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The Case for the Virtual Strike
An Appraisal of the Italian Proposal

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Abstract - In this paper we outline the economic rationale behind the virtual strike, and workers' incentives to use this bargaining solution rather than resorting to standard strike action. We show that, from a welfare perspective, a virtual strike always dominates a standard strike and it would be most needed precisely when workers have weaker incentives to adopt it.
We then discuss the pros and cons of legally regulating the virtual strike rather than leaving it to self-regulation. Finally, we apply our findings to the analysis of Italy's draft legislation on virtual strikes.

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1 Introduction[1]

All modern democratic societies recognize the strike as a fundamental right (Bercusson, 2007; Davies, 2006; Warneck, 2007; Ewing, 1991). Economists, legal scholars, and policy makers have long debated the economic rationale of strikes. Strikes have been depicted as a puzzling negative-sum game, since workers lose their wages and the employer loses its profits (the so-called "Hicks paradox"). In some cases, as for strikes in public services, the damage of a strike to third parties turns out to be much greater than the amount the managers were looking to save. Society as a whole may also suffer from a strike, at least when short-term substitution by final customers is essentially inhibited. The puzzle concerns the dual nature of strikes: on the one hand they appear to be a wasteful outcome produced by the failure of a previous bargaining process (See Hicks, 1932). On the other hand, parties use strikes as a tool to initiate and shape new bargaining, learn and reveal information (Kuhn and Gu, 1999), build reputations, and design new organizational and technological combinations within the production process.

This complexity explains the richness and scope of the economic models designed to analyze and measure strike activity[2]. Accordingly, the nature and extent of the strike, i.e. the union's ability to coordinate a strike at the sector level (Cheung and Davidson, 1991), as well as the monopolistic or oligopolies structure of the market where the firms operate (Clark, 1996), seem to be crucial in shaping the likelihood, probability of success, and duration of a strike. Over the years, several alternatives to the standard (or stoppage) strike have been proposed and even successfully tested on a voluntary basis. However, these are still limited to exceptional cases. This paper analyzes the so-called virtual or nonstoppage strike[3]. A virtual strike works as follows: "the workers keep working as usual and the firm keeps producing as usual, but neither side gets paid. Workers lose their wages and an employer loses its profits during a strike. So during a virtual strike the workers would work for nothing and the employer would give up its revenues. That money could go to Uncle Sam or a charity. Or the product could be free so that the revenues would be given to customers. Think of it. During a virtual strike there is no disruption to the rest of the economy. [...] Management and labor certainly feel the pain and thus have an

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[2]See Kennan (1986); Kennan and Wilson (1989); Card (1990); Hebdon and Stern (1998) for a survey.

[3]For the sake of consistency, we will refer hereafter to the virtual strike although the same concept is also known in the literature as non-stoppage strike. See Bernstein (1971) and the literature cited therein.

incentive to settle, but the government or charities or customers get a windfall" (Ayres and Nalebuff, 2002). In a nutshell, under a virtual strike managers and workers continue the bargaining activity without creating negative externalities on third parties, while privately suffering from the strike in terms of lost earnings and effort spent.

One of the first attempts to outline this kind of strike dates to Bernstein (1971), who focused on strike activity in public services: the "employee union would be free to declare a non-stoppage strike after all other bargaining procedures failed to produce a settlement. Employees would be obliged to continue to work full time but would forgo a portion of their take-home pay. [...] This money would be paid by [...] the employer directly into a special fund [...]. In addition to paying the equivalent of regular wages, the employer would also put into the fund an extra amount equal to what the employees have given up; this latter sum would constitute a loss to the employer. The union would have the option periodically to increase the amount of the foregone wages and employer payment."

Ayres and Nalebuff (2002) report several cases of successful, self-regulated virtual strikes. These include the US Navy's virtual strike to settle a labor dispute at the Jenkins Brothers valve plant in Bridgeport, Connecticut; the virtual strike arrangement used in a 1960 Miami bus strike; and the 1999 Meridiana Airline strike in Italy, in which employees worked as usual without receiving their wages, while the company donated the revenues raised during the virtual strike to charities. In 2000, again in Italy, the Transport Union forfeited $50,000 from a virtual strike carried out by 300 of its pilots. As Ayres and Nalebuff (2002) pointed out, "the virtual pilots' strike provided a public relations opportunity, since the strike payments were used to buy a fancy medical device for a children's hospital. Instead of destroying consumer demand as in the NBA lockout, the virtual strike windfall provides an opportunity to increase the brand's reputation". All the cases above refer to virtual strikes adopted on a voluntary basis, following an *ad hoc* agreement between workers and employers. These examples show that in principle, the virtual strike does not need to be regulated by law. There is room for parties to arrange their bargaining through a virtual strike procedure. Two simple questions then arise: if virtual strikes are so beneficial and effective, why are they so infrequently implemented[4]? Which are the conditions under which parties maintain strong incentives to implement the virtual strike?

Before moving to the answers we propose, let us summarize some arguments that have been outlined by economic and legal scholars as major factors working

[4]A similar question is discussed in Basili, Innocenti and Nicita, who run an experiment on incentives to take virtual strike action (2009).

against widespread spontaneous and self-regulated adoption of a virtual strike.

(i) *The virtual strike may not be incentive-compatible.* For instance, in a virtual strike the workers do not earn their wages (as in a standard strike), but nevertheless they sustain a costly effort. Unless there are reputational gains from the virtual strike, it appears to be less convenient than the normal strike for workers.

(ii) *The virtual strike may be hindered by coordination failures.* In order to make the virtual strike workable, the parties must necessarily agree in advance on its rules and procedures. . Before the virtual strike takes place, parties must agree on transferring wages and part/all profits to the fund and maybe they have also to agree upon the activity of the fund. Conversely, standard strikes can always be called on the basis of existing rules, and where such rules do not exist, they can simply be called unilaterally;

(iii) *The virtual strike may be discouraged by the tax regime.* If the tax code does not exempt the workday on virtual strike from income tax, the worker paradoxically has to pay tax without receiving his salary. In order to confront the employer, the worker can choose between the virtual strike where he exerts effort, pays taxes and transfers his salary, and the normal strike where no effort is exerted, no salary is produced and therefore no tax is paid. It is quite clear that this third argument combined with the first one may give the virtual strike few attractions for the worker;

(iv) *The virtual strike may reduce social pressure on management to settle.* "Somewhat perversely, the public relations benefit of virtual strikes may make them harder to implement. Indeed, a strike is often designed to inconvenience consumers so that they put pressure on management to settle. Thus, asking an employer to forfeit its profits may not replicate the true costs of a traditional strike" (Ayres and Nalebuff, 2002)**;**

(v) *The virtual strike may work against the general interests of unions and employers' associations.* The virtual strike might undermine the political economy of trade unions (and employers' associations). Without doubt, the virtual strike alters the range of tools that have been used by trade unions and employers' associations to solve their opposing interests for more than a century. Although the virtual strike requires more coordination than the standard strike and could therefore help to strengthen the role of these organizations, if the virtual strike were to cool off labor relations it could also jeopardize the strength and control of these organizations vis-à-vis their constituencies.

In this paper we focus both on the incentive compatibility argument and on the role of social pressure to investigate the relationship between the probability of

success of a standard strike over a virtual one according to the extent of the negative externalities it generates on third parties, typically final consumers. We characterize the standard strike as a trigger strategy known as *penal code* in bargaining game theory (Abreu, 1988) Under our model, a standard stoppage strike is a credible threat in the context of a stick and carrot strategy under an indefinitely repeated game and joint losses act as an endogenous enforcement device. We then argue that workers' incentives towards standard strike *vis-à-vis* virtual strike depend on the nature, direction and dimension of the externalities generated by strike activity in the two cases. When the standard strike generates relevant *negative* and *unilateral* externalities on third parties, workers might prefer it to the virtual strike, due to the enforcement role played by social pressure on management. On the other hand, when externalities generated by the standard strike are reciprocal in nature, because a portion of the social costs generated falls back on the workers' future stream of wages and opportunities—for example through a decline in future consumption by shifting customers demand to employer's competitors—then the virtual strike might become a valuable alternative. In particular, we show one case in which the virtual strike always dominates the standard strike, increasing total welfare and solving a market failure, i.e. when reciprocal externalities are potentially so great to inhibit a standard strike in the first instance..

We conclude that, from a total welfare perspective, when the negative externalities generated by a standard strike are high enough, the virtual strike dominates the standard strike; however the virtual strike turns out to be unenforceable when the externalities are not reciprocal. The consequence is that workers have fewer incentives to implement the virtual strike exactly when it would be most needed. This is why relying on self-regulation might be suboptimal, while regulation that makes the virtual strike incentive compatible could achieve the desired outcome. We then investigate how imposing the virtual strike while banning the standard strike, as recently proposed by the Italian Government, would affect workers' incentive to choose efficient effort levels.

The paper proceeds as follows. In Section Two we recall some experiences of virtual strikes and outline the main features of the Italian proposed reforms on the virtual strike. In Section Three, we provide a model based on Putterman and Skillman (1992), which defines the standard strike as a 'penal code' trigger strategy in an ongoing relationship between management and the workers' union, showing how strike activity affects incentives to select optimal efforts. Section Four compares the standard and the virtual strike, under framework of bargaining with joint losses. Section Five concludes comparing, under the lens of our model, the pros and cons of the reforms under discussion in Italy.

2 Italy's proposed reforms to implement virtual strikes

For more than ten years, Italian labor law scholars have been discussing the virtues and weaknesses of the virtual strike. There are a number of academic papers dealing with various—mostly legal—aspects of the topic [5]. The virtual strike debate has been conducted by policy-oriented academics, the most prominent of whom, Marco Biagi, was killed in 2002 by terrorists who condemned his close involvement with the government effort to reform the labor market (meaning that the route from academic debate to practice could have been quite short). However, so far, the virtual strike has seldom been implemented by collective bargaining even though it has been promoted and publicized by the authority that oversees strikes in public service sectors (*Commissione Garanzia Scioperi*).

Until recently, in Italy there have been only four collective labor contracts envisaging in one way or another a form of virtual strike(del Consiglio dei Ministri, 2006). These concern: 1) health managers of the National Public Health service (September 25-26, 2001); 2) administrative staff of Bocconi University (March 23, 2001); 3) doctors in primary care, service medicine, continued assistance and emergency; and 4) helicopter pilots, especially those offering emergency services. Although the virtual strike is provided for in the collective agreements governing job relations in these sectors, to date no virtual strike has occurred.

More recently two major proposals on implementing virtual strike have been presented, respectively by the Italian Government and by the Opposition. On 29 February 2009, the Italian Government presented a proposal[6] aimed at regulating the right to strike in the public transportation sector.- Among other things, it requires the parties to negotiate the virtual strike in their collective contracts and mandates the adoption of the virtual strike, thus banning the normal strike, "for certain professional categories which, for the peculiarities of their job, will determine, in case of strike, the impossibility to provide an essential service". As such the governmental proposal is silent on the duties of the employer under a virtual strike and advances the idea that the virtual strike should be considered as a substitute rather than as a complement of the standard stoppage strike. The governmental proposal will be further detailed in the next months, also taking into account the ongoing debate in the Parliament

[5] See for instance Biagi (1997); Gianfrancesco (2001, 2005); Magnani (2004); Ayres and Nalebuff (2003); *L'evoluzione dello sciopero virtuale nei servizi pubblici essenziali* (2002); Prosperetti (2000)

[6] Disegno di legge per la regolamentazione e prevenzione dei conflitti collettivi di lavoro con riferimento alla libera circolazione delle persone, approved by the cabinet on February 29, 2009.

and the reaction of unions.

The governmental proposal will certainly face an alternative proposal raised, few months earlier, by some upper house representatives of the opposition parties guided by Pietro Ichino -a leading Italian labour law scholar. They presented a bill on virtual strikes to the Italian Parliament as a cross-party measure in order to promote its wider adoption (Senate Draft Law N. 1170, 30 October 2008). The first objective of the bill was to clearly define what a virtual strike is. This is important for the sake of coordinating others' efforts to support its use. The opposition's draft bill then offers a default agreement that parties can easily implement in their collective contracts without much further effort. Of course, non-default arrangements are still protected by the law if they satisfy some general conditions. According to the bill (Art.1), the virtual strike is a form of strike that, without any stoppage of work, generates the following results: (i) the participating worker will surrender the wages earned for the duration of the strike (net of any other accruals such as retirement benefits and severance pay); (ii) the employer will transfer, to a special fund, double the amount of the worker's wages (the default rule), or in any case the amount of wages multiplied by a factor $M > 1$ as specified by the parties in their collective agreement.

Moreover, according to the draft bill, virtual strike terms must be negotiated *ex ante* and included in the parties' collective agreement (Art.2). In the agreement, the parties must iron out details that could otherwise lead to coordination failures. Such details concern: (i) how workers can call a virtual strike and whether a virtual strike is effective even if called by a minority of workers and/or unions; (ii) the ways in which individual workers should communicate their participation in the virtual strike; (iii) the option to call a virtual strike in addition to or instead of a national or general strike. The parties must also agree *ex ante* how to allocate the funds collected (usually to charities and in part to the unions' information programs). Article 2 is thus designed to address potential coordination failures that may lead the parties to prefer a standard strike over a virtual one.

The draft bill also addresses potential problems arising from the management of the collective funds (Art.3). Although it allows broad discretion as to how these funds can be used, it sets rules for solving disputes over their allocation. This is to prevent different opinions from being used strategically to stall the virtual strike. Finally, Article 4 of the draft bill makes the worker's surrendered wages tax free unless the funds are used improperly or returned to the workers themselves. The goal there is to neutralize the adverse effect of income tax, which penalizes the worker on virtual strike (who actually works and is paid, although his wages are transferred to the fund) vis-à-vis the worker on a standard

strike, who does not work, does not earn income and is therefore not subject to income tax.

The two proposals are now on the table and will be discussed in the next months. Chances are that the governmental one will succeed, maybe absorbing some of the proposal contained in the opposition's proposal. To be sure, the two proposals are not close substitutes. The governmental proposal is limited to the public transportation sector while the Ichino proposal is general. The governmental one lacks a precise definition of what the virtual strike is intended to be and it is especially silent on the costs employers should face in case of virtual strike. Moreover it suggests that the virtual strike should entirely replace the normal strike (that thus should be banned) for some professional categories, which is the most important and crucial reform advanced by the Government. The Ichino proposal instead offers a better definition of the virtual strike and a default arrangement fir its adoption. Most importantly, the proposal argues that the virtual strike should only be considered as an additional tool that should not neglect the constitutionally protected right to standard strike and that the employers always need to pay $M > 1$ in case of virtual strike. As we will outline, these are two remarkable and fundamental differences. In the next sections we will analyze incentive-compatible mechanisms to induce bargaining parties to adopt the virtual strike and we will then discuss whether the Italian proposed bill satisfies our conditions.

3 A joint-cost model of strike under non-cooperative bargaining

In this section we formalize the standard strike as a "joint-cost" mechanism, followingKennan (1980) and Reder and Neumann (1980). The "joint-cost" theory of a strike action focuses on the incentive to settle a standard strike, once started, under the assumption that the likelihood of early settlement is positively correlated with the sum of the costs incurred by the two parties under a strike. The hypothesis is that the higher the joint costs of the strike—to the firm and to the employees—are, the lower are its likelihood and its expected duration. Here, we apply the joint-cost approach to the standard strike in a model of team production where two stylized parties, a manager and a union, bargain over a surplus generated by both parties' unobservable efforts.

We shape the ongoing contractual relationship as an indefinitely repeated game, while the strike activity is designed as a trigger strategy shaped as 'optimal penal codes'(Abreu, 1988; Putterman and Skillman, 1992). The notion of 'penal code'

has been defined by Abreu (1988) in game theory as a particular trigger strategy which implies that a deviation from the optimal path of cooperation (say a deviation from optimal efforts in our setting) at period t generates automatically a punishment (say the stoppage strike in our setting) at $t+1$ for t periods, after which cooperation resumes.

By modeling the standard strike as a deviation from optimal team production we highlight two key features to our analysis: (i) the insights of the joint-costs theory are captured, as both parties incur losses when deviation from cooperation occurs; and (ii) the role of the standard strike as an endogenous enforcement device is highlighted. In fact, when the threat of strike action is credible, it becomes an enforcement device that aligns *ex ante* parties' incentives and thus fosters cooperation.

In Section 3.1 we outline the main features of the model, based on the work of Putterman and Skillman (1992). In Section 3.2 we introduce the case of a negative externality generated by the strike on third parties. We distinguish between: i) the case where the negative externality imposed on third parties does not affect union's and manager's payoffs; and ii) the case where the externality produced by the strike fires back and detracts from parties' payoffs. In Section 3.3 we introduce the virtual strike and assess its impact. In Section 3.4 we compare, from the workers' point of view and from a total welfare perspective, the standard strike, the virtual strike, and a policy banning strikes.

3.1 Modelling the strike as a trigger strategy

Consider a team consisting of i agents, with $i = (1, 2)$ where Agent 1 is labeled "the manager" and Agent 2 is labeled "the union". Team production is given by $x = f(e_1, e_2)$, where $e_i \geq 0$ represents Agent i's unobservable effort[7]. For simplicity's sake, let us assume that both agents' utilities have the same functional form given by $U_i(y_i, e_i) = y_i - v_i(e_i)$ where y_i is i's compensation level, $v(e_i)$ is the disutility of effort[8] and $y_i = x/2$. Here we assume that manager and workers face the same utility and disutility from their efforts, even if they perform different tasks within the firm. This is actually a strong assumption which is introduced only to simplify the framework, but it does not affect our results. The contractual relationship between the two agents is shaped as a long-term repeated interaction, and the standard strike is defined as a temporary breach of cooperative agreement that follows any deviation. In order to derive the conditions for cooperation and strike, we first need to derive the equilibrium in the

[7]We assume $f_i > 0$, $f_{ii} < 0$, $f_{ii}f_{jj} - f_{ij}^2 > 0$ for all i, j= 1,2 $i \neq j$ where function subscripts represent partial derivatives, see Putterman and Skillman (1992).

[8]We assume $v^{i'} > 0, v^{i''} > 0$ for all $e_i \geq 0$

Table 1: The payoff matrix for workers' and managers' efforts.

		Workers (Union)			
		optimal effort	moral hazard	shirking	minimal effort
Manager	optimal effort	$e*, e*$	$e*, \hat{e}$	$e*, e^s$	$e*, e^m$
	moral hazard	$\hat{e}, e*$	$\hat{e}, \hat{e}$	$\hat{e}, e^s$	$\hat{e}, e^m$
	shirking	$e^s, e*$	$e^s, \hat{e}$	e^s, e^s	e^s, e^m
	minimal effort	$e^m, e*$	$e^m, \hat{e}$	e^m, e^s	e^m, e^m

one-shot game (Putterman and Skillman, 1992). The first best solution is given by the vector of optimal effort levels $e* = (e_1*, e_2*)$ which solves the following, for $i = 1, 2$ and $i \neq j$

$$max \left\{ f(e) - \sum_{\mathrm{i}} v_i(e_i) \right\}$$

thus, assuming an interior solution, $e*$ satisfies the two first order conditions $f_i(e*) = v'(e_i*)$ for $i = 1, 2$ and $i \neq j$. Now, let us define as $e^{\mathbf{N}}$ the positive Nash equilibrium effort vector[9]—assumed to be unique—and as U_N^i the utility corresponding to each agent i when choosing $e_i^{\mathbf{N}}$.

Lemma 1: In a one-shot game, individual effort is always suboptimal

In the one-shot game, $e*$ is not enforceable, since for each agent i*, given optimal effort by the other agent, there is always an effort level $\hat{e}_i < e*_i$, which assures a payoff higher than the cooperative one, with $\hat{U}^i > U*$.*

So far we have defined three possible choices of effort: first best (e_i*), moral hazard ($\hat{e}_i$) and Nash equilibrium (e^N). In addition, following Putterman and Skillman (1992) we can define a positive shirking level $e_i^S \leq e_I^N$, which leads to a utility level of $U_S^i = f(e^s)/2 - v(e_i^s)$ when adopted by both agents. Similarly we can define as e_i^m the optimal response to the other agent's shirking, with an associate utility $U_m^i > U_S^i$. In Table 1, best reply strategies are outlined. Only two Nash equilibria are possible there: $(e*, e*)$ and (e^m, e^m) .

Using the above definitions derived by Putterman and Skillman (1992), let us define the ongoing contractual agreement between the manager and the union as a repeated relationship with time periods indexed by $t = 0, 1, 2, ...$ The payoff for Agent i in case of cooperation (no strike) is given by the utility stream $V^i = \sum_{t=0}^{\infty} \delta_i^t U^i(y_{it}, e_{it})$, where $y_{it} = x_t/2$, δ is the discount factor assumed, to

[9]The value $e_i^{\mathbf{N}}$ solves the program $max_{e_i} \left\{ f(e_i, e_j^{\mathrm{N}})/2 - v(e_i) \right\}$ for $i = 1, 2$ and $i \neq j$.

be the same for both agents[10].

Let us borrow Abreu's(1988)notion of trigger strategy as a "penal code". In Abreu's terms, a *"simple* penal code is an n-vector of strategy profiles defined by an n-vector of punishments $(Q^1, ..., Q^n)$. The initial path of the $k-$th strategy profile is Q^k, and Q^i is imposed if player i deviates (singly) from any ongoing punishment Q^i." The definition of an optimal penal code then follows: "it is an n-vector of perfect strategy profiles, the $-i$-th strategy profile of which yields the i-th player at least as low a payoff as does any other perfect equilibrium". (1988) An optimal penal code enlightens the maximally effective trigger strategies consistent with the structure of the game. The strategy typically follows a *stick-and-carrot* structure: "a penalized player must first take the medicine of unpleasant outcomes before being allowed to return to more desirable conditions, such as a return to Pareto-efficient play" (Putterman and Skillman, 1992). Players are induced to participate in their own punishment for some time before returning to the desired cooperative outcomes, and if terms are violated again, the punishment will recommence and so on.

Modeling the strike as a penal code captures the idea of the joint-cost approach to strike activity. In fact, when the strike occurs, the parties reduce effort levels and thus are forced into a lower payoff stream than that associated with the optimal Nash equilibrium and this raises the potential for restarting cooperation towards optimal effort levels in the future.

Let us define the trigger strategy as follows: given an initial path of cooperation with optimal efforts $Q^\circ = \{(e*), (e*), (e*), ...\}$ parties will continue to cooperate unless any player deviates from optimal effort; when this occurs, i.e. when at any period t, production is such that $x_t < x*$, the optimal play reverts to $Q^1 = \{(e^s), (e^s), (e^s), ..., (e*), (e*), (e*), ...\}$. A strike is then defined by the number of period $\tau \in [0, \mathbb{R})$ after deviation in which agents play their shirking levels, $e^m \leq e_s < e*$, before reverting to optimal effort levels $e*$[11]. Notice that this strategy is credible because no one-period deviation from Q° or Q^1 is beneficial to the defector (See Abreu, 1988; Putterman and Skillman, 1992). We can now derive the relationship between strike and cooperation.

Proposition 1

For any given value of the discount factor, the longer the duration τ of a strike, the longer the cooperation induced by the trigger strategy Q^1.

[10] Of course manipulating discount factors between agents may affect parties' behavior under the assumption of common knowledge. For simplicity's sake we focus here, as Putterman and Skillman (1992), to the case of symmetrical discount factors.

[11] Here, for simplicity's sake we include within our definition of a 'strike' the manager's decision to shirk in order to punish workers' moral hazard.

The size of the joint costs incurred by the two parties (the manager and the union) will determine the duration of the strike which, in turn, will affect the extent of cooperation. Contrary to Hicks' original intuition then, Proposition 1 suggests that the credibility of a strike threat constitutes an endogenous enforcement device for team production.

3.2 Strikes with negative externalities on third parties

So far we have assumed that the costs of a strike are entirely private and suffered only by the two agents involved in the contractual relationship. However, a distinguishing feature of many of the strikes observed in reality is that they generate significant costs for third parties, typically customers. In this section we explicitly consider the case for negative externalities. In particular we distinguish two cases: (i) **unilateral externality:** the externality harms third parties but this harm does not backfire upon the agents on strike; (ii) **reciprocal externality**: the harm imposed on third parties backfires and agents on strike are damaged too. These costs add up to the ones we have already considered (the salary and effort).

3.2.1 Unilateral Externalities

Let us assume that a social cost equal to $E^\tau > 0$ is suffered by a third party (which we may think of as generically "the public") when a strike of duration τ occurs. When third parties do not affect agents' utility stream after τ, then *proposition 1* applies. Total welfare in each period t will be given by $[x* - \sum_i v^i(e_i*)]$ in the event of cooperation and by $[x(e^s) - \sum_i v^i(e_i^s) - E^\tau]$ in the event of a strike, for $i = 1, 2$. Externalities result in a welfare loss, and when they are large enough, i.e. when $[x(e^s) - \sum_i v^i(e_i^s)] < E^\tau$, the standard strike ends up with a net welfare loss. This is the case outlined by Ayres and Nalebuff (2002) where the stoppage strike is designed precisely to inconvenience consumers so that they put pressure on management to settle.

3.2.2 Reciprocal Externalities

When the externality is reciprocal to some extent it may have an impact on the parties' decision over strike duration τ. We will show that parties' incentives to strike strictly depends on the dimension of the externality and on the way it is shared between the employer and the union.

Let us assume first that the externality is fully reciprocal and symmetrically suffered by the employer and the union.

Lemma 2: The larger the fully reciprocal externality, the shorter τ

With a fully reciprocal externality, the dimension of the externality has a countervailing effect on the duration of strike τ: for any value of the discount factor, a lower strike duration may obtain the same enforcement level as in the case of a unilateral externality, and the same level of cooperation might be sustained with a lower level of strike activity.

An important consequence of Lemma 2 is that when an externality is internalized, the parties may reduce the strike activity while continuing to use the strike as an endogenous device to enforce cooperation. This result depends on the assumption that reciprocal externalities are equally shared between the agents. However, when only one party is forced to internalize the externality, the other party may register a decrease in her private costs of striking, compared with the case of a unilateral externality shown in Proposition 1, given that the strike threat generates the same enforcement effect with a comparative lower strike's duration. As a consequence, this reduces the cost of the strike for this party and it comparatively weakens parties' incentives to cooperate in the first instance, as shown in Lemma 3.

Lemma 3: Cooperation is hindered if the reciprocal externality falls only on one party

When only one agent receives the feedback of a negative externality generated by the strike activity, he will be led to lower his τ value with respect to a strike with unilateral externality, while the other agent maintains the same incentives towards cooperation. As a consequence, both agents have reduced incentive to cooperate in the first instance compared with the case of unilateral externality.

Finally, cooperation is hindered also when the dimension of a reciprocal externality generated by the strike activity is such that parties maintain strong incentives not to strike. However, when this occurs, the strike lacks a powerful enforcement mechanism and thus also incentives towards cooperation are hindered. Thus, when both parties internalize the externality and the size of the externality exceeds the utility stream associated with the penal code Q^1, the reduction of the strike activity also implies that incentives to cooperate are too weak, as in Lemma 4.

Lemma 4: Cooperation and Reciprocal Externality

For any given strike of duration τ and discount factor δ, when both parties internalize the negative externality generated by a strike, the incentives to cooperate depend on the extent of the externality.

3.3 The case for the virtual strike

As stressed above, the virtual strike mimics the normal strike inasmuch as it takes away the surplus from both parties but differs in the fact that the work is actually carried out. In the framework here adopted thus, a virtual strike can be modeled as a different 'penal code' which impacts the surplus sharing without effects on the chosen levels of effort. As with the standard strike, when a deviation is observed, one party can call the strike and can deploy a penal code $Q^2 = \{(e*), (e*), (e*), ..., (e*), (e*), (e*), ...\}$. Under Q^2, both parties continue to choose the optimal effort levels $e*$, but obtain for τ periods only that portion of the surplus associated with shirking levels of effort, $e^s \geq e^m$, i.e. $x(e^s)/2$, rather than the first best share $x(e*)/2$. After τ periods, when cooperation restarts, the optimal share is restored $x(e*)/2$. The difference $(x * -x(e^s))$ produced but not shared between the two parties is donated to some third party or parties such as charities[12].

It is easy to verify that, under this setting, the virtual strike is hard to enforce because parties maintain an incentive to shirk (remember that effort levels are unobservable). As before, let us consider the case of unilateral and reciprocal externalities under the virtual strike. Lemma 5 shows that when externalities are unilateral, the virtual strike is not enforceable, while Lemma 6 shows that under reciprocal symmetric externalities, the virtual strike can be enforced only for a large enough externality.

Lemma 5: Unilateral externalities prevent the adoption of a virtual strike

Consider a penal code as Q^2. When a standard strike generates E^τ as a unilateral externality, Q^2 is not enforceable. As a consequence, under a virtual strike cooperation is always inhibited.

Lemma 6: Reciprocal externalities may favor the adoption of a virtual strike

[12]For simplicity, we assume here that these third parties do not have any interaction with our union and manager. To use our own words, the donation is only a unilateral positive externality and there cannot be any possible feedback and thus potentially a strategic use of the devolved amount by the parties to the strike.

Consider a penal code as Q^2. When a standard strike generates a high enough reciprocal externality E^τ and the parties do internalize it, then Q^2 is a self-enforcing strategy.

Recall now the case outlined by Lemma 4, where high enough symmetric reciprocal externalities prevent standard strike and thus hinder cooperation. Lemma 7 shows an important result: from a total welfare perspective, when the externality E is high enough, a virtual strike sustained by Q^2 always dominates a standard strike sustained by Q^1.

Lemma 7: The virtual strike may be incentive-compatible when the standard strike is not

The virtual strike enforces cooperation when the dimension of a reciprocal symmetric externality E would have inhibited cooperation under the assumptions of a standard strike.

The important consequence of Lemma 7 is that when the standard strike cannot be applied because of significant reciprocal externalities, the virtual strike provides an additional and powerful tool of negotiation.

3.4 The case of a ban on standard strikes

In this section we compare standard and virtual strikes under the assumption of a law banning standard strikes. As before we distinguish between unilateral and reciprocal externalities.

Lemma 8: A ban on strike eliminates the unilateral externality but reduces incentives to cooperation

Consider a standard strike generating a unilateral externality. Banning strikes, that is to say imposing by law $\tau = 0$, would save social cost E^τ but would weaken cooperation in the first instance. Thus, banning strike is efficient only when the gains from cooperation are lower than the unilateral externality generated by the strike.

Lemma 9: The inefficiency of a ban on standard strikes with reciprocal externality

Consider a policy banning strikes when the externality is reciprocal and symmetric. A ban on strikes is inefficient for a high enough externality and a short enough strike duration.

From Lemma 8 and 9, we conclude that while with unilateral externality a ban on strike activity may save social costs at the expense of cooperation, when the externality is fully reciprocal and symmetric a ban has a comparatively lower impact on social costs and furthermore it could be detrimental.

Lemma 10: Virtual strikes always dominate a ban on standard strikes

When the externality is reciprocal and symmetric, from a total welfare perspective a virtual strike always dominates a ban on stoppage strikes for any value of E*.*

Finally, let us consider the case where a ban on the standard strike is coupled with a mandatory adoption of the virtual strike.

Lemma 11: Mandatory adoption of the virtual strike under a ban on the standard strike with unilateral externality

When the externality is unilateral, a ban on the standard strike and the imposition of adopting only virtual strike is inefficient since it generates social costs and hinders cooperation

Lemma 12: Mandatory adoption of the virtual strike under a ban on the standard strike with reciprocal externality

When the externality is reciprocal, a ban on the standard strike and the imposition of adopting only the virtual strike is redundant.

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4 Summing Up and Conclusions

From the perspective of total welfare analysis, the virtual strike dominates the standard strike. We have asked why virtual strikes are so infrequent. Our explanation is based on the extent of social costs produced by the standard strike and on the unilateral or reciprocal nature of these externalities. We have argued that parties loose incentives to implement a virtual strike precisely when it would be needed the most, that is to say when externalities are significant but unilateral or asymmetrically reciprocal. In this section we summarize our main findings. The first is that, in our configuration, standard strikes are a self-enforcing device to achieve cooperative outcomes when the joint costs of a strike are high enough to credibly punish moral hazard (Proposition 1). When strikes generate only private costs, they pursue endogenous enforcement. From a total welfare perspective, however, things may be different when strikes generate

social costs that are not internalized by the parties on strike. When this occurs, a trade-off emerges between obtaining cooperative outcomes and avoiding social costs. Consequently, when social costs outweigh prospective cooperative outcomes it would be better, from a total welfare perspective, to prevent the strike activity. This turns out to be the only case in which banning a strike by law would lead to efficient outcomes. However, a ban on standard strikes generally contrasts with the right to strike that is a fundamental constitutional right in most modern countries. Furthermore, the efficiency of such a ban would be typically assessed ex-post, comparing the dimension of the externality with the foregone benefits of cooperation. A law banning strikes would equally affect cases in which externalities outweigh private benefits and cases in which this does not occur. Thus, beside constitutional right constraints, a typical logical mistake incurred by those who are in favor of banning strikes *tout-court* is assuming either that parties will continue to cooperate optimally in the absence of a self-enforcing mechanism such as the one provided by the strike threat or that the externality generated by the standard strike always outweighs the benefits from employer-workers cooperation for society as a whole.

Another policy option to mitigate the social costs generated by the strike activity would be to force the parties to internalize to some extent the negative externalities generated by the strike. We have shown that when there are reciprocal externalities—that is to say, when the parties receive negative feedback from third parties—the strike duration will be shorter than that associated with the case of unilateral externalities.

In this respect, when there are relevant reciprocal externalities, virtual strikes may enforce cooperation and eliminate social costs. Indeed, we have shown that when the reciprocal externality is particularly severe to the extent that even standard strikes would not be feasible, the virtual strike can still be applied. This implies that, in these situations, bargaining through strike (although virtual) can be carried out and cooperation can be sustained.

We have stylized four policy options: i) the "business as usual" scenario with the standard strike; ii) the virtual strike; iii) the prohibition of the standard strike; iv) the prohibition of the standard strike coupled with the imposition of the virtual strike.

We have seen that when relevant externalities do emerge, enforcing virtual strikes leads to the most efficient outcomes. On the other hand, when externalities are negligible, virtual strikes and standard strikes achieve more or less the same results, while a policy banning strikes is detrimental to cooperation. In particular the virtual strike always dominates the ban of the standard strike.

Unfortunately, when externalities are significant but not reciprocal, the parties lose incentives to use the virtual strike, because of moral hazard; thus, the likelihood of the parties voluntarily choosing a virtual strike is high when it is convenient for them to do so, but it is weak precisely when it would be needed the most. This is particularly true in those cases in which the externality is significant and reciprocal but asymmetric: when workers do not internalize the social costs of a strike, but the employer does. This is precisely the situation for which strikes are more likely to occur. This is the case, for instance, of strikes in public services: workers push up the social costs in order to exert pressure on the government leveraging on customer/voter dissatisfaction. These cases are also characterized (as in Lemma 3) by low incentives for cooperative outcomes, thus disagreement and strikes seem to be more frequent.

In this respect, forcing parties to commit to a virtual strike does not seem sufficient to obtain the desired outcomes (as in Lemma 5): social costs are saved, but efficient production is lost. The mere availability of the virtual strike as an option, or even a legal duty to strike virtually before resorting to a standard strike, do not seem to provide adequate incentives when externalities are significant but not reciprocal and symmetric. Some side effects in terms of monetary incentives and/or sanctions aimed at modifying parties' payoffs seem to be needed in order to properly align incentives towards the use of the virtual strike.

At the same time, prohibiting standard strikes while mandating virtual strikes, would be either inefficient when the externality is unilateral or redundant when it is reciprocal. When parties do not have incentives to spontaneously adopt the virtual strike, a policy that forces the adoption of the virtual strike coupled with the prohibition of the standard strike would only increase incentives to shirking, as we have shown in Lemma 11. Shirking may take the form of of 'formalistic strikes'.In these cases workers perform scrupulously through diligent and extremely attentive attitude to details. This behaviour may paradoxically generate relevant social costs, as delays in public transportation, traffic congestion and so on.Another form of shirking is the "illegal strike" or "hidden strike", where the employees use health related excuses (mostly certified by a medical doctor) to shirk, hence keeping their salary but disrupting production and precluding the government or the employer from applying standard strike related laws. If the legal system is very ineffective, this could be a serious problem for implementing adequate laws for the virtual strike. Furthermore, as we have shown in Lemma 12, when externalities are reciprocal and workers in any case would have chosen the virtual strike , the mandatory adoption of the virtual strike coupled with the prohibition of the standard strike, would be redundant.

Moreover, a mandatory adoption of the virtual strike may paradoxically reduce workers' incentives to signalling and invest in reputation through the virtual strike, since customers will not be able to appreciate those concerns if workers' behavior turn to be mandated by the law.

Going back to the Italian proposals on virtual strikes, our results suggest that the governmental proposal, by imposing the virtual strike and prohibiting standard ones will hinder cooperation without reducing social costs. Moreover, the actual definition of the virtual strike does not explicit clearly employer's duty and private costs.

The other draft bill on virtual strikes, which has been drafted by members of the opposition, has the merit of defining the virtual strike as a complement rather than a substitute of the standard strike. It creates a default agreement in an area where coordination costs are high. This may encourage virtual strikes where parties would have already had private incentives to choose them voluntarily. However, the bill merely offers the virtual strike as an option alongside the standard strike. According to our previous analysis, this option does not guarantee that the virtual strike will be used instead of the standard strike when it is needed the most, i.e. when the standard strike generates significant but unilateral externalities. Tax breaks are important, but certainly they are not sufficient to tilt the balance of incentives toward the virtual strike. From an economic point of view, in order to induce the parties to strike virtually , the bill should include stronger incentives for the virtual strike and/or high penalties when the standard strike is chosen instead, in specific areas where social costs are extensive and not internalized by workers. From a legal point of view, such penalties should be set in such a way not to violate basic constitutional rights. Without this arrangements any reform would probably fail to deter strikes in economic sectors where there are significant but unilateral (or asymmetrically reciprocal) externalities. The policy implications of this paper for regulating the virtual strike are clear cut: make the virtual strike convenient for workers introducing side payments for the virtual strike and/or high penalties for the standard strike but at the same time leave the virtual strike as an option along side the traditional standard strike.

Appendix

Proof of Proposition 1

Consider first that one-shot deviation from full cooperation is never profitable if $U^i * /(1-\delta) \geq \hat{U}^i + \delta/(1-\delta)U_P$ where U_P is the utility stream associated to

Q^1, given by $U_P = (1-\delta^\tau)U_S^i + \delta^\tau U*$, for $\tau > 0$. Rearranging, cooperation is sustainable, for any agent, as long as $\delta \geq (\hat{U} - U*)/(\hat{U} - U_P)$. Thus, the longer the strike's duration τ, the lower the U_P value and the greater the probability of cooperation, measured by the extent of the range of values of the discount factor which sustains cooperation.

Proof of Lemma 1

The value $\hat{e}_i$ is defined as the $argmax_{e_i} \left\{ f(e_i, e_j^*)/2 - v(e_i) \right\}$. Given our assumptions on U, f and v, it is straightforward to verify that $e_i^{\mathrm{N}} < \hat{e}_i < e*_i$ and that $\hat{U}^i > U* > U^N$.

Proof of Lemma 2

It is straightforward to verify that when Agent i internalizes the externality, his utility stream associated to Q^1, is given by $U_P^i = (1-\delta^\tau)(U_S^i - \eta E^\tau) + \delta^\tau U*$ where $0 < \eta < 1$ is the portion of the externality falling back to Agent i while $(1-\eta)$ is the portion going to the other agent. Thus, there is a value of strike duration $\widehat{\tau}$ such that the utility stream of the strike with externality is equal to what the parties would have chosen in case of unilateral externality, i.e. $(1-\delta^{\widehat{\tau}})(U_S^i - \eta E^{\widehat{\tau}}) + \delta^{\widehat{\tau}} U* = (1-\delta^\tau)(U_S^i) + \delta^\tau U*$. Thus the larger is the size of *E,* the lower will be the value of $\widehat{\tau}$.

Proof of Lemma 3

When only Agent i internalizes the externality, $\eta = 1$ and his utility stream associated with Q^1 is given by $U_P^i = (1-\delta^\tau)(U_S^i - E^\tau) + \delta^\tau U*$. Thus, as in Lemma 2, he will choose a value of strike duration $\widehat{\tau}$ such that $(1-\delta^{\widehat{\tau}})(U_S^i - E^{\widehat{\tau}}) + \delta^{\widehat{\tau}} U* = (1-\delta^\tau)(U_S^i) + \delta^\tau U*$. However since for the other party, say Agent j, $(1-\delta^{\widehat{\tau}})(U_S^j) + \delta^{\widehat{\tau}} U* > (1-\delta^\tau)(U_S^j) + \delta^\tau U*$, Agent j will maintain incentives to strike for longer than τ , thus increasing other party's and social costs. On the other hand, the choice of a strike duration shorter than what the parties would have chosen in case of unilateral externality might reduce the range of the discount factor for Agent j, decreasing parties incentives to cooperate.

Proof of Lemma 4

It is straightforward to verify that if $E^\tau < (U_S^j) + \delta^\tau/(1-\delta^\tau)U*$, then strike activity is reduced with respect to the case of unilateral externality and cooperation is maintained. If, for any τ, $E^\tau \geq (U_S^j) + \delta^\tau/(1-\delta^\tau)U*$, then the size of the externality is too penalizing for the striking parties, and strike action is not a credible punishment, thus weakening cooperation in the first instance.

Proof of Lemma 5

Under Q^2 , when a standard strike generates E^τ and parties do not internalize it, a party call for a virtual strike should in principle imply parties choosing optimal effort levels, while obtaining only $x(e)/2$. Since e levels are unobservable, this implies, as in Lemma 1, that each party has incentives to select the moral hazard level $\hat{e_i} < e_i*$, which solves the program $argmax_{e_i} \left\{ f(e_i, e_j^*)/2 - v(e_i) \right\}$. In turn, this implies that both parties, anticipating this result, will select the minimum effort level e_{im}, as defined above, generating the lowest production level $x(e_m)$.

Proof of Lemma 6

When the parties symmetrically internalize E^τ, under Q^2, they save the private cost of E^τ in case of a virtual strike action, while sustaining an extra-cost equal to $\triangle v = v(e*_i) - v(e_i^S)$. Thus, when $E^\tau \geq \triangle v$, Q^2 is enforceable, because a deviation from e^* would generate private losses equal to E^τ.

Proof of Lemma 7

It is sufficient to verify that, under Q^2 , total welfare, in the case of both cooperation and strike, is given in each period by $x* - \sum v(e*)$; under Q^1 the total welfare in case of cooperation is given in each period by $x* - \sum_i v^i(e_i*)$ and in the case of strike action it is given by$x(e_s) - \sum_i v^i(e_i^S) - E^\tau$, for $i = 1, 2$. Moreover, while Q^1 fails in sustaining cooperation when $E^\tau \geq (U_S^j) + \delta^\tau/(1 - \delta^\tau)U*$, under Q^2 cooperation is restored.

Proof of Lemma 8

From Proposition 1, we derive that the prohibition of the standard strikes implies that $U_P = U*$, i.e. that the penal code does not operate as a trigger strategy and the scope for cooperation is reduced to its minimum ($\delta > 1$). As a consequence, banning strikes is efficient only when, at any period t, $[x(e*) - x(e^s)] \leq E^\tau$.

Proof of Lemma 9

When parties symmetrically internalize the externality, the strike activity period is reduced to $\widehat{\tau}$, defined as the value which ensures that $(1 - \delta^{\widehat{\tau}})(U_S^i - E^{\widehat{\tau}}) + \delta^{\widehat{\tau}} U* = (1 - \delta^\tau)(U_S^i) + \delta^\tau U*$. Compared with the case where the parties do not internalize the externality, if strikes are banned, total welfare is reduced by an amount equal to $(E^\tau - E^{\widehat{\tau}})$. When, at any period t, the values of E and $\widehat{\tau}$ are such that $E^\tau < (U_S^j) + \delta^{\widehat{\tau}}/(1 - \delta^{\widehat{\tau}})U* \leq x(e*) - x(e^s)$ then a ban on the strike

activity is inefficient. Moreover when $U_S^j + \delta^{\hat{\tau}}/(1-\delta^{\widehat{\tau}})U* \leq E^{\tau} \leq x(e*) - x(e^s)$ a ban is inefficient and furthermore redundant since the threat of strike action is never credible.

Proof of Lemma 10

From Lemma 6, it comes that when parties symmetrically internalize the externality, the virtual strike eliminates social costs while it sustains cooperation, thus the virtual strike always dominates the prohibition of strikes.

Proof of Lemma 11

From Lemma 5, it comes that under Q^2 , when a standard strike generates E^{τ} and parties do not internalize it, both parties, will select the minimum effort level e_{im}, as defined above, generating the lowest production level $x(e_m)$. Since efforts are unobservable, parties may choose shirking levels without formally calling for a strike, thus hindering cooperation in the first instance.

Proof of Lemma 12

From Lemma 6, it comes that under Q^2 , when a standard strike generates E^{τ} and parties internalize it, both parties will be induced to select a virtual strike over a standard strike. Moreover, Lemma 7 shows that parties incentives to select a virtual strike over a standard strike increase as the externality becomes larger. Thus a ban on standard strike and the imposition of adopting only virtual strike is redundant.

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