

The effects of reputation :

a well-functioning market under quality uncertainty

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Abstract:

We explain the nature and the role of informal institutions regulating transactions between iron scrap collectors (small gleaners and scrap merchants) and scraps buyers when no objective measure of scrap quality is available. After showing empirically that Akerlof (1970)'s lemons pricing applies whenever no reputation mechanism is at work, we underline the characteristics of the observed reputation networks. Those enable scrap merchants to be protected from lemons pricing and solve the participation problem raised by the heterogeneity of collectors. An argument tracing back to Kreps, Milgrom, Roberts, Wilson (1982), shows that the possible irrationality of the buyer deprives the sellers of any incentive to cheat (by hiding waste in batches) because it relieves the fear of monopsony pricing. Finally, we show how this reputation-cum-irrationality serves, beyond solving incentive problems, as a distributive device. Particularly reliable suppliers benefit from a smoothing of inter-temporal price variation, providing a form of insurance favourable for investment.

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1. Introduction

Since the work of Akerlof (1970), it is a well-established fact that asymmetric information between buyers and sellers of a good can impair the functioning of the market. When the quality of the traded good is unobservable, only transactions that can be concluded at the price of the low-quality variety will take place. This "Tragedy of the Lemons" can be circumvented if transactions between the same buyers and sellers are repeated frequently and if more or less complete information about the deliverables can be obtained ex post at a low cost. Then the Folk Theorem ensures the existence of an efficient Nash equilibrium, among others, through the enforcement of tit-for-tat or trigger strategies.

The practical relevance of a reputation equilibrium as a solution to the Lemons problem crucially hinges on two assumptions : firstly, strategies must be observed ex post (or observable at a sufficiently low cost, as stressed by Kreps & Wilson, 1982) and secondly, players must find a way to coordinate on an efficient equilibrium. Iron scrap collecting is typically an activity for which these two assumptions are neither clearly rejected nor unquestionable. The buyer, a recycling firm, can look at a batch of scrap while it is transferred into the shredder, but it is difficult to keep track of the origin of a given batch without making storage prohibitively costly. On the other side of the market, the seller, a small gleaner or a scrap merchant, does not know readily whether he is offered a positive premium above Lemons pricing. The recycling firm we study divides actually his factor market in two segments : a minority of sellers conclude individual contracts in which a unit price and a minimal quantity is fixed for the next month ; the majority of sellers faces the judgment of a receptionist, appointed by the buyer, each time they bring a batch.

In this paper, we analyze the evolved institutional setup at play in a Belgian recycling firm. Building on a theoretical model and an historical case study by Greif (1989), section 2 shows that Lemons pricing is expected given the characteristics of the branch and of the transactions,

but is not systematically observed thanks to a reputation equilibrium, a phenomenon modeled by the theory of repeated games. Section 3 shows which problems could impair the stability of a reputation equilibrium and how some scrap sellers are organized in a multilateral reputation-and-information network. In these cases, the demand side is depicted as an imperfectly discriminating monopsony, as alluded to by Kreps(1990). The suppliers' reputation is indeed a specific asset that they can't invoke easily if they try and sell to a different buyer with which they don't do business frequently.

However, the guarantee of "fair" prices is in apparent contradiction with unrestricted monopsony power. The reputation mechanism imposes an incentive constraint on the buyer's pricing strategy, i.e. correlating announced prices with the observed quality of the delivered batch. There is also a participation constraint : offered prices must be raised above Lemons prices in order to make the cooperation equilibrium sufficiently valuable and defection (hiding waste in the batches or making no effort to bring a better quality of scrap) sufficiently costly. The end of section 3 borrows on Kreps, Milgrom, Roberts and Wilson (1982) to show that maintaining doubts about the rationality of the receptionist is a way for the recycling firm to alleviate the potential participation problems when the incentive constraint is not binding. A positive probability that the receptionist just "pays a market price" (sic !), instead of behaving strategically, diminishes the sellers' fear of being exploited for one thing, and for another thing, it also reduces the likelihood of having the suppliers rely on a strategic threat to put waste in the batches by shedding uncertainty on the reputation equilibrium.

Finally, we cannot ignore the major distributive issue raised by the multiplicity of efficient equilibria in a situation described by the Folk Theorem. Each party's effort to redistribute rent to his own profit could destroy the surplus created by the institutional setup described in section 2 and 3. Section 4 will make clear that the buyer offers a menu of rent-sharing arrangements to its suppliers. The social choice solution to this surplus-sharing problem is

empirically described, emphasizing that the portfolio of options available to a given supplier is constrained by his reliability on the incentive side. Inter-temporal income smoothing is the most commonly observed form of benefit allotted to the sellers, but the converse option also exists for particularly reliable scrap merchants : reference price variations are reflected more than proportionally in their prices, so that their activity is stimulated in periods of boom and suppressed when iron scrap is not worthy. This arrangement is especially suitable for not-too-big scrap merchants, whose variable costs take the lion's share of total cost.

The main lessons to be drawn from this case study are theoretical. Beside an empirical validation of Lemons pricing and illustrations of multilateral reputation, we want to emphasize the role of mixed strategies and of strategic stability arguments (robustness of the equilibrium to perturbation of the types of players) in actually supporting the reputation equilibrium. We conjecture that these two tools are particularly useful and should therefore be observed in situations where defection is hard to detect and participation constraints are binding.

2. Is There a Reputation Equilibrium ?

A. An overview of the branch

The analysis in this paper centers on a firm recycling ferrous metal scrap ; the particular firm to which we refer also recycles non-ferrous metal scrap and belongs to a conglomerate present in the steel sector. The recycling activity consists in buying scrap batches from (domestic and foreign) suppliers, then applying a transformation process that generates re-usable inputs and waste. The third stage consists in delivering ferrous and non-ferrous fractions to metallurgists "for a positive price" (a settled expression in the sector), "waste sellable at a negative price" (id.) to other recycling branches and "ultimate waste" (id.) to waste disposal centers.

Ferrous and non-ferrous metals are two separate goods, with different markets. The firm's organization is a reflection of this distinction : two different receptionists (called B1 and B2 in

the quotations) and two different commercial director (CF and CNF) report to the managing director. On each market, there exist two different kinds of transaction. Batch of an homogenous quality and not needing any transformation (shredding, sorting, cutting,...) will be directly sold to the client by the supplier, on behalf of the recycling firm. In this case, the recycling firm is a pure intermediary. So-called "workplace transactions" take place on the firm's production site; this is always the case when the batch must be prepared in some way before being usable by the client.

Although we will dwell on this here-below, we can mention immediately that batches of iron scrap supplied to the recycling firm come from several sources : metallurgy scrap (foundry, iron and steel industry), production or transformation scrap (manufacture using steel as an input), collected obsolete and capital scrap (household junks, end-of-life products,...) and imported scrap.

The weight and the quality of a batch determine the supplier's revenue. Quality is assessed in terms of the ferrous fraction of the content, the amount of "steriles" (non-negligible amounts of non-metallic material, earth, rubber, wood, plastic, lubricants, chemicals, organic material,...) in the batch, the dimensions of the batch and the thickness of ferrous parts. In the plant under study, the combination of these criteria give rise to sixteen quality categories. Two special types of waste are separately considered. The first type originates in the storing and extracting conditions of the batch before its delivery ; if an excessive proportion of this type of waste is present in the batch, it devaluates the quality of the batch and its unit price. The second type of waste is called "abnormal waste" ; it consists in elements that have nothing to do with ferrous material but that are hidden in the batch because they raise its total weight or because it is otherwise difficult to get rid of them. Old safes, water in the tank of an end-of-life vehicle, used tires, truck batteries all constitute abnormal waste, some of which induce a severe risk of pollution (acid, hydrocarbons,...) or of accident during the shredding

operation (pressurized gas, safe,...). The presence of abnormal waste in a batch triggers a weight deduction, sometimes of a conventional amount, sometimes as assessed by the receptionist.

Once bought, batches are sorted and stored on the production site, waiting to be shredded, cut and/or conditioned. High-quality batches only need to be dimensioned and cut. Scrap that contain ferrous, non-ferrous and non-metallic fractions is shredded and separated into its three subcomponents. *Secondary raw material* (the ferrous fraction) is an electric ark furnace feedstock. The shredder is very important asset in the recycling firm. Firstly, it is a high fixed cost to acquire one and the afferent authorizations. Secondly, the type of the shredder determines the type of scrap that can be treated with this instrument. The one used in the recycling firm we study enables its owner to shred thicker scrap than those treated by the geographically relevant competitors. Thirdly, given the high fixed cost of acquiring the shredder, it is important to keep it fed continuously, although supply is seasonally variable. Efforts of inter-temporal stabilization of the shredder's activity are materialized by the storage of heaps of scrap on the production site. Fourthly, the shredder's activity cannot be easily re-parameterized, so that the quality of secondary raw material that is produced is linked to the technical demands of a limited set of clients. Yet it is possible to modulate the output quality by intervening on the shredder's input flow or on the conditioning of output to be sent to the clients. Ultimate waste resulting from the separation from ferrous and non-ferrous fractions of scrap can only be sent to waste disposal centers.

An important point is worth being kept in mind during the analysis. Quality is the key issue in determining the unit price of input batches and outputs. However, the output market is completely different from the input market with this respect. When the recycling firm deals with steelworks, the European Steel Scrap Specification is an agreed-upon nomenclature of qualities, known and accepted by every agent. The specific technical demands of each client

is one element of monopsonistic competition on this market. There is a far worse problem on the input market, where quality nomenclatures vary from a recycling firm to the other. Only prolonged experience with a particular receptionist may transfer to the collectors enough knowledge about the assessment of quality by the scrap buyer. Furthermore, there exists a technical possibility of measuring quality on the output market by an economically affordable test ; the unit price can therefore be fine-tuned to the exact ferrous density of the good. Such a possibility is absent from the input market, where visual inspection is the only viable way of assessing the quality of a scrap batch. A third distinction, that results from the previous two, is that international reference prices do exist and can easily be checked for the output market while very little information is ever published on reference prices for the input market. On both markets, risks of pollution through the presence of waste in the batch is present. On the output market for example, radioactivity is a much feared hazard that can severely disrupt the production process. Nonetheless, technical means of detection can be implemented at a low cost. On the input market, detection of waste is difficult to perform by automatic means because iron scrap is combined with several types of material (including oil, tires and textile) in many different ways and cannot be sampled. Although these undesirable complements could be separated from scrap at an earlier stage, suppliers of the recycling firm have little incentive to do so, given the absence of recycling branch for some elements (e.g., used tires), the heavy cost of disposing of them, and non-negligible administrative difficulties.

B. Sources and suppliers

One can decompose the activity of ferrous scrap recycling into five stages : collecting ferrous waste at one of various sources, the transport and delivery of ferrous batches by suppliers to a recycling firm, the preparation (shredding, compacting and shearing) of *secondary raw material* by separating it from *shredder residue*, the treatment of residue and the delivery of

secondary raw material to metallurgists. Since our study focuses on the third stage of the branch, we will sketch a description of the first two as an introduction.

Sources (also called "lode" by analogy with iron ore) are heterogeneous in terms of available quantity and its seasonal variability, quality, homogeneity of the lode, access cost (must the collector pay or is he paid to take it away ?), transport cost and type of vehicle necessary to transport the batches. On the basis of these criteria, four kinds of sources can be distinguished.

Households generate small amounts of ferrous waste. These batches are of low quality (washing machines, refrigerators, old bikes,...) and of heterogeneous aspect. The access cost is low and any vehicle can do the trick. The ratio of transport cost to ferrous material weight is high : these batches will receive a low unit price but it is necessary to collect in a wide perimeter in order to accumulate enough material to make it worthwhile to take the batch to the recycling firm. Spring and summer are privileged periods for such a collecting method, but activity is very limited in the winter.

Factories generate stable flows of transformation or production scrap. These batches are almost constant in quality and quantity, the total volume varying directly with the activity of the factory. The visual aspect of the batches is very homogenous. Access cost is high : collectors must bid to place containers in the factory, where ferrous scrap will be recuperated on a regular basis. Transport costs depend mainly on the distance between the factory and the recycling firm.

The dismantling of industrial structures, called "demolition workplaces", generates large, one-shot opportunities for scrap collectors. The quantity of available ferrous scrap is large, but the spectrum of present qualities is usually wide, from neat steel to old cables. A high access cost is the main trait of those opportunities. Being able to pay an entry fee and to actively participate in the demolition with appropriate tools is a condition that few collectors can meet.

However, several suppliers can bid together and combine their resources to meet the compulsory technical requirements.

The last source of iron scrap is summed up under the name of "specific sources". These are specific to a sector of activity. For example, tin cans come from garbage collection, end-of-life vehicles come from garages and insurance companies, etc.

The second stage of the branch is represented by collectors. This is a very important stage for our study, which is focused on the relationship between collectors and the recycling firm. In a nutshell, this is the supply side of the market we intend to analyze. From the viewpoint of the recycling firm, suppliers are characterized by a number of individual traits : the sources to which he has access, the storage area available to him, the type of his professional vehicle, his proficiency at identifying the quality of his batches, the frequency of his visits to the recycling firm's production site and the reliability of his behavior at the time of delivery. The storage area and professional vehicle are important traits. A collector with no place to store scrap must deliver his batch immediately after collecting it, while the opportunity to store implies also the possibility of sorting several batches into homogenous-looking deliveries, or even the possibility of speculating against the variations of iron scrap price. Some collectors must rely on the firm's own container and trucks for the transport of batches from the storage place to the recycling site. The smallest suppliers simply transport scrap in the boot of a car.

The recycling firm chooses a last characteristic of his suppliers. A majority of them are paid during spot transactions, according to a quality judgment issued by a receptionist appointed by the firm. Some of them benefit from "prices over-the-counter" for some qualities ; if the receptionist ranks their batches in the appropriate quality, they receive a pre-determined price, which is held fixed for a one-month period. A minority of suppliers have contractual arrangements with the firm, in which a quality, a unit price and an expected volume of delivery are stipulated.

All these criteria are summarized under four labels, each naming a certain type of collector. Gleaners are at the same time iron scrap collectors and junk collectors. The households are their main source of activity. Their vehicles never exceed a transport capacity over three or four tons, for "big gleaners", but most of them can only bring batches of less than a ton. Not all gleaners do business with the recycling firm very often. Some visit the production site twice a day, others less than once a week.

Scrap merchants are characterized by their working knowledge of the profession and of the quality spectrum. According to a receptionist, "Those who know the profession learn with their fathers. They own a field on which they store the product of their activity, either to make up significant batches of an homogenous quality or to speculate." Speculation is not very profitable nowadays because prices are low and stable compared to levels observed in the mid 90's. As with gleaners, one can distinguish "small scrap merchants" who own only a small truck, from "big scrap merchants" who have larger production capacities.

Two other labels are also used in practice. "Occasional" suppliers are not identified by anything else than their relatively infrequent visits to the production site. These suppliers are firms and households that do not want to use the service of an intermediary like a gleaner. Finally, "demolitioneers" bring end-of-life vehicles stripped of spare parts that can be sold on a second-hand market. They store end-of-life vehicles on a terrain before bringing them to the recycling firm.

C. Assessment of the worth of a batch

The worth of a batch, equal to the supplier's revenue, is the weight net of observed waste times the price offered according to the receptionist's visual evaluation of quality. Here is an detailed outline of the elements entering in this evaluation and of the problems raised by the asymmetric information between the buyer and the seller. Some of these problems come out under the label of hazard moral and some are examples of adverse selection.

C1. A weight watchers' job

The weight of each batch is measured in two stage. When the collector arrives on the recycling site, he brings his vehicle and cargo on the weighbridge, connected to a computer. The total gross weight, the name of the collector, the date, hour and transaction number are recorded in the firm's information system. The collector then unloads near the particular scrap heap that is designated to him by the receptionist as the one appropriate for the quality of his batch. Finally, he drives his empty vehicle again to the weighbridge. The batch's net weight is computed as the difference between the first and the second pass on the weighbridge. The net weight, the announced quality of the batch, the unit price, the collector's name, the date and hour are then printed on a transaction record that the collector takes away with him along with the revenue of the transaction.

The weighbridge is regarded as a key asset in the recycling activity. It is a heavy investment and is therefore unaffordable for the suppliers. The reliability of this instrument is a crucial issue for both parts of the transaction. Indeed, two problems must be expected. Firstly, employees of the recycling firm confirm that some people in the sector are tampering with their weighbridge, but they stress at the same time that "suppliers learn about it very quickly"(CF). The certification of the instrument by an independent actor and the reputation of reliability of the weighting process are stressed by both parts. Suppliers try and test the accuracy of the instrument. For example, they check that the weight of the loaded or empty vehicle is approximately constant. Since they keep written tracks of their transactions, they can see whether similar batches brought over time were given similar weights. Another test is to have their empty vehicle weighted by a nearby grain merchant, who also owns a weighbridge. On the other hand, it has been mentioned that weights of batches were systematically under-reported by the operator when the current technology of weighbridge was not available ; the older technology, called "punch hole weighbridge", reacted with a time

lag that enabled the operator to cheat. A former receptionist explicitly confesses that, with an older model of weighbridge, he was "able to intervene in the process"(B2). The important point is that the recycling firm tries to commit credibly to a fair weighting procedure and the suppliers are given means to propagate this reputation.

The supplier can also try to make the net weight of his batch appear higher than what it is in reality. A receptionist denounces a practice he calls "selling kids" : the supplier's children come with him on the production site ; they stay hidden in the vehicle until it is unloaded, and they leave it before the second turn of the weighbridge, adding their own weight to the net weight of the batch.

When batch are taken away from the supplier's site by trucks, there is a possibility of collusion between the supplier and the truck driver (an employee of the recycling firm), since the weight is then simply reported by the latter to the firm without being measured and recorded by the weighing system. This collusion remained undetected and consequently possible until truck drivers were obliged to same weighing procedure as suppliers. As a conclusion to this point, we can assert that *a non-negligible cost is paid to make the information on the batch weight publicly observable. If there remains a problem of asymmetric information, it must lie in the assessment of the quality of the batch.*

C2. Quality and price : informational considerations

The receptionist firstly observes the quality of a batch, checks for the presence of "abnormal" waste and then announces the name and unit price of the quality. We will see that, both from a theoretical and from an empirical viewpoint, this distinction between observed quality and announced quality is a non trivial fact ! The quantity of waste, the name and the unit price of the announced quality are hand-written on a receipt note that will be used to print a transaction record. For suppliers having verbal contracts specifying quality and price, the assessment of the quality is very superficial, limited to a brief confirmation, unless a problem

had occurred in the previous transactions with the same supplier. There is no decision on the unit price since it has been negotiated before delivery. For suppliers who benefit from so-called "prices over-the-counter" for a list of qualities, the receptionist decides whether the delivered batch falls in one of the listed qualities, in which case he has no say over the price. In all other cases, in particular when facing the third category of suppliers, the receptionist has final say over the unit price. Irrespective of the type of the supplier, the receptionist decides on the amount of waste that is deducted from the weight of the batch. Assessing the quality of the batch and detecting waste are the receptionist's two equally important functions : hidden waste can be dangerous if it contains acid, gas or pressurized air ; explosions in the shredder's core are not infrequent and they sometimes put a stop to the activity for several hours.

In instances when quality is to be thoroughly evaluated, this task is not made easy by a certified instrument as for the weighting of batches. An automatic evaluation of quality simply does not exist for its design would be technically difficult and its implementation prohibitively costly. Actually the receptionist relies only on a visual inspection and on practical experience. Quality is not provable by any means and furthermore it is imperfectly observable.

The receptionist relies on a memorandum relating homogenous quality categories and recommended pricing. This memo is kept secret by the receptionist. It is neither used during the transactions nor invoked when facing a complaining supplier. Yet, as we will see, recommended prices are not obeyed blindly.

Four main reasons make the observation of the content of batches difficult, both from the viewpoint of quality assessment and, all the more so, of waste detection. Firstly, the buyer cannot trust an announcement made by the supplier about the content of the batch : "One never knows what could be in the batch and one cannot rely on what is announced [by the supplier]. Quality always has to be checked before announcing the price [...] but we know it is

a less risky business with some suppliers than with others."(B1) Secondly, batches are presented under the form of a heap of scrap, the heart of which is not easily inspected. Thirdly, suppliers tend to organize their batch layer by layer, with the better quality on top ; "making layers is the state-of-the-art in this profession !" Fourthly, in periods of hectic activity, the receptionist is also busy policing the suppliers' behavior when they unload : if nobody could see them, they could easily steal scrap from a high-quality heap.

The receptionist can rely on a crane driver's help in order to circumvent some of the aforementioned difficulties. The crane is supposed to bring the batch, unloaded near a scrap heap, on the heap itself. Actually, it also moves the content of a batch, making its inner content more visible : "The crane driver indicates what he sees in the batch. I avoid paying for a lower quality or buying waste." (B1) The firm and its suppliers insist on the fact that the crane driver must not make an assessment of the batch by himself, but his work generates information on quality : "If I can't see the batch content, the crane driver steps in and enables me to refine the assessment." (B1) Furthermore, since the crane is situated near the scrap heap, the driver also participates to the monitoring of suppliers on the production site. ***Besides the hiring of a receptionist and of a crane driver, it is fair to say that the recycling firm can do very little to further improve the information about the content of batches.***

On the other side of the market, suppliers do not share the receptionist's information about the quality standards and about the monthly reference price for each quality. Nonetheless, since the receptionist quotes the name of the quality of the batch and its unit price, collectors can build up experience on the way such announcements are made. "They can identify extreme qualities" (CF), such as end-of-life vehicle or washing machines (the lowest qualities) or neat production scrap (the highest one), but in most cases they are in no position to challenge the receptionist's announcement, except on the basis of their own experience. Suppliers who bring a constant quality over time expect a constant assessment and a constant announcement of

quality. This learning is only possible for those collectors who have repeatedly access to the same source of iron scrap (e.g. transformation or production scraps,...). What they actually learn is how the current receptionist correlates the presence of specific clues (e.g. well-known pieces of scrap) in the batch and his announcements, which criteria he relies on, "and especially what escapes his scrutiny". The receptionist's attitude towards waste, for example what he considers "normal" vs "abnormal" waste for a given quality, is also progressively anticipated.

There is very little initiative on behalf of the receptionist to transfer information about his assessment of the quality of the batch in order to conceal which details draw his attention and which do not. The reference price memo could well support the transfer of information about quality-price correspondences. When he is asked about the explicit use of this memo during transactions, B1 replies : "We would spend time discussing, they would ask for the definition of each category, then, the next time, they would disagree and it will be endless."(B1) Two other, equally important reasons are put forward : "Through such discussions, they would learn how I evaluate batches, and moreover, it [keeping the secret] enables me to swindle them."(B1) ; "They would easily compare each other's treatment, some of them will say that they don't receive equal treatment, that we make differences between them [...] They will say it isn't a fair evaluation" (R&D director). On the contrary, the receptionist tries to elicit information about the way the supplier evaluates his own batch. With the help of such qualitative information, the receptionist can form a belief about the supplier's expertise at distinguishing qualities among each other. As expected, the supplier is vulnerable to under-valuation if his expertise is in doubt.

We have seen that suppliers are heterogeneous in their ability to learn the receptionist 's evaluation of quality. They are also heterogeneous in their information about the general state of the iron market and about the reference prices on which the receptionist bases his

announcements. Among themselves, gleaners brag about prices they receive at the production site. It is very difficult for them to decipher the factors underlying the price they receive. From the business cycle to the receptionist's evaluation, the various causes bearing on scrap prices cannot be sorted out by small gleaners. When they complain about prices, they explicitly mention dual explanations, i.e. the receptionist's ability to quote a low price without being challenged and the depressed state of the iron market. Professional scrap merchants are in a very different position. They keep each other informed about the prices offered by the buyer to other suppliers and rely on reference prices quoted in specialized newspapers. They also call each other on the phone to know which prices are offered by the recycling firm for each quality of batch. This information network functions well because any information can be cross-checked with other people and a liar would be immediately excluded from further exchange of information.

This heterogeneity in knowledge about prices is maintained by the recycling firm itself, because very little information about prices is released. No price is offered on the phone, except to professional scrap merchants with which the firm often does business, and even with these, only the commercial director and the managing director are entitled to mention figures explicitly on the phone. The reason is that figures are regarded as committal by suppliers, they consider that the firm's word is engaged. To sum it up, in most cases, suppliers have only to decide whether or not to come with the batch on the production site and to receive a TOL price offer.

C3. Quality and price (continued) : Lemons or not Lemons

The receptionist, who assesses the quality of delivered batches, is an employee of the buyer. Suppliers have therefore some reason to doubt the accuracy of his assessment, especially because of the high cost of withdrawing from the transaction (because transport costs are then sunk). Inasmuch as the supplier he faces knows little about qualities and prices, the

receptionist is capable of strategic opportunism. Nonetheless, the receptionist (B1) insists on the importance of "fair assessments", "fair prices" and of the ensuing reputation, but he also stresses his somewhat uncomfortable role of middleman between the firm (buyer) and the collectors (sellers). In other words, the receptionist is the agent of two principals and he is the center of two kinds of moral hazard problems : the supplier wants to prevent him from under-evaluating the quality of the batch ; the firm wants to prevent him from over-evaluating it, for instance as a result of intimidation or bribery.

On this particular issue, suppliers openly compare the former receptionist and the current one. The next section being entirely devoted to the analysis of reputation mechanisms at the production site, we will just mention here that those two agents relied on completely different strategies to cope with the situation. The former one anticipated systematically that suppliers would try and cheat on quality and on the amount of hidden, "abnormal" waste. Any more or less valid reason, including the presence of dust (sic), is good enough for him to deduce a penalty from the net weight of the batch. A typical explanation given by B2: "I am protecting myself against what they are doing to me. They believe they have cheated me, but I 'm not willing to loose." The current receptionist has build a wholly different approach. Suppliers refer to him as "just". What is exactly meant by this must be made explicit in the light of theory.

Indeed, since the situation at the production site is characterized by asymmetric information on the product quality as is documented in the above section, theory predicts that equilibrium will occur only when prices will be set at a level corresponding to the minimum value in the support of the quality density function. In reference to Akerlof (1970)'s pioneering work on market functioning under asymmetric information, the strategy played by the buyer in this kind of equilibrium is briefly called "Lemons pricing" in the sequel. In other words, it is

tantamount to giving the seller the lowest price compatible with what is known on the quality of the batch.

In order to understand how this market for iron scrap functions, the first step is therefore to know if and when Lemons pricing is applied, and especially for what reason it is not always applied. The answer to these questions are provided by a statistical investigation on the pricing practices of the current receptionist.

A preliminary inquiry consisted in participating to the receptionist 's work in order to identify the relevant variables in the description of each transaction. The receptionist was asked to reveal secretly on which criterion he has based his assessment of the quality of the batch. This relatively long stage has enabled us to design a questionnaire to be administrated once for each batch. The pre-testing of the questionnaire has shown that the gathering of data during transaction should be short (a couple of minutes by transaction, at most) and that suppliers should not be allowed to hear the receptionist's answers. The variables that were finally recorded, for each transaction during three days, can be summarized in three distinct groups.

The first group of variables describe the supplier, his name, his category (gleaner, scrap merchant, contractual supplier, other), his vehicle and opinions on whether he comes frequently on the production site, which quality of scrap he usually brings, whether he tried to hide waste in his batches in the past and whether he tries to influence the receptionist's price announcement by complaining and bargaining. The second group of variables describe the batch, whether its quality is the one usually brought by the supplier and whether the receptionist mistrusts the outward appearance of the batch (a question cross-checked at the end of the questionnaire). The third group of variables describe the announcement made by the receptionist, i.e., which quality and unit price he could have announced and which he has actually announced, how much (if anything) was deduced from the weight as a sanction for abnormal waste and why.

It must be noted that some of this data is anyway collected by the recycling firm itself. Firstly, a transaction note, taken away by the supplier with his pay, quotes the name of the supplier, the recorded quality of the batch, the unit price, the net weight and the transaction number. Secondly, a transaction log is kept, with the same information as on the transaction record. In section 4, we will exploit the data in this transaction log from 1997 to 1999, but in order to establish the occurrence and avoidance of Lemons pricing, a finer information was needed, hence the necessity of first-hand data collection.

The hypotheses behind the data gathering process are simple. The announced price will presumably be different from the unit price of the expected quality of the batch when the transaction takes place in conditions unfavorable for the initiation or the continuation of a reputation equilibrium, through which payoffs that are not compatible with best response in a one-period setting become feasible thanks to trigger-like or tit-for-tat strategies. The exact prediction we call "Lemons pricing" is tantamount to announcing the lowest price compatible with what is publicly observable about the quality of the batch ; in Akerlof (1970) 's terms, the theoretical prediction for the price a one-shot transaction is the lower bound of the support of the quality density function. We received the verbal confirmation that, as soon as the receptionist announces a price below his evaluation, he will give the lowest possible price given the uncertainty about the particular batch under attention.

What is the expected influence of each variable on the occurrence of Lemons pricing ? It is *a priori* probable that gleaners and especially occasional suppliers are more vulnerable to such a practice than scrap merchants. The same holds between infrequent suppliers and frequent ones. A past experience of hidden waste would compromise a reputation equilibrium, as does a batch difficult to assess because of its unclear outward appearance. Some signals, such as the net weight of the batch, the type of vehicle or a complain about the price, may also be considered by the receptionist as informative about quality.

A first result is that no weight deduction for abnormal waste was declared when the receptionist did not detect and mention explicitly the presence of such waste in the batch. Obviously, weight deduction is not an instrument relied upon for Lemons pricing. Section 3 will begin with a detailed discussion on weight deduction, where the reasons behind this practice will be made clear. On the other hand, 66 out of 165 transactions with non-contractual suppliers³ exhibit a difference between assessed quality and announced quality, in favor of the former of course. Lemons pricing occurred in exactly 40% of spot transactions observed during the three days of our data collection.

Some correlation was observed between the variables that we intended to use as regressors. For example, batches with a mixed quality (often 50% of "shredder" quality and 50% of demolition scrap) were almost exclusively brought by infrequent suppliers. This type of batch is distrusted by the receptionist. The supplier's vehicle almost perfectly reveals his type (at least for the gleaners and scrap merchants). Scrap merchants are more likely to complain about prices than other types, and this depends more on the person than on any objective data. The choice of the final specification has been dictated by the receptionist himself, since we tried to elaborate an equation on the basis of his experience of assessment. He pointed out at a missing variable in our questionnaire : some suppliers are known to be ignorant and incompetent ; he calls them "suckers" and always inflicts a Lemons price on them. We asked for a list of names, that enabled us to construct the "Incomp" binary variable, taking on the value one if the supplier is in the list and zero otherwise. Besides this variable, we assume that the receptionist relies mainly on the frequency and the supplier's category, the other variable being highly collinear with those two.

Four binary variables are hence retained as regressors. "Network" takes on the value one if the supplier is labeled by the receptionist as a scrap merchant. "Often" takes on the value one if

³ 40 transactions took place with contractual suppliers. Since quality assessment is much quicker with those, we did not consider them in our sample. The data generating process is presumably of a different nature, as is shown

the supplier's frequency of visit is subjectively assessed as "often" or "very often". "SureQ" indicates that the quality of the batch was publicly observable, be it a batch of the lowest possible quality (e.g. end-of-life vehicle) or of very high but provable quality (e.g. steel cut scrap). "Incomp" was defined above. Of these four variables, only the last one is expected to have a positive impact on the probability of Lemons pricing, while the first three should decrease the likelihood of its occurrence. Two other variables were added in the equation, but their coefficients were constrained to be zero : the net weight of the batch and the supplier's past behavior were assumed to have a non-significant impact on the probability of Lemons pricing, for reasons that will be made clear in section 3. The hypothesis that this zero constraint is not binding can only be rejected with a 74% first-type error. We are therefore confident that the specification estimated below is a relevant one.

The result of the logistic estimation on Lemons pricing are described in the following table. Coefficients are reported under the form of odds-ratio, for which the critical value is one rather than zero. Standard errors and confidence intervals are transformed in the same way.

Logit Estimates				Number of obs = 165		
				chi2(4) = 94.86		
Log Likelihood = -63.617803				Prob > chi2 = 0.0000		
				Pseudo R2 = 0.4271		

Lemons	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	

Network	.2681727	.1400569	-2.520	0.012	.0963524	.7463911
Often	.0778604	.0399784	-4.972	0.000	.0284614	.2129987
SureQ	.0313098	.0206281	-5.257	0.000	.0086075	.1138899
Incomp	51.74478	52.37452	3.899	0.000	7.117143	376.2074

As expected, the first three regressors have a coefficient (odds ratio) smaller than one, which shows a negative impact on the probability of Lemons pricing. These variables indicate respectively the belonging to a network of scrap merchants, the collector's subjective frequency of visit and an indicator that the batch is of publicly observable quality. The fourth variable is a subjective assessment, by the receptionist, of the collector's ignorance, incompetence and irrationality ; it has a large positive coefficient.

If there are only 66 occurrences of Lemons pricing, the nature of our regressors clearly points towards attributing this to the presence of a reputation equilibrium. This is easiest to establish with subjective frequency. With suppliers who do not visit the production site often, the delay between two transactions is large enough to make a reputation equilibrium unstable : the immediate gain of defection is larger than the expected future gains, that are distant in time and thus heavily discounted. It is impossible to interpret subjective frequency as a proxy for bargaining power since only non-contractual, relatively small suppliers are present in our sample. But all the same, even with no bargaining power, a small supplier can induce the receptionist to correlate price with quality by the promise to bring good quality and not to hide waste in the future transactions. If this promise is credible, the receptionist will prefer to preserve cooperation to the small immediate gain of applying Lemons pricing to this particular delivery.

Membership in a network of scrap merchants also indicates a reputation equilibrium, this time sustained by a multilateral reputation mechanism (Greif, 1989). Applying Lemons pricing to such a supplier would induce retribution from a significant number of suppliers, that together constitute a volume of transactions that the firm cannot ignore. On the other hand, the members of a network monitor each other so that a deviator, putting waste in his batches and thereby compromising the reputation of the whole network, would be punished in activities that they conduct together, as is outlined in section 3. For example, some scrap merchants bid together for access to a demolition workplace. A deviator would be excluded from such collective bids.

The coefficients of dummy variables indicating observable qualities and incompetent suppliers have the expected sign and do not necessitate further discussion. The measurement of performance for a logistic regression is best established with a prediction table. If we assign a positive prediction to observations that have an estimated probability of Lemons

pricing above 50%, the following cross-table between predicted and observed occurrence of Lemons pricing obtains.

Logistic model for Lemons pricing

Classified	Lemons	not Lemons	Total
+	52	11	63
-	14	88	102
Total	66	99	165
Sensitivity		Pr(+ L)	78.79%
Specificity		Pr(- ~L)	88.89%
Correctly classified			84.85%

The logistic model performs quite well, since the best constant estimator would reach a percentage of only 60% (99/165) of correctly classified observations. We cut the number of errors by more than half. In order to simplify the specification further, *one can assume that the receptionists offers a Lemons price to incompetent suppliers and to suppliers who do not meet any of the three other criteria (network, often, sure quality)*. This threshold model is easily applicable by the receptionist, even without the help of a computer. It gives out predictions that are very close to those of the logistic regression and yields the following performance table.

Threshold model for Lemons pricing

Classified	Lemons	not Lemons	Total
+	49	9	58
-	17	90	107
Total	66	99	165
Sensitivity		Pr(+ L)	74.24%
Specificity		Pr(- ~L)	90.91%
Correctly classified			84.24%

On the basis of these results, we can safely claim the existence of Lemons pricing in some cases and the existence of reputation equilibria as a solution to asymmetric information in other cases. Reputation is the topic on which we concentrate in section 3.

3. Reputation in the Shredder's shadow

In this section, we explain the observations put forward by the first empirical estimation, namely that there is no generalized application of Lemons pricing, especially with suppliers

with which the receptionist can build a relationship appropriately represented in a repeated-game framework. In order to induce a cooperative strategy on behalf of the collectors, the receptionist has an alternative to reverting to Lemons pricing, i.e. he may inflict a penalty for abnormal waste, deduced from the net weight of the batch. On the other side of the market, suppliers may threaten to revert to hiding waste in their batches or, ultimately, to do business with a competitor of the recycling firm. These strategies are explained in detail and thereafter the particular shape of the reputation mechanism that can fit in this very special branch : as we said earlier, this activity lies at the borderline of the conditions under which a reputation equilibrium can be sustained.

One can summarize the problems raised by the asymmetric information on the quality of batches by three big issues. A first moral hazard problem, to be solved by the receptionist, is to prevent the suppliers from hiding waste in their batches. This is essentially an adverse selection problem since the key problem is the revelation of the type of the delivered batch. The converse problem has to be solved by suppliers, namely they have to give proper incentives to the receptionist to give them prices that are correlated with the quality of the batches. Here moral hazard is more of the essence, since the point is to trigger a certain behavioral response by means of an incentive scheme. Finally, there is a third issue, which is akin to moral hazard too : the recycling firm wants to induce suppliers into making efforts (sorting, refusing non-metallic items,...) aimed at improving the quality of the collected batches.

A. Deduction for abnormal waste : a probabilistic sanction

A weight deduction is an individualized sanction for abnormal waste in the batch, as opposed to a "risk premium" that would be supported by all suppliers. It is aimed at deterring the suppliers from hiding unacceptable material in a hidden layer of his batch. This penalty deducted from the weight of the batch is either customary (40 kg for a tire,...) or about twice

as much as the weight of the waste observed by the receptionist. Sometimes even more than that is deducted, "when they don't understand" (sic). No deduction must be applied to batches that don't deserve it, because this would be interpreted as a side-way of giving a Lemons price. Abuse of deductions will trigger an adverse effect on behalf of the suppliers. Anticipating a deduction that will bring his revenue to the same level as under Lemons pricing, the supplier will no longer have any incentive to sort out his batch and to remove hidden waste. The incentive role of the deduction for abnormal waste would then be lost !

The sanction has four major characteristics. Firstly, it must be carefully justified and individualized. The receptionist must not look actively for the slightest opportunity to sanction the collector, since this strategy would have adverse incentive effects. The R&D director declared with a very professional sense of humor : "Deduction is like knocking on a table. You can't knock too heavily, otherwise you break the feet and you won't be able to knock anymore." The weight actually deducted depends on the individual characteristics of the transaction ; for example, the doubled deduction never exceeds a reasonable percentage of total weight. Secondly, the deduction must be performed at the very moment of the transaction. If waste is discovered afterwards, no deduction can be applied to the next transaction with the same collector. Thirdly, no bargaining is possible about the announcement of a weight deduction. The main reason is that any form of renegotiation would lower the incentive effects of this system. Another justification is that the reputation of the receptionist is too precious to be taken as an asset-hostage. We will see later that, in both part's best interest, the receptionist's behavior must be unaffected by a threat of spreading false information and that scrap merchants police themselves among suppliers on this issue. Fourthly, the deduction will not be systematically applied. This fourth aspect is quite surprising and worth dwelling on a bit since it lowers the usefulness of the sanction as an

incentive mechanism. The fact is, sometimes the presence of waste in the batch is declared "*accidental*".

According to the recycling firm, accidental waste can occur in two instances. The collector may either ignore the presence of waste in a batch because of the difficulty of the collection process or he may not have been responsible for the collection himself, which is the case when he picks up weekly scrap containers loaded by a factory. In those instances, the receptionist will announce the presence of abnormal waste in the batch but will not proceed to a weight deduction. This will be accompanied by a verbal warning ("A good strategy consists in letting them know that one could have inflicted a sanction and not doing it actually" [...] "I told him to be careful next time because I wasn't sure he did it purposefully.[...] I give him an occasion to correct that."⁴).

If he believes that a deduction was unfair, a supplier can appeal to the commercial director. Such appeals are not infrequent since the deduction is voluntarily fixed at a level broadly and blatantly exceeding the actual amount of waste in the batch. The result of this bargaining process is that the deducted amount is halved, leaving only the exact amount of waste in the batch and suspending the penalty. Does this mean that the doubled deduction is not credible and that its incentive effect is therefore completely jeopardized ?

Actually this way of proceeding aims at isolating the receptionist's reputation from all threats. The receptionist is kept afar from the negotiation on the deducted amount, which is entirely conducted by the commercial director (a clear quote from him : "We discuss this as adults, you settle this issue with me only."). During the discussion, the commercial director of the recycling firm and the supplier remind each other of the benefit of working together and of the mutual cost of defection. Each one quotes the loss he can inflict on the part and shows his information about the benefit derived by the other thanks to the reputation equilibrium. The

surplus generated by the reputation equilibrium is clearly the stake of this bargaining process : "One knows how the receptionist works. One knows *he makes or is driven to make* fair assessments. As for me, I know how the suppliers function." (CF). The credibility of the sanction for abnormal waste is supported by the further, more severe, threat of stopping doing business together. Afterwards, we hear this particularly illuminating confession : "It's a game. Suppliers know that we prefer that they keep working with us, we know that they can't really work with a competitor, but we have got to play the game" (CF). The threat to stop doing business together is therefore not really credible, but it is important to make it look credible because it supports the system of doubled deductions, not matter how penalizing it is for caught cheaters. There are several reasons why suppliers are locked-in, the most important⁵ being that they cannot transpose a reputation equilibrium with another buyer without a long and costly phase of mutual learning. The firm 's CF sometimes raises the threat of predation : "We know where they go and we can offer better prices to their sources. They are too afraid, we can short-circuit them !"

The threat of stopping doing business together really exist, but will never be put into execution by rational players since an agreement is more profitable for both parts. This is a typical description of a bargaining situation, where there exist profit vectors dominating the threat point. The discussion actually bears on the mutual knowledge about the threat point : it is a profitable⁶ idea, during the negotiation, to show that the threat point is of low value for the partner and of not-so-low for oneself. If a supplier believes he is offered a disguised Lemons price via the application of a doubled deduction, the value of the transaction is very close to his evaluation of the threat point, because the gains of future transactions under the

⁴ The importance of allowing for mistakes without eliminating every possibility of future cooperation is stressed by Axelrod (1984) as a major quality of the tit-for-tat strategy in the infinitely repeated prisoner's dilemma, especially in comparison with the less forgetful trigger strategy.

⁵ Other reasons include, but are not limited to, the distance with other recycling sites and the different functioning of competitors (absence of receptionist, reputation of tampering with the weighbridge,...).

⁶ This property is called the "threat point monotonicity" of the bargaining solution. For a survey on cooperative bargaining, see Thomson (1996). Most reasonable bargaining solutions are threat point monotonic.

reputation equilibrium are compromised. It is therefore important for the commercial director of the recycling firm to understand how the suppliers value the disagreement option.

After the discussion, the stakes should be clear to everybody. The deduction is then halved, suppressing the penalty. Of course suppliers learn that they can benefit from appealing to the managing director. Therefore, *at random, the appeal is sometimes dismissed*, "no matter what it costs !" (CF) This probabilistic application of a penalty with the help of a third part (the commercial director) is very effective in promoting trust between the suppliers and the receptionist. The latter is not blamed for setting a penalty if he carefully justifies it, while he is not held responsible for the excessive deduction, necessary for incentive purposes, because someone else has final say about the deducted amount. The incentive effect of the sanction is probably lower than if it were applied with probability one, but there are enough parameters (doubling or tripling the deduction, choosing the probability of dismissing the appeal,...) in this system to ensure a good compromise.

It appears that this game of "hide-and-see waste" is solved in a way that does not compromise the flow of future transactions : a positive surplus is expected in the future thanks to the reputation equilibrium and to the mutual knowledge needed to support this equilibrium. It is very embarrassing to try and bring back a supplier because it is tantamount to admitting one needs him and to raising his bargaining power in future transactions. The recycling firm only wants to get rid of suppliers who are too small and not reliable enough, so that for those suppliers, the verification cost exceeds the profit margin per batch. Another case of actual interruption of transactions occurs when a supplier transmits false information about the receptionist's evaluation methods and in particular about the fairness of evaluations.

B. Fair assessment, fair prices

In section 2, we have already discussed the reputation centered around the weighbridge in order to assert that little asymmetric information was left on the weight of batches. We have

just explained why weight deductions were a crucial element in the fight against hidden layers of waste. Now we turn to a third element in the problem of the recycling firm : how to correlate credibly the announced unit price with the observed quality of the batch in order to induce suppliers to bring batches of a higher quality. In the opinion of suppliers, the buyer (either the receptionist or the commercial director) is "trusted"⁷, in other words he is thought to offer "market prices".

Trust is attached to the person. The receptionist has to act personally in a way to confirm the trust granted to him by suppliers. "Trust is the only thing we cannot transfer from the firm to the receptionist. He has to develop it himself. It's important but it can't be transferred" (according to the commercial director). Quality assessment are accepted when they are performed by the receptionist, they aren't when they are performed by a substitute.

Another characteristic of trust in our case is that it is presented as "a default option" (R&D director). Any question, any doubt regarding the other's behavior will be suspended, for want of more certainty and unless it appears that cheating has occurred. Trust is a belief, subject to casual tests and based on behavioral clues, i.e. expected behavioral rules on behalf of the other. Something similar to this form of trust is present in the tit-for-tat strategy in the infinitely repeated prisoner's dilemma : this strategy prescribes to cooperate, by default, during the first period.

A very particular trait in the buyer's behavior lies on a consciously maintained ambiguity : suppliers believe that the receptionist "*makes or is driven to make fair assessment*". Their trust is partly based on the impossibility to tell whether the buyer correlates prices with observed quality due to his intrinsic honesty ("he just pays the market price") or because of the strategic reasoning underlying a reputation equilibrium, in which he has proper incentives to do so. We will dwell specifically on this issue below (subsection D).

⁷ Both parts use explicitly the words "trust" and "market prices", despite the strategic context.

What are the behavioral rules that confirm the suppliers' belief in the receptionist's fairness ?

We have spotted essentially three principles :

1°) Assessments must be objective and independent of the suppliers' identity.

2°) Differentiated treatments between suppliers must be explained exclusively as differences in qualities of the batches they deliver.

3°) Inter-temporal price variations are caused by fluctuations of a reference price, the so-called market price.

These principles have important consequences on the organization of the recycling firm, on its contractual relationships and on the agency problem between the receptionist and his employer. Knowing the origin of a batch or the storage conditions is not a relevant argument for the price formation with contractual suppliers. If the suppliers anticipates that the price he got includes a risk premium for the possible presence of waste due to the storage conditions, he will automatically put waste in his batches "because he has already paid for it" (CF). In more theoretical terms, anything that would resemble Lemons pricing in the suppliers' eyes must be carefully avoided with suppliers on which Lemons pricing is not actually inflicted.

An identical argument justifies the other two principles mentioned above. The supplier's personal traits must be irrelevant for the receptionist because only the characteristics of the batch may be taken into account. The frequency of transactions with a given supplier may be decisive in determining whether Lemons pricing applies, but if it does not apply, this variable can never justify a differential treatment with other suppliers. The same holds with the past history of transactions with a given supplier. To make it appear irrelevant, the receptionist must consider each batch as if he didn't know the usual quality brought by the supplier, whether the latter has cheated the week before, etc. This rule was already stated in the case of weight deductions for abnormal waste : the assessment may only be based on the batch under attention, otherwise a supplier anticipating a vengeance will anyway put waste in his batch,

triggering further retribution and putting an end to the chain of mutual cooperation. In a nutshell, *in order to eradicate the belief of Lemons pricing, inter-temporal retributions are ruled out.*

About the third "fairness" principle, concerning inter-temporal price variations, something more has to be said. The receptionist must be isolated from any pressure, either by his employer or by suppliers. The menu of price-quality correspondences is revised every first day of the month ; this rule is common knowledge. Within a month, a receptionist cannot be told by his employer to boost or curb the activity of collectors. Demanding to keep the price-quality menu constant over the month is practically the only way suppliers can make sure that the price-quality correlation is maintained and that Lemons pricing is not in vigor, because they have limited information on prices. Any price variation within a month period will be interpreted by a supplier as an attempt to justify the price he got by something else than the quality of his batch ; it is easy to understand why such an interpretation will be made, given how little information about prices is available to suppliers.

However, if the price-quality menu and the fairness of the assessment must be kept constant within a month period and across suppliers, the same cannot be said about the receptionist's care in assessing a batch. The history of transactions with a given supplier does influence the monitoring effort expanded by the receptionist when dealing with this supplier. The managers and receptionists even admit, albeit reluctantly, that a " premium for low-risk" is conceded to some suppliers, but they insist on the fact that this differentiated treatment must be hidden. This provides them with a good reason to keep the price-quality menu private instead of publishing it at the entrance of the recycling site. In this ambiance of secret about prices, scrap merchants and frequent gleaners still trust in the reputation equilibrium, on the grounds that the buyer is being given proper incentives to correlate announced price with the observed

quality. In other words, "trust", i.e. the set of beliefs that is the outcome of the reputation mechanism, is maintained if no public signal contravenes it.

An equally important dimension of the preservation of anonymous treatments is the protection of the receptionist against threats issued by the suppliers. A threat to hide waste in the batch in the future is not very dangerous for the receptionist. He must simply ignore it and apply weight deductions if and only if he detects abnormal waste. This equanimity makes the threat inoperative. On the contrary, a threat against the receptionist's reputation (a potential hostage-asset) must be made incredible by an external device, namely the monitoring by scrap merchants themselves of any information spread by suppliers. The collective action problem raised by this device is essential in the good functioning of the whole branch. It will be studied in details without further ado, in subsection C. We can notice immediately that a significant share of suppliers themselves have huge gains in maintaining the receptionist's reputation, since they can escape Lemons pricing, but individually, each supplier may want to extract a high price from the receptionist by threatening to spread false news about his evaluation methods. Obviously, this problem exhibits the typical structure of a collective action problem.

C. Multilateral reputation : a self-defeating solution ?

Fair pricing and fair assessment are the perceptible shades of multilateral reputation (a term coined by Greif, 1989 ; see also Platteau, 2000). This network performs two functions essential for the reputation equilibrium. Firstly, it gives the buyer proper incentives to correlate prices with observed qualities. Failing to do so would trigger a cascade of defections that would dramatically reduce the firm's input supply and the quality of delivered batches, and furthermore may result in environmental problems. Secondly, it gives the network members proper incentives to spread accurate information about the buyer's assessment methods. In order to meet this second incentive condition, suppliers must be proficient enough

to evaluate the work of the receptionist ; they must know the nomenclature of qualities and be able to detect accidental waste. Furthermore, they must depend on each other and rely on effective and credible means of punishment. Collective bids for the access to demolition workplace is a perfect example of a benefit from which unreliable partners must be excluded, making the threat of exclusion credible. The penalty incurred by the excluded member is high, especially since it also includes the loss of access to information about scrap prices and the buyer's reputation.

Unfortunately, the existence of a reputation network will also lead to giving enormous market power to the buyer and hence impose a sharp decrease on the suppliers income. Indeed, what does make this reputation network so effective about inducing a price-quality correlation on behalf of the buyer ? In other words, what credible threat may be posed by a network of collectors in order to rule out Lemons pricing ? We have seen earlier that the discontinuation of transactions between a firm and a given supplier is not very likely to occur if the latter is not utterly exploited. Sacrificing the knowledge about the receptionist's way of evaluating batches, loosing information about prices, etc... is too big a loss to benefit from the competition between buyers. ***Reputation is a specific asset that links the suppliers' network and the recycling firm.*** Nothing can refrain the buyer from reaping the full benefits of monopsony. The suppliers' participation constraint in the reputation equilibrium must therefore be binding, making them ultimately indifferent between setting up a reputation network and incurring Lemons pricing. Hence the reputation network is a self-defeating solution since the very agents that set it up will end up indifferent between doing it and not doing it, the benefits being reaped by another agent.

Traditionally, scrap merchants can lean on the possibility to speculate. They could refrain from delivering to the recycling site for a time, accumulating on their private heap. Since it is important for the recycling firm to maintain a constant level of activity (due to the high fixed

costs), this kind of pressure was effective, suspending transactions for a while instead of interrupting them. Literally, this is a way of going on strike without losing one's salary but merely by deferring it. The cost inflicted on the buyer is much higher than the cost of storage and the time discount. From his viewpoint, the buyer could develop alternative interpretations of this strategy, either believing that the supplier really wants to wait for higher market prices, or thinking that he is sanctioning the recycling firm for abuse of market power. Incentive effects are clear in the way speculation affects the buyer's beliefs, but the reputation equilibrium is preserved since no part is publicly making clear that a defection has occurred and that transactions are interrupted. Yet speculation is only feasible under three conditions. Firstly, a large storage capacity must be available for suppliers. Secondly, suppliers must rely on other income sources in order to "lay the siege" (sic) for long enough. Thirdly, prices must be high enough to make speculation worth a try. In a generally depressed market, storage costs and low levels of savings make speculation unaffordable. In the period in which our study took place (1997-2001), the unanimous opinion is that the three conditions for speculation did not hold.

There is still another way for suppliers to inflict costs on the buyer : hiding layers of waste in batches. This can be made at a very low cost. The trouble is, the threat of weight deduction for abnormal waste, raised by the buyer, should deter rational suppliers. Here an argument tracing back to Kreps et.al. (1992) can easily describe the solution found by the suppliers. Pretending that a fraction of them are actually irrational and ready to face the risk of weight deduction is easy for suppliers ; it is fair to say that scrap collectors are not exactly renowned for their cool temper. Then even the rational members of the reputation network have an incentive to mimic this irrationality in order to induce the desired behavior on behalf of the recycling firm. *Waste is used as a strategic device to extract part of the surplus of the reputation mechanism*, that would otherwise be appropriated solely by the buyer. The very fact that waste is sometimes

viewed as "accidental" makes this threat all the more credible, just as it was the case for speculation : in a given batch, the presence of waste may be interpreted by the buyer as accidental or as a strategic retribution against a low price. The current receptionist (B1) shows a very deep understanding of this mechanism : "For some of them, it is part of their nature to hide waste, they can't help it. For some others, it could well be a reaction to my own behavior. [...] Finding waste in a batch means that I must be careful with my assessment next time."

Now that we have made the point about the incentive effects of the reputation network on the buyer, it must be emphasized that the network will only work if an internal regulation is enforced about the coordination of strategies vis-a-vis the buyer and about the transfer of information. This function is performed by the scrap merchants thanks to their particular position in the branch. Because they collaborate for the access to demolition workplaces and other profitable sources of activity, scrap merchants have some experience in collective action and the stakes of maintaining cooperation among themselves are high. They are also sufficiently proficient to detect, with a positive probability, whether the receptionist's assessment is fair or not. The information passed from a scrap merchant to a second one will systematically be verified with others ; those who pass erroneous information will be excluded from the network : "They phone each other, in order to know their respective transaction prices [...] one can cross-check the transmitted information, one learns very quickly who gives inaccurate information. That one will be rapidly isolated" (CNF). On all of these characteristics, gleaners and demolitioners cannot match scrap merchants. "Gleaners brag about prices when they collect or when they are waiting before the weighbridge. It's the profession's peculiarity : when a price is offered to a North Pole gleaner, before you ring off the South Pole one knows that price. But they boast. Gleaners always claim a higher price than what they actually got." (R&D director) Demolitioners have a long history of mistrust among themselves.

Beside guaranteeing a price-quality correlation and policing the information spread by its members, a reputation network has three other effects. It increases the total information about the market, because the buyer must keep a stable nomenclature of qualities to enable the scrap merchants to perform their police functions ; outsiders therefore benefit from the existence of the network since they have an opportunity to learn more about the buyer's behavior and about the general state of the iron market. Another effect is the increased protection of the receptionist's reputation : the severe sanction for false news is taken over by the recycling firm. If a supplier repeatedly spread erroneous information about the way the receptionist acts, he is also excluded by the firm : "Those guys, we throw 'em out !" (R&D director) As we have seen earlier in the text, the accuracy of information on the receptionist is a very valuable public good, for the recycling firm as well as for all suppliers.

The last effect of reputation networks that we want to dwell on is the self-regulation of the amount of waste in batches. Indeed, waste is used by the members of reputation networks as a signal to the buyer. It is important to deliver waste-free batches most of the time, when there is no problem to complain about. Otherwise, the presence of waste would not be informative anymore for the recycling firm and no credible message could be transmitted that way. Likewise, when several suppliers collaborate to gain access to a given source, they check each other's batches originating from that source, because any added waste that would be spotted by the receptionist would raise doubts about all batches from the same source. Besides, collaborations are publicly observed and the recycling firm is well-informed about the most frequent associations. In order to preserve the possibility of future collaborations, any supplier is therefore committed to keep the buyer satisfied about the product of such collective actions, including by checking his partners' batches.

D. I'm irrational enough for both of us !

Although multilateral reputation network combined with the buyer's belief in a small fraction of irrational suppliers may produce the expected efficiency-enhancing effects, it raises a problem. The vector of messages, namely waste, introduces unnecessary costs in the system, especially if the self-regulation of the network is imperfect and if suppliers not participating in reputation networks imitate this strategy to act as if they were members of some network. With this in mind, an objective clearly put forward by the recycling firm is to avoid the presence of waste in batches as perfectly as possible. Which strategy can meet this target ?

The anonymous nature of the receptionist's assessments and the absence of inter-temporal incentive device on the recycling site suggested a transfer of the belief in the other's irrationality. The receptionist will pose as a market maker, paying "the market price" due to his intrinsic honesty rather than obeying to incentive schemes set jointly by his employer and by suppliers. "*He (B1) makes or is driven to make* fair assessments" ; "There are several reasons why our prices fluctuate, [...] but we tell them it's because of the market." (CF). A corollary of his intrinsic honesty would be an intrinsic reluctance to pay monopsony prices. The buyer's behavior is constantly oriented towards the confirmation of this belief on behalf of the suppliers. For example, they are actually given a share of the surplus generated by the reputation mechanism, despite the lock-in phenomenon. If there is an *a priori* non-zero probability that the buyer is actually honest, this belief is never falsified and, consequently, suppliers don't have to rely on their own threat to act irrationally by putting waste in their batches. The transfer of irrationality, or more precisely the transfer of the belief in the other's possible irrationality, accomplishes the minimum-waste target set by the recycling firm in its transactions with members of the reputation networks.

To sum it up, suppliers don't have an incentive to try and cheat because it is possible that the buyer acts strategically, but on the other hand, they don't have to face the self-defeating nature

of reputation networks because it is possible that the buyer just pays the market price rather than obeying to incentives set by a reputation equilibrium. Finally, there is another by-product of this solution. By observing how a given supplier behaves when he is given no certainty about being punished, the buyer measures this supplier's propensity to defect. The most reliable ones are selected to participate in direct transactions with metallurgists, for batches that don't need any treatment by shredding or shearing. In the past periods of scrap scarcity, the recycling firm even provided some suppliers with credit, so that they could invest in own material (storage area, professional vehicle); after experiencing several cases of hit-and-run, the firm stopped with such practice. Again, this is profitable for both parts since the recycling firm saves monitoring costs with suppliers that are not likely to endanger the firm's output quality or its reputation on the output market.

E. Should prices be publicly quoted after all ?

Among all the facts we observed on the field, there remains only one puzzling phenomenon at this stage of the argument. If the buyer's rationality were not in doubt, there would be some reasons to hide the monthly updated reference prices for all qualities. If the firm cannot exert its market power to a full extent in order to rule out the threat of waste, the belief that offered prices are just market prices could be further strengthened by public quotes, much like at a restaurant's front door or at a gas station. Three justifications were put forward by the directors of the firm. Firstly, publishing prices would show to the suppliers how much can be gained by having the quality of one's batch raised ; it would therefore trigger long discussions and raise the collective monitoring costs. This explanation looks unconvincing if the receptionist's authority and honesty are well-established. Two other, less benign, explanations were mentioned later on.

On the one hand, if Lemons pricing is to be inflicted on some suppliers, they shouldn't be given a chance to know it and to learn the nomenclature of qualities. Even though the largest

transactions are concluded with competent scrap merchants within the bounds of contractual arrangements and under the eye of a reputation network, one must not forget that a very large number of transactions bearing on smaller quantities are concluded on the spot with small gleaners, only 60% of which visit the production site frequently enough to enable the receptionist to pave the way for a reputation equilibrium. Lemons pricing is a way to maximize profits on suppliers that cannot be expected to modulate their behavior as a function of promises. This strategy must not be compromised by public statements about qualities and prices.

On the other hand, the recycling firm must take into account the fact that some suppliers don't have the necessary resources to participate in reputation networks. For example, some collectors do not possess the appropriate tools to take part in a collective bid for access to a demolition workplace. For them, the stakes are too low to guarantee that they won't ever transmit false information. Observable characteristics, such as the type of professional vehicle, reveal the supplier's ability to participate in reputation networks. This will inevitably trigger differential treatments, even though the buyer must make sure that this behavior can never be disclosed. *These differential treatments cannot be discriminated from Lemons pricing by a supplier who does not have access to precise information about input and output prices.* Cheating is then optimal. Likewise, cheating would be optimal for newcomers that would be in a position to notice that getting a price correlated with the quality of the batch necessitates the display of some characteristics they don't possess (yet). Giving too much information about prices would therefore be detrimental for the recycling firm inasmuch as suppliers' information will nevertheless remain incomplete and Lemons pricing would be suspected at the slightest proof of differential treatment.

Consequently, the recycling firm must prohibit comparisons between suppliers by depriving them of credible means of exchanging information except by being able to participate in a

reputation network. Hiding the price-quality menu is part and parcel of this policy. The segmentation between contractual suppliers, who discuss the terms of their contracts with the commercial director, and other suppliers, who conclude spot transaction with the receptionist, is another way of muddying waters.

One must not deduce from the above argument that all gleaners that cannot participate in reputation networks receive a Lemons price. Those who visit the recycling site frequently enough build up a bilateral reputation mechanism with the receptionist. For them too, it is important that the receptionist does not exert unrestricted monopsony power. Acting as possibly irrational is the receptionist's way of inducing them into collecting scrap of a good quality (though there is an upper bound on the quality improvement given the source to which a gleaner has access) and into displaying the content of their batches in a way that lowers monitoring costs. Nonetheless, the receptionist is aware that this reputation equilibrium is much more fragile with this category of suppliers and that most of them simply act mimetically rather than on the basis of perceived incentives. Gleaners observe the size of the queue in front of the weighbridge, check the number of transaction records that are kept on the reception desk, observe the height of the firm's scraps heaps and elaborate more or less self-contradictory theories on the link between these observable variables and the prices that would be offered to them. The recycling firm's interest is to confine this way of functioning to those suppliers whose effort to collect good quality scrap cannot be influenced, i.e. to confine Lemons pricing to situations where it simply performs a redistribution in the firm's favor rather than impairing efficiency as well.

4. Social Choice under information and participation constraints

Differential treatments of suppliers are a fact, although the recycling firm denies it and keeps only the most reliable suppliers informed of it, because they are the ones who benefit from it of course. It is worth elaborating how these differential treatments manage to share the surplus

generated by the reputation equilibrium compared to an inefficient Lemons equilibrium, while satisfying all the strategic constraints.

Three kinds of constraints can be distinguished. Firstly, there is an incentive constraint, bearing on price differences between consecutive qualities in the nomenclature ; suppliers will be incited to collect better qualities only if those price differences are high enough. The impacts of this constraint have been mentioned in section 3 and will not appear here because of the empirical methodology imposed by the data. Secondly, there is an information constraint, requiring that differential treatments be hidden and that the receptionist appear as intrinsically honest. Thirdly, there is a participation constraint, stipulating the minimal amount of surplus that must be conceded to each category of suppliers to make it worthwhile for them to play their respective roles in the complex institutional setup that we have just described.

One neat and profitable way for the recycling firm to share the surplus with its suppliers is to provide them with a form of insurance against income fluctuations. Presumably, the firm is less adverse to cash flow variability than its suppliers. Submitting them to price variations that are less than proportional to the output price variations will keep them satisfied while maximizing the firm's expected value. Therefore, in order to understand how surplus is shared, we must identify relevant groups of suppliers for which reference prices are reflected at the same rate on offered prices. We will focus successively on two qualities of scrap that are especially difficult to distinguish and that together constitute the major part of the shredding activity, namely the "shredder" quality and the "shredder +" quality (the upper fringe of which is also called "light steel scrap").

Let us start with "shredder +". The data is the firm's entire transaction log from February 1997 to December 1998. The general opinion in the sector is that two structural breaks happened within that time span. The first subsample ends on 01/27/1998. It is characterized by rising scrap prices and increasing profitability at all levels of the branch. The second period lies

between February 1998 and 07/01/1998 ; iron and steel prices are more stable, with a slight downward trend. The third period, ranging from July 1998 to December 1998, is a tremendous crash, at the end of which prices have gone down to less than 50% of their initial level. The same structural breaks are relevant for the description of the "shredder" quality and all other qualities, except cast iron. Since we can take advantage of the large size of our database (the unit of observation is a transaction for the considered quality), we will analyze separately the three subsamples, in three different regressions. The regression for the crash period will not be reported in this text, because it is far less informative than the other two in terms of differential treatments.

In each case, we split suppliers into two groups : contractual suppliers and others. Each of these groups is again split into 125 subgroups, according to the quintiles of total frequency (number of days, within the two years periods, where the supplier visited the recycling site), of total weight delivered (sum on all transactions, all qualities) and of average weight of the batch for the considered quality. Consequently, there are (2x5x5x5) groups. Most of those groups are empty though (e.g. there is a logical contradiction between a low frequency, a low average weight and a high total weight).

The specification we estimate is a regression of the difference (in Belgian francs per kilo) between offered price and reference price on dummy variables indicating membership in one of the 250 groups, on the reference price itself and on interaction terms between the reference price and the dummy variables. By so doing, we estimate to which extent the variations in the reference price were transmitted in the price offered to suppliers of each group. Using a difference as dependent variable is a way to avoid stationarity problems in this case. The hypothesis underlying the choice of regressors is that the frequency and volume of transactions determine the reliability of the supplier and which of the constraints is binding.

We were in a position to check that suppliers falling within the same group were treated in the same way by the reception and by the commercial director.

It would be quite impractical to report the regression results with 250 regressors, and then to perform hypothesis testing in order to show that some groups could be merged. Rather than this statistically accurate method, we chose to present the regression results after merging of groups, although standard errors are then vulnerable to the criticism against pre-test estimators. Keeping in mind that we do not intend to use these results for prediction, this a small price to pay in order to provide the readers with modestly sized result tables.

The definition of the merged groups is the following. Group 1 is the basis category. It is composed of all suppliers that do not have a contractual arrangement with the recycling firm, except those classified in group 8. Group 2 is composed of the intersection of the first two quintiles of average volume per batch and the first two quintiles of total frequency. These are small contractual suppliers, who average volume per batch merely surpasses the one the biggest gleaners. Group 3 is a category of semi-public institutions that collect waste as part of their public-good production activity ; they are in the second and third quintile of average volume and in the first two quintiles of frequency ; they have considerable bargaining power but are not really experts on the functioning of the scrap market. Group 4 members are in the second and third quintile of average volume per batch and in the last two quintiles of frequency ; these are the average scrap merchants, that possess no huge transport equipment and that must rely on their frequency of visit to gain an significant market share. Group 5 is the subset of the first quintile of frequency that also lies in the third quintile of average volume per batch ; in many ways, this is the mirror of group 4 ; these merchants bring once in a while very large batches of scrap. Groups 6 and 7 partition the last two quintiles of average volume per batch ; we have filled group 7 with a few iron and steel factories that directly deliver production scrap to the recycling firm and with German recycling firm that export

their output to Belgium and merge it in order to exercise market power on the output market ; even the biggest scrap merchants, populating group 6, and the recycling firm itself cannot compete in size and market power with this dozen of particular suppliers. Group 8 is composed of gleaners that bring infrequently batches in the upper quintiles of average volume ; those batches are likely to contain hidden layers of waste.

Group 3 and 7 have somewhat particular characteristics that put them aside. For example, suppliers of group 3 actually bring a quality higher than "shredder +", but since they don't have any experience of the quality nomenclature, they receive a Lemons price most of the time ; their batches are sometimes classified under "shredder +" when it is obvious that they are not of the lowest "shredder" quality. Members of group 7 send whole trains of scrap batches ; each transaction with them is bargained upon specifically, the agreed price reflecting international considerations as well as local ones. From the viewpoint of frequency, groups 2, 5 and 6 stand below group 4. From the viewpoint of average volume per batch, group 2 stands below group 4 and 5, that in turn stand below group 6. Members of groups 1 and 8 are not contractual suppliers and are expected to be treated almost exactly as mentioned by the reference price. Quintiles of total weight delivered (all qualities) were not so useful in distinguishing among suppliers than quintiles of frequency and of average volume per batch.

FIRST PERIOD

difference	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
group 2	-.4510418	.1787318	-2.52	0.012	-.8013893	-.1006942
group 3	-.0390809	.1364954	-0.29	0.775	-.3066373	.2284756
group 4	-.2745096	.115727	-2.37	0.018	-.501356	-.0476632
group 5	3.195374	.8199978	3.90	0.000	1.588026	4.802722
group 6	-.8020529	.1234736	-6.50	0.000	-1.044084	-.5600217
group 7	-.3083887	.1281828	-2.41	0.016	-.5596509	-.0571265
group 8	-.2594316	.0886449	-2.93	0.003	-.433192	-.0856711
refer. price	-.111204	.0078537	-14.16	0.000	-.1265988	-.0958092
ref.p.group2	.156726	.0605984	2.59	0.010	.037942	.2755101
ref.p.group3	.0030659	.0469591	0.07	0.948	-.0889827	.0951146
ref.p.group4	.2272977	.0392953	5.78	0.000	.1502715	.3043238
ref.p.group5	-1.025488	.2736551	-3.75	0.000	-1.561902	-.4890726
ref.p.group6	.3384202	.0417122	8.11	0.000	.2566565	.420184
ref.p.group7	.113959	.0438528	2.60	0.009	.0279995	.1999186
ref.p.group8	.0961624	.0300843	3.20	0.001	.0371915	.1551333
_cons	.2823264	.0231717	12.18	0.000	.2369056	.3277472

Source	SS	df	MS	Number of obs =	10694
Model	74.3858372	15	4.95905581	F(15, 10678) =	195.49
Residual	270.875227	10678	.025367599	Prob > F =	0.0000
				R-squared =	0.2154
				Adj R-squared =	0.2143
Total	345.261065	10693	.032288513	Root MSE =	.15927

SECOND PERIOD

distance	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
group 2	-.3119411	.4008155	-0.78	0.436	-1.097692 .4738094
group 3	3.796026	.3624321	10.47	0.000	3.085522 4.50653
group 4	-.2755249	.2413565	-1.14	0.254	-.7486752 .1976255
group 5	-4.411216	1.658897	-2.66	0.008	-7.663283 -1.159149
group 6	1.743315	.2353511	7.41	0.000	1.281938 2.204693
group 7	-1.756182	.2801182	-6.27	0.000	-2.30532 -1.207044
group 8	-.6116382	.2181691	-2.80	0.005	-1.039332 -.1839439
prff1	-.1031788	.0193858	-5.32	0.000	-.1411824 -.0651752
ref.p.group2	.1374697	.1496151	0.92	0.358	-.1558325 .430772
ref.p.group3	-1.154964	.1352543	-8.54	0.000	-1.420114 -.8898142
ref.p.group4	.2855043	.089899	3.18	0.002	.1092682 .4617404
ref.p.group5	1.819845	.6571211	2.77	0.006	.5316387 3.108052
ref.p.group6	-.4566755	.0881226	-5.18	0.000	-.6294292 -.2839219
ref.p.group7	.6663859	.1047666	6.36	0.000	.4610036 .8717681
ref.p.group8	.2576477	.0818249	3.15	0.002	.09724 .4180555
_cons	.2262166	.0519622	4.35	0.000	.1243509 .3280823

Source	SS	df	MS	Number of obs =	5728
Model	162.960752	15	10.8640501	F(15, 5712) =	356.74
Residual	173.953577	5712	.030454058	Prob > F =	0.0000
				R-squared =	0.4837
				Adj R-squared =	0.4823
Total	336.91433	5727	.058829113	Root MSE =	.17451

Group 1 is the basis category. It is insured at a 10% level against variations in the reference price. The average price perceived by its members is exactly the reference price, in the boom period as well as in the second one. Group 2 is not very differently treated from group 1 although it is composed of contractual suppliers. These are called "undesired contracts" in the recycling firm, i.e. suppliers who have explicitly asked themselves for a verbal contract but who are not given a better treatment for that sole reason. Group 3 is exposed to the rise of prices in the boom period, but it receives a constant price in the second period (the total impact of the reference price on the dependent variable is not significantly different from -1 for group 3). It never receives a higher average price than the basis category. Group 4 is slightly overexposed (10% to 15%) to reference price variations. Speculation is the reason why this phenomenon is observed. Members of group 4 still try to take advantage of price variations. Actually enabling them to do so by over-adjusting the contractual unit prices is a

risk for the recycling firm : when such suppliers are given high unit prices, the incentive to artificially raise the weight of batches is high. The recycling firm nevertheless gives them a better overall treatment than to the basis category because the frequency of visits by members of group 4 is high enough to guarantee that they are monitored frequently and that they have little incentive to cheat. Group 5 is given a constant price during the boom period (coefficient close to -1) and is over-exposed to the decrease in prices in the second period. Large, infrequent deliveries are suspect for the receptionist and for the commercial director. It is therefore important not to raise prices too quickly with such suppliers, because they could easily hide waste in the heart of their batches. But on the other hand, their market share in the firm's total input is significant, which explains why they receive a much higher average price than the basis category (as testified by the intercept coefficient of the group in the first period, an astonishing 3.20). In the second period, their average price quickly returns to the one given to the basis category. Group 6 is exposed to the rising prices and insured against the decrease in prices occurring in the second period. These are the buyer's pet, always receiving the highest average price of all categories, and for good reasons ! The biggest scrap merchants have a large market share in the recycling firm's total input ; most of them have invested in production capacities during the boom period and they need income stabilization after this decision. The firm provides them with this service through contractual arrangements. Group 7, as it is said earlier, receives prices that reflect international conditions, something that is not really incorporated into our specification. Finally, group 8 does not benefit from the slight income stabilization offered to other non-contractual suppliers, because their low frequency and high average volume per batch raises the suspicion of the receptionist.

Groups 4 and 6 are obviously those with which sharing the surplus of the reputation mechanism is the easiest. Speculators want big price variations, investors need stable cash

flows. Group 5 is trapped by the information constraint because its members do not visit the recycling site as frequently as members of group 4 ; they are therefore not so easy to monitor and hence not so trustable. It is very likely that the price they receive is simply dictated by the participation constraint. The difference between group 1 and group 8 also reflects the willingness to stabilize the suppliers' income and the inability to do so with some of them given the incentive constraints.

Now we turn to the same regressions for the "shredder" quality. 50 categories of suppliers were considered, because, in this case too, suppliers could not be relevantly discriminated on the basis of total weight of scrap delivered for all qualities. Contractual suppliers are considered separately from others, and in both groups quintiles of frequency and of total volume are the relevant subgroups. After the merger of subgroups that exhibit similar coefficients, nine categories of suppliers appeared. Group 1 is our basis category ; it is composed of most collectors that do not have a contractual arrangement with the buyer, except those in highest quintiles that are members of groups 2, 3 and 4. Group 2 is the intersection of the fifth average volume quintile and the second frequency quintile, while group 3 gathers the third and fourth frequency quintile in the fifth frequency quintile. Group 4 members are in the third and fourth average volume quintile and in the fourth and fifth frequency quintile. Group 5 is the intersection of fifth quintiles. Group 6 members are the most infrequent contractual suppliers, those lying in the first two frequency quintiles. Groups 7, 8 and 9 are composed of contractual suppliers who visit the recycling site frequently ; group 8 members are the same international suppliers as those mentioned in the "shredder +" quality ; group 9 gathers the eight biggest suppliers of the firm in this quality of scrap, eight scrap merchants that clearly intervene in the functioning of the reputation networks ; the remaining ones are classified in the group 7, that gathers "the smallest ones among the biggest ones" so to speak.

FIRST PERIOD

difference	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
group 2	-.9924728	.5610959	-1.77	0.077	-2.092353	.1074074
group 3	2.416998	.5944741	4.07	0.000	1.251689	3.582307
group 4	-.8653913	.2047017	-4.23	0.000	-1.266655	-.4641277
group 5	6.564058	.6966117	9.42	0.000	5.198535	7.929581
group 6	-.9907124	.1367087	-7.25	0.000	-1.258694	-.7227311
group 7	2.262511	.4423447	5.11	0.000	1.395411	3.129611
group 8	(no observation during this period)					
group 9	-2.246381	.1718597	-13.07	0.000	-2.583267	-1.909495
refer. price	.3007959	.0190566	15.78	0.000	.2634405	.3381513
ref.p.group2	.3929803	.2206738	1.78	0.075	-.0395924	.825553
ref.p.group3	-.9300936	.2323823	-4.00	0.000	-1.385618	-.4745695
ref.p.group4	.3406333	.0809715	4.21	0.000	.1819101	.4993564
ref.p.group5	-2.540977	.270873	-9.38	0.000	-3.071951	-2.010002
ref.p.group6	.4164822	.0546802	7.62	0.000	.309296	.5236683
ref.p.group7	-.7999641	.1730537	-4.62	0.000	-1.13919	-.4607381
ref.p.group8	(no observation during this period)					
ref.p.group9	1.01264	.0681364	14.86	0.000	.8790769	1.146204
_cons	-.7658155	.046814	-16.36	0.000	-.857582	-.674049

Source	SS	df	MS	Number of obs = 8746		
Model	142.072482	15	9.47149881	F(15, 8730) =	209.82	
Residual	394.084797	8730	.045141443	Prob > F =	0.0000	
				R-squared =	0.2650	
				Adj R-squared =	0.2637	
Total	536.157279	8745	.061310152	Root MSE =	.21247	

SECOND PERIOD

distance	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
group 2	-1.169317	.335716	-3.48	0.001	-1.827553	-.5110802
group 3	-.9430716	.2128907	-4.43	0.000	-1.360485	-.5256579
group 4	.0238575	.1912475	0.12	0.901	-.3511205	.3988354
group 5	-.3099612	.2133219	-1.45	0.146	-.7282204	.1082979
group 6	-.0255042	.1709283	-0.15	0.881	-.3606424	.309634
group 7	-.3188201	.20219	-1.58	0.115	-.715253	.0776128
group 8	2.822707	4.802757	0.59	0.557	-6.594033	12.23945
group 9	-.3673339	.1840821	-2.00	0.046	-.7282626	-.0064052
refer. price	-.1338828	.0384404	-3.48	0.001	-.2092526	-.0585129
ref.p.group2	.5784371	.1554129	3.72	0.000	.2737198	.8831544
ref.p.group3	.4638223	.0991168	4.68	0.000	.2694846	.65816
ref.p.group4	.0041574	.0876647	0.05	0.962	-.1677263	.1760412
ref.p.group5	.160749	.0991816	1.62	0.105	-.0337158	.3552137
ref.p.group6	.0514369	.0782743	0.66	0.511	-.1020351	.2049088
ref.p.group7	.352165	.0916397	3.84	0.000	.1724875	.5318425
ref.p.group8	-.9550061	2.289322	-0.42	0.677	-5.443667	3.533655
ref.p.group9	.3807119	.0853371	4.46	0.000	.2133918	.5480319
_cons	.3450709	.0831048	4.15	0.000	.1821278	.5080141

Source	SS	df	MS	Number of obs = 3266		
Model	106.609556	17	6.27115036	F(17, 3248) =	122.35	
Residual	166.479635	3248	.051256045	Prob > F =	0.0000	
				R-squared =	0.3904	
				Adj R-squared =	0.3872	
Total	273.089191	3265	.083641406	Root MSE =	.2264	

Summary of offered unit price (FIRST PERIOD)				
group	Mean	Std. Dev.	Freq.	
1	2.4232373	.24936458	5103	
2	2.5470543	.34942007	129	
3	2.5994979	.29266481	239	
4	2.5226211	.23717596	908	
5	2.6086274	.28106602	306	
6	2.5406519	.43747176	905	
7	2.7768699	.31462119	246	
9	2.8303736	.34734995	910	
Total	2.5111422	.31914437	8746	

Summary of offered unit price (SECOND PERIOD)				
group	Mean	Std. Dev.	Freq.	
1	2.2126323	.19029952	1417	
2	2.2882474	.34692702	97	
3	2.2490228	.31232686	307	
4	2.2662939	.20192902	313	
5	2.2364769	.26695112	281	
6	2.3219935	.43367769	306	
7	2.7121192	.5057992	151	
8	2.9813044	.02848847	46	
9	2.6584195	.31148725	348	
Total	2.3171586	.33150446	3266	

A first comment bears on the interpretation of the coefficient of the reference unit price. For the basis category, it should be zero, because the reference price (100%, not more, not less) should apply to suppliers who are not favored in any way, namely those in the basis category for the lowest quality of scrap. The following reason explain the 30% over-exposition of those suppliers to the rise in reference price during the first period. The difference between "shredder" and "shredder +" qualities was introduced precisely when our sample starts. In order to avoid a misinterpretation of this distinction as a way to implement a Lemons strategy, the buyer had to price both qualities at comparable rates for some time, although reference prices were already following distinct time paths, i.e. the "shredder +" price was rising at a faster speed than the "shredder" price.

The second and third groups were also over-exposed to the decreasing trend of prices during the second period, but not to the increasing trend of prices in the first period (at least, for group 2, in a manner that is not significantly different from the treatment of the basis category). Enabling speculation is indeed a risky strategy with such suppliers, bringing large

batches with a low frequency. The average price received by those groups are anyway not different from the one granted to the basis category. It was already stressed in the interpretation of results about the "shredder +" quality that infrequent suppliers could never be given a more-than-proportional rise in price compared to the reference price, in order to refrain them from exploiting these opportunities by hiding waste in their (large) batches.

Groups 4 and 5 are not given a treatment different from the one of the basis category during the second period. However, group 4 is offered an opportunity to speculate in the first period, while group 5 is given a stable revenue at the same time. This difference is somehow puzzling but may be explained by a possible transition of members of group 5 to the status of contractual suppliers, through investment ; if this is the case (unfortunately, we have been unable yet to collect data at a personal level with suppliers), group 5 badly needed income stabilization.

Coefficients of contractual suppliers groups are even more easy to interpret. Group 6 gathers "false contracts", as we called people receiving a comparable treatment in the upper quality. Notice that this group receive, in both periods, average prices that are in no way higher than the ones granted to non-contractual suppliers ! They are simply given the same opportunity to speculate as group 4. Group 7 benefits from income-smoothing during the first period, just like gleaners of group 3, and just like them again but at a higher level of average prices, the reference price cut occurring during the second period is transmitted more than proportionally to their offered price. The coefficient of group 8 should not be interpreted in the light of local conditions since those transactions are concluded at an international level. On the contrary, group 9 is the heart of the sector and is given at the same time higher average prices and nice opportunities to speculate in both periods.

Differential treatments between suppliers have now been emphasized and justified, even though they should be hidden from the view of suppliers according to arguments developed in

section 3. For some suppliers, information and participation constraints are binding. With some others, it is clear that the recycling firm benefits from its relatively low preference for stable cash flows, because stabilizing the suppliers' incomes is a way to meet their demands while keeping high expected profits. We can also observe the fact that difference between contractual and non-contractual suppliers are much more blatant in the "shredder +" quality, while only the biggest of the biggest are treated in a way that indicates no binding constraint on the side of the "shredder" quality. This is not surprising because the "shredder" quality is a low one.

5. Conclusion

This paper is an inquiry into the apparently well-functioning market of iron scrap setup by a Belgian recycling firm. We have underlined that, although Lemons pricing actually occurs in a non-negligible share of transactions, some of these are preserved from it through the play of a reputation equilibrium. This equilibrium is partly supported by a probabilistic punishment strategy on behalf of the buyer and by a multilateral, self-policing reputation network on behalf of the suppliers. The self-defeating nature of the latter collective action, empowering the recycling firm with a local monopsony, is circumvented by confirming mirror beliefs on the other party's possible irrationality. Suppliers may well hide waste in their batches when they are unsatisfied with the buyer's pricing attitude, while the buyer acts as if he were the eye and hand of an abstract market where "true prices" would exist. Differences of treatment between suppliers must be kept secret at all costs because they would be interpreted as unavowed applications of Lemons pricing. Though they are hidden, such differences exist and are explained by the recycling firm's interest in meeting the suppliers' demand in terms of income stabilization or opportunities to speculate, but also by the information and participation constraints that bear on these individualized pricing strategies. The firm must hit a good compromise between preserving the surplus generated by the reputation equilibrium

and maximizing its own expected value by sharing this surplus under the form of risk management rather than in terms of average price.

From this case study, we can draw a number of lessons of much wider scope. The first of these lessons is the empirical validation of Lemons pricing, a well-known and well-established theoretical prediction that did not receive the attention it deserves from empirical researchers, especially if one compares that with the numerous illustrations of monopoly pricing or discriminatory pricing. Our example emphasizes that monitoring, if it is costly, does not solve the problem entirely, a fact that is easy to establish in theory but is often disregarded in practice.

A second lesson is the existence of a solution to the inefficiency raised by Lemons pricing. This solution can be accurately depicted as a reputation equilibrium in a repeated-interaction context. Two theoretical predictions were illustrated here. Firstly, the time frequency of transactions is a favorable factor for the reputation equilibrium. Secondly, the presence of multiple equilibria is not really proven, but more than hinted at, by the existence of a group of suppliers (indicated by the "Incomp" variable) on which Lemons pricing is inflicted despite other favorable characteristics. These suppliers are described as ignorant and incompetent, but it is not clear whether it is a cause or a consequence of their failure to coordinate on a reputation equilibrium.

The buyer's reliance on a probabilistic punishment strategy is somewhat surprising. Mixed strategies are very convenient tools to work with in theory, but not in practice. Here, the cause of their occurrence is the difficult observability of defection strategies : waste can be "accidental" or not. It is therefore difficult to meet at the same time an incentive constraint, requiring that defections are severely punished, and a participation constraint, requiring that heavy sanctions cannot be imposed all the time, i.e. even when waste is accidental. A mixed strategy is two-dimensional and can settle these two issues more easily than a one-

dimensional strategy. A hard penalty may be imposed with a moderate probability, assigning the first instrument to the pursuit of incentive functions and the second one to the taming of participation constraints. The particular importance of mixed strategies is probably worth investigating in other contexts as its scope exceeds this case study.

Fourthly, we provide the reader with one additional empirical evidence on multilateral reputation networks. Besides the obvious similarities, there are a few differences between this illustration and Greif (1989)'s seminal example. His was historical, ours is contemporary ; this is of some epistemological importance since the range of evidences is thereby expanded to actual observations and data collection. By indirect means (i.e. the time series effects of reference prices on individual prices), we could also establish which constraints were binding for which categories of agents. Those predictions (in terms of necessary frequency and average transaction volume) might generalize to other sectors, although this can only be proven by further tries.

A fifth lesson to be drawn is the self-defeating nature of a multilateral reputation network when it creates monopoly power, a likely consequence of the characterization of reputation as a person-specific asset. The collective action undertaken by the side of the market that creates the network generates no benefit for its members since the other side of the market can then confiscate the surplus. Some positive means of preventing that from happening is needed. In our case, such an opportunity has arisen through confirming the buyer's belief that some suppliers may hide waste in their batches as a sign of discontentment.

This last point brings us to the last contribution of this paper. The robustness of a game-theoretic equilibrium to the belief that some players may not play equilibrium strategies, but perturbed strategies (more exactly, they are of a perturbed type with respect to rational players), is called "strategic stability", a property first put forward in a systematic way by Kohlberg and Mertens (1986). Although defining strategically stable equilibria in all

generality requires powerful mathematical tools well beyond the current practitioners' abilities, the underlying reasoning seems intuitive enough to be mentioned by the receptionist in our interviews. Strategic stability may well be a necessary requirement, and therefore a relevant selection criterion, for reputation equilibria in borderline situations, where the observation of strategies is costly, detection of defection is difficult, and incentive, information and participation constraints may limit severely the institutional setup. In practice, this is done by confirming beliefs that one could well be of a perturbed type (the particular types of irrationalities mentioned in our text being only examples). We have therefore identified a class of situations where hiding information (on one's rationality) ends up to efficiency-enhancing, through the play of multilateral reputation networks. It is very easy to construct a theoretical example where revealed information destroys efficiency, but the lack of practical examples, to our knowledge, was pointed out by Walliser (1994). Actually, we can conjecture that this idea will hold in all situations where a reputation equilibrium must be supported by the threat of irrational actions. Finally, the requirement of strategic stability interacts with the problems raised by the heterogeneity of suppliers. Those who are not able to participate in reputation networks may nonetheless engage in a reputation equilibrium with the recycling firm. While heterogeneity (except heterogeneity in wealth endowments, that can be beneficial by creating leadership) is a well-known detrimental factor in collective action problems, it does not appear to bear on the outcome of the reputation equilibrium here, although it bears on the institutional and behavioral setup that supports it.

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