63), according to whom, "distributional coalitions slow down a society's capacity to adopt new technologies and to reallocate resources in response to changing conditions, and thereby reduce the rate of economic growth".

Despite these early advances, only recently has economic growth theory introduced social resistance to innovation on the part of interest groups into its models and analytical schemes. In this new strand of literature the type of barrier which is usually examined is that involving opposing to new

[1] See also Kuznets (1968; 1972a).

technologies already conceived and employed elsewhere[2]. Economic intuition is straightforward and in line with the less formal arguments proposed in the past: market regulation and the monopoly rights enjoyed by employees and firms operating in existing industries make it very costly for other firms to enter the industry and discourage adoption of more productive technologies. The reasons for such regulation and protective strength lie in the political power enjoyed by those who operate with the old technology (Acemoglu and Robinson, 2000) and in their electoral influence (Adamopoulus, 2001; Aghion and Howitt, 1998; Bellettini and Ottaviano, 1999; Krussell and Rios-Rull, 1996). However, they may also be the consequence of cumulative economic delay which has limited the number of existing firms and favoured the development of vested interests of those offering their services to the firms in question (Parente and Prescott, 1999; Parente, 2000). Whatever the reason, the conclusion seems to be invariably the same: every form of social and political inertia which is created in the economic system when new technologies are being adopted reduces social welfare and makes the countries affected relatively less affluent compared with those which are free from technology adoption barriers, reducing the level of steady-state per capita income and possibly the growth rate.

Is such a drastic conclusion acceptable? To what extent have formal organisations of special interests been able in history to block the introduction of innovation? Though their ability to slow down technological change is acknowledged, can we say for sure that the

[2] This strand of literature, started by the works of Parente and Prescott (1994) and Krussell and Rios-Rull (1996), was then developed in various directions by Acemoglu and Robinson (2000, 2001), Adamopoulus (2001), Hansen and Prescott (1998), Ngai (2000), Parente (2000), Parente and Prescott (1999a, 2000), and Prescott (1998). Another chiefly empirical line of research, however, focuses on the effects that interest groups and policy distorsions may have, modifying the relative price of investments, on the process of capital accumulation (Mankiw et al. 1992; Easterly, 1993; Jones, 1994;

institutions and social forces opposed to innovation have always been a negative factor for social welfare and a barrier to economic growth?

Of course, in order to attempt to question the conclusions of a model, we need to question the assumptions underpinning it. The recent economics literature on social barriers to technological change is based on two crucial assumptions: (a) introducing innovations does not generate negative externalities in the economic system; (b) adopting new technologies does not require firm-specific investments. We are obviously dealing with two considerable simplifications of reality which, if taken on their own, would be no greater than those that all economic theories are forced to introduce in their analytical schemes. The point is that the existence of negative externalities and the presence of firm-specific investments are precisely those elements which may justify, in terms of economic efficiency, the presence of institutions to safeguard special interests and the existence of social barriers to innovation. Thus, in the presence of negative externalities and firm-specific investments, the action of institutions to protect vested interests may favour the growth process or at least bring it close to its socially optimal level.

In the next section we will briefly review the experience of medieval craft guilds. From the 12th century onwards, for the subsequent six or seven centuries, the craft guilds were, throughout Europe, formal organisations to protect widespread vested interests, invested with great social and political power. As will be seen, the conclusions reached by economic historians concerning their influence on the economic life of the period and on technological development are highly ambivalent and underline the various factors that may have turned guilds into welfare and growth enhancing organisations.

Chari et al. 1996; McGrattan and Schmitz, 1998; Restuccia and Urrutia, 2000; Restuccia, 2001).

In the following two sections, we will present a model of endogenous growth with successive non-overlapping generations, in which we introduce the existence of social inertia to development and the adoption of new technologies similar to those represented by medieval craft guilds. As in the Romer model (1990), we assume that the only final good of the economy is produced with the use of a certain number of intermediate goods. Each of these goods, in turn, is produced by a monopolist with the use of labour alone (Aghion and Howitt, 1992). Besides the monopolistic rents, the producer of the intermediate good enjoys a certain social prestige and political power. The former is intentionally accumulated by an institutions operating on behalf of monopolists and is, in part, also transferred to those working in the intermediate goods sector. For a given amount of social lobbying effort, however, social prestige tends to diminish as the number of firms operating in the intermediate goods sector increases.

Political power is instead used by incumbent firms to block the entry of new firms and new intermediate goods. To start up new firms, new intermediate goods need to be introduced, which requires firm-specific investments. Once the new goods are designed, the barriers set by the incumbents still have to be overcome. Therefore, incumbents and entrants play a rent-seeking game at the end of which the number of intermediate goods produced in the subsequent period is determined.

The economic intuition of our model is therefore typical of neo-Schumpeterian literature. The monopoly power enjoyed by firms that manage to design and introduce new goods is the stimulus to innovation without which the economy does not grow. The difference lies in the fact that in our model, monopolists benefit not only from monopoly rents but also from a certain social prestige which nevertheless tends to diminish with the increase in the number of firms supplying that type of good. Hence the ambivalent effect of social inertia: what drivers monopolists to block

entry, namely the lessening of social prestige, is also what encourages potential entrants to employ resources in designing new goods and what makes the economy grow[3].

2. The craft guilds in medieval Europe

The best known and most widely studied example of institutions established to protect vested interests is undoubtedly that of occupational (merchant and craft) guilds of medieval Europe[4]. The system of guilds developed in Italy in the 12th and 13th centuries, and rapidly spread throughout Europe. The guilds were formal associations, established on a voluntary basis, with the aim of regulating how a trademight be performed, both by fixing quality standards and sale prices for goods and services, and to explicitly regulate how production should be organised and the terms of entry to a profession. Their powers of control were often established by law; in exchange, the guilds were called upon to pay taxes or royalties (Pirenne, 1933).

However, besides regulating the economic life of the period, the guilds were also firmly established social and political institutions. Each member enjoyed not only economic protection as regards income level, continuity and the independence of his own work. Belonging to a guild meant acquiring a distinct moral identity and important social prestige (Black, 1984, p. 14). The profound solidarity that bound the members of a guild was due both to religious and social incentives and to ties of kinship (fostered, for example, by the many marriages that united guild members) perhaps to a greater extent than to mere economic incentives (Thrupp, 1963, pp. 238-9; Black, pp. 12-3).

[3] Without undertaking any welfare analysis, our model actually removes only the second assumption which is typical of technology adoption models with social barriers, namely the absence of firm-specific investments. For a model that analyses the role of institutions in the presence of negative externalities tied to the introduction of innovations, see Carillo and Zazzaro (2000).

In time the guilds began to acquire considerable political weight as well, generating "a distinct group of administrators who cultivated political skill" (Thrupp, 1963, p. 238). Although always considered private associations, the guilds took an extremely active part in the work of city administration and their officers were often considered "as quasi-public officials" (Thrupp, 1963, p. 232). It was not rare for their more distinguished members to assume public office (Simonde de Sismondi, 1827). Indeed, the guilds actively and rationally cultivated their political power and social prestige, undertaking social relations activities (Thrupp, 1963, p. 249).

Associations of this type were common even before the emergence of craft guilds. A prime example consists in the *collegia* of the Roman period, even if their aims were chiefly non-economic, concerning the handing-down of the profession rather than its protection (Pirenne, 1933; Finley, 1973; Hickson and Thompson, 1991). Above all, associations comparable with guilds are commonly found today in the form of professional orders, thus making the study of the experience of medieval craft guilds also relevant to contemporary economies[5].

A major part of historical reconstruction, and probably the most authoritative, seems unanimous that medieval craft guilds on the whole had a negative effect on the economic prosperity of the regions into which they spread. The traditional economic interpretation supplied by historians considers craft guilds as monopoly institutions which with their statutes on apprenticeship and with their constraints on the organisation of workshops and labour (such as the maximum number of apprentices per master, the ban on employing workers registered with other guilds, the prohibition on adopting certain production methods or introducing certain types of

[4] For a detailed review, see Thrupp (1963), Black (1984).
[5] In a companion paper we have analysed the process of professionalisation and the role of professional orders in economic growth (Carillo and Zazzaro, 2002).

production) limited competition, thereby seriously reducing citizen welfare, but being especially detrimental to the entrepreneurial spirit of local populations. According to Carlo Cipolla (1952, 1970), for example, one of the elements found in all episodes of stagnation and economic decline between the 16th and 18th century affecting first Spain and then Italy and lastly the Netherlands is the strong mental and social resistance to change on the part of such populations, resistance that was created and stimulated by the system of guilds. In Italy, noted Cipolla (1952, p. 183), "the excessive powers of the obsolete guilds and of the old corporative legislation compelled […] industry to adhere to antiquated and out-of-date methods in business and production"[6]. Cipolla (1952, 1959) reports various enlightening examples of obstacles placed in labour organisation on the part of guilds, such as that of a Genoese silk spinner, Paolo de Simone, who in 1570 was prevented by the dyers' guild, with the support of the city administration, from employing a dyer in his own workshop lest this might open the way to the proletarianization of dyers. Then there is the case of the *Collegio Lanificio* in Venice who, faced with the ban by local guilds of manufacturing woollen clothes according to the new English or Dutch style, which had rapidly supplanted local manufactures on retail markets, was forced to formally request that the masters be left free to produce the types of clothes that they felt most appropriate with production methods which they deemed best.

By contrast, according to other authors, the elimination of the privileges of the artisan guilds, the removal of their political power and more permissive laws favouring individual initiative are the factors that contributed to the rapid development of the Netherlands in the 17th century

[6] Other strongly-held opinions on the negative effect that the guilds had on economic growth in Medieval Europe are expressed, amongst others, in Hobsbawm (1971), Pirenne (1933), Postan (1972), and Cipolla (1989).

and the Industrial Revolution in England in the following century[7]. According to David Landes (1969), for example, the fact that in England the control of the guilds over production and apprenticeship had already been largely dissolved by the end of the 17th century is one of the most convincing reasons as to why the Industrial Revolution started up precisely in England. Unlike in other European countries, notes Mokyr again (1990, p. 241) "the British government was by and large unsupportive of reactionary forces that tried to slow down the Industrial Revolution"[8].

Despite the authoritativeness of the hostile opinions expressed vis-à-vis medieval craft guilds, the historical evidence is far less clear and unambiguous than one might be led to believe. There are various examples, such as Portugal and Spain in the 15th and 16th centuries, Denmark and Sweden in the 17th and 18th centuries, of rapid increases in growth following the strengthening of the power of guilds in their favour (Kellenbenz, 1963; Hickson and Thompson, 1991). Besides, as noted by Hickson and Thompson (1988) and Epstein (1998), if craft guilds were definitely opposed to economic prosperity and growth, why would it have had so many imitators and spread so rapidly throughout Europe?

In actual fact, there are various reasons for believing that craft guilds did not only constitute a check on economic growth. First of all, the guilds had never had the power to completely block the process of innovation, which had always developed in country areas outside the walls of cities, where their statutes did not apply (Simonde de Sismondi, 1827; Thrupp, 1963). Clearly, the innovators could be refused the status of guild member.

[7] This positive link between the constraints on the powers of guilds and economic prosperity has been underlined, amongst others, by Landes (1969), Mokyr (1990; 1993; 1994), Rosenberg and Birdzell (1988), Van der Wee (1977).

[8] " […] the rights of individuals to use their personal efforts and property in trade and manufacturing without having to answer to their competitors – Rosenberg and Birdzell (1986, p. 31) write – became embedded in English law. By the late eighteenth century, when the introduction of the factory system seriously disrupted some types of earlier handicraft production, there was rarely any way to prevent innovation except by force".

This prevented them from enjoying prestige and considerable social and political benefits which were tied to membership of a guild (Black, 1984; Thrupp, 1963), but did not prevent them from undertaking that particular occupation (Pirenne, 1933). However, often, as in the city of London, there was the opportunity for new entrants to appeal to the city council: by demonstrating their skill in the profession, their application to join a guild might be successful (Hickson and Thompson, 1991). Thus, the ability of guilds to block the entry of new masters or journeymen could not be carried out across the board but had to be negotiated on each occasion with the political authorities.

Secondly, the existence of guilds was a device, in some ways rationally designed but in others only hit upon by chance, to reduce transaction costs and internalise both positive and negative externalities. The guilds, for example, undertook the important task of preventing undue expropriation on the part of bureaucrats with little respect for the laws in force (Hickson and Thompson, 1988; Greif *et al.* 1994), transferring the reputation of the whole tradeto products and masters who were not well-known outside domestic markets (Persson, 1988) and facilitating access to credit (Pfister, 1998). However, the guilds and the rights to restrict access to the profession, were also a means of efficiently internalising the positive externalities related to defensive expenditure to protect cities and the accumulated physical capital (Thrupp, 1963; Thompson, 1974, 1979; Hickson and Thompson, 1991) and negative externalities regarding the destruction of human skills caused by technological advances (Epstein, 1998). Moreover, by lengthening the times required by apprentices to reach a stable position, the constraints imposed by guilds had the effect of limiting births and thereby making the spectre of Malthusian traps more remote (Simonde de Sismondi, 1827).

Thirdly, concerning innovation policies, the attitude of guilds was not always suffocating. Although the guilds system may well not have acted as a stimulus to the entrepreneurial spirit, undoubtedly, as Sylvia Thrupp also recalls (1963, p. 279), the external conditions of the age generally made caution necessary and also "entrepreneurs who stood outside [guilds] ranks made no better showing". "It would be an error – writes Thrupp (1963, p. 231) – to identify medieval guilds solely with so desperate a conservatism. Their policies could move also in opposite directions, open to innovation and favouring the masters who had capital".

For example, the guilds system, by driving artisans' workshops to crowd within fairly restricted areas, favoured the creation and diffusion of technological externalities (Poni, 1990; Epstein, 1998). Furthermore, by closely defining the activities that each occupation could undertake, the system favoured specialisation in production, the division of labour and technological progress (Epstein, 1998). Lastly, the same struggles to slow down innovation and protect the masters of the trade which the guilds so often waged, managed to act as a stimulus for those who intended to develop a new product or a new production method. In other words, in medieval times the guilds and their regulations, as regards innovation, played a very similar role to that played by patents today[9].

It is precisely this ambiguity of the effects that social inertia had with regard to technological innovation that will be the focus of the next sections.

[9] "The most significant premodern incentive for invention – Epstein (1998, p. 704) writes - was thus the capacity to capture the rents provided by a technical secret; and the most effective source of these rents was the craft guilds".

3. The model

3.1. *An informal account*

A class of growth models that can be used to represent the ambiguous effects of social inertia on technological change comprises the monopolistically competitive models. The main building block of the model we present in this section is the variety-based model due to Romer (1990).

Unlike the Romer's model, in our model there is no capital accumulation and there is, instead, a succession of non-overlapping generations. Each generation, *j*, lives for two periods. At the beginning of the first period there is a constant number *N* of workers, each endowed with one indivisible unit of skilled-labour, and a variable amount of entrepreneurs-firms, each endowed with the technology and ability to organize production.

In the economy there are three productive sectors. A final-good sector, whose inputs consist of a variety of a unique specialised craft good; an intermediate craft-goods sector, whose inputs consist of skilled workers only; and a sector which designs and develops new varieties of the craft good, which also requires only the use of skilled workers.

All the entrepreneurs and workers who produce the intermediate input belong to a craft guild, the former with the qualification of master, the latter with that of apprentice.

In the first period of each generation *j* all productive sectors operate. The number of intermediate goods or workshops or masters (for the sake of simplicity, we assume that these quantities are exactly the same) coincides with the number existing at the end of the previous generation. Thus the idea is that each master at the end of his own life has a descendant to whom he is able, due also to the protection of the guild, to transfer his tacit knowledge and the technical secrets to carry out the trade.

Each craft workshop enjoys an absolute monopolistic power. This, we may imagine, is partly guaranteed by the tacit knowledge required to produce that particular variety of craft good and partly by the statute of the guild that prohibits its own members from imitating, even where it was technically possible, goods produced by other members. Apart from monopoly profits, masters also enjoy a certain social prestige which, in line with what was stated in the previous section, we imagine is intentionally boosted by the guild and which is extended, albeit to a lesser extent, to those who work there as apprentices.

Still in the first period, outside the guild, hence without enjoying the protection and social prestige that membership ensures, a certain number of individuals employed as journeymen work to design new products. However, the creation of a new product is not enough to ensure its actual production in the subsequent period. Moreover, it is also necessary to enter and become part of the guild. As with the increase in the number of masters operating in the guild its social prestige diminishes, the guild will attempt to block the opening of new workshops[10]. The entrants, for their part, will appeal to the local political authorities to force the guild to accept their entry, and between the two parties a rent-seeking game will take place where each will use their own lobbying power to influence the authorities' decision.

In each generation, in the second period only production of the consumption good and intermediate goods is undertaken, while there is no further research carried out. All those who worked as journeymen in the sector outside the guild offer their labour to workshops that produce

[10] Of course, the link between the crowding of the guild and social prestige may hardly be considered univocal. Initially, the prestige of the guild will be enhanced as the number of masters belonging to it increases. In this phase the guild would not operate as a factor of inertia to technological change, as it has no interest in blocking the opening of new workshops. Hence, the model may be understood as an analysis of the role of guilds once the initial development phase is past.

intermediate goods, which thus in the second period, in equilibrium, absorb all the labour force.

The number of workshops existing in the second period depends on the outcome of the rent-seeking game. If the competition is won by the guild, the number of the workshops remains unchanged and the innovations will be lost. Otherwise, the number of workshops will increase according to the number of new goods invented, as will the production of the final consumption good.

3.2. *The economy*

The economy consists of a continuum of individuals of measure N, which lives for two periods and is endowed with one indivisible unit of skilled-labour, the disutility of whose supply is nil. Any individual is characterized by the same linear intertemporal utility function which relates the flow of utility to the quantity of consumption and to the social prestige accruing from the job performed. The intertemporal preference rate, $r \geq 0$, is constant and, in equilibrium, coincides with the rate of interest at which firms collect savings.

The consumption good, which acts as numeraire, is produced in a perfectly competitive market according to the following production function:

$$Y_t^j = \int_0^{A_t^j} \left(x_{it}^j\right)^{\alpha} di; \qquad 0 < \alpha < 1 \quad (1)$$

where j indicates the generation, t the period of life and i the variety of craft goods employed in the production of the final good. A_t^j is the number of goods actually produced in the period t. In the first period the latter coincides with the number of intermediate goods produced by masters of generation j-1 in the second period of their life, and handed down to masters of generation j. In the second period if innovators are able to enter

the guild, the number of intermediate goods will increase; otherwise it will remain constant. In symbols:

$$A_1^j \bullet A_2^{j-1}$$

$$A_2^j \bullet \begin{cases} A_1^j & \text{if the guild impedes the entrance of new masters} \\ A_1^j - A^j & \text{otherwise} \end{cases}$$

Each variety of the craft good is produced by the same linear production function:

$$x_{it}^j \bullet n_{x_{it}}^j \qquad (2)$$

where $n_{x_{it}}^j$ denotes the number of apprentices involved in the production of the *i*-th craft-good in period *t* and generation *j*. Having assumed that each craft good has the same productivity in the production of the consumption good and their marginal productivity being independent of each other, in equilibrium all the workshops will always produce the same amount of output and will enjoy the same profits. This implies that hereafter we can omit the index *i* without ambiguity.

In the first period, a certain number of individuals are employed in an activity researching and developing new varieties of the craft-good whose production function is the following:

$$\Delta A^j \bullet \delta A_1^j n_{r_1}^j \qquad (3)$$

where $n_{r_1}^j$, is the number of workers employed as journeymen in the research, and δ is a productivity parameter.

As in Romer (1990), the productivity of research increases with the number of the intermediate goods already produced, giving rise to a positive externality which sustains the growth process. As equation (3) shows, the employment of a journeyman definitely gives rise to the production of δA_1^j new intermediate goods. Therefore, the introduction of new intermediate goods can be seen, following Romer, as a research

activity that produces new goods. Otherwise, it may be fairly interpreted as a process of adoption of a new technology that is incorporated in new goods and whose application requires firm-specific investments[11].

4. The craft guild

All the masters and apprentices who at a certain moment work in the intermediate craft-goods sector belong to a guild. The latter performs various functions on behalf of its members. In particular, apart from protecting the monopoly power of each workshop, the corporation regulates access of new masters to the guild and safeguards the image and social prestige of the profession. Clearly, these two activities are intimately bound and both require intense political and social lobbying. For the sake of analytical simplicity, however, we will deal with them separately, under the assumption that the political power and social power of the guild can be cultivated separately without the one affecting the other. Let us begin with social power.

4.1. *Social lobbying*

In the economic literature there are various contributions focusing on the demand for social status on the part of socially-minded individuals and the effects that this has on the performance of the economy in the presence of social ranking of professions (Fershtman and Weiss, 1996; Weiss and Fershtman, 1998). Nevertheless, in the literature in question, social ranking of occupations is generally considered an exogenous element on the basis of which individuals make their own choices. In reality, however, the social prestige of occupations is at least partly an endogenous variable,

[11] It is worth noting that Parente (2001) criticises the interpretative capacity of neo-schumpeterian growth models in that such models assume that each country is forced to produce innovations on its own behalf in order to introduce new products. In reality, what such models assume is only that the introduction of new products, whether it be

intentionally demanded by the formal organisations representing them, like the guilds of yesteryear and the professional orders of today (Larson, 1977).

Thus, let us imagine that the guild may play a role of social relations, with a view to enhancing the social prestige of the craft and its more distinguished members, the masters. The costs of this activity (measured in units of effort) are proportional to the organisational effort ℓ devoted to it. However, the benefits, besides depending increasingly on the guild's organisational effort, diminish with the increase in the number of masters belonging to it. As usual, the organisational effort of the guild in social lobbying will be such as to maximise the difference between benefits and costs:

$$\max_{\ell_t} \frac{S_m}{A_t} \ell_t^{\alpha} - c\ell_t \qquad (4)$$

where $0 < \alpha < 1$ indicates the productivity of the organisational effort, S_m / A_t its effectiveness at the margin and c its marginal cost (as each generation is identical to the other, to simplify the notation hereafter we omit the index *j*). The optimal lobbying effort is therefore:

$$\ell_t^* = \left(\frac{S_m}{cA_t} \right)^{\frac{1}{1-\alpha}} \qquad (5)$$

The social lobbying performed by the guild thus increases as its effectiveness increases (i.e. with the increase in S_m) and as its costs diminish. Nevertheless, as the guild expands (i.e. A_t increases) the organisational effort to social relations is reduced, in that its effectiveness is reduced. Finally, an increase in social lobbying productivity has a

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the result of original innovation or only the adoption of technology already existing in other countries, requires firm-specific investments.

positive effect, but only until the number of guild members becomes excessive[12].

In equilibrium, the social prestige accruing to masters is $SP_m \bullet \frac{S_m}{A_t} \ell_t^*$. However, the social prestige of the craft, which the guild maximises in consideration of the masters' prestige, is also partly transferred to apprentices:

$$SP_a \bullet \frac{S_a}{A_t} \ell_t^* \qquad (6)$$

where SP_a is the social prestige of the apprentices and $S_a/A_t < S_m/A_t$ the effectiveness for them of social lobbying undertaken by the guild. Therefore, the level of social stratification within the craft (SP_m/SP_a), does not depend on the optimal social lobbying effort of the guild but only on the ratio between its effectiveness for masters and apprentices (S_m/S_a).

4.2. *Political lobbying*

Besides being engaged in social lobbying, the guild is also committed to political lobbying with a view to regulating the entry of new masters within the profession. As in our model the entry of new masters has no positive effect on the incumbents, in each generation the aim of the guild will be to block new entrants. This will be opposed by those who have devised new varieties of the craft-good. As already stated, in order to supply the product they have created the latter must first become members of the guild. In light of the certain refusal they will encounter, the entrant masters cannot but appeal to the political authorities so as to force the guild to accept them as members.

[12] Formally, $\partial \ell_t^* / \partial \quad 0 \quad \log \frac{S_m}{cA_t} \quad \frac{1}{\quad^2}$.

This situation can be formalized as a rent-seeking game, where innovators and the guild compete to gain the favour of politicians and administrators by devoting resources to lobbying[13]. For analytical simplicity, let us assume that also the potential masters act as a single agent or, which amounts to the same thing, that the acceptance or exclusion of a new master on the part of the guild is extended to all those who designed new products in that generation. The guild and entrants thus act so as to maximise respectively the benefits of all incumbent masters and all potential masters. The cost of political lobbying is proportional to the effort made and the number of incumbents or entrants.

Let e_r and e_x stand for the resources, in terms of effort, devoted to political lobbying by the entrant masters and the guild. The probabilities of success of the two groups assume the traditional logit form introduced by Tullock (1980), but are not perfectly symmetric. More precisely, let us assume that political lobbying is a constant return activity in the effort of lobbying groups, but that the marginal productivity of the effort is not the same[14]. Hence it follows that the probability that new masters enter the guild and the probability that the guild impedes this entrance are respectively:

$$q \bullet \frac{e_r}{e_r + \theta e_x} \qquad (7)$$

$$(1 - q) \bullet \frac{\theta e_x}{e_r + \theta e_x} \qquad (8)$$

where θ denotes the relative ability of the guild to undertake political lobbying.

The pay-off functions are:

[13] Since Tullock's (1980) study, a large body of literature has developed on rent-seeking games. For a recent survey see Nitzan (1994).
[14] This particular form of the success function has been used by Baik (1994).

$$u_x = \frac{\gamma e_x}{\gamma e_x + e_r} A_1 V_{x_2}^{A_1} + \frac{e_r}{\gamma e_x + e_r} A_1 V_{x_2}^{A_1+A} - A_1 e_x \qquad (9)$$

and:

$$u_r = \frac{e_r}{\gamma e_x + e_r} AV_{x_2}^{A_1+A} - Ae_r \qquad (10)$$

where A_1 and A are respectively the number of incumbent and of entrant masters, $V_{x_2}^{A_1}$ and $V_{x_2}^{A_1+A}$ the per-master value of conducting a craft workshop in the case in which entry is refused and in the case in which it is accepted.

Since the guild has already established political relations in the past its contractual bargaining and lobbying capacity is greater than that of the entrant masters. Formally we express this situation by hypothesising that the marginal productivity of lobbying is greater for the guild (i.e. $\gamma \geq 1$) and by assuming that the rent-seeking game is sequential, that is that the guild has the first-mover advantage and constrains the innovators to respond to its action[15].

Given the pay-off functions, the reaction function of the entrant masters group is:

$$e_r^* = \sqrt{\gamma e_x V_{x_2}^{A_1+A}} - e_x \qquad (11)$$

while the level of effort which maximises the guild's pay-off function is:

$$e_x^* = \frac{\gamma V_{x_2}^{A_1} - V_{x_2}^{A_1+A}}{4V_{x_2}^{A_1+A}} \qquad (12)$$

Proposition 1. *The rent-seeking game has a unique equilibrium in pure strategies if and only if* $V_{x_2}^{A_1+A} \geq \frac{\gamma V_{x_2}^{A_1}}{2+\gamma}$. *In this case the lobbying effort exerted by the guild increases, and the probability that the new masters*

[15] For treatment of the rent-seeking game in a model à la Stackelberg, see Dixit (1987) and Perez-Castrillo and Verdier (1992).

enter the intermediate craft-good market decreases, as the difference between the values of being masters before and after the entrance of new masters and the lobbying capacity of the guild increase.

Proof: On substituting (12) in (11) it is evident that if $V_{x_2}^{A_1 - A} \leq \frac{-V_{x_2}^{A_1}}{2}$ then $e_r^* = 0$. In this case, it would also be optimal for the craft guild not to devote effort to lobbying, thus making $e_r^* = 0$ a non-optimal response (and so on). Moreover, substituting (12) and (11) in (7) we have the result that the probability of the new masters managing to enter the guild and offering new products is:

$$q^* = 1 - \frac{-\left(V_{x_2}^{A_1} - V_{x_2}^{A_1 - A}\right)}{2V_{x_2}^{A_1 - A}} \qquad (13).$$

Therefore, the larger the difference between the values of being masters, and the stronger the political power of the guild, the fewer the resources that the innovators will invest in lobbying, and the lower the probability that they obtain entry into the intermediate craft-good market. In such cases there would be considerable social barriers to innovation and the benefits of innovation would thus be very low, trapping the economy in an equilibrium of very low growth (if any).

5. The equilibrium

In symmetrical equilibrium, the demand functions of the different varieties of craft goods are identical and may be calculated starting from the profit maximisation of firms producing the final commodity. In particular, recalling from (1) that the final good acts as numeraire, the inverse demand function for any craft good is:

$$p_{x_t} = x_t^{-1} \tag{14}$$

In turn, the masters who operate in the craft good sector choose the number of apprentices to employ, maximising their profits, $\pi_{x_t} = p_{x_t} x_t - w_{x_t} n_{x_t}$. Substituting equations (2) and (14) in the latter formula, in equilibrium the wages paid to apprentices are equal to:

$$w_{x_t} = \tfrac{1}{2} x_t^{-1} \tag{15}$$

and the masters' profits are:

$$\pi^*_{x_t} = \tfrac{1}{2} x_t \tag{16}$$

As stated above, however, the social benefits arising from belonging to the guild must be added to the economic benefits. In particular, let us assume that social prestige is a multiplicative variable of salaries and profits. In equilibrium, therefore, taking due account of the optimal social lobbying effort conducted by the guild (see equation (5)), the total benefits apprentices and masters receive in each period of their lives are respectively:

$$U_{x_t} = \left(\frac{S_a}{A_t}\right)^{\frac{1}{1-\alpha}} \tfrac{1}{2} x_t^{-1} \tag{17}$$

$$V_{x_t} = \left(\frac{S_m}{A_t}\right)^{\frac{1}{1-\alpha}} \tfrac{1}{2} x_t \tag{18}$$

The expected benefits of research are the total benefits that the researchers can secure by producing in the second period the new goods invented multiplied by the probability of gaining access to the guild. Therefore, assuming free entry to the research sector, and taking into account equation (3), in equilibrium the wage paid to the journeymen employed in this sector is:

$$w_r = q^* A_1 + \frac{V_{x_2}^{A-A}}{1+r} \tag{19}$$

The labour market is in equilibrium when all individuals find employment. In the first period, the research sector is also active and the number of intermediate craft goods is that inherited from the past generation, the labour market equilibrium is given by the following expression: $N = n_r + A_1 \bar{x}_1$. In the second period, the research sector is no longer active and all the workers find employment in the intermediate sector. Therefore, if innovators win the rent-seeking game and enter the guild the equilibrium condition is $N = A_1 + A \bar{x}_2$. On the contrary, if the guild manages to block the entry of new masters, the equilibrium is $N = A_1 \bar{x}_2$.

Finally, as in the second period all the workers are employed in the craft sector, in the first period, in equilibrium, the utility deriving from employment as apprentice or journeyman in the two sectors must be the same. That is:

$$w_r = \frac{S_a + S_m}{A_1 + cA_1} \sqrt{1 + 2x_t + 1} \qquad (20)$$

6. The pace of technological change and long-run growth

In our economy, the growth in the production of the final good from one generation to another is related to the number of new intermediate goods which are introduced on the market. As stated above, this depends on the resources employed in research, conditional upon the fact that innovators manage to win the rent-seeking competition and gain access to the guild.

The equilibrium equation of the research sector together with the equilibrium conditions of the labour market allow us to determine the number of workers who in each generation in equilibrium will be employed in the research sector.

Therefore, substituting equation (18) in equation (13) and then the latter and equation (20) in equation (19), we obtain the optimal number of

workers who, in equilibrium in each generation, are employed as journeymen in research:

$$S_a (N - n_r^*) \geq \frac{(S_m - 1)(N - n_r^*)}{2} \left[\frac{2}{1 + (1 - n_r^*)^{\frac{1}{2}}} \right] \qquad (21)$$

As may be easily verified, the marginal costs of research (the expression on the left hand side of equation (21)), increases with n_r, while the marginal benefits (the right hand side) decrease with it. Thus, if in $n_r = 0$ $LHS_{21} > RHS_{21}$ holds, the number of workers employed in research is that determined by condition (21). Otherwise, $n_r^* = 0$ and the economy remains trapped in an equilibrium without growth.

As regards the effects of social inertia on the pace of technological change, straightforward exercises in comparative statics allow us to reach the following proposition:

Proposition 2. *An increase in social stratification within the craft (i.e. an increase in S_m and a decrease in S_a) weakly increases the resources employed in research and favours technological change. An increase in the productivity of social lobbying of the guild and an increase in its political lobbying capacity (i.e. an increase in and in) reduce the probability of entering the guild and, consequently, reduce the resources employed in research and slow the pace of technological change.*

Proof. It follows trivially from (21).

As mentioned previously, the effects of social inertia on the rate of an economy's technological progress are ambiguous. The presence of social barriers acts as a check to innovation insofar as it reduces, for those involved, the probability of succeeding in gaining its benefits and increase

its costs. Indeed, the social prestige accruing to those who find employment within the guild as apprentices, drives up the wages of journeymen in the research sector. On the other hand, for those who manage to overcome obstacles placed by those who have an interest in maintaining the status quo, social barriers increase the performance of innovation precisely because they ensure high social prestige and reduce the probability that in the future other individuals may introduce further innovation.

Naturally, more intense research increases the ex-post rate of growth of the economy. However, ex-ante an increase in n_r^* reduces the probability of innovations being actually introduced; in other words it reduces the probability of innovators winning the rent-seeking competition and makes the effect on expected growth rate ambiguous.

Formally, the growth rate expected between one generation and the next is given by:

$$E(g_Y) \bullet q^* \frac{Y_2^j - Y_2^{j-1}}{Y_2^{j-1}} \tag{22}$$

In symmetrical equilibrium, in each period, and in each generation, production of the final commodity is $Y_t^j \bullet A_t^j \bar{x}_t^j$. Substituting this expression and equations (13) and (19) in (22), then:

$$E(g_Y) \bullet \frac{1}{2}\left[2 - (1+n_r^*)^{\frac{1}{1-\alpha}} + (1+n_r^*)^{1-\alpha} - 1\right] \tag{23}$$

Proposition 3. *Sufficient condition for an increase in resources employed to bring about an increase in the expected growth rate of the economy is* $(1+n_r^*)^{1-\alpha} < \frac{2-\alpha}{1-\alpha}$.

Proof. The proposition can be straightforwardly verified by differentiating equation (23) with respect to n_r^*, and conducting some tedious algebraic manipulations.

In other words, in economies in which the productivity of innovation is so low or in which the social barriers to innovation are so high as to make n_r^* very small, the relative benefits that the craft-guild would obtain from blocking the entry of new masters may be particularly high. In such cases, the beneficial effect on growth of any stimulus to innovation whatsoever would be ex-ante more than compensated by a reduction in the probability of actually managing to introduce innovations into the economy. In all other cases, however, the stimuli for innovation increase, both ex-ante and ex-post, the growth rate of the economy.

7. Conclusions

Processes of technological innovation, whether involving the adoption of existing technology or the creation of new products or production methods, call into question many vested interests. The introduction of such innovation thus has to overcome social inertia and institutional barriers set by those who have such interests at stake. These factors, in some ways, will reduce the resources that a society devotes to innovation. However, the same inertia and social barriers end up ensuring protection for those who undertake the innovative process today, who will be able to reap the benefits of such protection tomorrow.

According to recent historical reconstructions, mechanisms of this type were also created in medieval times, when industry and the economy were strictly controlled by craft guilds. In this paper, starting from a description of the experience of medieval craft guilds, we presented a simple variety-based model of endogenous growth in which we assume that an institution

(the craft guild) which represents the interests of the existing industrial élite (the masters) undertakes social and political lobbying to enhance its prestige and prevent the entry of new firms. The main result that we obtain is the ambiguity of the effects of social barriers on technological change. The greater the guild's capacity of social and political lobbying the fewer the resources committed to research. By contrast, however, the more effective is social lobbying and the greater the social stratification created by it, the greater is the expected rewards from research and the resources devoted to it.

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