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INFORMATION ASYMMETRY IN CONTRACT LOGISTICS: PROBLEMS AND SOLUTIONS

Cognome / Surname	Bossakov	Nome / Name	Petko Veselinov
Matricola / Registration number	078475		

Tutore / Tutor:	Prof. Silvio M. Brondoni
Coordinatore / Coordinator:	Prof. Silvio M. Brondoni

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Declaration of originality

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1. INTRODUCTION

1.1. Research problem and contributions

This work aims to explore a specific type of business opportunity brought about by the globalization of markets, the increased availability of information and the subsequent challenges related to extracting, summarizing and monetizing valuable data obtained from the global information flow.

This potential opportunity stems from the hypothesis that a provider who manages to solve the well-recognized information asymmetry problem through careful and focused use of widely available technological solutions may obtain valuable expertise and use it to build trust between buyers and sellers, increase efficiency along the supply chain, build a stable clientele and achieve profitability in the process.

In particular, existing work on web-based solutions to information asymmetries is surveyed, and the possible contributions of such a solution, when applied to the logistics market in Italy, are researched.

Field research includes development cooperation with Omnilog, an Italian company acting as an intermediary in providing services related to transport of goods, stock management, and logistics. Competitive advantages, derived from Omnilog's intangible assets and information technology experience, are considered. Specific technical solutions and operational data accumulated over three years of implementing web-based information services are analyzed.

1.2. Background and macro-trends

1.2.1. Overview of global markets

In recent decades, globalization has changed markets in several ways. The lower barriers to international trade have expanded the geographical reach of sourcing and outlet markets for goods. Since the 1980s, international agreements have extended trade liberalization to important new areas such as services and capital, intangible goods such as intellectual property, and types of goods previously considered too sensitive to be liberalized, such as agriculture products and textiles (World Trade Organization & General Agreement on Tariffs and Trade 1999).

As a consequence, trade in services has followed the same trend as trade in physical goods, and has overcome geographical boundaries as a result of increased cross-border supply, easier physical access of consumers to suppliers abroad, commercial presence in foreign countries, and movement of personnel (Hufbauer & Warren 1999). Easier movement of capital between nation states has favored these processes as well.

Another important factor is purely technological and concerns the ability to transfer information in larger amounts, over larger distances; increased bandwidth and coverage have enabled instant and constant collaboration on a global level. The increasing penetration of Internet access across all regions of the world has implications for both business-to-consumer and business-to-business trade:

> The proliferation of the Internet and e-commerce is wide reaching. The number of Internet users in the world reached 1.4 billion by March 2008, which amounts to almost three times that of 2000. According

to InternetWorld Stat, 41.2 percent of the Internet users come from Asia, followed by 24.6 percent and 15.7 percent from Europe and North America, respectively. Although the Middle East and Africa account for only 6.3 percent of Internet users, these two regions rank top two in their usage growth of over ten times between 2000 and 2008. In the same period, Internet usage in Asia and Latin America/Caribbean grew by 475 percent and 861 percent, respectively. As a result, the total global e-commerce turnover ballooned more than 33 times from $385 billion in 2000 to $12.8 trillion in 2006, taking up 18 percent of the global trade of commodities in 2006. Developed countries led by the United States are still leading players in this field, while developing countries like China are emerging, becoming an important force in the global e-commerce market.

Compared to business-to-consumer (B2C) e-commerce, business-to-business (B2B) e-commerce is larger, growing faster, and has less unequal geographical distribution globally. Increases in the freedom of the movements of goods, services, capital, technology, and people, coupled with rapid technological development, resulted in an explosion of global B2B e-commerce. The share a country is likely to receive of the global B2B e-commerce, on the other hand, depends upon country-level factors such as income and population size, the availability of credit, venture capital, and telecom and logistical infrastructure; tax and other incentives, tariff/nontariff barriers, government emphasis on the development of human capital, regulations to influence firms' investment in R&D, organizational level politics, language, and the activities of international agencies. (Kotabe & Helsen 2010, p.5)

These phenomena have changed the patterns of competition in several ways. As described by Brondoni (2010a, p. 11), "with globalization, the company abandons the static, limited conception of competition space and attributes the development of particular partial competitive advantages to specific geographical contexts, where they will be coordinated in a more complex system of corporate operations and profitability (market-space management)".

The necessity to increase market reach and efficiency by successfully managing such market-space competition contexts, and at the same time to maintain flexibility in order to be able to respond to sudden and quick changes in competitive scenarios brought upon by the increased competition and over-supply and compounded by the global economic decline in the late 2000s, has determined the necessity to establish and maintain a management strategy based on a network structure. Networks have been described as disseminated and interconnected organizations based on relations "managed in such a way as to permit control of alliances, equity (international joint ventures, equity investments) or non-equity (shared manufacturing/co-makership, R&D partnerships, outsourcing, supply-chain partnerships, cooperative marketing, licensing, franchising, etc.)" (Brondoni, 2010a)

Complexities linked to these types of network structures, as well as the need to leverage every possible source of competitive advantage, move the key competitive factors towards non-trivial elements such as intangible product dimensions (design, brand, customer service) and intangible corporate assets (brand portfolio, corporate image, corporate culture and information system).

The evolution leading to the market orientation paradigm in management is closely linked to the understanding of these intangible assets (Brondoni, 2002). Until the 1950s, the dominant management pattern was the *production-oriented* "scientific management", embodied in Ford's management system involving economies of scale and standardized mass production, and symbolized by his famous phrase: "Any customer can have a car painted any colour that he wants so long as it is black" (H. Ford & Crowther, 1922). The main determinant for this business model is a systemic, consistent excess of demand in relation to supply, and therefore the main sources of competitive advantage would be derived not by turning to customers, but by reducing production and sales costs in relation to competitors.

With economic growth between the 1950s and the 1980s, supply in many mass-produced goods increased and it became less efficient to compete solely on prices. At the same time, aggregate demand was still stable and predictable, and therefore *customer-oriented* "marketing management" took hold. Demand segmentation and product differentiation dominated an economic environment characterized by a dynamic equilibrium between supply and demand.

Since the early 1980s, the increased pace of globalization has led to market saturation and increased instability in many markets. Thus in the 1980s *Market-driven management* took hold, as a consequence of the globalization of the economy. Japanese manufacturers were among the first to introduce multiple innovations (lean production, just-in-time logistics, flexible management, etc.) that were later adopted by US and global firms in order to move forward to a management paradigm focused on the market

and on competition rather than strictly on manufacturing (*scientific management)* or demand (*marketing management*) (Brondoni, 2010b).

Among the aforementioned primary competitive factors, the present work examines in detail the implications of the information system and some specific opportunities that it offers for intermediaries to link supply and demand and to optimize exchange of products and services by implementing and monetizing market-changing innovations.

1.2.2. Information as a competitive resource

Information can be a powerful tool, both when used in the context of an internal information system, and in a larger framework of data interchange between organizations.

The role of information system technologies (IST) as a potential source of competitive advantage has been known and studied for decades. Shortly after the groundbreaking article by Porter (1979) was published, describing the five competitive forces that are now well known and accepted in academic research and business practice, the potential value of information systems in relation to these five forces has been pointed out. Ives & Learmonth (1984) cite the work of McFarlan (1983) that proposes five questions which may be used to link IST to each of Porter's five competitive forces:

- Can IST be used to build barriers against new entrants (CF1)?
- Can IST change the basis of competition (CF2)?
- Can IST be used to generate new products (CF3)?
- Can IST be used to build in switching costs (CF4)?
- Can IST change the balance of power in supplier relationships (CF5)?

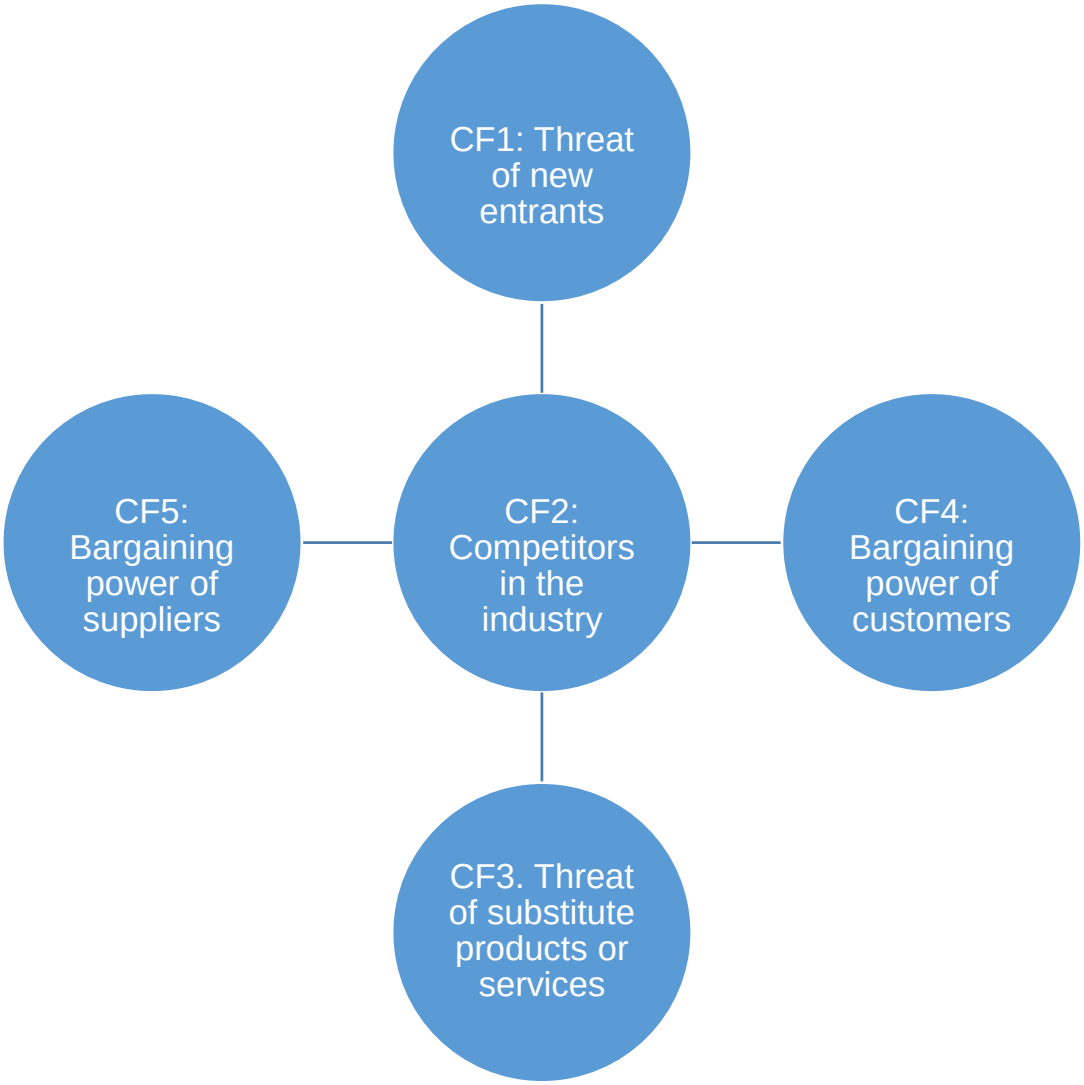


Figure 1. Competitive forces (Porter 1979)

Furthermore, Ives & Learmonth list specific examples of ways in which IST have been used in the 1980s to gain competitive advantages both in a business-to-business context (e.g. by providing pre-sales information to prospective corporate customers, assess demand, manage customers' inventories and place automatic orders), and in a business-to-consumer (B2C) setting (by enabling shopping, orders and payment, as well as providing end

customers with specific hardware for managing orders and customer service, thus creating switching barriers).

1.2.3. Technology background

1.2.3.1. Computer networks and IST as a tool for engaging consumers and stakeholders: a brief history

From the above, it can be shown that even though the use of IST in a competitive context (outside of internal corporate information management systems) is typically mentally associated with the World Wide Web, which gained a foothold in developed countries in the mid-1990s (Vetter, Spell, Ward, & Oman, 1993), it actually goes back at least three decades in time.

In fact, the technological prerequisites for cost-efficient digital data transmission between businesses, and even between businesses and consumers, have been available even earlier, as can be seen by the description given by Wolf & Marino (1969) of a simple device that can transmit digital data streams by modulating an audible sound tone, therefore making it possible to convey such digital data over a standard telephone line.

Bell 103, released in 1962, was the first popular, commercially available model of such a modulation/demodulation device (modem), based on the earlier *Bell 101* which was developed for military use. In the next decades, even as speed and efficiency of digital data transmission over telephone lines increased by two orders of magnitude, modems still maintained support of Bell 103 signal and speeds for compatibility reasons and for use over particularly noisy telephone lines. Therefore, in theory, a Bell 103 system could be used even today to access the Internet.

Prior to the establishing of a widely adopted worldwide computer network, such direct telephone-modulated connections between businesses' mainframe computers and consumers' terminals were used to accomplish what is currently being normally done through the Internet: "With a modem you can transfer bank funds, order airline tickets, look for a job, get a date, send letters, receive programs, list a house for sale, shop for bargains on cameras, cars, and TV sets... and lots, lots more" (Berry, 1984).

For consumers and small businesses, analogue transmission in the voice band, an approach compatible with virtually all telephone lines in the world, would remain the preferred digital communication method, and it has been constantly improved until the beginning of the 21st century, when V.92, the most recent standard for transmitting digital data over partially analogue telephone lines, was adopted, allowing transmission at 56 kilobits per second, a speed which is considered the theoretical limit for voice-band communications (ITU Telecommunication Standardization Sector, 2000). Since then, further work on voice-band digital data transmissions is virtually non-existent as consumers and businesses have moved towards broadband and wireless data exchange.

During that time, probably the most significant innovation in the area of voice-band modulated digital data, in terms of its implications for information interchange as a competitive factor, was the introduction of the *Hayes Smartmodem* in 1981 (CW Communications, 1981). It included in a single device, in addition to the modulator and demodulator circuits, an electronic controller that could be programmed with commands from the computer terminal and that was capable of interfacing with the telephone circuit by e.g. dialing a number, hanging up, and answering the phone. Before that, these

operations would have to either be done manually, or through an expensive external module. With accessible auto-answer modems, hobbyists and small businesses would be able to easily provide various kinds of information services to consumers.

While the majority of businesses and consumers initially used the telephone switching network as a primitive store-and-forward infrastructure to exchange digital data, in the late 1960s research was started at the U.S. Department of Defense, laying the groundwork for what we know as the Internet (Cerf & Cain, 1983). Even though it is thought of as cutting-edge technology, in fact 96% of the traffic on the Internet is still being routed by the standards of Internet Protocol version 4 (IPv4), which were drafted and adopted more than 30 years ago (Jon Postel, 1980).

A newer version, IPv6, has also been available for a long time (Deering & Hinden, 1998), but its adoption is still very low as shown on statistical data collected by Google Inc. (2014) – meaning that, essentially, today's Internet is basically running on 1980s technology. It is still good enough for managing data flow – the major reason why the trend towards IPv6 adoption is slowly picking up is that the number of available Internet addresses is diminishing.

IPv4 uses 32-bit addressing, meaning that roughly 4.2 billion devices can be directly connected to the Internet at the same time. (Many more can be connected indirectly through NAT routing and other IP address sharing techniques, but that approach has its limitations). This limit is nearly exhausted (Internet Corporation for Assigned Names and Numbers, 2007), and the IP address depletion is accelerating now that Internet connectivity is no longer tied to computers: many other devices such as smartphones,

tablets, e-book readers, digital TV sets, smart watches, and other appliances can exchange data via the Internet.

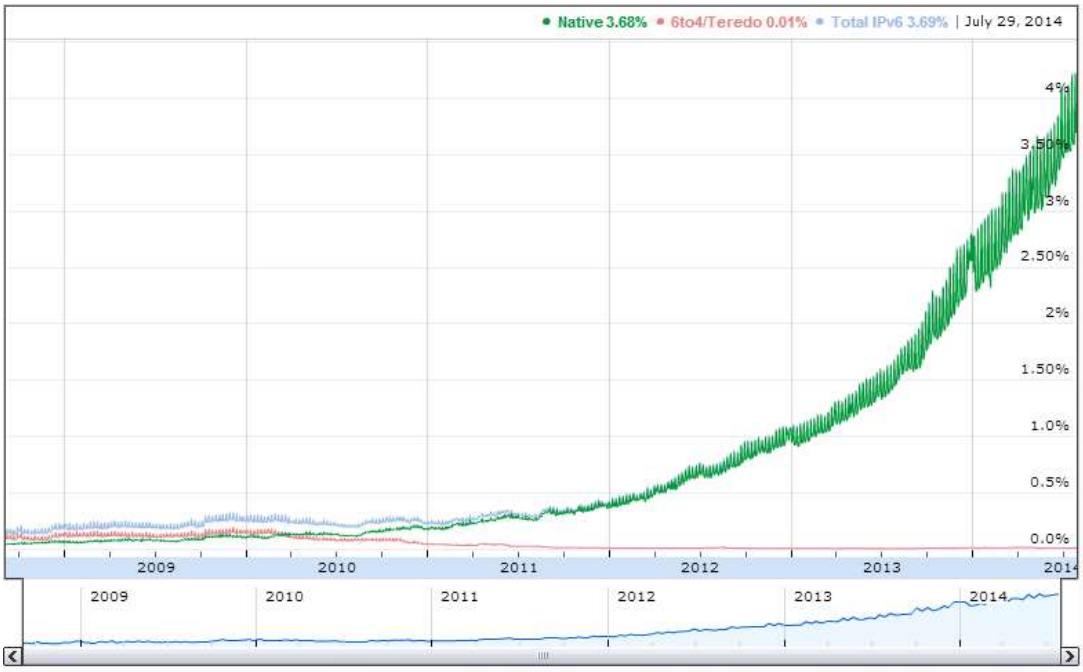


Figure 4. IPv6 adoption is still very limited, albeit increasing. (Google, 2014)

This shift towards portable devices is probably the most important trend that's underway in computer networking today. It has been enabled by the virtuous cycle in IT innovation (described in more detail later) that has reduced physical size and manufacturing cost of electronic devices. Moreover, several factors work towards enabling a more efficient use of radio frequencies, which are a scarce resource that's necessary for wireless communication. First of all, more efficient component design and manufacturing means that new devices have higher processing power. This factor, along with better error correction and time sharing algorithms, allows portable devices to transmit, receive and process the same amount of data in

a shorter time, thus freeing up the frequency band for other devices in the area. Additionally, government regulators have worked to allocate radio frequency bands in a more efficient way, freeing up more of the scarce bandwidth for digital devices. For example, analog television signals have been abandoned, or are in the process of being abandoned, in many parts of the world. Replacing analog TV signal with digital signal (which uses less bandwidth) frees up frequencies for digital data communication such as mobile internet access.

1.2.3.2. Marketing and management drivers of technical advances

The above brief description of the evolution in information and communication technologies (ICT), and specifically in digital network connectivity, demonstrates that development in ICT is closely linked with the evolution seen in corporate management and the establishing of the market-driven management paradigm described earlier. Therefore, it can be argued that the development of long-distance digital interconnectivity and the development of competition-focused management are not two isolated phenomena.

Market orientation has been trending in management culture since the 1980s, and companies have been using widely available digital technology to engage consumers and business partners, again, since the 1980s. In fact, advances in ICT and market-driven management work in synergy to form a positive feedback loop: the ability to transfer information faster and cheaper over a long distance expands the reach of markets, modifies competition space and reduces time constraints, which in turn increases supply, market saturation and competition intensity.

The over-supply conditions then foster innovation and reduce the life cycle of most products. In fact, in such market conditions demand is so volatile ("disloyal, with high reactivity to promotions, 'unpredictable' in many purchase processes") that typical medium-term and long-term concepts popular in the framework of the marketing management paradigm (such as product life cycle, market segments, etc.) lose their sense and are replaced by very short-term, unstable, intentionally crafted "demand bubbles" that "identify temporary groupings of purchasers, which may be aggregated on the basis of sharing specific characteristics of a given corporate supply. [...] Demand bubbles are created and extinguished, starting from a precise, explicitly planned, corporate stimulus which normally takes shape in a corporate supply presented with tangible features such as to attract the preferences of a group of prospective customers and which is rapidly taken off the market when it is deemed opportune for the bubble to burst" (Corniani 2004, pp.60-61).

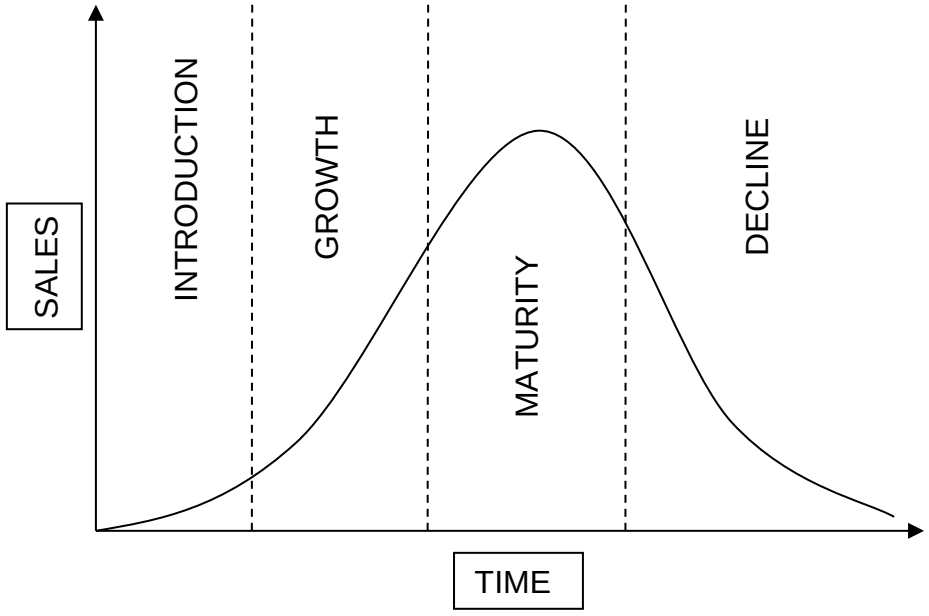


Figure 5. In marketing management, a product is viewed as a living entity with a "life cycle" that usually spans several years (Levitt, 1965)

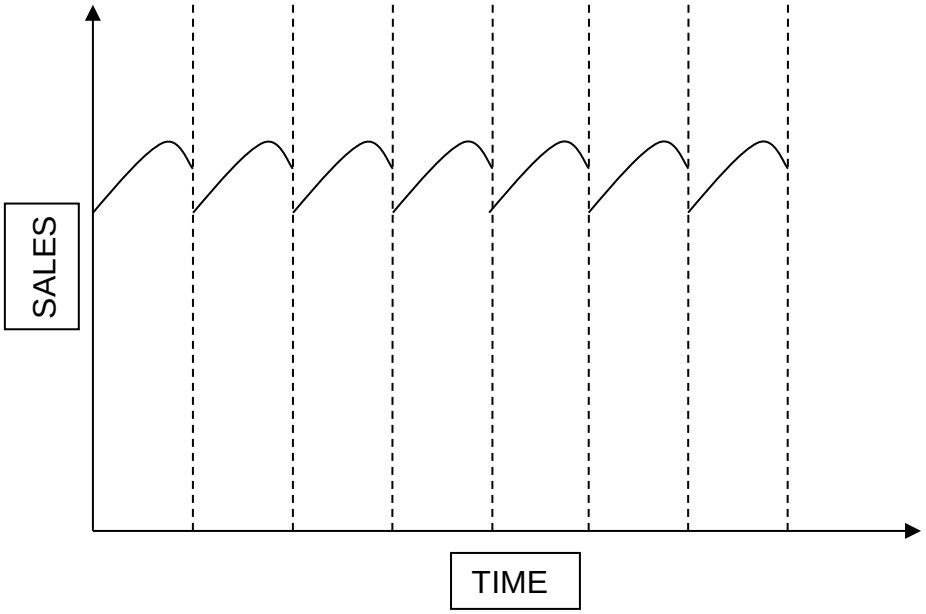


Figure 6. "Demand bubbles" are short-lived aggregations in an environment characterized by high intensity of competition, created and extinguished by market-driven firms in a quick succession, based on temporary demand conditions (Corniani, 2004)

This cycle of fast-paced innovation is most evident in the ICT sector itself, where innovation is constant and efficiency is rising at an unparalleled measure. In this way, the aforementioned positive feedback loop is completed, since such technological advances make doing business on a global scale much cheaper and easier, therefore increasing competition pressure even more.

In spite of this continuing rapid innovation, and the enormous progress computers and other electronic communication devices have gone through,

virtually all of these devices manufactured today still work on the principles summarized and published by Von Neumann (1945) while designing one of the first electronic computers, the EDVAC, at the University of Pennsylvania's Moore School of Electrical Engineering. Those principles are now collectively known as the *Von Neumann architecture*.

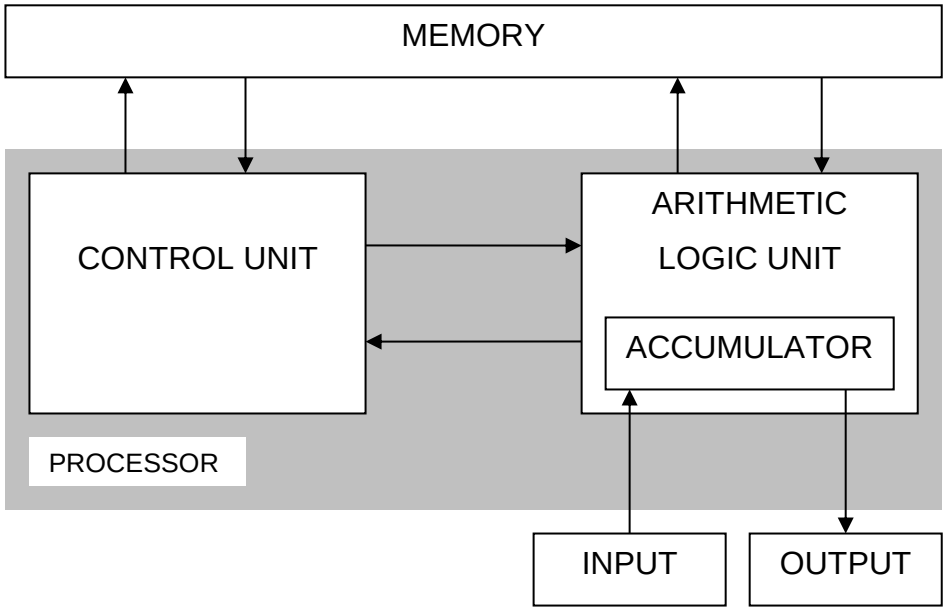


Figure 7. The Von Neumann architecture (1945) is still being used for modern computers and for other electronic devices that are not ordinarily thought of as "computers" by the public, but do, in fact, contain all the essential elements of a computer (such as SIM cards, biometric passports, and many other devices).

Computers, in their very core essence, have stayed the same since the 1950s. With very few exceptions, they are Von Neumann computers, with minor deviations and improvements in the architecture in order to obtain

better performance (e.g. by providing a way to link input/output devices directly to the computer memory, without the intermediation of the central processing unit; or by installing a small amount of memory directly on the processor chip in order to speed up its operation).

At the same time, the accessibility and the usage model of information technology has changed radically. Therefore, the innovations which have played the most important roles in shaping the way we use digital communications technology have not been related to advances in core computer technology *per se*, but instead, in most cases, they have been either improvements in the manufacturing process, or marketing innovations.

The greatest advance in the manufacturing process was probably the introduction of the integrated circuit (also known as a microchip), which is the core unit in all computer component (processor, memory, input/output devices). Instead of producing electronic components (transistors) one by one and assembling them in a circuit, as was done until the 1960s, with the new invention it was possible to "print" them on a single semiconductor plate by photolithography. The resulting lower cost and defect rate expanded the market for electronic devices, allowing further cost reductions by achieving economies of scale.

The aforementioned "lean production" system promoted by Toyota also had an important effect on the affordability of integrated circuits. Earlier microchips were very vulnerable to defects, because a single scratch or piece of dust on the surface can render the entire chip useless; this high defect rate had a very large influence on the pricing of the "good" chips by increasing production costs. By fine-tuning production processes in order to eliminate

defects, the cost could be reduced by an order of magnitude. The design of the integrated circuit can have an important influence in this respect, because by reducing the physical size of the chip surface, the statistical probability for defects becomes lower: "...an 8" silicon wafer usually yields 1000 to 2000 LSI (Large-Scale Integrated) circuits. If, say, 20 areas have defects, up to 1980 usable chips remain." (Canon U.S.A. Inc. 2006, p.11)

A prominent example of an advance in the marketing of computers is the introduction of the *personal computer*. A personal computer is what most people imagine when hearing the word "computer" today: it is a machine designed in such a way as to allow it to run as a stand-alone system in an ordinary room or office, without being connected to large-scale mainframe devices, and to be used by a single, non-specialist person, without professional engineering teams constantly catering to its support, programming and maintenance.

The world's first personal computer was the *Programma 101* device produced by Italian manufacturer Olivetti (Wall Street Journal, 1965). As described in detail by Perotto (1995), the computer was innovative in several ways:

- It could physically fit on top of a desk;
- Programs for the computer were available on magnetic cards, therefore it was usable by a single person without special technical knowledge; the computer user did not have to write computer programs or input them manually into the computer's memory;

- It included various engineering solutions aimed at making it inexpensive relative to other commercially available computers at that time.

The Programma 101 was, therefore, a groundbreaking product, since it paved the way for marketing computers to new types of customers. While it was still strictly a business machine, the innovations present in the product were soon developed further by the industry, and "home computers" were born.

The almost simultaneous introduction of the first mass-produced home computers in 1977 – the *Apple II*, the *Tandy TRS-80*, and the *Commodore PET* – provides a good example of the shift of innovation management in the industry to a market-based paradigm. The three companies sensed the receptivity of the consumer market to what was essentially a new product created by combining already available technology with a new business model, and owed their success not so much to technical superiority or advantageous prices, but mostly to the way they were marketing their products as a complete, differentiated offer that included many intangible aspects such as design and customer support. For example, the Apple II has been described as "compact, attractive, and professional in appearance"; "elegantly designed, easy both to use and manufacture"; "an integrated and understandable product"; "able to draw on the large crop of external suppliers of software and add-ons that quickly sprang up" (Langlois, 1992). This pioneering market-driven idea (to bring computers to consumers' homes), and its successful implementation, brought about a major turning point that defined the way information technology is used now, in the 21st century.

History of information technology abounds with similar examples where applying an existing technology to satisfy a newly identified demand has resulted in marketing success and major reshaping of the industry; an example is the Internet which, as already mentioned, started out as a network to link military and academic research facilities, but now enables applications that target virtually all electronics users (consumer or business). Similarly, portable computer devices such as smartphones and PDAs were initially targeted towards a small number of professional consumers (travelling businesspeople, engineers doing field work, etc.), but are now considered a part of ordinary consumers' everyday life. In the specific case of tablet computers, more than thirty years after introducing its avant-garde "home computer", Apple Computer made another, similar revolution in marketing with its iPad line of devices, which is still the most popular brand of tablet computers in the world. Again, the iPad was not a technological innovation, as many other brands and models of tablet computers had been produced for over 20 years before its introduction. However, by turning the physical product into a complete, convenient "ecosystem", with a large number of intangible components, Apple turned a niche product with a highly specialized use into a necessity for the general public.

In conclusion, it can be argued that many innovations in information technology often have a major marketing component, and a more limited "technical" component. This is a striking case of the importance of market-driven approach, especially in highly developed, fast-changing, global markets. "In the microcomputer industry, the most successful products were those that took the greatest advantage—and allowed users to take the greatest advantage—of the market; and the greatest failures occurred when

business enterprises bypassed the external network and attempted to rely significantly on internal capabilities." (Langlois 1992, p.1)

In view of this potential of already existing technology to "revolutionize" markets when its opportunities are identified and applied successfully by "market-driven winners", the present work intends to study whether a single firm's IT expertise and its capability to identify market imperfections and opportunities can converge to provide unique new services to that company's customers, possibly with long-lasting implications for the market as a whole.

1.3. Research summary

This thesis aims to develop a concept for a practical software tool for increasing sales and promoting customer loyalty by providing IT-based solutions that help customers solve information asymmetry problems faced by them, and to discuss the potential advantages of such a strategy along with the possible approaches for its implementation.

Omnilog is an Italian company providing transport, logistics and inventory management services to businesses. It is an intermediary operating with virtually all major transport service providers in Italy, and its downstream clients include firms that vary in size, geographical location, and sector. Omnilog is, therefore, in a position to obtain valuable datasets that can be considered representative for the Italian logistics market as a whole.

The problem of information asymmetry in an outsourcing market is examined, and quantitative analysis is performed on some indicators in the Italian logistics market by processing operational data obtained by Omnilog over a period of three years in an attempt to obtain an estimate of how likely

information asymmetry conditions are to be present on the market. In view of these indicators, specific steps for implementing an information-asymmetry-reducing business model are considered.

1.4. Structure of the thesis

This PhD thesis is structured as follows:

- *Chapter 2* reviews literature on outsourcing in general and on logistics outsourcing specifically, and introduces the problem of information as a common linking thread related to multiple barriers limiting the development of logistics outsourcing. Typical features of the make-or-buy decision process are considered and their implications for logistics are discussed.

- *Chapter 3* provides an exploratory analysis of the logistics market in Italy, the market size and most important competitors, supply-demand relationships and other particular features. Quantitative analysis (multiple regression) is performed on costs and prices, and possible indicators pointing towards the potential existence of information asymmetry on the market are researched.

- *Chapter 4* describes several major players and innovative startups on the market, specifically in the IT and web marketing sphere, that tend to capitalize on existing information asymmetries and provide solutions for reducing them.

- *Chapter 5* presents possible specific technological solutions applicable to the logistics market in Italy, and specifically to Omnilog as a company present on the market. A SWOT analysis

is performed to determine the feasibility and efficiency of maintaining and utilize a database of transportation related data, and to use such a database in order to provide unique information-based services to potential customers.

- *Chapter 6* concludes the research by summarizing up-to-date progress in developing the aforementioned software solution and discussing the potential for further research and development in the area.

2. EFFICIENCY ISSUES IN LOGISTICS

A good understanding of the concept of efficiency holds the key to the age-old management dilemma: to outsource or not to outsource. Logistics is a field where outsourcing is a relatively new practice, the classical case being a firm with an internal organizational unit that manages logistics either as its primary job, or in combination with other tasks. However, in the past few decades, managerial enthusiasm has been increasing for outsourcing in general (Embleton & Wright, 1998), and for outsourcing logistics operations specifically, leading to a significant and steady growth in third-party logistics, described in more detail in the next chapter.

Typically, for each economic activity, a firm can choose between several different options: to seek an intermediate good or a B2B service on the market, to produce the same good or service internally, or to choose a hybrid solution (e.g. a long-term contract with a supplier or a joint venture, among other possibilities).

That choice has been studied within the framework of the theoretical paradigm of transactional costs, set out by Coase (1937), and further developed by economics and management scholars such as Williamson (1979; 1989).

In Coase's neoclassical view, there are two primary factors that influence the scale and scope of a firm and the degree to which it carries out its tasks internally instead of contracting them out:

- The extra transaction costs connected with sourcing that are not captured by the price mechanism. That includes monetary

and non-monetary costs connected with researching the market, negotiating and exchanging information, concluding and enforcing a contract, keeping trade secrets, etc. In environments where these costs are higher, firms will tend to be larger.

- The costs and risks connected with producing a good or service internally – various overhead costs necessary to maintain the organizational structure, as well as potential difficulties and possible mistakes when managing an overly complex organization. The presence of these factors acts in the opposite direction, restricting the growth of a firm.

In view of this theory, a complete assessment of the market for third-party logistics, its current state and its potential for further development can only be made by taking into account the efficiency implications of handling logistics operations internally versus entrusting them to a 3PL provider. It can be shown that some hurdles still exist and limit the penetration of third-party logistics, and that potential innovative uses of technology, never applied before in this particular industry, may have the potential to overcome these hurdles.

First, however, it is necessary to define the point where internal logistic activities end and 3PL starts. This distinction is not fully clear and straightforward, owing to a certain amount of vagueness in the terminology, especially the terms "subcontracting" and "outsourcing" that have been used in different periods and different sources – sometimes interchangeably, and sometimes with important nuances in the meaning:

> "In the 1970s, subcontracting practices were rather restricted to the production of goods. However, in the 1990s, their range of application came to encompass such functions of the company as supportive or administrative ones which had been unheard of in terms of outsourcing (Parrotin & Loubère, 2001). The decision of outsourcing has thus become a strategic action showing that firms aim at refocusing on their core activities or at looking for skills they do not have outside the company. The increasing number of research works on outsourcing has led to some kind of stabilization of the concept today. Barthélemy (2001, p. 7-8), in his research work on outsourcing strategies, clearly distinguishes outsourcing from subcontracting, downsizing and reengineering by defining it as "the fact to entrust a supplier or an external provider with an activity and its management rather to carry it out in-house". According to the author, three crucial elements characterize outsourcing: 1) the activity used to be carried out by the outsourcer, 2) the outsourced activity usually goes together with an assets transfer, 3) the relationship between the outsourcer and the provider usually runs on the middle or long term."
>
> (Ivanaj & Franzil, 2006, pp. 4–5)

Italian industry reports (Marchet et al., 2013, 2014) adopt a broader meaning of "contract logistics" and include providers of minor, discrete, non-strategic logistics-related activities, in the overview of the 3PL market (as in the example of non-incorporated haulers). They do, however, make a distinction between basic service providers and strategic contract logistics companies, and note that being in the latter category highly correlates with

a business consolidation and growth pattern that is different from the rest of the operators on the market, and is defined as being a "top player".

It is therefore desirable, for the purposes of analyzing the drivers promoting growth of third-party logistics, and conversely, the limiting factors that should be overcome in order to increase its penetration, to maintain this kind of distinction. For this reason, in the following sections "internal logistics" are defined to include third-party services, as long as they are discrete services (e.g. renting a warehouse or simple transport of goods and materials), provided by the subcontractor companies on a non-strategic level and lacking any integration with other operations.

2.1. Concerns in internal logistics

2.1.1. Scalability and uncertainty

Scale is probably the most problematic factor when developing logistics internally. In a typical case, the scale of the logistics assets that a firm can *afford* to maintain is consistent with the scale of all the other primary activities; logistics usually cannot be disproportionately smaller or larger than, for example, manufacturing or marketing.

At the same time, the scale at which logistics are the most efficient does not always fully correspond to the optimal scale of the firm's core activity. Market size constraints, difficulties in supply of materials and financing, organizational complexity, and other similar limitations can create diseconomies of scale that could prevent a larger firm from being viable in a competitive industry. A business could therefore find itself in a position where

growth would make its logistics functions much more efficient, but the market conditions do not support such growth.

The problem of uncertainty is another issue that limits the efficiency of internal logistics and it is, again, related to scale (or more precisely, to fluctuations in scale):

> "In the field of logistics, internal uncertainty has to do with, for example, the difficulty of company to estimate precisely their future needs, particularly concerning volume (Stank & Maltz, 1996). This form of uncertainty is directly connected to the uncertainty affecting the industry in which the company evolves. Consequently it is rather referred to the transactional hypothesis according to which the firms that must meet fluctuating demands are incited to resort to external resources for want of flexibility as well as for lack of capacity"
>
> (Ivanaj & Franzil, 2006, p. 11)

2.1.2. Economies of scope

A distinctive feature of 21st century markets is the acceleration of globalization and the continually diminishing boundaries between geographical market spaces. As described by Brondoni (2005, p. 2):

> "Since the late Nineties, the internationalisation of the world economy has been consolidated, and for a growing number of sectors, their geographical target market is no longer the nation or the continent, but industrialised countries in general. This evolution creates planet-wide competitive relationships (particularly crucial in Europe because of the size of the domestic markets) which make traditional multi-national (or multi-domestic) organisations obsolete, replacing them

with forms of transnational organisation. What is more, economic interdependence increases and domestic markets can no longer be considered separately, but must be seen as part of a single target market."

This expanded market space creates global economies of scale: the decreased legislative barriers and harmonized regulations, the easier access to international sources of capital, along with the cultural globalization that facilitates local adaptation of global brands, all make the processes of material sourcing, manufacturing, sales and management scalable on a global level, in contrast with a more traditional multi-domestic strategy that includes comprehensive local customization of the firm's product offering and marketing strategy, and is therefore more complex than a simple increase in scale, having the disadvantage of greatly reducing the economies of scale achieved through cost-sharing and centralization.

However, where logistics are concerned, the situation is not so simple, considering the fact that transport and logistics operations have a very important tangible component that is sensitive to geographical distances.

In simple words, the cost of placing an order is nearly identical, regardless of distance, since modern-day communications are cheap and approach the speed of light; at the same time, the cost of delivering the ordered physical goods is still rather proportional to distance. This makes it impossible, in logistics, to take advantage of the full benefits from globalization simply by increasing the scale (e.g. by constructing a single gigantic warehouse where the incoming and outgoing deliveries for a firm's

operations in the entire world are processed, to give an example taken to the extreme).

Instead, space expansion in logistics is achieved in a network pattern, by adding global transportation nodes, routes (origin-destination pairs), and hubs. In the context of transportation firms, it has been demonstrated that "economies of transport network expansion should be viewed through the concept of economies of scope rather than through the concept of economies of scale" (Jara-Díaz & Basso, 2003).

Thus, in addition to the aforementioned, scalability issues, achieving optimum efficiency in internally managed logistics is connected to the ability of the firm to properly develop and utilize economies of scope. Again, due to non-controllable conditions in the business environment, it may be the case that a smaller business (or one that has limited capabilities) may be unable to optimize its logistics function fully in this respect.

Today's competitive environment defined by the existence of global marketplaces with negligible geographical barriers may often create such a scenario (i.e. a micro-enterprise that, regardless of its small size, has the opportunity to sell on a global market). For example, this has been made possible through intermediaries who have already developed a network spanning multiple geographical regions and provide e-commerce tools to sell goods (and services) on the Internet. Several examples are given by Katz et al. (2003, p. 45): "Intermediaries such as Amazon.com, 1-800-FLOWERS, Priceline.com, and eBay have emerged to offer auction opportunities and/or to "broker" deals between multiple buyers and sellers in different kinds of markets (Franke, 1999; Dou and Chou, 2001; Garicano and Kaplan, 2001).

These types of companies have been referred to as “e-brokers,” “net-broker,” or “cybermediaries.”

While internet connectivity can greatly *improve* the logistics system (transportation, warehousing, inventory, etc.) it cannot *replace* the storage and transportation facilities in the same way that it has, in many cases, replaced the physical point of sale (brick-and-mortar stores). E-commerce may even, in some cases, increase the logistical cost burden on the retailer, since with traditional in-store purchases the consumer performs a significant part of the distribution function by picking up the physical product in the retail store (Alba et al., 1997). On the other hand, transportation from the warehouse to the retail store is a cost that the retailer does not have to bear in the case of e-commerce sales (Gurău, Ranchhod, & Hackney, 2007). Therefore, the net result of Internet shopping on the logistics function in business-to-consumer sales of tangible goods is, at best, uncertain. Global online marketplaces provide tools to expand marketing and sales reach even for small enterprises who do not have the capabilities to develop their own global network, but logistics operations are lagging behind in this aspect.

2.1.3. Access to resources

In addition to transaction cost economics, outsourcing activities can be explained under the resource-based theory (RBT) paradigm. According to RBT, the competitive advantage of a firm lies in its ability to access and apply a bundle of resources, either tangible or intangible (Barney, 1991; Eisenhardt & Martin, 2000; Nelson, 1991; Penrose, 1959; Peteraf, 1993; Rumelt, 1984; Wernerfelt, 1989). The value of resources can be leveraged by a firm regardless of whether such resources are internal or external; this creates

incentives for a firm to form partnerships that grant the firm with access to other firms' valuable resources (Madhok, 1997; Ramanathan, Seth, & Thomas, 1997).

Under this theory, exclusive reliance on internal resources can be seen as a handicap in logistics. Conversely, outsourcing can be in itself seen as a resource, and the strategic capabilities to outsource effectively and efficiently is, in fact, an intangible resource (Hobbs, 1996; Teece, 1986). The RBT paradigm can therefore be applied to explain the growth of 3PL: "As firms have increasingly outsourced larger portions of their logistics function, 3PLs have grown in their scope of responsibility accordingly. RBT suggests that the use of 3PLs has enabled firms to gain access to complementary resources and create much more competitive resource bundles, providing them with a competitive advantage." (Zacharia, Sanders, & Nix, 2011)

2.1.4. Access to network relationships

Network theory views outsourcing in logistics as a tool to build relationships that help manage the supply chain as a whole through relational contracting and network coordination (Bolumole, Frankel, & Naslund, 2007; Ellram, 1990; D. Ford, 1990; Snehota & Hakansson, 1995; Zacharia et al., 2011). In fact, supply chain management practice typically recognizes the interconnectedness of firms operating upstream and downstream. Under this view, treating logistics operations as purely internal functions of the firm may limit the range of its network interactions, and place it in a disadvantaged position.

Table 1. Underpinnings of social science theories relative to the role of 3PLs (Zacharia et al., 2011)

Social science theory	*Theory foundation*	*Support for outsourcing to a 3PL*
Transaction cost economics (TCE)	Firms exist to maximize profit by reducing their transaction costs	Minimizes a firm's transaction costs; as 3PLs grow in capability they offer services at lower costs further supporting their use
Resource-based theory (RBT)	Firms are comprised of bundles of resources that gives them a competitive advantage	Maximizes a firm's ability to access a range of resources; as 3PLs grow they can increasingly offer a wider range of resources
Network theory (NT)	Firms seek efficiency of an entire network through interactions with other firms	Maximizes a firm's ability to leverage relationships; as 3PLs become responsible for a larger number of supply chain members their ability to offer greater network interactions increases

2.2. Concerns in third-party logistics

2.2.1. Asset specificity

Many of the issues related to 3PL are specific cases of well-known generic problems of outsourcing under the transactional cost theory. Contracting third-party providers involves costs deriving from the activities of negotiating contracts, enforcing them, and managing the risk of opportunistic behavior. One of the determinants of these costs is asset specificity. It is defined as "the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value" (O. E. Williamson, 1989, p. 142). Specifically, Williamson distinguishes between several forms of asset specificity:

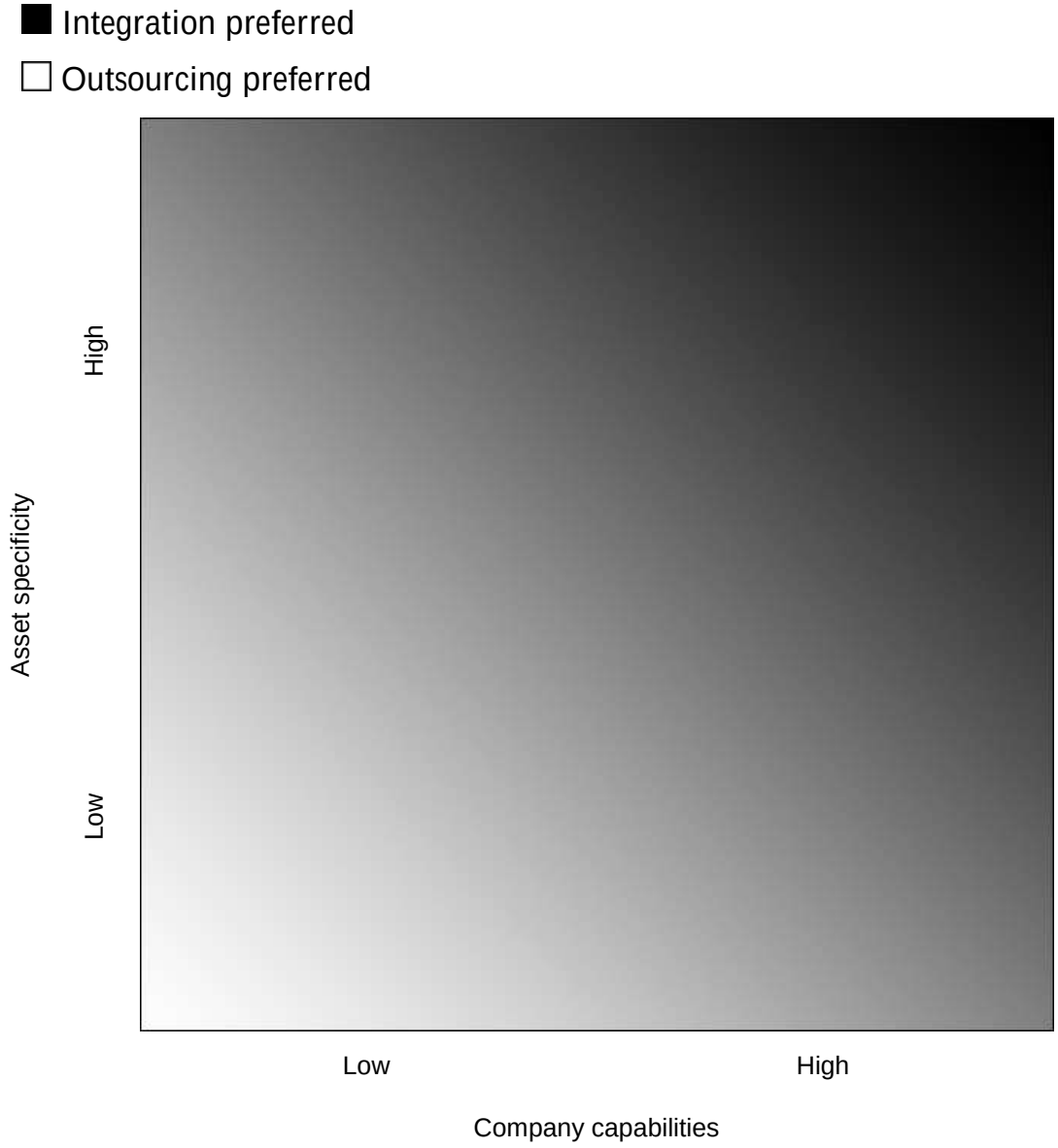
- Site specificity
- Physical asset specificity
- Human asset specificity
- Dedicated assets
- Brand name capital

The presence of highly specific assets presents higher risks of opportunistic behavior, especially if not properly taken into account when contracting; in this way, activities characterized by a high level of asset specificity may discourage outsourcing in favor of vertical integration.

When outsourcing, a lot of attention is placed on the need to protect the firm's core competencies (Lonsdale, 2001). However, even when core competencies are *not* outsourced (as is generally the case with 3PL), asset specificity can lead to a non-contractual lock-in with the supplier, which could then be exploited by the latter.

As Williamson indicates, asset specificity is connected to the concept of sunk costs. Therefore, for a firm that does not have the necessary capital and capabilities to implement a function efficiently by relying only on its internal organization and resources – and activities requiring highly specific assets may often be difficult to develop internally – the risk of opportunistic behavior by the supplier can still be acceptable (Figure 1).

Figure 1. Influence of company capabilities and asset specificity on the choice of outsourcing an activity



Nevertheless, even for an activity that inherently requires highly specific assets, outsourcing can be an appealing decision if multiple third-party contractors possess the necessary capabilities and compete with each other, allowing the client firm to choose, if and when necessary, a different provider with relatively low switching costs. According to Ivanaj & Franzil (2006, p.

9), this condition is somewhat satisfied in the 3PL industry, with some limitations:

> "In the field of logistics, the degree of assets specificity is a crucial determinant. For Paché and Sauvage (1999: 108), the degree of assets specificity corresponds to the fact that the activity of physical distribution may sometimes require special handling or warehousing equipment depending on the non standard products and /or market they address. Logistic suppliers have become more and more knowledgeable and demanded. They have developed relatively standardized especially in the field of warehousing, packaging and so on, so that the degree of assets specificity tends to decrease. However, reality is not that trivial. Many relatively basic operations such as transport, handling and warehousing and so on require specific and costly investments. We can mention here refrigerated vehicles, deep freeze storing surfaces for frozen foodstuffs, sophisticated forklift trucks, guidance systems, etc. (Bienstock & Mentzer, 1999). The irrecoverable costs of such investments are high and given this situation of bilateral monopoly, the risks of opportunist behaviour are almost inevitable. On the fringe, the high degree of specificity reduces the profits of outsourcing and encourages the principal to organise the given activity in-house. This situation has been noted by several researchers in the field of logistics (e.g., Aertsen, 1993; Beier 1989; Maltz, 1993, 1994)."

In brief, increased competition intensity in contract logistics and imitability of 3PL services and capabilities may prove beneficial for all competitors by standardizing the use of assets which are, otherwise, inherently highly specific. Such standardization could limit tie-in effects

between contractors and clients, and thus, according to transaction cost theory, make firms more open to the idea of outsourcing their logistics operations, even if they are capable of developing and maintaining such operations internally.

Therefore, asset specificity in 3PL is a market growth hurdle that can be overcome through innovation. Market leaders may benefit from developing standardized but flexible technological solutions that can be easily adapted to different clients' needs (especially where it comes to transporting types of goods for which special knowledge or equipment is required), encouraging more clients to turn to 3PL and increasing the demand as a whole. Such an approach would be similar to the business strategy of mass customization that has proved highly successful and popular mostly in B2C contexts (Blecker & Abdelkafi, 2006).

2.2.1. Information system costs

In addition to the risk of opportunistic behavior, the degree of service and asset standardization of the 3PL provider may also affect the direct technology costs borne by the client.

When outsourcing logistics, it is necessary to note that logistics operations are activities that require a regular (in most cases, daily) flow of data to be established between the client and contractor. This situation is contrasted to other typical cases of outsourcing where projects with a longer timeframe may be defined and the parties may share requirements, summaries and reports on an as-needed basis.

In practice, this data flow is virtually always automated, and it leverages the EDI instruments that have been developed in the past decades. It must be noted, however, that EDI is a very broad term and is generally used to designate any "computer-to-computer interchange of strictly formatted messages that represent documents other than monetary instruments" (Bhasker, 2006, p. 78). This definition encompasses all kinds of electronic data flow standards that are intended to allow transmission of information between two computer systems (that may possibly be otherwise incompatible), as opposed to electronic data that is meant to be human-readable.

The format of the electronic data itself can follow an international standard, or a proprietary one. Logistics and transportation operators often provide differentiated services to their clients and therefore it is not rare to encounter a data format agreed between the communicating parties that does not strictly follow any industry standard.

Even where standards are followed, there are multiple such standards that exist in hundreds of different varieties according to the data that has to be transmitted.

An example is the X12 EDI standard, developed in the early 1980s in the United States (Swatman & Swatman, 1991) which currently contains a set of standard formats for almost 300 documents used in different contexts for information transfer between businesses or government institutions (Accredited Standards Committee, 2011).

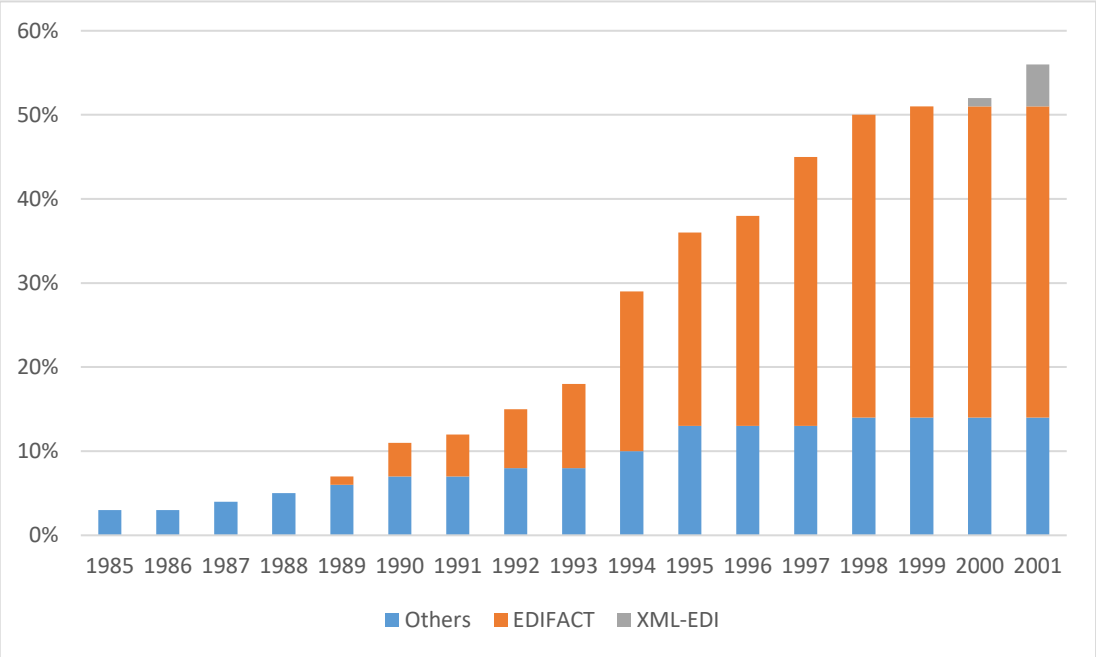
As a further development, in the late 1980s, in an attempt to respond to the challenges brought about by trade globalization and resolve incompatibility problems with industry-specific and national EDI standards,

the United Nations/Electronic Data Interchange For Administration, Commerce and Transport (UN/EDIFACT) specification was approved as an international standard (ISO, 1988b).

The expected advantages of adopting an international standard have not been universally embraced by businesses, and the usage of proprietary standards has remained a widespread practice. Even among firms who do use standardized EDI messages, it is not a common practice to upgrade IT systems and workflows when new variants of such standards are released, as it may be considered inefficient to bear the switching costs instead of staying with the older standard.

As a result, a firm wishing to automate transactions with business partners should be prepared for the fact that it is likely that they would be using different communication formats. For example, Figure 2 shows the EDI standard adoption in Germany according to a 2002 survey (Beck, 2006, pp. 79–93), which indicates a significant minority of organizations that have adopted EDI in a non-standard way.

Figure 2. EDI adoption in Germany (Beck, 2006, p. 88)



The resulting complexity is further compounded by the availability of multiple ways to transmit the data. It could be sent and received over telephone lines by using a modem, over a dedicated network line, or (most frequently) over the Internet or a virtual private network (VPN) running on the Internet. The Internet itself supports a vast variety of protocols that are all suitable to transport this type of data. Newly developed solutions often use HTTP, but it is not rare to encounter different solutions, for example storing the information on FTP servers run by the sender or the receiver.

A review of the data formats and transmission channels used to communicate with several major express courier and parcel delivery firms operating in Italy confirms the complexity of the matter. Virtually all couriers have a significant proprietary component in their formats that does not

directly conform to any international standard and makes their EDI flows incompatible with the ones of their competitors.

Table 2. File formats for electronic data interchange supported by various express couriers in Italy

Courier	*File format*	*Field mapping*	*Transmission protocol*
Artoni	Fixed-width text	Proprietary	FTP[1]
BRT	Fixed-width text	Proprietary	FTP
DHL	SOAP[2]	Proprietary	HTTP[3]
FedEx	SOAP	Proprietary	HTTP
GLS	Fixed-width text, SOAP	Proprietary	FTP, HTTP
SDA	Comma-separated text[4]	Proprietary	FTP
TNT	Fixed-width text, SOAP	Proprietary	FTP, HTTP

[1] (J Postel & Reynolds, 1985)

[2] (Moreau et al., 2007)

[3] (Fielding & Reschke, 2014)

[4] (Shafranovich, 2005)

Finally, the used data formats may also present localization problems that further increase the complexities of implementing one or more EDI interfaces. Some commonly encountered examples are:

- *Date format*: in Italy and many European countries, the order *day-month-year* is used when specifying a date. The United States uses the *month-day-year* order, and that might sometimes be encountered even outside the USA, if US-developed software or data transmission standards are used. Additionally, an international standard that is recommended but not always followed, uses a "big-endian" ordering, *year-month-day* (ISO, 1988a).

- *Decimal separator:* in Italy and many European countries, the comma (,) is the commonly used decimal separator. In most English-speaking countries, the dot (.) is used. Again, the influence of software and standards developed in the USA means that even when international shipping is not involved, mixed standards may be encountered when encoding decimal numbers such as shipping weight or customs value.

- *Record separator:* for example, depending on the localization settings, Microsoft Excel, a popular software tool often used to view and edit files in CSV format, may separate records using a semicolon (;) in Italy and many European countries, and a comma (,) in the United States and other parts of the world. This means that even two files created with the same software, but in different parts of the world, may be incompatible with each other.

In brief, implementing the automated data flows necessary in order to outsource logistics operations can be a significant investment that creates two barriers that are related to the aforementioned issue of asset specificity, and that may potentially limit the penetration of third-party logistics:

1. Difficulties in justifying the initial cost, *and*
2. Incompatibility between the systems used by different contractors, resulting in penalizing switching costs if the firm decides to change service providers.

2.2.2. Information asymmetry

Information asymmetry is a term used in economics to describe and study market situations involving a transaction where one of the parties has more information, or better information, than the other. In 2001, the prestigious Nobel Prize in Economics was awarded to three economists who provided major contributions to the development of the asymmetric information market theory in the 1970s: George A. Akerlof, A. Michael Spence, and Joseph E. Stiglitz.

Akerlof (1970) describes that in many markets the seller may possess more information on the quality of the sold item than the buyer does. The risk of buying a low-quality item will reduce the price the buyer is willing to pay, regardless of whether the good is actually low-quality or not. Subsequently, this lower market price will drive away sellers offering high-quality goods, and in extreme cases, the market may even deteriorate until it ceases to exist.

Lonsdale (2001) explains how, specifically, information asymmetry can be a problem in outsourcing:

> "What often happens following the outsourcing of a complex business activity is that the supplier becomes more knowledgeable about the product or service than the buyer. Where there is a need for adaptations or add-ons, therefore, it will often be the supplier that is making suggestions. If the buying firm is at an information disadvantage vis-à-vis the supplier, it will be difficult for the buyer to know whether the supplier's suggestions are genuine or an opportunistic attempt to increase revenue."

Again, this problem seems to apply in a significant measure to logistics outsourcing. Many firms may choose to use third-party contractors for logistics operation in order to be able to focus on developing their core competencies (Bhatnagar, Sohal, & Millen, 1999; Troyer & Cooper, 1995). Such firms can be assumed to possess less expertise in the field of logistics, making them more susceptible to information asymmetry and uncertainties related to the expected levels of service quality (Boyson, Corsi, Dresner, & Rabinovich, 1999). There is the risk of having to pay for unnecessary or overpriced services.

Finding a way to reduce information asymmetry and improve buyer trust would provide an incentive for more firms to outsource their logistics operations, bringing growth to 3PL providers who have implemented such information-asymmetry-reducing measures.

Some typical solutions that tackle the problem of information asymmetry in general are shown below, and their applicability to contract logistics is discussed.

2.2.3. Non-market responses to information asymmetry

In some markets where very clear structural conditions for information asymmetry exist, a possible response to the problem is external regulation through government policy to protect the weaker party in a transaction. The importance of information has been recognized in political and legislative approaches to protect vulnerable parties in cases where the market can be assumed to be inherently biased, giving bargaining power to buyers or sellers.

Consumer protection policy is a prime example of intervention in competitive markets based on information theory. Consumers, defined as physical persons who purchase goods or services for personal use, can be expected to have a disadvantage in terms of information, since they typically do not have any professional experience with the products they use, unlike the firms who produce and sell such products (Beales, Craswell, & Salop, 1981). Hadfield et al. (1998) summarize a list of market characteristics that may serve as possible indicators that "a market-based solution is unlikely to emerge":

> "1. Repeat transactions are rare, and consequently the performance incentives created by the possibility of repeat business from satisfied customers are blunted.
>
> 2. Entry and exit costs in the industry are low, leading to the possibility of a large number of fly-by-night operators with few sunk costs and only modest investments in reputational capital.

3. Many sellers or producers are extrajurisdictional, making redress through private law more difficult for consumers.

4. Sellers characteristically have few assets against which a judgment may be enforced,

5. The costs to consumers of a "bad" transaction are delayed or potentially catastrophic, making ex post relief an inadequate or unsatisfactory solution,

6. The small size of a typical transaction creates a significant disincentive to seeking ex post relief through the courts."

(Hadfield et al., 1998, pp. 155–156)

In many B2C markets such conditions are present, stable and easy to identify, so regulatory solutions are applied routinely and consistently. On the other hand, in B2B markets in general, and in strategic outsourcing specifically, the presence of structurally determined information asymmetry cannot be clearly identified in the same way, so pre-emptive legislative regulation is not practically feasible.

Therefore, it is obvious that in the field of third-party logistics, clients cannot rely on any special protection. To further develop the 3PL market and improve buyers' confidence in the service, providers can only attempt to gain trust by looking for market-based solutions to the information asymmetry problem.

Naturally, another non-market response to the information asymmetry problem would be vertical integration – that would simply take the transactions out of the market. As has been already outlined above, choosing

not to outsource an operation would solve any issues emanating from market inefficiencies, transaction costs, uncertainty, and insufficient information, but outsourcing can bring benefits that outweigh those disadvantages. In logistics, the growth of the 3PL market indicates that such benefits are sufficient to sustain that market, but from the point of view of a contract logistics provider, improving information availability and reliability could bring even further growth by making the vertical integration – or in-house logistics – not as desirable as it would be otherwise.

2.2.4. Market responses to information asymmetry

In competitive markets inherently characterized by information asymmetry, sellers may seek to improve perceived trustworthiness of the products and services that they advertise by *signaling*, i.e. voluntarily providing credible information to the other parties, sometimes bearing significant costs in doing so. The job market has been described as a paradigm case of signaling (Spence, 1973): applicants looking for employment opportunities are willing to make a considerable investment in education and other credentials. The competitive advantage obtained by having their skills verified by an independent authority (such as an accredited education provider) can provide them with significant benefits (higher wages and more job opportunities).

Conversely, when the cost and effort of revealing private information is borne by the less-informed party, the process of *screening* is observed – again, prominently present on the job market, among others (Stiglitz, 1975). Both signaling and screening act as mitigating factors that increase transaction costs, but prevent adverse selection from corrupting the market.

Some level of signaling and screening is present in contract logistics. For example, the decision of FedEx to expose its tracking system to customers (Baker, 2006), which has later been adopted by virtually all other major express courier brands, may be seen as a form of signaling that aims to improve transparency and highlight good performance. However, such systems presently have limitations and shortcomings that are discussed in more detail in the following chapter.

Interest in suitable pre-screening methods for selecting logistics contractors has been expressed as well (Perçin, 2009). However, again, such screening is a complicated process and many firms may lack the resources to develop such methods to perfection: "3PL provider selection can be viewed as a complex multi-criteria decision-making (MCDM) problem due to the availability of quantitative, qualitative, and multiple criteria that have to be considered in the decision process" (Perçin, 2009, p. 589)

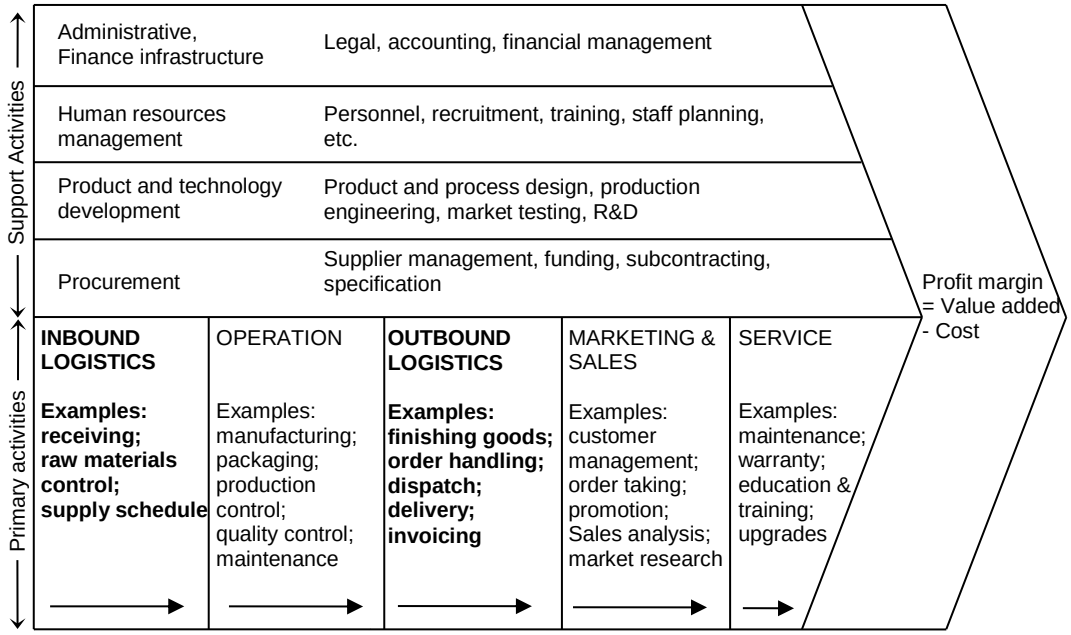
In the next chapters, some characteristics of the logistics market in Italy are presented, several efficient IT-based signaling and screening solutions that reduce information asymmetry in other markets are examined, and the applicability of similar solutions to contract logistics is discussed.

3. THE ITALIAN CASE: THE LOGISTICS MARKET IN ITALY

Logistics operations are a critical part of creating and delivering a product or service to the market. Porter (1985) classifies inbound logistics ("activities associated with receiving, storing, and disseminating inputs") and outbound logistics ("collecting, storing, and physically distributing the product to buyers") as *primary activities*, essential to all businesses operating in any sector, although some variability between industries can naturally be expected: "For a distributor, outbound and inbound logistics are the most critical. For a service firm providing the service on its premises such as a restaurant or retailer, outbound logistics may be largely nonexistant and operations the vital category [...] In any firm, however, all the categories of primary activities will be present to some degree and play some role in competitive advantage." (M. E. Porter, 1985, p. 40)

Logistics functions, therefore, always exist in all businesses (in one way or another), and in some industries they can be a major factor in competitive dynamics.

Figure 3. Logistics within the value chain paradigm (M. E. Porter, 1985)



3.1. Market size and trends

Traditionally (as with all other primary functions in the value chain), logistics operations have been performed internally by the firms (Lieb, 1992). Conversely, the notion of "third-party logistics market" implies the existence of providers who offer logistics services as a discrete market proposal.

Third-party logistics (3PL), also called contract logistics, is indeed a relatively new business model that has developed in the recent decades. Worldwide, this business model is enjoying steady medium term growth (Langley, 2015; Maloni & Carter, 2006), even in economies negatively affected by stagnation or recession (Table 3). As described in more detail below, the same trend can be observed in Italy (Marchet et al., 2014).

The courier, express and parcel (CEP) industry has been developed since the 1970s when low-weight parcel shipments were standardized and established as a separate market that split off general less-than-truckload (LTL) cargo transportation (Helmke, 2005).

3PL and related phenomena are largely a consequence of the shifting market environment characterized by radically new competitive conditions and trends. The marked decrease in legislative and technological obstacles to doing business on a global scale has largely broken up the limited geographical and non-geographical enclosures in which companies have traditionally competed: "Globalisation, in particular, imposes transition in the spatial competition relationships, specifically the abandonment of uni-dimensionality, that is the reference to a competition domain coinciding with specific physical or administrative contexts (a product category, a country, a region, a geographical area, etc.)." (Brondoni, 2002, pp. 28–29)

This cascade of globalization effects acts in several ways to create incentives for firms to turn to the market in order to form strategic partnerships and contract out some of the activities that they have traditionally performed internally:

- The vastly increased size and permeability of competition spaces has caused a significant rise in competition intensity, making it necessary for firms to develop and leverage either cost or differentiation advantages. Any costly internal function of the firm, and any activity not directly related to the differentiation parameters which the firm has chosen for its products, may

potentially benefit from outsourcing (Hitt, Ireland, & Hoskisson, 2006).

- In addition, the expansion of addressable markets has increased the magnitude of potential production and sales volume, making it possible to achieve unprecedented global economies of scale and conceptually similar economies of scope, as well as economies of learning. By triggering such an expansion of the market boundaries, combined with the aforementioned trend towards competition intensification, globalization has made it possible to pursue economies of scale that may previously have been deemed unimportant or unachievable, and to accumulate large pools of industrial expertise that increases the efficiency of many processes (Brondoni, 2008). These phenomena have allowed the entrance of new, highly specialized operators, providing a single focused expert service – such as contract logistics – to multiple clients on a global scale.

- Another major change contributing to the increasing interest in 3PL is the phenomenon of time compression, which is another consequence of intensified global competition. The resulting fast cycles of action and reaction stimulate companies to minimize waste by reducing the time consumed by corporate processes as much as possible (Brondoni, Clementi, & Ciampi, 2007). In the realm of supply chain management, lead-time reduction is achievable by opting for an integrated approach and entrusting logistics operations to external providers with vast experience and competence in the area. For this reason, time compression is

one of the factors that play a part in the increasing demand for advanced logistics services (Hertz & Alfredsson, 2003).

- Lastly, globalization provides new opportunities for restructuring equity and reorganizing organizational ladders in a more efficient and adaptable network arrangement. Large multinational companies may choose to decouple their own internal functional units (such as the logistics department) and reconfigure them as independent, wholly or partially owned, subsidiaries, to which the parent company contracts these operations. Such a regrouping of assets and management hierarchies can potentially optimize corporate structure, improve flexibility on a global scale, and bring benefits of a legal or fiscal nature. Subsequently, the newly created companies may also provide the same services to other clients. In the area of logistics, many such examples exist: "Shipper-rooted logistics service providers in the United States include Caterpillar Logistics Services (CLS), which manages Land Rover's worldwide parts warehousing and distribution; American Delivery System (ADS), which specializes in retail and publishing distribution operations and in new product launches;

> Kaiser Logistics Services (KLS), which was recently acquired by ACF industries, a builder and lessor of rail cars; Intral, which has recently spun off from Gillette and concentrates on international forwarding; Pathfinder Inc., which spun off from Farmland Industries and specializes in logistics for the agricultural industry; and LogiCorp, which is a subsidiary of Rockwell International, serving a diverse domestic and international customer base with emphasis on the manufacturing sector." (Sheffi, 1990)

These and other related benefits of managing logistics operations as a contract service within the framework of a strategic alliance between a 3PL provider and their client have been described in a study by Andersson (1995, cited in Hertz & Alfredsson 2003, p.140): "...improvement of economies of scale and scope, efficient operations, bargaining power, range of services, faster learning, network with other providers, knowledge of various kind, fast implementation of new systems, restructuring of supply chains, reduced investment base, and smoother production".

On a global level, over the past few years, the 3PL market has enjoyed growth that is significant, albeit decelerating, and it has been outperforming the world economy in general (Table 3). At the same time, client companies have taken advantage of the cost optimization benefits brought by outsourcing of logistics activities (Table 4).

Table 3. Global 3PL growth in comparison with overall economy growth (Langley, 2015, p. 11; The World Bank Group, 2015)

	Global 3PL revenue growth	*Gross world product growth (nominal, current US Dollars)*
2011	+13.7%	+10.6%
2012	+9.9%	+1.8%
2013	+2.7%	+2.8%

Table 4. Measurable benefits delivered by 3PL services (Langley, 2015, p. 12)

Results		*2013 study*	*2014 study*	*2015 study*
Logistics cost reduction		15%	11%	9%
Inventory cost reduction		8%	6%	5%
Logistics fixed asset reduction		26%	23%	15%
Order fill rate	Changed *From*	58%	66%	60%
	Changed *To*	65%	68%	66%
	Changed *From*	67%	68%	61%

Order Accuracy	Changed *To*	72%	69%	66%

The effect of these trends can be seen clearly in Italy where according to recent industry reports (Marchet et al., 2014) the 3PL market has been steadily growing at a rate exceeding the GDP growth of the country. As can be seen in Table 5, there are two major trends in the market: consolidation and sales growth (the number of companies operating on the market has decreased by 9,4%, while turnover has grown by 8,5% between 2009 and 2012).

Table 5. Summary of the third-party logistics sector in Italy

Provider type	Number of providers				Turnover (millions of Euro)			
	2009	2010	2011	2012	2009	2010	2011	2012
Incorporated haulers (road freight operators)	14,491	14,973	15,231	14,876	22,666	23,456	25,272	25,619
Non-incorporated haulers (road freight operators)	89,945	84,366	83,223	78,849	13,616	14,538	14,164	14,070
Couriers / express couriers (Less than Truck Load (LTL) transport operators; parcel / envelope delivery services)	617	629	651	660	4 725	5 052	5 205	5,160
Interport managers (Operators who run intermodal exchange platforms)	79	83	84	85	694	816	843	854
Warehouse managers (Operators who mainly carry out activities of cargo storage and handling)	5,794	5,544	5,910	5,760	7,366	7,143	7,718	7,540
Rail transport operators (Operators of rail and combined road/rail transport)	30	29	31	35	889	870	840	858
Logistics operators (Providers of integrated logistics services)	1,106	949	985	1,047	8,116	8,193	8,632	8,926
Freight Forwarders (Organizers of international transport that combine different means of transport)	2,429	2,394	2,444	2,439	13,170	13,716	14,114	14,275
TOTAL	114,491	108,967	108,559	103,751	71,242	73,784	76,788	77,303

The nominal turnover growth rate of 3PL in Italy can be adjusted for inflation in order to obtain data indicative in real terms. According to official data, cumulative inflation rate for the observed period is 7.5% (Table 6). Real growth in this market between 2009 and 2012 can be therefore estimated at 1% (3.5% until the end of 2011, followed by a contraction in 2012).

For the same period, the GDP of Italy, when discounted with the same cumulative inflation rate, has a negative growth (-4.4%). 3PL is, therefore, a business that grows significantly in spite of a difficult economic environment.

Table 6. Inflation rate and gross domestic product in Italy for 2010 and 2011 (Istituto Nazionale di Statistica, 2014, 2015a, 2015b)

Year	Annual average consumer price index	GDP (millions of Euro)
2009	137.7 *(base 1995 = 100)*	1,519,695.1
2010	139.8 *(base 1995 = 100)*	1,551,885.6
2011	102.8 *(base 2010 = 100)*	1,579,946.4
2012	105.9 *(base 2010 = 100)*	1,566,911.6

Another important factor in the market is the trend towards consolidation. Among the categories in Table 5, the most numerous one is that of "non-incorporated haulers". These are often sole proprietors, possibly owning a single transport vehicle making contract deliveries. The average annual turnover of these businesses is about 150,000 Euro, which places them in the category of micro-enterprises (European Commission, 2003). These types of service providers are the most affected by a reduction in absolute

numbers (12.3% over three years), but not in terms of total turnover, and are therefore subject to significant integration and consolidation.

It is to be noted that, according to the same industry reports, a significant part of 3PL services in Italy are typically subcontracted. For example, 40% of haulers' sales are directed towards other 3PL firms (couriers or integrated logistics service providers) rather than towards final clients. For this reason, it is not sufficient to sum different providers' sales in order to estimate market size; the "internal transactions" between different 3PL providers must be excluded. After this correcting for this factor by applying the Delphi method to assess the percentage of sales directed towards final clients, the market size of 3PL in Italy is estimated at "42.9 billions of Euro in 2012, with an increase of +3,5% in real terms relative to 2009" (Marchet et al., 2014, p. 12)

Therefore, the 3PL market in Italy is affected by the global macro-trend towards increased output and intensifying competition. This is compounded by significant increases in input costs. For example, the cost of diesel fuel, one of the main inputs in logistics, is rather volatile and generally rising: today it is more than 25% higher than in 2009, with a peak in 2012 reaching 180% of the cost at the beginning of 2009 (Ministero dello Sviluppo Economico - Dipartimento per l'Energia, 2016). The increase in energy prices, and the uncertainty connected with this increase, is among the most challenging factors connected with the cost of providing logistics services, although the prices of almost all the other inputs, such as human resources, credit, etc. have been increasing as well (Marchet et al., 2013, p. 13).

3.2. Top players

Companies providing 3PL services differ greatly in their ability to steer the market and to set trends. As discussed earlier, the majority of the actors on the Italian 3PL market are micro-enterprises providing a very limited range of services as subcontractors, and over time, they tend to cease to exist as independent entities. To gather more information about the market's ability to evolve and support innovation, it is suitable to examine in more detail a more limited set of "top players".

According to Hertz (1993), third-party logistics providers can be classified under four general categories based on two types of problem-solving abilities (general problem-solving and customer adaptation):

- *General transport companies* (haulers and railway freight operators) who provide a standard, basic transport service;
- *Special transport companies* which provide the same basic transport service but adapted to a specific business category (e.g. furniture movers);
- *Highly integrated transport companies* able to combine different modes of transport in order to make time-sensitive deliveries;
- *Specialized logistics service companies* offering further integration with the customer by providing multiple third-party logistics services.

Further research (Hertz & Alfredsson, 2003) identifies a more fine-grained division of the latter category, based on the same two dimensions, that provides a set of criteria suitable for identifying the most innovative 3PL companies in line with the latest trends. Specialized 3PL providers can be thus subdivided into:

- *Standard providers* "supplying the standardized TPL services like warehousing, distribution, pick and pack, etc. This firm would often offer these services at the side of their normal business."

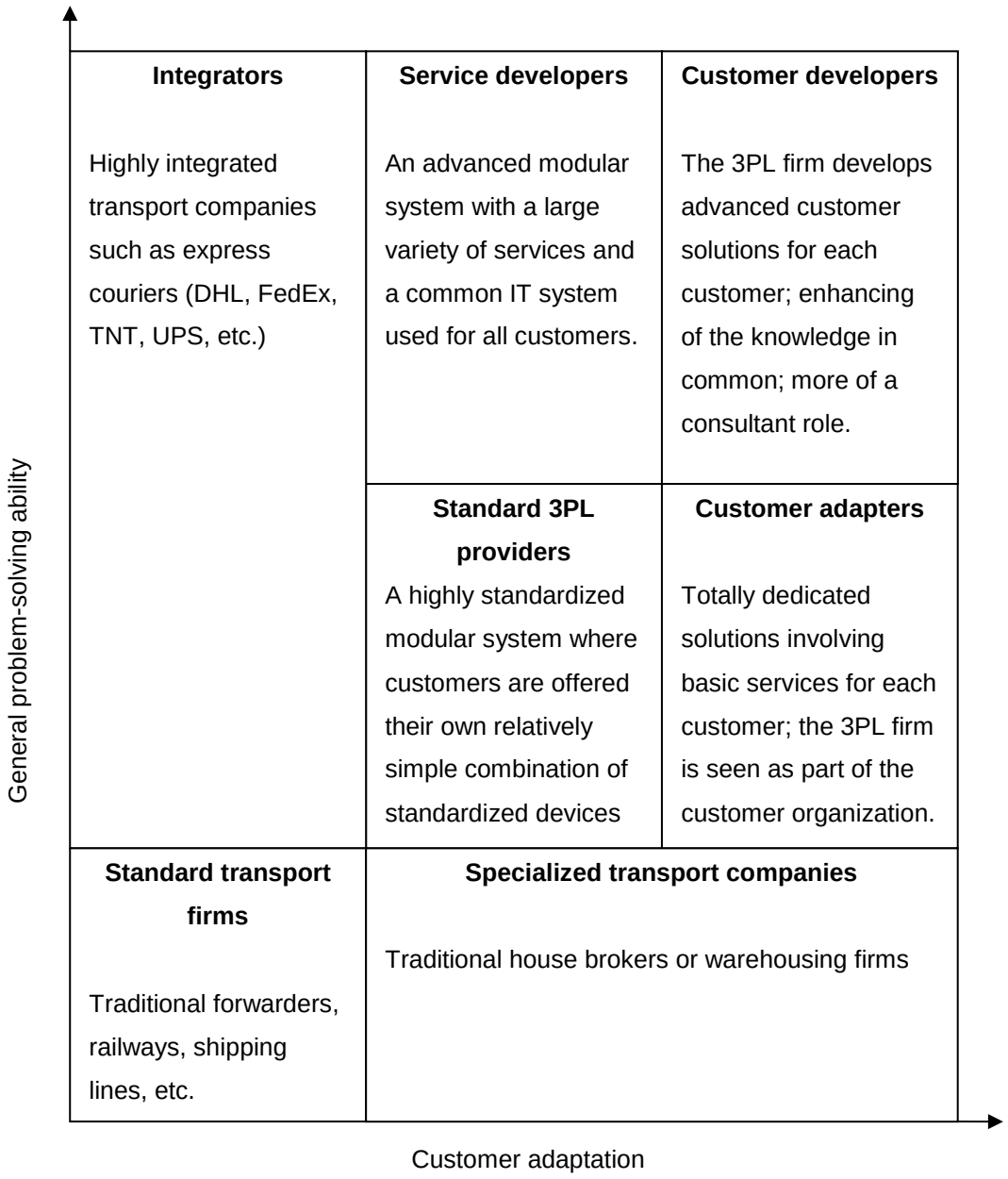
- *Service developers* "offering advanced value-added services. This could involve differentiated services for different customers, forming specific packaging, cross-docking, track and trace, offer special security systems, etc. An advanced service package often involves several sets of more standardized activities turned into modules that could be combined according to each customer demands. An advanced IT system facilitates such a development. The focus would be more on creating economies of scale and scope."

- *Customer adapters* "taking over customers' existing activities and improving the efficiency in the handling but actually not making much development of services. This type of provider might take over customers' total warehouses and the logistics activities and relies on a few very close customers."

- *Customer developers* offering "a high integration with the customer often in the form of taking over its whole logistics

operations [...] sharing the risk and rewards of the logistics management with the customer".

Figure 4. Types of 3PL providers (Hertz, 1993; Hertz & Alfredsson, 2003)



While Table 5 shows that the bulk of the Italian 3PL market consists of fragmented (but steadily consolidating) small companies which only provide basic transport services and therefore score low on both of the aforementioned dimensions, the 2014 Italian industry report has identified a sample of a small number of significant companies or groups that, together, represent 60% of the strategic contract logistics market (Marchet et al., 2014, p. 14). 85% of these companies belong to two specific categories: *logistics operators* and *freight forwarders*, i.e. companies working directly in close relation with their customers, offering them a multitude of services (largely subcontracted to the other types of service providers). Therefore, the leaders who define the 3PL market in Italy are actually characterized by a high capability of communicating with the customer and of coordinating and integrating a multitude of services in order to meet the customer's needs. Often these single services are provided by smaller subcontractors who may therefore benefit from the positive market trends but do not actually create them, and instead act as "followers". For this reason, the market growth is unequally shared and it is largely enjoyed by the highly integrated innovators and trend-makers. These "top players" have a revenue growth significantly higher than the industry as a whole: +15% in real terms in 2012 relative to 2009 (Marchet et al., 2014, p. 14). Furthermore, the aforementioned growth has remained above inflation rates even in 2012, when other 3PL providers have experienced negative real growth for the first time after a period of sustained expansion.

Specific traits of those top players include:

- Ability to utilize economies of scope
- Ability to utilize economies of scale
- Strong ICT skills
- Strong operative logistics skills
- High financial capacity to invest in logistics
- More control of subcontractors

Thus, the common traits between most of the market-shaping, fast-growing firms on the Italian 3PL market are innovation and integration of multiple services (often subcontracted). In logistics, both activities have a significant IT component, since they involve real-time information interchange between the 3PL company, its contractors and its clients, as well as processing of large amounts of data in order to identify the right solution for the customer's needs; the latter are not static and therefore should be evaluated dynamically, and since time is a critical factor in the industry, this evaluation must be automated. Innovation and integration are often costly investments, but in the logistics business it is evident that they pay off since the data indicates that such investments correlate with the companies' ability to actually shape the market and act independently (as opposed to being simple service providers who follow the market trends and are passively dependent on their customers), which is an advantage in today's volatile and highly competitive economic environment.

The field research in this thesis is performed with regard to Omnilog, an Italian 3PL provider firm that displays a set of characteristics in line with the way top players are defined in this context. The company provides a diverse range of logistics services, such as warehousing, intermediation between clients and transporters in order to obtain price advantages and better customer support, as well as advanced ICT services to facilitate ordering and tracking shipments. These services may sometimes be customized in order to meet the specific needs of the individual clients. For example, when providing the aforementioned ICT services, Omnilog uses in-house software, designed as a flexible, modular system. It applies the "mass customization" principle to information services and can be easily adapted to integrate with customers' inventory, order management and e-commerce solutions. At the same time, the established practice in the industry is exactly the opposite (the client's software and ICT infrastructure is usually adapted to match the system requirements of the service provider, which may be a costly investment for small enterprises).

Some of the company's distinctive traits are:

- A multi-service approach;
- A high level of adaptability to clients;
- Leveraging the services of multiple subcontractors, economies of scale and economies of scope to provide a more efficient service at no extra cost to clients;
- Innovative solutions not previously offered by other companies in the sector;

- Significant use of modern technologies, including web-based and mobile means of communication.

As a result, Omnilog has achieved a turnover growth of 11% for two consecutive years (2012 and 2013). In this respect, the company is in line with the average for the "top players" defined earlier.

Considering the fact that Omnilog's range of services, relations with subcontractors, expertise, capacity for innovation and financial results match almost exactly the traits previously listed for the market trendsetters, its relations with clients and other service providers are arguably a good model for the market as a whole. While a sample of one cannot be considered representative from a quantitative point of view, looking at Omnilog's clients and partners can provide valuable insight on the typical actors on the 3PL market.

3.3. Target clientele and penetration

Studies indicate that the net logistics costs of Italian companies amount to 110 billions of Euro (Marchet et al., 2013, p. 14). As indicated earlier, 42.1 billions of Euro are spent on contract logistics, which translates into an estimated penetration rate of 38%. Therefore, while the data indicates a growing market, there is still a strong potential for further development.

The decision whether to contract out an activity that is traditionally performed internally involves a fine balance between efficiency and trust. If investments and ongoing costs were not a factor, companies would naturally prefer to maintain logistics as an internal function, since entrusting it to the market may open vulnerabilities such as conflicts of interest, hold-up

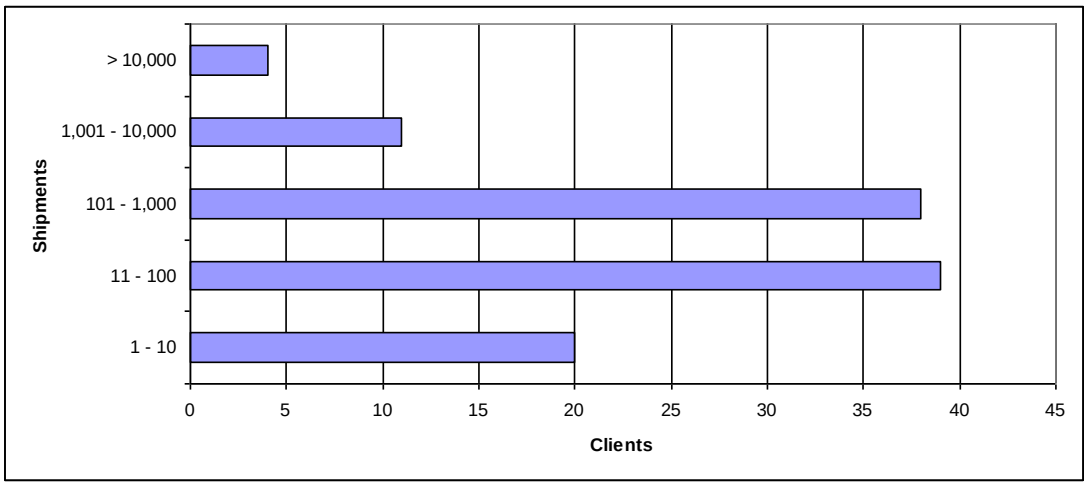
opportunities, information leaks, or simply lack of control leading to uncertainty about the quality of service.

However, as indicated above, innovation and service integration in logistics allow 3PL operators to provide a service that has been empirically shown to outperform traditional, "low technology" logistics solutions in a competitive situation. Any firm wishing to perform logistics activities internally must therefore implement the same solutions in order to stay competitive. This requires considerable investment in ICT infrastructure and human resources. Especially for small and medium-sized businesses, it can be expected that the benefits of entrusting logistics operation to a third party outweigh the risks.

The following charts (Figure 5, Figure 6, Figure 7, Figure 8) display some basic data on Omnilog's clients and their activity in 2013, extracted from the company's electronic delivery tracking database.

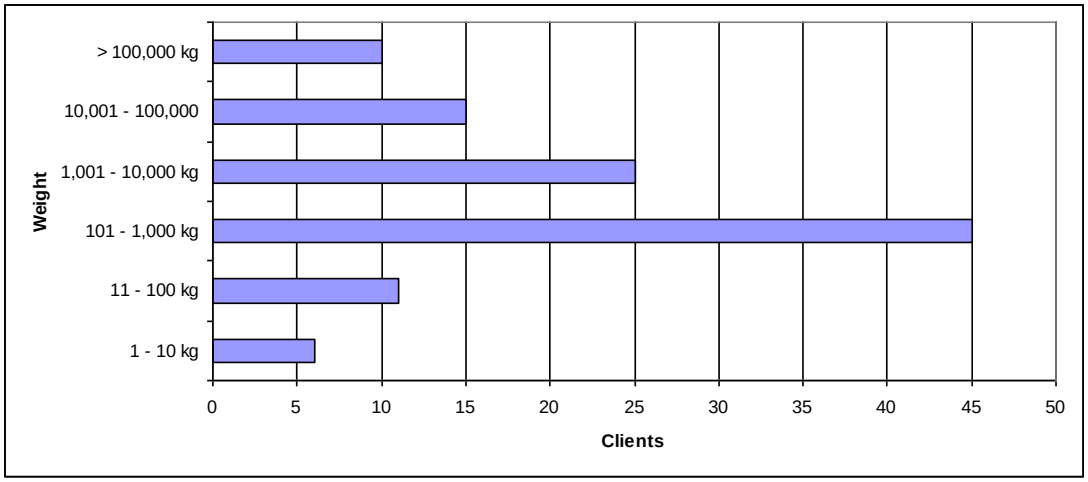
Clients who have entrusted their deliveries and complementary logistics operations to Omnilog have been assigned their own client code, which marks each individual shipment. In this way, it is possible to identify 112 clients who have ordered at least one shipment in 2013.

Figure 5. Omnilog's 3PL clients grouped by total number of shipments in 2013



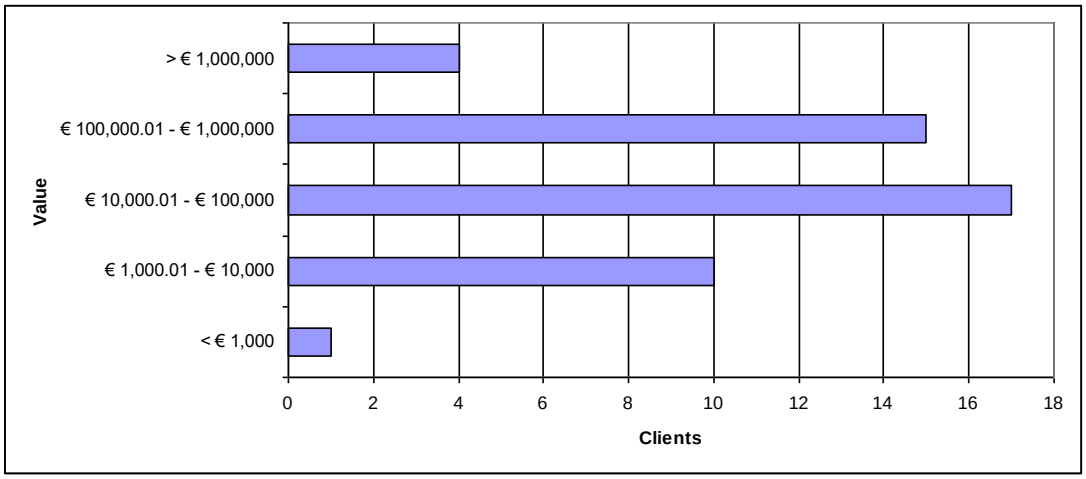
Shipment weight is a suitable proxy to estimate the relative level of revenue generated by each client, since weight is the single most important factor determining the final service price, as described in more detail further on. While it is not possible to calculate the absolute income generated by a client by looking only at the aggregate shipment weight, it is still a good estimate of the *relative* importance of each client from the 3PL provider's point of view.

Figure 6. Omnilog's 3PL clients grouped by total weight of shipments in 2013



Additionally, some clients use supplementary financial services offered by the 3PL providers or their subcontractors, such as insurance, invoicing, or payment handling (via bank transfer, cash-on-delivery, etc.), making it necessary to declare the value of their shipments. In this way, the logistics operator is in a position to infer estimates on the total sales of each client, since most 3PL clients, especially smaller ones, use a single provider's services exclusively as their only delivery channel. In Omnilog's case, almost half of the company's clients ship goods with a declared value, allowing stratification of those clients in different categories.

Figure 7. Omnilog's 3PL clients grouped by total declared value of shipments in 2013*



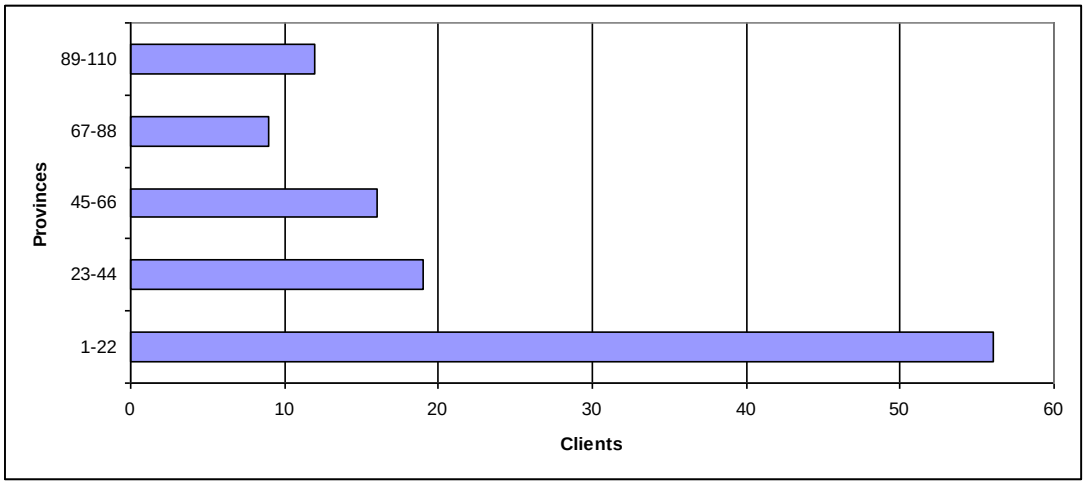
* Calculated only for clients who ship goods with a declared value

By cross analyzing the weight and declared value data, it results that 87% (by weight) of the shipments handled by Omnilog in 2013 were generated by large enterprises (i.e. with an annual turnover exceeding 50 million Euro), while 13% were generated by small and medium enterprises. This may partially explain the growth gap between "top players" in third-party logistics and the rest of the providers on the market. Since the Italian 3PL market is still relatively fragmented, many providers are simply too small and lack the

reach, capital and infrastructure needed to secure relationships with the most lucrative clients, which in this case seem to be the large companies. While these clients are apparently an important source of revenue and growth to the 3PL business, they are also "hard to get" since large businesses are often able to manage their own logistics efficiently; in fact, as can be expected, Omnilog's small and medium clients greatly outnumber the large ones. One of the factors that make it possible to attract such large clients is the fast cycle of obsolescence of information technology, which means that entrusting IT-intensive operations such as logistics to an external provider may be the most cost-efficient way to replace old technology, especially in times of financial difficulties.

Another interesting categorization of 3PL clients is the geographical reach of their logistics operations. In Italy, it can be captured in the number of different provinces of origin/destination of their shipments. The vast majority of clients had their activities limited within only one of the six top-level statistical regions of Italy (North West, North East, Centre, South, or Islands). Only the largest client of Omnilog shipped to all 110 Italian provinces at least once in 2013.

Figure 8. Omnilog's 3PL clients grouped by number of different Italian provinces where deliveries were made in 2013



In conclusion, it can be inferred that the typical user of third-party logistics services in Italy is a small or medium enterprise that does not have the resources to efficiently maintain an in-house logistics department. Their low volume of sales (on average, less than one item per day) means it is more economical to rely on a third party to provide the warehouse space, transport services, and human resources necessary to manage their logistics together with other clients of a similar type. These clients can be relatively easy to attract since they require a rather standard service and consider cost and location the main factors when choosing a contractor. The main challenges for the 3PL operator in dealing with this type of customers are the poor differentiation of services (with thousands of competitors offering a comparable product in Italy) and the increasing cost pressures, especially the cost of fuel; those challenges, considered together, make it necessary for the 3PL providers to either operate on a thinner margin or to consolidate and invest in providing a more comprehensive and differentiated service. Selling services to a smaller number of larger companies can potentially increase

revenue and growth rates, but requires considerable investment in order to be able to meet the needs of this category of clients.

3.4. Pricing models

Third-party logistics is a complex, multi-layered service. As described earlier, typically final clients of 3PL companies will entrust multiple, integrated logistics operations to a third party with a single contract. Warehousing, packing, transportation, delivery tracking and inventory management are some examples of 3PL operations which blend together in order to provide a full-scale logistics service. All these operations, however, may often be very different in terms of inputs and other critical factors that influence costs, quality of the overall service, and ultimately, price. For example, transportation is very dependent on fuel costs, while data processing relies on highly qualified human resources.

Such a multifaceted service creates many potential price-forming scenarios, making it difficult to arrive at a universal, standardized pricing scheme that suits the needs of all agents on the market and is perceived as fair. Walker (2009) briefly describes several approaches that have been used in practice:

- *Fixed price:* a non-variable fee due to the 3PL company, "held for a specific term regardless of volume fluctuations". Where used, it is often a short-term, transitional solution – sales volume can often vary beyond the expected, especially in an open, volatile economy. As a result, fixed-price contracts may pose a risk that the 3PL provider operates on unfairly high or unfairly low margins.

- *Percentage of sales value:* this approach allows for some variation and allows clients to better plan their logistics costs. However, perceived unfairness may still render such contracts undesirable in the long term, since sales value often is not directly related to the costs sustained by the 3PL providers and by companies that have kept their internal logistics units. For example, it does not take into account the variations in price of storage space that are often a consequence of changes on the real estate market.

- *Activity-based rates:* probably the most straightforward approach, based on actual work performed, expressed in terms of goods' weight and/or volume, number and type of special services provided. This is a suitable choice in many cases, but it shifts the burden of risk towards the 3PL firm in case of "low or erratic" volumes – for example, if the customer sells "highly seasonal products" (Walker, 2009, p. 25).

- *Hybrid rates:* this type of arrangement accounts for the aforementioned disadvantage by introducing a fixed component in the contract. This allows the 3PL company to set prices that closely reflect the components of its costs, such as "warehouse space, leasing of mobile and static assets, information technology and management overheads".

As with all B2B services, the parameters of every contract are highly negotiable and prices are more often adapted to the characteristics of individual supplier and buyers. For this reason, it is difficult to find a single

standardized pricing scheme in the practice of 3PL firms operating in Italy. Again, Omnilog serves as a suitable case example, being a single provider with multiple arrangements that often use multiple different components to calculate how much a client will be charged. Omnilog's invoicing software has been built to reflect the practical experience of the company and is programmed to be able to calculate charges based on data fed directly from the operations tracking software components. Some of the factors included in the calculations are:

- Number of shipments
- Number of packages per shipment
- Weight of shipped goods
- Volume of shipped goods
- Declared value of shipped goods
- Extra services: time-definite delivery, shipment by air, oversize packages, handling of wrong addresses, etc.

In spite of the complexity of the service, recurring pricing practices may nevertheless be identified in the industry. In the vast majority of pricelists, the single primary key factor is the so-called "dimensional weight" or "volumetric weight", which is the result of a simple formula involving a package's weight and volume:

$$\text{dimensional weight} = \max \{ \text{weight}, \frac{\text{length x width x height}}{\text{dimensional factor}} \}$$

Dimensional weight is the current *de facto* industry standard that has largely replaced the earlier practice of charging transport and warehousing fees solely by weight:

> "Historically, the cost of transporting goods was always directly calculated by weight. Illuminating the relationship between weight and volume, it was highlighted that a vehicle may be full in terms of volume, yet be well below its maximum laden weight.
>
> The revelation of this fundamental source of inefficiency caused a major upheaval to the way that the express carriers charge for their services.
>
> The cost of transport services is now a function of two components:
>
> - Volume
> - Weight"
>
> (Mettler-Toledo Cargoscan AS, 2008, p. 1)
>
> "Dimensional weight pricing was first introduced by international air carriers in order to make efficient use of cargo space. It has become standard in the transport industry and today is used by all major carriers. The objective of such a pricing structure is to ensure that items are invoiced based on the space they occupy, not just their weight.
>
> The dimensional weight of an object is calculated by determining its cubic size and dividing this number by a dimensional factor. The international Air Transport Association (IATA) established a standard dimensional factor; however, companies regularly choose their own factor based on the average density of their shipments. Dimensional

weight is compared to actual weight and the greater of the two is used as billable weight."

(Mettler-Toledo Cargoscan AS, 2010, p. 1)

The units and the constant denominator used in the dimensional weight formula may vary over time and are arbitrarily set by individual providers according to their pricing policies. Some dimensional factors used by several major shipping companies (as of 2014) are listed in the table below.

Table 7. Examples of dimensional weight factors

UPS	5000 cm^3/kg	
DHL	5000 cm^3/kg	USA Express and Economy
	4000 cm^3/kg	Euro Road
FedEx	5000 cm^3/kg	Europe, Middle-East, Africa and the Indian Subcontinent
	166 in^3/lb	USA domestic shipments
DB Schenker	6000 cm^3/kg	
TNT	4000 cm^3/kg	

Unsurprisingly, along with dimensional weight, geographic distance is often a major factor for shipment pricing. As stated earlier, fuel expenses have been determined to be the top item among the costs borne by transportation service providers, and weight, volume and distance together determine, to a large extent, the fuel consumption necessary to provide transport and logistics services.

3.5. Cost-price correlation

This research is focused largely on the efficiency of the logistics market; any indications that the market is not operating at the maximum potential efficiency would mean that there might be a commercial opportunity for introducing and marketing technical solutions that help optimize the buyer-supplier relationship.

According to economic theory, a highly competitive market may be considered more "efficient", i.e. allowing prices to adjust quickly in order to reflect all the available information. The more a market approaches perfect competition, the more market prices are expected to converge with marginal costs.

It is, therefore, possible to estimate the market efficiency by comparing the variability of inputs with variability of final prices.

3.5.1 Factors of production

Prior research in the field (Marchet et al., 2014) has determined that logistics costs are driven by six main inputs:

- Real estate rent
- Fuel
- Cost of credit
- Labor
- Electric energy
- Equipment

Pricing of transportation, as mentioned above, is relatively complex due to the intrinsic factors of the service (transport costs and other involved factors may vary widely for each individual shipment). Furthermore, the difficult comparison effect gives an incentive for transportation service providers to reduce pricing transparency and to render price comparison more difficult: "buyers are less sensitive to the price of a known reputable supplier when they have difficulties comparing alternatives" (Hinterhuber, 2004; Nagle, Hogan, & Zale, 2010).

The favorable market position of 3PL firms allows them to collect transportation service pricing information that might otherwise be difficult to obtain. Multiple definitions of 3PL exist, and some are broader than others (Marasco, 2008). In a narrower view, 3PL is *strategic outsourcing* encompassing a comprehensive range of integrated logistics services, as

opposed to individual services, such as transportation and warehousing, or limited service bundles. Under the narrow definition, a 3PL service provider will organize and handle the logistics process in such a way that usually includes intermediation, i.e. hiring subcontractors for the transportation of goods.

There are several factors specific to 3PL providers that allow them to observe and process a large number of transactions, and thus we can assume that they can access pricing information not readily available to the general public:

1. the position of 3PL providers as intermediaries between *multiple customers* who use logistics services and *multiple subcontractors* who provide transportation as an individual service;
2. their tendency to acquire specialized knowledge in the area, as a consequence of the larger scale of operation achieved by managing multiple clients' logistics operations together ("learning curve effect");
3. the increasing penetration of 3PL, which makes transportation operations of 3PL clients more representative of transportation operations as a whole.

Consequently, by analyzing a sample from the data pool available to 3PL firms acting as intermediaries between shippers and transportation service providers, it is possible to collect evidence that helps answer the following research questions:

1. Is pricing of CEP services in Italy mostly cost-based?

2. What are some typical cost drivers in transportation that influence the final price of a single courier shipment?

This could be achieved by comparing the variation over time in the aforementioned cost drivers with the variation over time in the final prices of individual shipments. In any case, the examined timeframe must be larger than a year, since some of the considered cost drivers are relatively stable in the short term.

However, such a model must take into account the fact that these individual shipments are not homogeneous, and control for the uneven division of total costs between them.

3.5.2. Allocating costs to individual shipments

A suitable method of allocating costs to single deliveries can be derived by looking at industry practice. By comparing the parameters requested by the top express courier firms in order to provide a quotation for a delivery, we can derive a set of variables used for cost allocation. All of these express courier companies provide a quotation function on their websites. To avoid excessive complexity, standard shipments are considered, excluding premium services that may be difficult to compare across providers (e.g. delivery to a residential address; stricter identity checking; oversize deliveries; carbon neutral shipping; pre-paid returns).

Almost all the standard parameters are uniform across the examined courier firms (

Table 8). The list of common parameters can be simplified as follows:

- For domestic shipments in Italy, which are the subject of this study, the necessary information about origin and destination points is encompassed by the postal code (CAP). The pair of origin/destination postcodes is, in itself, a proxy for service availability, distance, and route complexity. Thus, *distance* can be used as a relatively good simplification of the origin/destination matrices used internally by the providers to allocate costs and determine prices.

- The number of packages, dimensions and weight of individual packages, are ultimately summarized as total weight and total volume of the entire shipment. As explained above, weight and volume can then be combined to calculate the so-called *volumetric weight*.

- In all cases, the nominal variable called "product" or "service" by the courier firms can also be expressed numerically in terms of maximum *working days and hours* to deliver the goods.

Table 8. Top 5 express couriers in Italy by market share (Autorità per le garanzie nelle comunicazioni, 2015) **and shipment parameters requested by them to provide a quote**

	DHL Express Italy	*UPS Italia*	*BRT*	*TNT Global Express*	*FedEx*
Sender country	✓	✓	✗	✓	✓
Sender city	✓	✓	✓	✓	✓
Sender postal code	✓	✓	✓	✓	✓
Recipient country	✓	✓	✓	✓	✓
Recipient city	✓	✓	✓	✓	✓
Recipient postal code	✓	✓	✓	✓	✓
Number of packages	✓	✓	✓	✗	✓
Length	✓	✓	✓[5]	✓	✓
Width	✓	✓	✓[5]	✓	✓
Height	✓	✓	✓[5]	✓	✓
Weight	✓	✓	✓	✓	✓
Customs value	✓	✓	✗	✗	✓
Insurance value	✓	✗	✗	✗	✓
Service/ Product	✓	✓	✓	✓	✓

[5] Volume in m^2 considered equivalent to separate length/width/height measurements.

The availability of a set of continuous variables that express both the common costs of production factors, and the cost allocation proportions for individual shipments, makes it possible to perform a sample-based analysis of shipments and see how their final price correlates with shipment costs at the time it was performed. Correlation hypotheses can be tested for each cost driver individually, and for the model as a whole.

3.5.3. Correlation testing methodology

To test the cost-price correlation hypotheses, the following approach has been applied:

1. A sample of invoices for delivered goods (n=400) was extracted from the database of Omnilog by randomly selecting rows of the 3PL provider's operational database that correspond to the following criteria:
    a. Shipment date: between 1.1.2014 and 31.12.2015
    b. Volumetric weight: same as the real weight (i.e. any excessively voluminous packages are excluded)
    c. Requested special services: none (only standard shipments are considered)
    d. Sender country: Italy
    e. Recipient country: Italy
2. The following variables were extracted from the selected rows:
    a. Shipment date

b. Delivery date

c. Measured weight

d. Invoice sum (before taxes)

e. Sender postal code

f. Recipient postal code

3. Any rows with missing or incomplete data were excluded from the sample.

4. The rows were integrated with the following data from national statistics and other sources:

   a. Quarterly mean prime industrial rents per square meter (Buccini, 2015, 2016, Cushman & Wakefield LLP, 2014a, 2014b, 2015a, 2015b, 2015c; Tóth, 2015);

   b. Average monthly price of automobile diesel fuel, including excise tax, relative to the date of shipment. (Ministero dello Sviluppo Economico - Dipartimento per l'Energia, 2016);

   c. Simple mean of average effective annual percentage rates on business loans: authorized overdraft, accounts receivable financing, factoring and leasing (Banca d'Italia, 2016);

   d. Monthly index of contractual hourly wages for transport and warehousing (Istituto Nazionale di Statistica, 2016b);

e. Monthly producer price index for production, transmission and distribution of electric energy (Istituto Nazionale di Statistica, 2016a);

f. Monthly producer price index for capital goods (NACE 2007: 0050) (*ibidem*);

g. Distance between the origin and destination postcode (Google Maps).

5. A multiple linear regression model was constructed for the following variables:

Independent variables	*Dependent variable*
Shipment weight	Invoice sum before taxes
Distance	
Workdays until delivery	
Rent	
Fuel price	
Credit rate	
Wages	
Electricity price	
Capital goods price	

6. Where applicable, logarithmic transformation was applied in order to improve the fitness of the variable to a linear model. To determine whether this is necessary, skewness with and without transformation is calculated.

7. An evaluation was performed on the statistical significance of the model as a whole (F-test) and of each coefficient separately (t-test).

3.5.4. Results

The complete dataset of shipments eligible for analysis contains 422 898 records. Of those, 400 were randomly selected (Appendix 1).

The distribution of the examined variables in the sample indicates that for four variables, logarithmic transformation can be expected to improve fitness for inclusion in a multiple regression model.

- Shipment weight
- Distance
- Workdays until delivery
- Invoice sum (dependent variable)

For the other variables in the model, the regression equation has been fitted without transformation. The resulting model parameters and coefficients are as follows:

Table 9. Cost-price correlation: model summary

R	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
.74	.55	.54	.43

Table 10. Cost-price correlation: ANOVA

	Sum of Squares	***df***	***Mean Square***	***F***	***Sig.***
Regression	84.07	9	9.34	51.03	.000
Residual	69.93	382	.18		
Total	154.00	391			

Table 11. Cost-price correlation: coefficients

	Unstandardized Coefficients		***Standardized Coefficients***		
	B	*Std. Error*	*Beta*	*t*	*Sig.*
(Constant)	2.43	25.93	.00	.09	.925
Log(Weight)	.20	.01	.77	20.67	.000
Log(Distance)	.11	.02	.15	4.29	.000
Log(Workdays)	-.03	.03	-.04	-1.04	.299
Rent	.28	.14	.40	1.97	.049
Fuel	.00	.00	-.07	-.51	.611
Credit	-.82	.38	-.42	-2.14	.033
Wages	-.19	.14	-.36	-1.33	.184
Electricity	-.06	.03	-.36	-2.05	.041
CapitalGoods	.17	.18	.06	.98	.329

3.5.5. Discussion

As expected, volume, weight and distance significantly influence the price for transporting an individual shipment:

- A 1% increase in volumetric weight leads, on average, to a 0.2% increase in price for transporting goods;
- A 1% increase in distance leads, on average, to a 0.11% increase in price for transporting goods.

Speed of delivery was not found to influence price significantly. This may be due to the model being unable to measure the very low prevalence of premium-speed shipments (where delivery by air or delivery in the morning was requested). Next-day business-hours delivery is the norm for domestic shipments in Italy.

Among the examined macro-factors, only industrial property rent and cost of credit seem significantly ($p < 0.05$) correlated with the service price:

- Increasing rates for renting industrial property by 1 Euro per square meter leads to a 0.28% increase in price for transporting goods;
- Increasing business credit rates by 1% leads to a 0.82% decrease in price for transporting goods;
- Increasing price for electric energy (at production) by 1% leads to a 0.06% decrease in price for transporting goods.

The strong inverse relationship with bank interest rates may be surprising, but it does not imply direct causality. In a post-crisis recovery period such as the one experienced by the European economy during the observed timeframe, it is possible that improved liquidity may stimulate lenders to lower interest rates, and at the same time, improved consumer confidence might drive prices up. Such macroeconomic considerations are beyond the scope of this research, but the important conclusion is that no *direct* relationship is observed between cost of credit and prices of transportation services. Similarly, the evidence of an inverse relationship between cost of electric energy and prices of transportation services is not convincing, indicating a weak correlation that might be driven by a confounding factor.

Prices also seem to be rather stable even with significant changes in prices of inputs that are thought of as important cost factors. The apparent lack of significance of factors that directly influence marginal cost (such as fuel prices) may seem unexpected in this market. The studied sample examines only basic transportation service, which has been standardized to a great extent, so the pricing is not influenced by perceived product differentiation or value-added services. B2B demand is generally very rational and clients have no reason not to leverage their buying power fully whenever it is beneficial for them.

The temporal stability of the prices cannot be explained by scarcity of supply either: with regard to express courier services specifically, market concentration is rather low (Autorità per le garanzie nelle comunicazioni, 2015).

However, proper price comparison before concluding a transportation contract is often a difficult task. As shown above, pricing is heavily dependent on the origin, destination, and physical characteristics of each individual shipment. The overhead of comparing such complex prices may generate more costs than benefits. In addition to the "difficult comparison" effect, switching costs could prevent clients from being more active in the management of their logistics partners in the short term. The latter problem can be circumvented by maintaining contracts with more than one operator at the same time, but such a solution may generate significant overhead costs too.

Thus, in some cases transportation service providers may be chosen in a seemingly irrational way rather than by carefully evaluating and comparing different quotes and contract conditions as is customary in B2B transactions.

Therefore, two points of intervention are likely candidates for improving the transparency of the buyer-supplier relationships:

1. An intermediation service capable of dealing directly with multiple transportation service providers so that customers do not have to worry about switching costs. This is already provided by many 3PL firms, but not always in a way that is fully transparent and grants complete control to the client.

2. A set of IT instruments that would allow clients to quickly and efficiently compare both prices and expected performance on the individual shipment level and on the aggregate level. This would be most feasible and useful in synergy with the above

intermediation service. A more detailed technical solution is proposed further on.

3.6. Quality of service indicators

Another natural yet complex concern when working with a service provider in the logistics business is the problem of defining, tracking, and predicting service quality. Continuous, reliable service is a top concern, but again, developing consistent indicators to measure service quality can be a challenge for a firm that is seeking to outsource its logistics operations.

Again, as with pricing, the multi-component nature of logistics operations makes it difficult to implement a simple way to monitor quality, and even more difficult to obtain information about service quality *a priori*, before entering into a contract.

On the other hand, many 3PL providers do keep quality statistics for internal use. Putting the aforementioned complexities aside, logistics management essentially deals with getting goods and materials at the right place, in the right moment, and in the correct quantity. Thus, when making a single delivery, the success or failure of a 3PL provider to meet customer expectations can be measured by answering the following questions:

- Has the item been delivered on time?
- Has the item been delivered in the correct quantity/amount?
- Has the item been delivered with no damages?

In practice, on-time delivery is the most often used metric, and with good reason: late delivery (usually only marginally late, by one day on average) is

the problem encountered most often when shipping goods. It is not always caused by poor service on the 3PL company's part. A late delivery could be caused by inefficiencies at the site of the client, of the recipient, or of subcontractors; and, naturally, travel and shipping are sometimes affected by *force majeure* events as well.

To illustrate the importance of late delivery, the deliveries mediated by Omnilog and executed by three large express couriers in Italy have been studied over the course of one month. No statistical significance of this data is claimed for the market as a whole, but it still provides valuable clues on the nature of problematic deliveries. From the results, it is evident that more than two-thirds of delivery issues are related to late delivery.

Table 12. Problems in deliveries contracted by Omnilog (November 2014)

Courier	*Total shipments*	*Late delivery*	*All other issues*
BRT	8048	1070	280
TNT	832	34	36
Artoni	13757	2473	1369
Total	22637	3577 (15.8%)	1685 (7.4%)

This means that managers might be inclined to use the on-time delivery rate as the only measure of logistics service quality. However, neglecting the other aspects of the service would result in a failure to capture a significant percentage of service quality problems.

An oft-cited example in the industry is the customer-driven approach adopted by FedEx (Baker, 2006; Best, 2008; Milakovich, 1995). The company originally used to measure quality performance by a simple indicator – "percent of on-time deliveries"; however, as part of a broader strategy to obtain a competitive advantage by differentiating its service, in 1987 FedEx replaced the old performance measure with a more complex index composed of 12 service quality indicators, each weighed by the inconvenience it is assumed to cause to the customer. By focusing on the client's point of view and applying this approach within a broader framework of dedication to customer satisfaction and constant monitoring of service quality, FedEx has been able to achieve remarkable results in terms of customer satisfaction: "Since 1987, overall customer satisfaction with FedEx's domestic service has averaged better than 95 percent, and its international service has rated a satisfaction score of about 94 percent. In an independently conducted survey of air-express industry customers, 53 percent gave FedEx a perfect score, as compared with 39 percent for the next-best competitor." (Milakovich, 1995, p. 21) "FedEx is able to create greater overall customer satisfaction with fewer errors, lower costs, and greater profits for shareholders." (Best, 2008, p. 212)

It is therefore in the interest of a third-party logistics provider to adopt a similar approach and evaluate service quality as a multi-component index, replicating the experience of FedEx completely or in part.

Table 13. FedEx service quality indicators

Indicator	*Weight*
Abandoned calls	1
Complaints reopened	5
Damaged packages	10

International	1
Invoice adjustments requested	1
Lost packages	10
Missed pickups	10
Missing proofs of delivery	1
Overgoods (lost and found)	5
Right day late deliveries	1
Traces (incomplete package scan data)	1
Wrong day late deliveries	5

It is easily understandable why it is in every logistics contractor's interest to implement and maintain a constant quality-measuring program of this kind in order to withstand the intense competitive pressure in the sector. A more difficult question is whether the results should be published, or whether they should simply be used internally in order to improve service quality; in the former case, another natural question would be – can the published data be expected to be transparent and trustworthy?

Again, we can look at the FedEx example for a rationale on why a culture of transparency might be a good strategy when customer satisfaction is involved:

> "The most critical technology that enables FedEx, and its customers, to track every single package anywhere in the system is its sophisticated package-tracking system, now known as COSMOS®, for the FedEx Customer-Oriented Service and Management Operating System. COSMOS monitors the movement of all shipments within the FedEx network – more than 3 million each business day. Customers

can tap into COSMOS via the Internet to verify a shipment's status – and they do so millions of times each month.

When Fred Smith implemented the tracking system, many asked why he would invest such large sums of money in a technology that would not speed up delivery by one second. In other words, in a Taylorite view of the world of efficiency, there would be no increase in outputs relative to inputs. But that was not the point. By providing FedEx customers real-time access to their package information, he was creating an *excuseless culture* inside FedEx, by designing a system that held all team members accountable to the success factors important to the customer."

(Baker, 2006, pp. 81–82)

The fact that virtually all major players on the market have followed FedEx's lead, implementing similar tracking systems that can be directly accessed by clients, speaks for itself.

By making the customer feel informed and valued, the company is building trust and loyalty, but how far does this transparency reach? While giving customers full access to track their individual deliveries, FedEx does not publish the aggregate value of their famous Service Quality Indicator. It is used exclusively as an internal company tool to improve performance. Other express couriers and delivery companies are reluctant to openly disclose their performance statistics as well. The trouble with real-time objective data is that they may follow unpredictable trends, and it is understandable why no business would be comfortable publishing them without prior screening.

On the other hand, performance data coming from the company itself can also present a problem of trust: a current (or potential) customer may find it harder to perceive such data as reliable, as opposed to statistics coming from dependable third-party information providers.

Therefore, in the present state of the art, there is no tool to allow a firm to evaluate a transport/logistics provider's quality of service *a priori*, before committing itself to a contract. The only guarantee in this respect is provided by service level agreement clauses that make late, damaged or lost deliveries eligible for refunds and indemnities, but that does not help the customer to predict the probability of such events occurring and to take preventive measures by simply choosing a more reliable provider in the first place.

The issue is further complicated by the fact that transportation, by its nature, can never be a local business: it requires a geographically spread, capillary network of offices and facilities. If a customer contracts a company to make a delivery from London to New York, the quality of the service is dependent upon both the London and New York offices, as well as upon any intermediary hubs. This additional source of variability results in an even more difficult situation for businesses who wish to outsource their logistics: for any single delivery, the contractor providing the best service can vary based on the point of origin and destination.

It has already been shown that in Italy, the majority of businesses do not operate on a global level, and smaller companies often confine their sales within a single region of the country. Nevertheless, the capillary nature of transport means that quality may vary considerably even at this smaller, national scale; for example, the offices of the same transport company in

Rome, Milan, Venice, and Genoa may perform differently in terms of service quality and efficiency.

Global logistics and transport companies strive to unify the customer experience they provide, basing their brand on a universal promise valid across the planet. In reality, at least some level of national and regional variability is inevitable. This may be even more pronounced in cases where the service provider uses franchising to leverage their brand's value and to help expand the company's global presence. In those cases, compliance with the brand values is not enforced through a direct hierarchy, but through looser franchise contract relations, which carries the risk of debasing some of the service quality guarantees promised by the brand.

3.7. Innovation in 3PL services

In historical perspective, the outsourcing of logistics operations is, in itself, an innovation when applied to the supply chain structure. The use of third-party services permits a faster and more efficient implementation of innovative solutions – both technical and structural:

> "In regards to logistics, some elements have resulted as changing factors that go beyond a simple technical optimization allowed by developments in information and communication management. More specifically, for innovative relationships within the channel, characterized by the need for greater coordination and integration, logistics can be seen as an interface between strategic and tactical orientations that can sometimes be different or conflicting among the channel partners. To lower the cost of stock management, handling, and transports, several organizational solutions have been developed,

aimed at making the logistic cycle faster and without errors. These solutions can be developed via third party operators or by the use of transit logistic facilities, according to the cross docking technique."

(Musso, 2010, p. 27)

Apart from competing with each other, third party logistics providers also have to compete against the classical alternative of handling logistics internally. That is why, as the 3PL industry is maturing, it continues to leverage innovation as a major competitive advantage in order to provide added value for clients who choose to outsource logistics. When evaluating the collaborative relationships with 3PL providers, 68% of clients agree that "3PLs provide us with new and innovative ways to improve logistics effectiveness" (Langley, 2014, p. 41)

The most important dimension in logistics innovation regards the adoption of information technology tools in order to improve the flow of data between trading partners. "It has been clear for some time that the provision of capable IT services has been a key element of the value proposition in shipper-3PL relationships [...] In fact, there is a relatively discernable relationship between the propensity of shippers to utilize specific IT-based services and the types of logistics services that are outsourced to 3PLs" (Langley, 2015, p. 15)

The fundamental IT tool in logistics that acts as a base over which innovations are typically built, is the concept of electronic data interchange (EDI), i.e. the use of a common file format in order to exchange information between the computer systems of two trading partners (which often use proprietary or otherwise incompatible data formats internally). Originally an

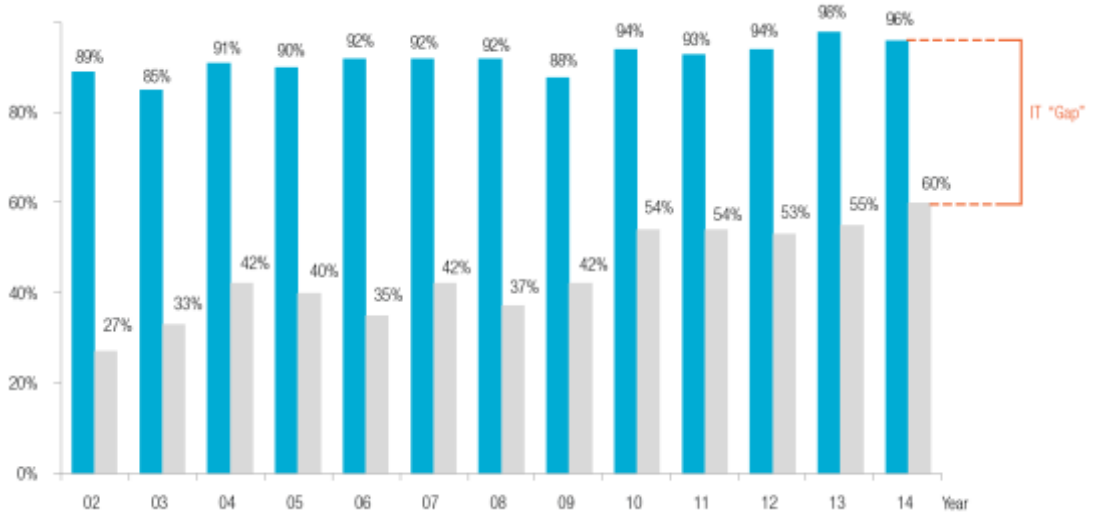
innovative element itself, EDI has been present in logistics since the 1960s and is currently a mainstream, indispensable instrument (Swatman & Swatman, 1991). Multiple IT capabilities built upon EDI are currently provided by 3PL companies and being used by clients with varying intensity (Table 14); some notable emerging IT services provide integration with customer relationship management (CRM) platforms, support for cloud-based technologies, and mobile technologies.

Table 14. IT capabilities in 3PL (Langley, 2015, p. 16)

Region	Percentages Reported By					
	3PL Users			3PLs		
	2013	2014	2015	2013	2014	2015
Transportation Management (Execution)	72%	75%	73%	84%	81%	86%
Warehouse/Distribution Center Management	64	74	65	78	71	76
Electronic Data Interchange	68	78	65	79	76	80
Transportation Management (Planning)	67	69	64	80	77	79
Visibility (Order, Shipment, Inventory, etc.)	60	76	63	75	78	76
Web Portals for Booking, Order Tracking, Inventory, etc	59	62	50	72	75	76
Bar Coding	50	50	47	60	53	55
Transportation Sourcing	45	45	48	58	52	59
Customer Order Management	41	42	41	64	66	79
Global Trade Management Tool	43	51	36	42	38	31
Advanced Analytics and Data Mining Tools	26	34	30	39	42	45
Supply Chain Event Management	26	38	30	49	53	50
Network Modeling and Optimization	30	35	29	44	55	51
Supply Chain Planning	30	36	26	59	59	53
Collaboration Tools (SharePoint, Lotus Notes, etc.)	32	43	25	41	46	46
CRM (Customer Relationship Management)	-	-	23	-	-	59
Yard Management	17	30	21	28	35	37
RFID	24	22	18	36	26	28
Cloud-Based Information Technologies	-	-	12	-	-	38
Mobile Technologies for Sales Support	-	-	11	-	-	36

Even though 3PL service providers can be expected to be willing and able to dedicate more resources to technical innovation than logistics structures of a company with a different core business – and therefore to have a technological advantage with respect to non-outsourced logistics – reports indicate that a gap exists between the IT capabilities requested by clients and those provided by 3PL firms (Langley, 2015, p. 17). Unsurprisingly though, market pressures lead to a gradual narrowing of that "IT gap" over time:

Figure 9. The "IT gap" in third-party logistics (Langley, 2015)



Therefore, the discrepancy between businesses' needs for innovative IT services in the area of logistics, and the current ability of 3PL operators to provide them, generates an opportunity to create a strong value proposition.

One specific potential innovative use of IT in a 3PL context consists in applying data processing technology in order to help clients solve some of the aforementioned issues of price and quality comparison difficulty, combined with a business model that provides a way to choose subcontractors

freely and switch between them at zero cost; this innovation opportunity is studied in more detail in the following chapters.

4. IT SOLUTIONS THAT REDUCE INFORMATION ASYMMETRY

Information technology is, by definition, involved with gathering, processing, storing, and transferring information. With present-day IT, it is possible to perform previously uneconomical operations related to obtaining and processing information. As such, IT is promising in applications that aim to manage the information asymmetry problem and to reduce the costs of signaling and screening.

Many of the well-known advantages of e-commerce and related applications of IT and computer networks are related to information economics. Traditionally, the brand is the primary signaling tool used by firms to overcome mistrust related to information asymmetry: "...when consumers are uncertain about product attributes, firms may use brands to inform consumers about product positions and to ensure that their product claims are credible. Thus, brands may signal product positions credibly. Brands as market signals improve consumer perceptions about brand attribute levels and increase confidence in brands' claims. The reduced uncertainty lowers information costs and the risk perceived by consumers, thus increasing consumers' expected utility." (Erdem & Swait, 1998, p. 131)

Building brand equity, especially on a global level, is a costly and time-consuming process (Aaker, 2009). E-commerce technology provides compensatory mechanisms that allow sellers to broadcast credible information about their reliability and their product's qualities at a much lower cost. At the same time, e-commerce customers often experience lower sunk costs and lower switching barriers, thus being more confident that

information asymmetry is less likely to result in opportunistic behavior on the part of the seller:

> "Buyers face search costs in obtaining and processing information about the prices and product features of seller offerings. These costs include the opportunity cost of time spent searching, as well as associated expenditures such as driving, telephone calls, computer fees and magazine subscriptions. Similarly, sellers face search costs in identifying qualified buyers for their products, such as market research, advertising, and sales calls. [...] Internet technology can also lower the cost to buyers of acquiring information about the reputations of market participants. Such reputations may be provided as part of the marketplace (for example, on eBay), or through specialized intermediaries, such as Bizrate, which rates retailers on specific attributes (like service, product quality, and delivery promptness) by surveying consumers who have recently purchased products from these retailers."
>
> (Bakos, 2001, p. 70)

In some cases, the information asymmetry problem might also be overcome with the help of independent intermediaries. When providing information about the goods and services offered by a firm, information from third-party dealers may be deemed more reliable than if it is coming from the firm itself (Yacouel & Fleischer, 2012). Diamond (1984) demonstrates how this phenomenon is observed in the financial services market, where intermediaries have a prominent role. Many of the examples below show how in the case of "cybermediaries", information technology can potentiate this positive effect of intermediation.

Here, a classification of four types of Internet-based mechanisms that help overcome information asymmetry is proposed.

- *Quality evaluation:* providing reliable independent tools to measure, summarize, and compare quality between different product sellers or service providers;

- *Price comparison:* providing reliable independent tools to measure, summarize, and compare prices of similar products or services;

- *Reducing transaction and switching costs:* providing common tools and procedures that standardize the buying process between different sellers and/or acting as an intermediary so that customers do not deal directly with the final seller or provider;

- *Fostering virtual communities:* allowing buyers to communicate freely and exchange information that helps reduce the level of information asymmetry;

Successful real-life examples of e-commerce applications will typically combine two or more of these mechanisms.

4.1. Quality evaluation

4.1.1. Online retailers and marketplaces

Virtually all large online marketplaces provide the buyer with tools to evaluate the quality of the goods and services offered. Arguably, the most successful e-commerce firm presently is Amazon.com. It first went online in 1995 as an online bookstore (Byers, 2006). It has since expanded and

diversified its assortment, and is currently the largest online retailer in the world, with more than $80 billion worth of sales on a yearly basis (Reuters, 2016). In terms of market capitalization, Amazon is also larger than any traditional retailer in the United States, having surpassed Walmart in 2015 (Figure 10).

Figure 10. Amazon market capitalization growth (MoneyWeek, 2015)

A distinctive feature of Amazon is its product rating system, which provides information on a product's quality and value based on "crowdsourced" data entered by other members of the website. Visitors can submit reviews to amazon.com and rate any product on a standard scale ranging from one to five stars.

Amazon provides several separate mechanisms to allow reviewers to signal the authenticity and trustworthiness of a review. If they have a verified credit card associated with their Amazon account, the website can use this information to confirm that the member is posting the review under their real

name. If the reviewer has purchased the product from Amazon, this is also indicated next to the review as a confirmation that the member has actually bought and owns the product. In addition to that, other members of Amazon may vote on the review and indicate whether they consider it helpful.

Despite all these measures, there is still a proportion of deceptive online reviews – also known as "opinion spam" (Jindal & Liu, 2008). Nevertheless, the Amazon website is the most frequently consulted source used by consumers when researching product reviews and ratings, and it is overwhelmingly perceived as a credible source of such information (Freedman, 2011).

Another popular e-commerce platform is eBay, which does not handle supply chain management and delivery, but simply provides an online marketplace to connect buyers with merchants. It originally started in 1995 as an online auction platform for consumer-to-consumer sales, and the founders had the explicit desire to create a "perfect market" (Berkun, 2010; Cohen, 2008). According to economic theory, that would imply a perfect, unobstructed flow of information about trading parties, their reputation and the goods they exchange.

The eBay website provides a feedback mechanism that allows each buyer or seller to rate their counterparty positively or negatively after a transaction is concluded. When submitting feedback, eBay member include a short note explaining their reasons for choosing that rating. The feedback information is publicly available, and aggregate statistics (such as, for example, percentage of positive feedbacks in the last three months) are displayed in the public profile page of each member.

This system was further refined in 2008, when star ratings ranging from one to five (similarly to the aforementioned Amazon ratings) have been added to the feedback system. Buyers can rate the seller's performance in four categories, and unlike the older, fully public positive/negative feedback mechanism, which is still in place, in the four new categories only aggregate statistics are displayed (while individual ratings are kept anonymous).

The seller's reputation on eBay has been demonstrated to improve the probability of a successful sale by reducing the level of information asymmetry (Shen, Chiou, & Kuo, 2011). In this regard, eBay's feedback mechanism provides sellers with powerful tools to build reputation and signal their trustworthiness at a relatively low cost.

4.1.2. Business-to-business e-commerce

E-commerce model is applicable and thriving in a business-to-business context as well. "Forester Research Inc estimates current business-to business e-commerce to be five times that of consumer e-commerce" (Wind & Mahajan, 2002).

In the world of B2B e-commerce, the most prominent example is Alibaba.com, a web portal that connects suppliers in China with buyers in other countries. It is currently the "world's leading B2B e-commerce company" (Honghong, 2008). Alibaba.com is well aware of the lack of information that buyers face when negotiating with foreign suppliers, and for that reason, similarly to the other online marketplaces listed above, has provided various technology tools to help bridge the information gap where supplier trustworthiness and product quality is concerned:

- Supplier statistics – for each supplier listed on Alibaba.com, the portal keeps information on previous negotiation and transactions with other buyers (transaction history, response rate, response time, quotation performance). This information is displayed publicly as a trustworthiness signal.

- "Gold Supplier" and "TrustPass" identity checking - since Alibaba.com intermediates large-amount B2B transactions, the portal does not limit its trust and reputation development mechanisms to passively collected feedback and statistics, but instead will also step in and pre-emptively perform verifications on the buyers' behalf. Suppliers can choose to enroll in the voluntary "Gold Supplier" and "Trust Pass" programs at a set price, and then they will be subjected to verifications both by Alibaba.com and by third-party credit rating agencies. Such verifications include checking of business registrations, licenses and trademarks, and on-site visits of the supplier's facilities to prevent fraudulent registrations.

- Additionally, Alibaba.com offers a guarantee scheme called "Trade Assurance". Selected suppliers who have passed specific verifications can benefit from the Trade Assurance program, and Alibaba.com will provide payment protection to the buyer if the supplier does not fulfil the contract in terms of delivery time and/or quality of the goods. If the supplier, for some reason, does not fulfil a Trade Assurance order properly or refund 100% of the payment, Alibaba.com will refund the buyer at its own expense. In this way, Alibaba.com is an example of an even higher level of

involvement where the information technology provider steps in as a direct business partner, overcoming the information asymmetry problem through independent third-party guarantee model.

4.1.3. Travel-related services

Numerous examples of markets where information asymmetry regarding quality is typically present and where Internet-based technical solutions help overcome this problem are present in the field of tourism, travel, and vacation planning. Travel-related services (air travel, hotel bookings, etc.) may be especially vulnerable to information asymmetry (Crase & Jackson, 2000; Fernández-Barcala, González-Díaz, & Prieto-Rodríguez, 2010; Yacouel & Fleischer, 2012). Such services typically cannot be evaluated before they are effectively rendered, they are often highly seasonal and with a low level of repeat transactions, and they involve travel to remote areas where the consumer is not familiar with the market, with the legal framework, or even with the language spoken in the area.

For that reason, numerous information-based online tools are available and enjoy popularity among consumers. Some platforms are purely information-based: websites such as TripAdvisor and Yelp base their model on accumulating user-generated reviews about businesses and landmarks. Website visitors voluntarily share their quality assessments and the website handles the task of summarizing this information in a synthetic quality marker, such as a 1-to-5-star rating. Research finds that the model is generally successful: "...social media and user generated content are rapidly gaining traction among travel consumers. All hotels sampled on Tripadvisor.com had been the subject of multiple reviews, where consumers voiced their opinions

about experiences in that property. Given the number of visitors to the site, it's clear that this content is being consulted; the guest experience is becoming essentially transparent; and reviews are having an effect on consumer decisions." (O'Connor, 2008)

In other cases, user-generated reviews are an add-on functionality provided by "cybermediaries" who handle booking and/or payment of travel-related services. This model has the advantage of providing additional confirmation of the authenticity of user-generated reviews (i.e. reviewers have completed the booking process through the website by verifying their credit card, which provides both confirmation of their identity, and of the fact that they have actually stayed at the hotel they review). Booking.com is an example of such a platform, and a case study involving the website concludes that online travel agents "...provide reliable information regarding hotels' past service quality by allowing only guests that actually stay at a hotel to write a review on their site. Since the information on hotels' past quality is revealed to the guests, the guests are willing to pay higher price to hotels with a good record (hotels that they expect to keep on providing high service quality). This price premium for a good reputation motivates the hoteliers to actually invest in providing high standards of service quality." (Yacouel & Fleischer, 2012).

In brief, online intermediaries effectively overcome the issue of adverse selection caused by information asymmetry by aggregating buyers' experiences and opinions, and by providing independently managed tools to evaluate sellers' performance without conflict of interest. As a result, buyers feel more informed and actually base their purchasing decisions on the information provided; and well-performing sellers are able to monetize their

good service and collect a price premium in what would otherwise be a "lemon market".

Another platform that may be used to analyze and compare service quality in a travel-related market is the FlightStats website. It demonstrates that quality evaluation does not necessarily have to rely on user-generated data as in the other examples examined so far. IT platforms for quality evaluation may simply obtain raw data from publicly available sources. Then their powerful processing capabilities can be used to infer results that would otherwise be difficult to obtain: "...in the technology business, a mashup is a web application that takes information from more than one source and combines them–the data is "mashed up" to create a new integrated experience" (Descy, 2007).

In the case of FlightStats, multiple data sources are used (airport websites, airline data feeds, regulatory agencies, etc.) to provide both real-time and past performance data on flights across the world:

> "FlightStats is the leader in global flight data services and solutions to travelers and the companies that serve them. The company provides real-time global flight information which includes about 90,000 global flights per day, serving airlines and airports, travel agencies, developers, consumers, and others. More than 6 million unique visitors per month rely on FlightStats' real-time flight and airport tracking tools to optimize their day of travel. [...] "Our competitive advantage is not simply having great data, but also our ability to manage, analyze, and distribute that data," says Tod Hutchinson, chief executive officer and co-founder at FlightStats" (New Relic, 2015)

FlightStats' relevance to the information asymmetry problem lies in the fact that past performance statistics may be used to infer information about service quality, such as percentage of on-time arrivals and average delay minutes. Typically airlines are very reluctant to disclose such data, and "the majority of airlines consistently underforecast delays" (Penn, Garrow, & Newman, 2015). By using publicly available information to analyze airline performance and forecast delay probability, FlightStats and similar websites and applications may provide a more complete snapshot of different service providers' performance, and compensate for information asymmetry in the air travel market.

4.1.4. Freelance marketplaces

As mentioned in the last chapter, the job market is a very typical case where information asymmetry may lead to adverse selection and where considerable investment in signaling is undertaken by job applicants in order to communicate their advantages over competitors (Spence, 1973). In some particular cases, the aforementioned mechanisms for online quality evaluation may be applied to signal potential work performance at a much lower cost when compared to traditional education, qualification and skills benchmarking.

Freelance marketplaces, such as Upwork, freelancer.com, Guru.com, and many others, connect providers with buyers for short-term projects involving remote work where the end product can be delivered through the internet (i.e. typically involving professional capabilities related to intellectual property, such as design, programming, copywriting, translation, etc.).

The short-term nature of such work relationships means that several performance evaluations can be accumulated by a provider within a reasonable timeframe, and the fact that they are fully Internet-based means that buyers can select from a large pool of providers on a global level. This allows for the implementation of automated feedback and reputation mechanisms similar to the ones used by the aforementioned consumer-oriented platforms for exchanging goods and services.

Typically, buyers will post information about their projects and freelancer providers will then post bids for projects they are interested in working on. Reputation measurements are a valuable addition to these bids: "Unlike traditional auctions, in this setting, buyers do not pick the winning bid based on just prices; rather buyers trade-off sellers' reputations, bid prices, other bid attributes, and the cost of waiting and canceling, when making their decisions. [...] estimation results from a leading online freelance place suggest that buyers are forward looking and that they place significant weight on bidder reputation." (Yoganarasimhan, 2013). A good reputation will, then, make it more likely for a provider to find work, and that will also benefit the intermediary, which benefits from implementing the reputation mechanism: "In the absence of a reputation system, buyers have lower value from choosing bids, and more of them prefer to cancel the auction. This has a direct negative effect on the site's revenues. Further, since the reputation attributes have now disappeared, buyers' relative weight on price increases. Thus successful auctions now clear at lower prices, which has an additional negative effect on the site's revenues though decreased commissions" (Yoganarasimhan, 2013).

In this way, the experience of online freelance marketplaces directly demonstrates how a market inherently characterized by information asymmetry can grow by more than 11% when an automated IT-based system for estimating quality and measuring reputation is introduced, benefitting buyers, well-performing suppliers, and online intermediaries equally.

4.1.5. An alternative to government regulation?

It has already been outlined that direct regulatory intervention is a powerful tool to protect the vulnerable party in markets with structural information asymmetry. Sometimes, such regulatory limits may have the unintended consequences of adding overhead costs to ensure compliance, increasing barriers to entry, and limiting competition, so while the consumer can feel safer and more confident in the quality and reliability of the product or service they are purchasing, they may be unhappy about the higher price this protection entails. Nevertheless, a high level of protective regulation has been the policy choice in many business-to-consumer markets in developed countries, either by directly making information availability mandatory or by otherwise compensating indirectly for the lack of available information, because pure market solutions may have been unavailable or too costly (Beales et al., 1981).

With contemporary IT-enabled tools, this may be changing. The internet "allows innovators to offer an expanded range of goods and services, greatly expands the information available to consumers, and provides strong reputational incentives for firms to improve the level of service being provided" (Koopman, Mitchell, & Thierer, 2015). The tools for quality evaluation provided by internet-based platforms might provide the same, or a higher, level of information asymmetry mitigation as protective government

regulations do, at a much lower cost, leading consumers to choose and prefer online "sharing economy" options in markets that are heavily regulated. Examples include Uber, as a passenger transport alternative to taxicabs (which are typically restricted and regulated for consumer protection reasons), and the Airbnb short-term renting platform that provides an alternative to hotel accommodation. "To the extent that consumer protection regulation is based on the claim that consumers lack adequate information the case for government intervention is weakened by the Internet's powerful and unprecedented ability to provide timely and pointed consumer information." (Moorhouse, 2003, p. 139)

4.2. Price comparison

Another set of operations where information technology can excel is related to collecting, analyzing, and comparing price information. In traditional marketplaces, buyers may research the market and look for the best price, but that often results more costly and is not worth the money saved; "from the perspective of information economics, buyers can be expected to optimize the allocation of their scarce time and mental resources" (McKenzie, 2008). In that way, lack of information may lead buyers to rationally accept an offer that is not the most convenient in terms of price.

By drastically reducing these research costs, IT allows buyers to be more informed about available prices. In this way, technology can improve market performance to the benefit of buyers and cybermediaries who collect, disseminate, and monetize such information.

4.2.1. Basic price comparison in e-commerce

In its simplest manifestation, price comparison can take the form of basic search tools functioning within an online retail marketplace. This can be simply a result-ordering tool available when searching for products that allows the user to see lowest-priced or highest-priced goods first. In addition, the website could allow searching for a specific product and price range. Such options are virtually always included in online marketplaces that aggregate services from different providers, such as the ones already examined (Amazon, eBay, Booking.com, Airbnb, etc.).

In rare cases, where the service is homogenous, the online intermediary can even impose fixed prices on service providers, which is the case with Uber and Lyft, or it can provide them with price recommendations (for example, the Fiverr freelance marketplace is built around advertising services where price starts at $5).

4.2.2. Advanced multi-sourced price comparison

4.2.2.1. In e-retailing

More advanced instruments for pricing information and price comparison can also be made available to the buyer. For example, when such information is available, eBay will not only display the current auction bid or direct sale price of a product, but it will also integrate this information with other useful price comparison data derived from past sales and even sales external to the eBay platform:

> "*What does "List price" mean?*
>
> This is the price (excluding shipping and handling fees) a seller has provided at which the same item, or one that is nearly identical to it,

is being offered for sale or has been offered for sale in the recent past. The price may be the seller's own price elsewhere or another seller's price. The “save” amount and/or percentage is the difference between the seller-provided original price for the item and the seller's current discounted price. If you have any questions related to the pricing and/or discount offered in a particular listing, please contact the seller for that listing.

What does “Seller's previous price” mean?

This is the price (excluding shipping and handling fees) this seller has provided at which the seller has sold the same item or one that is virtually identical to it, in the recent past. The “save” amount and/or percentage is the difference between the seller-provided original price for the item and the seller's current discounted price. If you have any questions related to the pricing and/or discount offered in a particular listing, please contact the seller for that listing.

What does “Outside competitor” price mean?

This is the price of an exact product in new condition, taking into consideration shipping charges, from an outside competitor to eBay.com. The "save" amount and/or percentage is the difference between the seller-provided original price for the item and the seller's current discounted price. If you have any questions related to the pricing and/or discount offered in a particular listing, please contact the seller for that listing.

What does the “Trending on eBay” price mean?

> This is the median price based on sales of this product, taking into consideration item condition, from all sellers on eBay.com in the past 14 days, or if there are an insufficient number of listings for a meaningful calculation, the past 90 days."
>
> (eBay, 2014)

4.2.2.2. In travel and hotel booking

In the context of online travel agencies, so called "meta-search engines" are "software platforms combining the offers of different OTAs, as well as the own websites of the various suppliers. They facilitate the end customer's choice by filtering the information according to different criteria, most often price. They do not participate in the sales process, but they redirect the customer to the respective supplier or OTA. For the service, they charge a fixed price per booking or according to negotiated terms. Typical examples are: Skyscanner.com, Kayak.com, Hotelscombined.com, Trivago.com. Momondo.com" (Ivanova, 2016).

Such meta-search engines monetize their information processing capabilities and facilitate online price comparison by automatically summarizing information available from multiple online sources, thus greatly decreasing the necessary time (i.e. opportunity cost) for the buyer to make a purchasing decision. This makes it rationally possible to compare prices in some cases where it would not otherwise be feasible to do that, and can therefore lower market prices. The service provider may, for its part, apply price discrimination in favor of customers arriving through price comparison engines, who can be assumed to be more price-conscious, while offering higher prices for direct bookings.

4.2.2.3. In real estate

Real estate is a field where price estimation can be notoriously difficult; residential properties, specifically, have a very large number of characteristics which may influence the price of an individual property, and which may make it complicated to select a statistic to synthetically measure the market trend, such as median price per square meter (Case & Quigley, 1991).

Zillow is a popular online platform in the United States that applies a patented technology (Cheng, Humphries, Chung, Xiang, & Burstein, 2011; S. B. Humphries, Xiang, Burstein, Bun, & Ultis, 2012; S. Humphries, Xiang, Chung, & Burstein, 2014; Ma, Burstein, & Andersen, 2013) to estimate the value of a specific home. Zillow's algorithm processes data about recent sales in a specific geographic area and multiple attributes sourced from publicly available databases and user-contributed data.

Zillow has single-handedly modified information relationships on the US real estate market by providing multiple research instruments for free and by increasing customer involvement: "A more disruptive change is that consumers are not simply the recipients of information, but producers and disseminators as well. This has significantly reduced the asymmetry and opaqueness of information." (Ba & Yang, 2016)

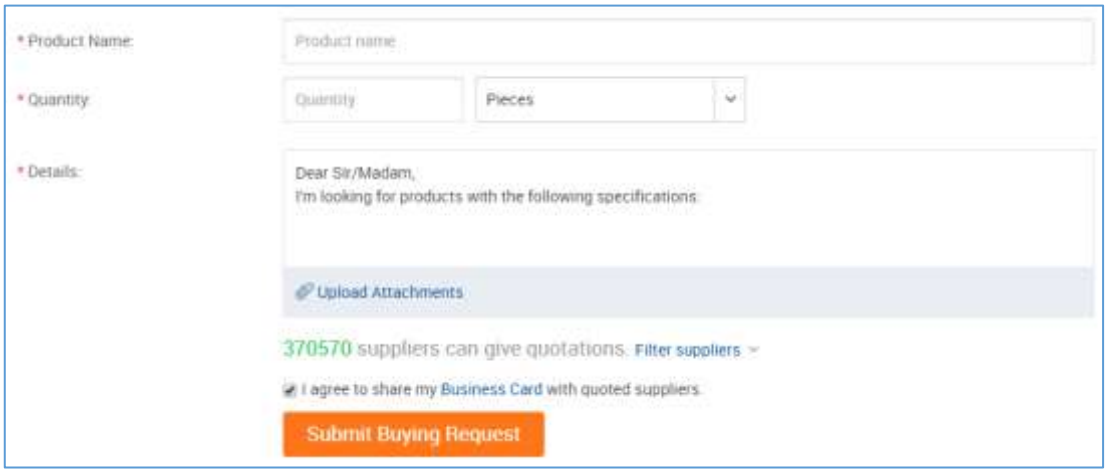
These characteristics allowed Zillow to become the market leader among real estate websites, especially since many of its competitors are simply online extensions of traditional multiple listing services, i.e. databases strongly geared towards real estate professionals who are already well informed about the market. Zillow, on the other hand, focuses on "informing the uninformed" and fosters disruptive innovation by being highly active on all fronts: research

and development, marketing, and acquisitions of other promising innovators in real estate (Ba & Yang, 2016).

4.2.3. Quote requests in B2B e-commerce

In wholesale B2B e-commerce, where imperative list prices are less common and pricing may often be negotiated individually, Alibaba.com adopts a different approach: it provides tools that enable buyers to request individual quotes from multiple suppliers at once (Figure 11). In this way, buyers can access a larger pool of potential suppliers and reduce their overhead costs for requesting and comparing quotes.

Figure 11. Alibaba.com buying request sent to multiple suppliers simultaneously



4.2.4. Reverse auction models

Another way to overcome the information bias in pricing is a reverse auction model where buyers announce the price they are willing to pay, and sellers then choose whether to accept or reject the bid.

4.2.4.1. Name-your-own-price

An innovative variation of this model is the name-your-own-price format popularized by Priceline.com. Again, it operates in travel, tourism and hotel sector, where information asymmetry and price discrimination is commonplace. Paradoxically, unlike other online solutions, in terms of information, the name-your-own-price is *less* transparent to the end-user compared to traditional buying channels. Sellers will provide some of their inventory and indicate the price at which they would accept bids; and buyers bid for a service by entering only the price, and do not know anything about the service provider until the booking transaction is complete.

Anderson (2009) describes how this can be used to leverage the powerful price comparison capabilities of online platforms without antagonizing the service providers. The cybermediary can still use its information power to provide the consumer with a significantly lower price; however, by making the process opaque, Priceline ensures it does not cannibalize other sales channels that the same provider uses (e.g. standard booking for less price-sensitive business travelers). The opaqueness of the process attracts consumers who are very price-sensitive and repels all the other buyers. In this way, the name-your-own-price model benefits both the seller, who is able to use Priceline's platform for a price discrimination strategy, the price-sensitive buyer, who is able to find a better deal than would be possible without the online platform, and the Internet-based intermediary who can earn a commission on the transaction.

4.2.4.2. In freelance marketplaces

Freelance marketplaces, already examined above, are another notable example of price comparison achieved by a reverse auction model. The high level of specificity of each individual work project makes it difficult to let providers set prices *a priori* or to compare prices for similar projects, but the large available pool of global supply makes it possible to overcome this limitation by simply having suppliers bid their price for each individual project. The buyer is then provided with a convenient interface to view and compare bids. In many cases, present and past proposed and accepted bids are made public, which permits both buyers and suppliers to research the market and adjust their behavior accordingly. This aspect of freelance marketplaces, combined with their global span, define their fiercely competitive nature which often tends to work to the significant advantage of buyers (Beerepoot & Lambregts, 2015).

4.3. Reducing transaction and switching costs

Opportunistic behavior connected with information asymmetry is enabled and reinforced in cases where switching costs are higher. Even if new information is revealed after a party commits to a transaction, and that information indicates that the transaction is less favorable to that party, if switching barriers are high, it might be rationally preferable to bear the disadvantages rather than end the relationship: this creates a tie-in effect that in practice equates *delayed* information availability to information *unavailability*.

Again, the global nature of electronic marketplaces usually makes it possible to choose among a very large pool of suppliers. This replicates and

further accelerates the general trend in globalized markets where oversupply results, ultimately, in drastically reduced customer loyalty (Brondoni, 2005).

In addition, the standardized negotiation and transaction tools provided to buyers and sellers make it possible to change suppliers and hardly notice any difference in the buying process.

For example, on eBay, the bidding process is the same for any auction, regardless of who the buyer and the seller are. The payment process is also rather standardized due to the strong partnership between eBay and PayPal: "Today, most of eBay auctions accept Paypal payments, and Paypal is the payment method of choice used by the majority of eBay users" (O'Regan, 2015, p. 81). Similar standardization exists in virtually all online platforms examined so far.

Since in online sales competitors are "just a click away", it can be expected that switching costs would be much lower, providing customers with more opportunities to exhibit disloyal behavior. This expectation is confirmed by research:

> "...the lower the perception of good alternatives available in the market, the more loyal customers will be. It would appear that an e-retailer is not as well protected by new entrants in the online environment as their offline counterparts, as this result contradicts studies in the offline environment. In the offline environment, switching costs play a greater role in determining loyalty as compared to alternative attractiveness, where competitive insulation appears to be more substantial. This has been found especially among studies on

> continuous and/or contractual service (e.g., financial, credit card and phone services, etc.)."
>
> (Ghazali, Nguyen, Mutum, & Mohd-Any, 2016, p. 167)

This tendency of online market platforms to reduce switching costs complements and fortifies their ability to provide better information compared to regular markets and to overcome inefficiencies caused by information asymmetry.

A "cybermediary" could therefore enjoy business success because it has the opportunity to extract value from the market by virtue of this improved efficiency, transfer it to the negotiating parties, monetize part of it, and still provide more attractive negotiating conditions compared to offline channels.

4.4. Virtual communities

Giving consumers a medium to exchange information freely is a less formal and less structured way to "level the field" concerning information about the price and quality of products and services. This is accomplished by building virtual communities that often complement and augment the more structured tools.

For example, on the Amazon website when a customer posts a product review along with a star rating, other site members may reply the review and form a discussion. In addition, Amazon actively encourages the use of the "Customer questions & Answers" feature where prospective buyers may ask product owners directly regarding product features they are not certain about. As Amazon describes it:

"This is a great opportunity to get feedback from other customers who have experience with the product. Ask a question that will capture this experience. For example:

- Does this camera take good quality pictures in low light?
- How long does the battery last in this laptop while watching movies?
- Does this computer have noisy cooling fans?"

(Amazon.com, 2016)

Such virtual communities let their users exchange purely qualitative information, without any summary statistics and quantitative scales attached. This is an important complement to the above tools for information exchange, as it allows free flow of nuanced communication between people who share an interest in a product or service. It is arguably most efficient if implemented in conjunction with the other rating and reputation mechanisms above, but firms and organizations can profit from establishing standalone virtual communities as well. Such communities (e.g. blogs or social networks like Facebook and Twitter) do have a significant impact on markets by encouraging decentralized production of knowledge and mitigating information asymmetries (Saxton & Anker, 2013).

4.5. Data sourcing models

All of the above models and examples involve obtaining, processing, and dissemination of information. Current technology allows fast and efficient data processing, and from the point of view of the cybermediary, probably the most significant challenge is to actually obtain enough raw data to process

in order to produce a meaningful and economically useful result. The ability to build databases and obtain access to data feeds is a major determinant of competitive advantage for the operator of an online market service.

In many cases, user-generated content is the norm. By allowing users who benefit from their services to freely contribute data on quality, pricing, and product/service attributes, online marketplaces benefit from cost savings (i.e. their users often generate valuable content free of charge), and at the same time they enjoy a higher level of perceived impartiality and credibility of the generated content.

The magnitude of this phenomenon was recognized by *Time* magazine, which chose "You" as person of the year in 2006, recognizing all the people who contribute such content to online platforms:

> "It's a story about community and collaboration on a scale never seen before. It's about the cosmic compendium of knowledge Wikipedia and the million-channel people's network YouTube and the online metropolis MySpace. It's about the many wresting power from the few and helping one another for nothing and how that will not only change the world, but also change the way the world changes."
>
> (Grossman, 2006)

Usually, user-generated content is favored by online marketplaces and similar platforms; only in cases where content creation requires expert knowledge, or where the information is costly to generate and transmit, external data sources would substitute or complement such user-generated content.

It is notable that, typically, both buyers and sellers contribute data voluntarily, and this feature of online communities and marketplaces may be viewed as an indicator that the operation of the cybermediary ultimately benefits both categories (supply and demand).

The following examples of online platforms illustrate what kind of data feeds are used in such a context, and demonstrate that hybrid data sourcing is often used, i.e. multiple data feeds involving buyers and/or sellers and/or third parties are integrated.

Online platform	Seller-generated data	Buyer contributed data	External data sources
Amazon	Inventory, pricing	Product reviews, product ratings	
Airbnb	Inventory, pricing	Desired travel times and destinations	Maps
Alibaba	Inventory, pricing	Desired products	
Booking.com	Inventory, pricing	Desired travel times and destinations	
eBay	Inventory, pricing	Seller rating, acceptable prices (auction bids)	Prices from external retailers
FlightStats			Flight schedules and delays
Priceline	Inventory, pricing	Acceptable prices	
Skyscanner	Schedules, pricing (from partners)	Desired travel times and destinations	Schedules, pricing (from third parties)

Upwork	Experience, credentials, prices	Projects for bidding	
TripAdvisor	Business names, locations and descriptions (for actively managed pages)	Review and ratings for businesses and landmarks	Business names and locations (taken from public databases and directories)
Zillow			Home locations, attributes, sales prices

These examples, among others, illustrate the high impact of online information exchange platforms in many different market contexts; therefore, by applying similar mechanisms, it may be possible to overcome some of the barriers that limit the growth of outsourcing in logistics. A possible technical implementation is outlined in the following chapter.

5. PROPOSAL FOR IMPLEMENTATION OF AN ONLINE EXPRESS COURIER MARKETPLACE

5.1. Summary and SWOT analysis

This chapter examines the feasibility, for an already established 3PL operator, to establish a digital platform for purchase and follow-up of transportation and logistics services, inspired by some of the elements of the previously examined B2B e-marketplaces.

Transportation has been chosen as the first and basic service that the online marketplace could provide: it is a core component of logistics, and for most firms it is the single most important component in terms of costs, accounting for up to two-thirds of total logistics expenditure (Ballou, 2004). The implementation, however, can be designed with a view of further extending the assortment of available services and adding warehousing, inventory, return management, etc.

Some (ultimately failed) attempts to establish online marketplaces for transportation date back to the "dotcom bubble" in the USA:

> "These marketplaces (aka "exchanges") didn't work for many reasons, but the prime one was that these startups didn't really understand the transportation market. They assumed that transportation was a commodity, no different than buying paperclips, and so their primary focus was on facilitating reverse auctions, where carriers would bid against each other for shipments to drive down costs for shippers.
>
> But transportation is not a commodity. It is a relationship-based business where trusted relationships matter — because it impacts customer service and satisfaction, and by extension, the shipper's

> brand and reputation — which is why the vast majority of freight is moved via contracted carriers, not the spot market." (Gonzalez, 2015)

As a consequence, it is clear that a practical implementation of a transportation marketplace should always consider the customer's need for building a continued relationship with both the intermediary and the carrier. The following three aspects could strengthen such an implementation:

- Initially working exclusively with already established national and global express courier brands;
- Focusing the pricing aspects of the marketplace on list price comparison, as opposed to a reverse auction model and other common B2B spot market solutions;
- Being operated by an established 3PL provider with an already existing client base.

Such a model builds on already existing brands and infrastructure, adding a strong IT component. In this way, innovation becomes a significant aspect of the implemented service, but without being the *sole* component.

Compared to a new startup implementing a technological solution, this integrated approach could provide better competitive advantage. Focusing *exclusively* on technology innovation may be imprudent in current competitive conditions (Brondoni, 2012); having no previous foothold in logistics would result in a purely technological product that is extremely easy to imitate. Specifically, experience with B2B e-commerce platform startups in the "dotcom bubble" years shows that they often subsequently lose any first-mover advantages they may have (Hidding & Williams, 2003).

An established 3PL provider will, in any case, have at least some IT-related capabilities already, since they are considered an essential part of the 3PL value proposition (Langley, 2015) and are therefore a *sine qua non* condition to stay on the market. These can be built upon with the help of strategic partnerships with more IT-oriented firms; information-based projects provide a fertile field for building a network-based collaboration model and forging equity or non-equity alliances to build value in the form of intangible assets (Brondoni, 2010a).

A 3PL provider is basically an intermediary between buyers and suppliers, and is therefore in a delicate position. It should strive to build positive relationships with both their clients and subcontractors who will not always have compatible needs and interests.

The focus on price comparison and reducing switching costs in the previous chapters may lead to the thought that an online marketplace for transportation would have the sole goal of pressuring suppliers to lower prices. Such an inherently uncooperative model is not sustainable, so a technical implementation should necessarily emphasize potential benefits to suppliers as well: overall market growth, increased reach, a more streamlined contracting process, reduced overhead costs, etc.

The effectiveness of a cooperative approach towards suppliers has been confirmed in the manufacturing sector: the results of an annual buyer-supplier relations study in the automotive industry (Henke, 2015) consistently indicate that supplier satisfaction is positively correlated to operating profit. Furthermore, it is revealed that buyers *can* pressure suppliers to lower prices and, at the same time, improve relationship with them: a good buyer-supplier

relationship is based on a fair treatment and a cooperative outlook. This is demonstrated by Japanese automobile makers Honda and Toyota, which consistently rank better in supplier satisfaction than their USA counterparts do.

The study also lists several mechanisms through which good working relationships and satisfied suppliers lead to better performance for the buyer.

"These suppliers:

- Are more willing to invest in new technology to meet future OEM needs, and are more willing to share new technology with the OEM
- Are more willing to support the automaker beyond contractual terms
- Communicate more openly and honestly with the OEM
- And importantly, give greater price concessions to the OEM"

(Henke, 2015, p. 4)

By summarizing these considerations in a SWOT analysis grid, it can be shown that the conditions can be favorable for an online transportation marketplace, provided that it is developed by an experienced 3PL operator with existing favorable relations with both customers and suppliers (Table 15).

Table 15. SWOT analysis grid for an online transportation marketplace developed by a 3PL service provider, connecting customers with national and global express couriers

Strengths	*Weaknesses*
Expertise in the logistics market; Prior exposure to both clients and subcontractors; Already developed brands and infrastructure; Low capital requirements for online platforms;	Possibly limited IT experience
Opportunities	*Threats*
Partnerships with e-commerce marketplaces and tech companies	Perceived rivalry by subcontractors Disrupting the bargaining power balance can reduce intermediation margins

5.2. Input and output flows

In the previous chapter, it has been shown that many successful online marketplaces work with already available external databases and real-time data sources; their innovative aspects are centered on *processing* the data, *extracting* valuable information and *presenting* it in a clear and concise way. An example, already mentioned previously, is flightstats.com that parses multiple air traffic data feeds, including detailed parameters for thousands of flights, which can be summarized in a single unit of information useful for the customer, e.g. on-time flight percentage for a specific airline.

The value of this approach has been the key behind many innovation success stories in the past 15 years: "Enterprises that can quickly extract

critical nuggets of information from the sea of accessible data and transform them into valuable business assets are in a strong position to dominate their markets" (Roth, Wolfson, Kleewein, & Nelin, 2002). Some possible solutions that allow multiple data feeds to be used in order to make decisions at various points of the logistics process are described below.

For day-to-day shipment management, it would be a rational choice for many clients to prefer solutions that require the least possible manual intervention and provide a highly automated workflow. For example, a high level of automation is a necessity for business-to-consumer e-commerce retailers:

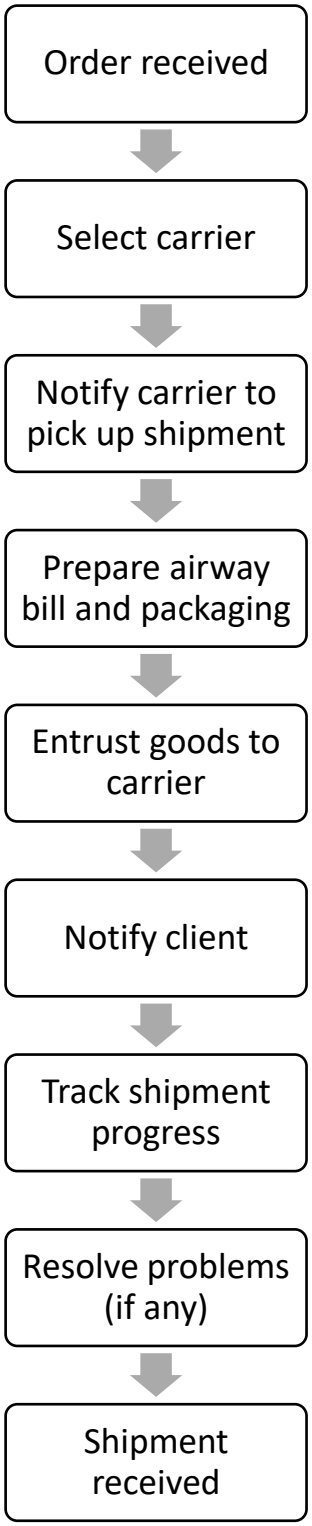
> "While both clicks-and-mortar and pure-play online distributors put lot of effort into meeting or exceeding the front-end of a customer's online shopping visit, the hard work really starts in the DC where the perfect order must be picked, packed and despatched in increasingly smaller timeframes.
>
> To do so requires flexible, scalable, modular materials handling equipment and processes, along with smart order fulfilment software and IT systems, which are fully integrated with the online ordering platform."
>
> (Ledbury, 2015)

Furthermore, the solution should allow integration with the client's own in-house order management system. Considering this, it would be suitable to deliver the solution under the "software-as-a-service" (SaaS) model – a "software delivery paradigm where the software is hosted off-premise and delivered via web to a large number of tenants and the mode of payment

follows a subscription model" (Nitu, 2009). Firms potentially interested in outsourcing logistics would favor SaaS solutions for the same reasons: "SaaS helps organizations avoid capital expenditure and let them focus on their core business instead of support services such as IT infrastructure management, software maintenance etc." (Godse & Mulik, 2009). Such an approach is "especially beneficial to smaller companies that are just starting in business and can avoid the purchase of expensive equipment to perform certain tasks" (Skendzic & Kovacic, 2012).

Figure 12 shows a number of steps that firms generally follow when transporting goods to customers, assuming that they keep goods in stock (i.e. excluding more complex logistics models such as drop shipping) and that they use the services of one or more external transportation service providers (typically an express courier):

Figure 12. Outbound logistics process



A third-party logistics company will typically handle most or all steps of this process on behalf of its customers, or less evolved 3PLs will at the least offer assistance with these steps (Zacharia et al., 2011). A fully functional online transportation marketplace, similarly, should provide tools to automate or facilitate this process where feasible. Each step has the potential to use one or more input and output data feeds in order to provide an integrated experience with significant added value.

5.3. Receiving orders from clients

To notify the online platform when the client receives an order they need to ship, multiple channels can (and should) be used. The availability of many possible ways to transmit shipment information from the client's order management or e-commerce system to the transportation marketplace will guarantee a high integration potential at a low development cost for the client. This is an important factor to market the service: the "ability of product to integrate with other applications [...] becomes quite relevant for SaaS products as SaaS products are hosted off-premise and hence can be perceived as difficult to integrate with the on-premise legacy systems" (Godse & Mulik, 2009, p. 155).

In practice, this means that several ways to upload orders can be offered to customers: in addition to the transmission channels and data formats already used by major express couriers as outlined in Chapter 2, a competitive solution can add even more options in order to provide extra value.

The data formats listed in Table 16 have a wide coverage and support integration with virtually any software that firms typically adopt. They allow

clients either to simplify the process of preparing shipments manually, or to automate shipments fully through a direct link with an e-commerce platform.

Table 16. Data formats for receiving orders from customers

Data formats	*Benefits*
Fixed-width text	Simple Human readable; can be edited manually with a text editor Compatible with legacy systems and mainframes
Comma-separated text	Simple Human readable; can be edited manually with a spreadsheet software Compatible with multiple standard software packages
JSON XML (including generic XML and XML-based protocols such as SOAP)	Flexible Recent technology Allows advanced processing and integration within a more complex software architecture
Excel Binary File Format (.XLS) Office Open XML spreadsheet	Easy to create with Microsoft Office and other spreadsheet software packages widely adopted by businesses Human readable; can be edited manually with Microsoft Excel and compatible products

The data files can be transferred over different network "push" or "pull" channels as outlined in Table 17. Of all the widely used application layer Internet protocols, basically only SMTP (email) is omitted in this proposal because of its poor support for remote system authentication, receipt confirmation and preventing third-party eavesdropping attacks (Duncan, 2013; Kurtz, 2016).

Notably, in the case of clients running an e-commerce website (exclusively or alongside other sales channels), "pulling" order data directly from the e-commerce platform can be beneficial because it requires minimal client investment and involvement in the process. The market for e-commerce software has been consolidating towards a smaller number of stable and popular products in the recent years (aheadWorks, 2015, 2016). In fact, presently the top four e-commerce platforms together take up about 75% of the market (Table 18). They all support similar, cross-platform integration channels which can be used by third-party software to obtain information about new orders automatically.

Table 17. Transmission channels for receiving orders from customers

Channels	*Benefits*
File transfer protocol (FTP) server	Standard, cross-platform solution Asynchronous by design – a large number of files can be queued and the client system does not have to wait until they are processed Allows manual transmission for less technologically advanced clients
SSH File Transfer Protocol (SFTP) server	Same as above, plus adequate security for sensitive data
Hypertext Transfer Protocol (HTTP) server	Standard, cross-platform solution Allows manual transmission for less technologically advanced clients
HTTP over TLS (HTTPS) server	Same as above, plus adequate security for sensitive data
E-commerce API client	Minimal setup for clients already running an e-commerce website

Table 18. Top e-commerce platforms, March 2016 (aheadWorks, 2016)

Platform	*Market share*	*Protocols for integration with third-party software*
Magento	29.1%	SOAP, REST
WooCommerce	26.5%	REST
Shopify	10.9%	REST
PrestaShop	9.4%	REST

Finally, the least common denominator among customers would include those firms who have more limited resources to invest in IT, such as small retailers, which can be expected to have at least the minimum IT equipment and capabilities by current standards, and not much more (Lee, 2004). By 2016 standards that would include, in any case, a workstation computer, a broadband Internet connection, a modern web browser, and an office suite. This is still sufficient to support and automate, at least in part, the first step of the process before the transportation marketplace platform takes over. Such clients can use a web form to enter type in shipment data manually, or to send orders in bulk by uploading a spreadsheet file containing a list of shipment orders.

The aforementioned data formats and transmission channels share many common traits and a modular architecture can provide support for all of them

without increasing development costs exponentially. This allows for a truly cross-platform solution that can cater to the needs of clients with wide variations in terms of size and IT capabilities.

5.4. Selecting a carrier

For the purposes of selecting an operator to whom the order will be entrusted, there are several ways in which the contractual relationship between the client, the intermediary and the express courier transporting the consignment can be configured.

1. In the simplest configuration, the client will already have a contract with only one express courier; the online platform would simply be used to streamline and automate the shipment process, and possibly to evaluate past performance. In this case, the platform would function not as an online marketplace, but simply as a productivity tool. However, it would still have the potential to reduce the level of information asymmetry by providing real-time feedback and statistics. This might be the case with small businesses with a low order volume and a low level of logistics automation. The intermediary might choose to provide such clients with access to the platform mostly as a means to "get a foothold" in the market. With a similar configuration, this step would be skipped entirely and the problem of selecting a carrier would be inexistent in practice.

2. In a more advanced setup, the client may have concurrent ongoing contracts with two or more couriers; the online platform would then handle the task of choosing the most appropriate one for

each individual shipment. This could be achieved, for example, by querying each available courier electronically to obtain a rate, and then comparing the prices to choose the cheapest option (Marks & O'Brien, 2014). Alternatively, other criteria could be used (fastest service, most reliable based on past performance, etc.). A single criteria or a weighted average score could be applied.

Many express couriers have a rating service which, given an origin and destination pair of postal codes, will return a set of available services, with estimated delivery dates and prices. This can be used to estimate a score for a specific delivery; alternatively, for couriers who do not offer such a real-time electronic rate service, a locally run database may be built based on the accumulated data, experience and knowledge of the 3PL provider operating the online service. A similar database can be built to evaluate past performance, such as percentage of on-time deliveries, or a more complex formula similar to the FedEx service quality index mentioned in Chapter 3. The value proposition lies in the online platform's ability to synthesize thousands of data points (e.g. origin/destination pair prices, service delivery estimates, past deliveries) into a single result useful to the customer: best courier for a particular shipment (

Table 19).

3. Another option that would provide added value if supported by the platform would be a type of intermediation where the client does *not* have any direct contractual relations with the courier. The shipment would be subcontracted directly by the operator of the online platform or an affiliate partner, making this solution similar to third-party logistics and freight brokerage; the client would then have no long-term contracts with the firms doing the actual transportation. This may be beneficial, because it requires no prior negotiations or investment by the client, allows a choice among a broader range of couriers, and may help obtain favorable shipping rates and volume discounts. However, some clients may already have negotiated better rates, or may prefer to be able to use the online platform for placing shipment orders under their ongoing contracts with express couriers. For this reason, the platform should ideally support both this option (provision of digital tools *and* subcontracting) and the one above (provision of digital tools *without* subcontracting).

Table 19. Inputs and data sources used to select the best provider for a specific shipment among multiple express couriers

Client inputs	*Other inputs*	*Processed variables*	*Output*
Source postcode	Courier's online rating web service	Estimated delivery date	Selected courier
Destination postcode	Local pricelist database	Delivery price	
Weight	Local database of past deliveries	Past performance	
Volume			
Shipment date			
Courier contracts			
Criteria (cheapest, fastest, etc.)			

5.5. Ordering a shipment

5.5.1. Forwarding the order to a courier

Having selected a carrier for the shipment, the next step in the process is to forward the order to the carrier. Virtually all express couriers provide a bidirectional electronic interface for creating shipments: the client can send the shipment parameters (origin, destination, number of packages, weight, volume, contents, special services requested, etc.) and obtain in return the airway bills to affix to the packages.

This data flow is customary, but in no way standardized. As shown in Table 2, the file formats and transmission channels often vary. Again, the online platform's customer can benefit by having access to a "black box" interface where they can send their input (shipping request) and obtain the respective output (an airway bill) without worrying about the data format used by the specific courier they wish to use.

5.5.2. Printing package labels

That output, in turn, can typically be presented in two different formats. Typically, airway bills are either printed using standard laser printers on plain paper, or printed with thermal printers on self-adhesive labels.

For the former technology, the Portable Document Format (PDF) is the de facto leading printable file format, whereas for thermal label printing, the Zebra Programming Language (ZPL) is the most widespread data format since Zebra Technologies is the market leader in professional thermal printer manufacturing (Berchon, 2015).

Both formats are widely used; occasional shippers may prefer to use their office laser printers for labels, while high-volume shippers will improve their efficiency and lower costs by having dedicated thermal printers (Berchon, 2015). Online services provided by express couriers allow clients to obtain in either format; therefore, the online transportation marketplace platform should support both formats according to the customer's preferences.

Printing the AWB itself can too be accomplished in different ways, depending on the customer's needs and IT capabilities. The tradeoff here is between low initial investment in IT infrastructure and training, or low ongoing costs in terms of time and consumables. The online shipping platform should be able to support different options to adapt to the customer's unique needs. The following three examples illustrate a possible solution to this requirement:

1. Print labels from the user interface – in this case, once the shipment is imported into the database of the online transportation marketplace, the customer can log in with their username and password, and print a file directly to the browser. This is best suited to the needs of the aforementioned occasional shippers who are likely to use office laser printers connected to desktop workstations.

2. Send labels by email or FTP – this is a similar low-tech solution that might cater to the needs of a larger organization, where orders are placed by one unit and fulfilled by another one. For example, the e-commerce website of the business can automatically send orders to the transportation platform, which in turn will forward them to the

express courier, obtain an AWB, and send the label to the warehouse via email or FTP.

3. Print labels automatically with dedicated hardware – this is an advanced timesaving option for businesses with more intensive logistics operations. In 2016, the hardware for a dedicated print server can be as cheap as $25 (Suehle & Callaway, 2013). Supplying larger clients with pre-programmed print servers that can stay connected to the online transportation marketplace and automatically print any new labels for outgoing packages can be a great tool to improve efficiency, build customer loyalty and take a step towards building a larger hardware/software ecosystem. Additionally, even though in recent years patentability criteria of computer programs have been relaxed in practice (Hunt, 2002), having a hardware component in the solution can help it stand in a better position in terms of intellectual property protection.

5.5.3. Booking a pickup

Once the shipment is ordered and the label is printed, the package needs to be consigned to the courier. If the sender has contracted a fixed daily pickup time with the express courier (which is usually the case with high-volume warehouses who send packages every day), no further action is required. Otherwise, it is necessary to call the courier and request a pickup.

Again, booking a pickup is a time-consuming task that can instead be automated and performed electronically. This is, therefore, the last step in the shipment preparation process where an online transportation platform

can improve data flow, provide a unified interface for different couriers' proprietary systems, and increase efficiency.

In any case, scheduling a pickup is almost always required for return shipments in B2C sales, and reverse logistics is an area of supply chain management with significant potential for efficiency improvements (de Brito & Dekker, 2004).

The web services and data interfaces for booking a pickup made available by express couriers are usually the same as those for ordering a shipment. Again, the file formats and transmission channels listed in Table 2 are a good starting point indicating which protocols need to be supported by the software.

5.6. Tracking a shipment and handling events

Track and trace functionality is a staple of express courier deliveries. Real-time parcel tracking via the Internet has been introduced by FedEx in the 1990s, which profoundly modified the way express couriers interact with their customers (Taylor & Meyer, 2000); practically all global and local express couriers have followed FedEx's lead and introduced such track & trace systems.

While online shipment tracking is a de facto standard feature, it is implemented in different, proprietary ways. Virtually all carriers offer tracking web pages with a HTML-based user interface designed to match the carrier's corporate identity. Such tracking information is human-readable, but more difficult to interpret by a machine (e.g. for linking with the customer's e-commerce website or a warehouse management software). Some carriers

will offer tracking data feeds as text files, XML or a web service. Again, no two such services use the same data layout and formats.

Therefore, clients could benefit from a software platform capable of tracking shipments consigned to different couriers and "translating" the data into a unified human-readable or machine-readable format. For example, a firm could obtain a single spreadsheet listing all their FedEx, UPS and DHL shipments, and their respective status.

In addition to passively providing information about shipment status, the online platform could provide added value by handling certain tracking events automatically as instructed by the customer. For example, an e-commerce retailer could send an email to the customer when the express courier's tracking system indicates that their package has departed. Similar event-driven e-mail alerts can be sent to the carrier, sender or recipient for both ordinary events (e.g. shipment departed, out for delivery, delivered) and extraordinary events (delays, wrong address, etc.).

In this way, the customer can focus on managing extraordinary situations and save person-hours dealing with regular shipments where no particular attention is needed. Such cost savings can lower expenses for all the players along the supply chain.

Such an all-round online transportation marketplace can improve the logistics information asymmetry problem in several ways. It can provide electronic data intermediation between customers and transportation providers at all process steps – from the ordering to the delivery of the goods; align data formats typically incompatible with each other; and overcome

information overload by summarizing data and handling certain electronic notifications automatically without the need for costly human intervention.

Some modules of this online marketplace have been built for the Italian market in collaboration with Omnilog, a firm developing innovations in the field of logistics that has provided assistance as the main research partner for this thesis. A description of the parts of the platform that are already operational is provided in the conclusion chapter that follows, and potential for further research and development is discussed.

6. CONCLUSIONS AND DISCUSSION

This study was set out to explore the concept of information as an important factor determining the attractiveness of the decision to outsource a firm's logistics activities. Possible information-related challenges such as uncertainty and trust issues have been examined as potential limiting factors for further growth in the third-party logistics market.

The general theoretical literature on the subject indicates that the development of a robust outsourcing market is vulnerable to issues of trust, lock-in, uncertainty and risks of opportunistic behavior, which are all related to the concept of information asymmetry. This theoretical framework is directly applicable to the specific case of logistics outsourcing.

Looking at quantitative data, the third-party logistics market has been developing at a steady pace, outgrowing the general economy worldwide. However, in a global, highly competitive economy dominated by a market-oriented management paradigm, it is important to stay a step ahead of competitors and identify threats before they materialize. Any factors capable of limiting growth in the contract logistics market in the future should be identified now and solutions to problems should be considered in order to maintain the viability and competitiveness of a firm operating in the industry.

Theoretically, contract logistics may be vulnerable to structural information asymmetry because of the know-how gap between buyers and providers. Differences in ability to estimate costs, future sales and trade volume fluctuations, and difficulties in comparing competing offers, may hinder the fully efficient operation of the market. While in B2C settings consumers benefit from a certain level of legal protection against information

asymmetry, B2B services such as contract logistics are not regulated so strictly and any solutions to information asymmetry must be provided by the market itself.

To look for indicators of possible information asymmetry issues in the specific case of pricing courier, express and parcel (CEP) delivery services in Italy, a randomly drawn sample of shipments spanning two years has been analyzed to look for correlations between cost factors and prices for individual shipments. While cost factors that vary between individual shipments (such as weight and distance) are strongly correlated with the final price, cost factors that vary collectively over time (such as fuel prices and wages) do not have a significant correlation with the charged prices.

Since the CEP market in Italy is strongly competitive and buyers are sensitive to prices, it can be expected that prices should be driven down to the point where they correlate closely with costs. The non-significant correlation of some cost factors with prices is consistent with the hypothesis of price comparison difficulties preventing buyers from fully leveraging their buying power (a "rational ignorance" explanation where costs of proper price comparison outweigh the benefits) – a case of information asymmetry.

This research is limited in terms of geographical coverage (Italy), timespan (2 years) and scope (CEP), so it would be imprudent to draw generalized conclusions at this point. However, from a managerial point of view, the data appears encouraging enough to develop and market a solution to increase information transparency in CEP shipments; and from an academic point of view, it probably merits additional research with an extended scope.

This research proposes a specific technical solution in the form of an online marketplace with tools to automate many day-to-day logistics activities, switch between different carriers at a very low cost and with no extra training and investment necessary, and provide *ex post* performance evaluation metrics to customers.

It can be assumed that such a digital platform would have the potential for disruptive changes in the contract logistics market in view of the findings exposed up to this point, namely that:

- There is significant demand for logistics services and it may continue to rise in the future;
- However, there are intrinsic factors connected to the practice of outsourcing business processes that are expected to limit this growth – at present, such factors are probably not allowing the contract logistics market to reach its full growth potential, and in the future might outweigh the benefits that 3PL provides. These factors are connected to the phenomenon of information asymmetry between providers and clients;
- In logistics, the information flow between contracting parties is often obstructed and limited to the necessary essentials due to rational business considerations between the agents. This is contributing to the aforementioned information asymmetry;
- Information technology is, by definition, meant to facilitate data flows and information processing; it can therefore provide an opportunity to build new tools that may help mitigate the problem

of information asymmetry when implemented within the framework of a robust and innovative business model.

- Established third-party logistics providers have an advantaged position as intermediaries between buyers and contractors. This advantage, combined with the proper IT tools, may be used to collect, extract, process, and disseminate information about operators in the market, allowing their clients to make more informed choices, and creating an online marketplace platform that can be monetized and developed into a sustainable business.

A partial implementation of the proposed solution is already operational under the trademark Gsped (http://www.gsped.com/), a web-based set of tools that offers various modules to facilitate the management and monitoring of all stages of transport, from the moment an order is received until any post-delivery operations. Gsped integrates with various e-commerce and warehouse management platforms upstream (e.g. Magento, Prestashop, Woocommerce and proprietary software), and with multiple web services of Italian and global express couriers (Artoni, BRT, DHL, FedEx, GLS, Nexive, TNT, SDA, UPS, and others) downstream. The system has been built over the course of this research (2013-2016), and a new business entity has been incorporated in order to manage and further develop the system.

To overcome the inevitable limitations of this work, in addition to expanding the time scope and geographical reach of the research, there is also the potential to study reverse logistics in more detail, and include smaller carriers with more limited IT capabilities that provide less data, but make up a significant part of the market. In addition, following up on Gsped and its

performance will provide a suitable empirical test of the hypothesis that a solution for the information asymmetry problems in contract logistics is both viable and useful.

APPENDIX 1. DELIVERY DATA SAMPLE

The following tables contain the extracted sample of deliveries examined in Chapter 2 (n=400), along with descriptive statistics of raw and log-transformed data. The full dataset is available on request.

Table 20. Delivery data sample rows

Shipment #	Courier	Weight	From	To	Distance	Created	Delivered	Business days	Fuel price[6]	Wages[7]	Capital Goods[8]	Electric energy[9]	Rent[10]	Credit rate[11]	Invoice Sum
8690996314	Artoni	5.00	47822	10014	446 417	2014-02-03	2014-02-05	2	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 4.88
8696615614	Artoni	100.00	81043	37059	680 630	2014-02-04	2014-02-06	2	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 7.37
8697533014	Artoni	10.00	47822	80059	540 384	2014-02-05	2014-02-10	3	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 5.24
1000201862	BRT	27.00	40065	93100	1 261 239	2014-02-05	2014-02-10	3	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 24.04
8703011714	Artoni	3.00	47822	72021	682 667	2014-02-07	2014-02-12	3	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 5.24
8706107214	Artoni	86.00	47822	00168	365 393	2014-02-10	2014-02-12	2	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 10.13
NQ01993217	TNT	0.20	15121	20090	89 684	2014-02-11	2014-02-12	1	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 4.00
8713614314	Artoni	64.00	47822	40054	104 687	2014-02-12	2014-02-14	2	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 6.64
RL21040917	TNT	14.15	15100	00054	552 036	2014-02-18	2014-02-19	1	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 6.70
8724471314	Artoni	345.00	47822	31033	255 837	2014-02-18	2014-02-21	3	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 25.80
8735548014	Artoni	5.00	47822	32100	347 526	2014-02-24	2014-02-26	2	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 4.75
12000014806	BRT	9.00	15033	60026	501 587	2014-02-25	2014-02-26	1	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 7.19

[6] (Ministero dello Sviluppo Economico - Dipartimento per l'Energia, 2016)

[7] (Istituto Nazionale di Statistica, 2016b)

[8] (Istituto Nazionale di Statistica, 2016a)

[9] (Istituto Nazionale di Statistica, 2016a)

[10] (Buccini, 2015, 2016, Cushman & Wakefield LLP, 2014a, 2014b, 2015a, 2015b, 2015c; Tóth, 2015)

[11] (Banca d'Italia, 2016)

Shipment #	Courier	Weight	From	To	Distance	Created	Delivered	Business days	Fuel price[6]	Wages[7]	Capital Goods[8]	Electric energy[9]	Rent[10]	Credit rate[11]	Invoice Sum
8744562114	Artoni	65.00	47822	61020	43 068	2014-02-27	2014-03-03	2	€ 2 266.39	106	102.8	106.2	€ 46.83	7.51%	€ 8.71
8749044214	Artoni	86.00	47822	10044	455 092	2014-03-03	2014-03-05	2	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 8.75
39000017800	BRT	29.00	15018	20131	171 003	2014-03-03	2014-03-04	1	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 10.74
8753326414	Artoni	50.00	45100	37059	76 828	2014-03-04	2014-03-06	2	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 7.17
8759003914	Artoni	192.00	47822	35010	242 934	2014-03-06	2014-03-07	1	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 14.74
164000067813	BRT	2.00	80016	00135	242 108	2014-03-07	2014-03-10	1	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 5.75
8771486714	Artoni	68.00	47822	00019	386 615	2014-03-12	2014-03-19	5	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 10.13
8772524114	Artoni	53.00	47822	83031	511 011	2014-03-12	2014-03-14	2	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 10.13
LY01655209	TNT	0.25	15121	15121	0	2014-03-21	2014-03-24	1	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 4.00
8797712914	Artoni	55.00	47822	33170	331 150	2014-03-25	2014-03-26	1	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 9.33
8801496914	Artoni	42.00	47822	57122	291 765	2014-03-26	2014-03-27	1	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 7.27
RL21706033	TNT	80.00	22100	39100	316 796	2014-03-28	2014-03-31	1	€ 2 255.23	106	102.9	106.1	€ 46.83	7.51%	€ 16.20
LY01657078	TNT	80.00	15121	51100	287 352	2014-04-01	2014-04-02	1	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 16.20
8812653214	Artoni	100.00	71122	37059	686 434	2014-04-01	2014-04-04	3	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 10.13
8812624114	Artoni	43.00	47822	14100	389 728	2014-04-01	2014-04-03	2	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 7.52
8816199514	Artoni	322.00	47822	34070	373 165	2014-04-02	2014-04-07	3	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 32.97
1006790814	Artoni	2.00	47822	28922	426 415	2014-04-16	2014-04-18	2	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 4.88
1016980114	Artoni	3.00	47822	13894	420 267	2014-04-23	2014-04-30	4	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 5.00
1016981014	Artoni	6.00	47822	81055	496 854	2014-04-23	2014-04-28	2	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 5.24
1023031714	Artoni	5.00	47822	47833	42 214	2014-04-28	2014-04-30	2	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 4.62
1023048014	Artoni	5.00	47822	33080	363 545	2014-04-28	2014-04-30	2	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 5.02
9128N0001050F	SDA	8.20	12066	32028	497 770	2014-04-28	2014-04-30	2	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 5.06
1025863014	Artoni	11.00	47822	47893	17 187	2014-04-29	2014-04-30	1	€ 2 251.27	106	102.9	105.9	€ 46.83	7.48%	€ 5.68
1030576214	Artoni	62.00	47822	09010	895 437	2014-05-02	2014-05-06	2	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 15.49
1030590914	Artoni	3.00	47822	10059	503 915	2014-05-02	2014-05-07	3	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 4.88
12000036693	BRT	27.00	15033	20812	106 916	2014-05-07	2014-05-08	1	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 9.14

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210000342722	BRT	50.00	15029	80026	803 934	2014-05-07	2014-05-08	1	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 21.86
NQ00254752	TNT	1.00	15121	25068	197 120	2014-05-08	2014-05-09	1	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 4.00
133000153456	BRT	2.00	31020	65126	588 314	2014-05-14	2014-05-15	1	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 4.30
1065846214	Artoni	321.00	47822	70126	577 332	2014-05-20	2014-05-23	3	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 35.46
1069182214	Artoni	1.00	47822	81041	487 885	2014-05-21	2014-06-10	13	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 5.24
1069177514	Artoni	389.00	47822	40131	113 660	2014-05-21	2014-05-22	1	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 27.28
9128N0002158F	SDA	4.60	12066	10137	57 887	2014-05-21	2014-05-22	1	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 5.07
1084568114	Artoni	200.00	47822	15020	405 450	2014-05-28	2014-05-30	2	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 33.00
1088505414	Artoni	6.00	47822	74122	675 581	2014-05-30	2014-06-05	3	€ 2 248.35	106	102.8	105.8	€ 46.83	7.48%	€ 5.24
1091941014	Artoni	80.00	47822	20852	338 359	2014-06-03	2014-06-05	2	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 7.82
1091018714	Artoni	24.00	47822	25086	296 004	2014-06-03	2014-06-04	1	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 5.90
1106893514	Artoni	7.00	47822	36027	258 840	2014-06-10	2014-06-11	1	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 4.75
1118538514	Artoni	2.00	47822	20900	333 263	2014-06-13	2014-06-17	2	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 4.75
1115866314	Artoni	70.00	20080	84018	795 885	2014-06-13	2014-06-18	3	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 10.13
1116631014	Artoni	10.00	47822	35020	226 940	2014-06-13	2014-06-16	1	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 4.75
9128N0003667F	SDA	9.70	12066	76125	934 879	2014-06-16	2014-06-18	2	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 6.68
9128N0004046F	SDA	5.85	12066	95040	1 482 321	2014-06-23	2014-06-25	2	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 5.69
1139225014	Artoni	200.00	47522	37059	221 785	2014-06-25	2014-06-26	1	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 13.64
1141992714	Artoni	147.00	47822	20831	345 852	2014-06-26	2014-06-30	2	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 11.73
1147243414	Artoni	16.00	47822	00019	386 615	2014-06-30	2014-07-07	5	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 6.91
9128N0004492F	SDA	12.45	12066	84011	919 053	2014-06-30	2014-07-04	4	€ 2 250.48	106	103	105.8	€ 46.83	7.48%	€ 6.68
1149582514	Artoni	76.00	47822	20040	337 497	2014-07-01	2014-07-02	1	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 7.82
1154636714	Artoni	380.00	37059	37036	10 128	2014-07-02	2014-07-03	1	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 29.48
1152858614	Artoni	18.00	47822	33100	368 019	2014-07-02	2014-07-04	2	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 6.59
1152838014	Artoni	19.00	47822	40131	113 660	2014-07-02	2014-07-03	1	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 5.68
1156605314	Artoni	144.00	47822	35031	223 746	2014-07-03	2014-07-04	1	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 11.06

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1165504814	Artoni	13.00	47822	20090	324 548	2014-07-08	2014-07-09	1	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 5.90
1177011114	Artoni	9.00	47822	25030	326 455	2014-07-14	2014-07-15	1	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 4.75
1181496214	Artoni	10.00	20080	20027	45 003	2014-07-15	2014-07-18	3	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 4.62
1001330045	BRT	5.00	40065	64100	351 745	2014-07-15	2014-07-16	1	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 21.63
1181423214	Artoni	16.00	20080	35031	266 798	2014-07-16	2014-07-17	1	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 5.90
1195206614	Artoni	95.00	20080	24127	76 862	2014-07-22	2014-08-20	20	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 6.82
1198305414	Artoni	3.00	20080	61029	390 988	2014-07-23	2014-07-30	5	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 4.88
1207264514	Artoni	19.00	47822	10146	456 289	2014-07-28	2014-07-30	2	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 5.98
1210136114	Artoni	19.00	47822	25040	402 042	2014-07-29	2014-07-30	1	€ 2 251.88	105.6	103	104.3	€ 46.83	7.64%	€ 5.90
1218981714	Artoni	3.00	20080	57016	341 230	2014-08-01	2014-08-06	3	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 4.80
1218985414	Artoni	3.00	20080	31041	290 913	2014-08-01	2014-08-05	2	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 4.75
1223854514	Artoni	32.00	47822	21100	382 974	2014-08-05	2014-08-07	2	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 7.17
39000070049	BRT	0.20	15122	00144	618 708	2014-08-05	2014-08-06	1	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 4.00
MY39079284	TNT	30.00	15033	85020	899 007	2014-08-06	2014-08-11	3	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 8.20
1228058414	Artoni	6.00	47822	13894	420 267	2014-08-07	2014-08-11	2	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 4.88
1230350014	Artoni	183.00	47822	20852	338 359	2014-08-19	2014-08-21	2	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 15.64
1233897914	Artoni	42.00	47822	86100	431 585	2014-08-25	2014-08-27	2	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 8.75
39000073604	BRT	0.50	15100	20010	108 018	2014-08-26	2014-08-27	1	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 5.08
1238845414	Artoni	77.00	47822	05100	267 363	2014-08-28	2014-09-11	10	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 9.94
45000095091	BRT	15.80	12066	42122	254 196	2014-08-29	2014-09-01	1	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 8.36
1241011114	Artoni	10.00	20080	02100	566 902	2014-08-29	2014-09-05	5	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 6.91
1241133414	Artoni	194.00	15121	90010	1 458 744	2014-08-29	2014-09-04	4	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 67.20
1240970914	Artoni	32.00	47822	10060	511 768	2014-08-29	2014-09-02	2	€ 2 255.44	105.6	103.1	104.3	€ 46.83	7.64%	€ 7.52
1243428714	Artoni	6.00	20080	10045	178 483	2014-09-01	2014-09-02	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 4.88
1243377314	Artoni	6.00	20080	80040	793 287	2014-09-01	2014-09-04	3	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 5.24
1243405014	Artoni	39.00	20080	12051	137 844	2014-09-01	2014-09-04	3	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 7.52

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1243300014	Artoni	15.00	20080	20147	25 810	2014-09-01	2014-09-03	2	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 5.68
1246464814	Artoni	33.00	20080	41012	188 526	2014-09-02	2014-09-03	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 7.17
1249464814	Artoni	400.00	60131	37059	353 148	2014-09-03	2014-09-04	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 35.20
1252791714	Artoni	100.00	35010	37059	88 693	2014-09-04	2014-09-05	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 7.37
1260789814	Artoni	29.00	20080	40013	229 734	2014-09-08	2014-09-22	10	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 7.17
RL24389150	TNT	1.00	15122	43014	167 734	2014-09-10	2014-09-11	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 4.35
1267476514	Artoni	24.00	20080	32100	380 331	2014-09-10	2014-09-12	2	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 5.90
1265240814	Artoni	10.00	47822	64028	252 572	2014-09-10	2014-09-26	12	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 8.10
78000225526	BRT	4.00	84013	85021	143 289	2014-09-12	2014-09-16	2	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 5.55
1286251714	Artoni	15.00	20080	33010	462 971	2014-09-19	2014-09-22	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 6.59
1286287314	Artoni	1.00	20080	37135	180 411	2014-09-19	2014-09-23	2	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 4.75
1289378214	Artoni	8.00	20080	20135	20 388	2014-09-22	2014-09-23	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 5.68
1289379714	Artoni	17.00	20080	62029	506 576	2014-09-22	2014-09-25	3	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 5.98
1289375114	Artoni	6.00	20080	10135	159 743	2014-09-22	2014-09-23	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 4.88
1295226114	Artoni	3.00	20080	12084	180 649	2014-09-23	2014-10-03	8	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 5.05
133000293987	BRT	0.10	31020	20060	314 743	2014-09-24	2014-09-25	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 4.29
1300341214	Artoni	18.00	20080	00060	537 658	2014-09-25	2014-09-30	3	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 6.91
45000107727	BRT	6.30	12066	40139	319 104	2014-09-26	2014-09-29	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 6.06
1308484614	Artoni	28.00	20080	65015	577 459	2014-09-30	2014-10-06	4	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 8.71
45000109170	BRT	4.20	12066	00179	679 804	2014-09-30	2014-10-01	1	€ 2 241.41	105.6	103.2	104.4	€ 46.83	7.64%	€ 6.04
1311369214	Artoni	30.00	47822	76123	523 845	2014-10-01	2014-10-07	4	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 8.75
1314332314	Artoni	6.00	20080	30016	323 103	2014-10-02	2014-10-08	4	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 4.75
1319432514	Artoni	8.00	20080	41049	194 416	2014-10-03	2014-10-06	1	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 5.90
1319432014	Artoni	8.00	20080	27043	44 808	2014-10-03	2014-10-06	1	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 5.68
RL24923479	TNT	1.00	40065	20060	246 665	2014-10-07	2014-10-08	1	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 4.00
45000113416	BRT	14.80	12066	10143	73 799	2014-10-08	2014-10-09	1	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 7.45

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45000114168	BRT	6.60	12066	20145	157 879	2014-10-09	2014-10-10	1	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 6.07
1359511914	Artoni	42.00	47822	06012	138 150	2014-10-22	2014-10-27	3	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 8.18
1363164914	Artoni	1.00	20080	33050	376 252	2014-10-23	2014-10-30	5	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 5.05
RL25356518	TNT	4.05	15122	76123	855 899	2014-10-29	2014-11-05	5	€ 2 234.58	106.6	103.1	105.8	€ 46.83	7.42%	€ 5.35
RL25481495	TNT	9.45	84013	03043	136 222	2014-11-04	2014-11-05	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 5.35
1387111114	Artoni	283.00	20080	40055	234 797	2014-11-04	2014-11-05	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 23.46
45000127205	BRT	3.50	12066	38121	377 974	2014-11-05	2014-11-06	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 5.74
45000127789	BRT	25.60	12066	80125	874 569	2014-11-06	2014-11-10	2	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 8.01
1396387514	Artoni	195.00	47822	20060	332 183	2014-11-07	2014-11-11	2	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 15.64
45000129997	BRT	3.10	12066	21052	183 496	2014-11-10	2014-11-11	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 5.74
1404296314	Artoni	28.00	20080	33058	383 845	2014-11-11	2014-11-12	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 7.96
1403943714	Artoni	7.00	20080	26845	66 097	2014-11-11	2014-11-18	5	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 4.62
45000131231	BRT	4.20	12066	20098	162 634	2014-11-11	2014-11-12	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 5.74
45000131241	BRT	8.90	12066	15033	91 109	2014-11-11	2014-11-12	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 7.84
1406953614	Artoni	17.00	20080	10082	157 061	2014-11-12	2014-11-13	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 5.98
45000133628	BRT	3.30	12066	20124	160 530	2014-11-13	2014-11-14	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 5.73
45000135681	BRT	0.90	12066	16143	153 678	2014-11-17	2014-11-18	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 4.66
MY41725504	TNT	4.90	35010	15040	341 070	2014-11-18	2014-11-19	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 5.35
39000103916	BRT	361.00	15121	66020	664 926	2014-11-18	2014-11-20	2	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 72.15
1424059214	Artoni	100.00	15121	50019	327 585	2014-11-20	2014-11-25	3	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 13.86
49002918913	BRT	0.80	12066	10137	57 887	2014-11-25	2014-11-26	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 4.66
1438385314	Artoni	8.00	20080	24126	78 723	2014-11-26	2014-11-28	2	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 5.68
39000107199	BRT	2.00	15033	86039	740 061	2014-11-26	2014-11-27	1	€ 2 213.04	106.6	103.3	105.7	€ 46.83	7.36%	€ 10.52
49003011578	BRT	3.20	12066	20021	171 673	2014-12-02	2014-12-09	4	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.73
49003026296	BRT	3.90	12066	20090	152 690	2014-12-03	2014-12-04	1	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.74
49003026597	BRT	15.30	12066	20096	176 796	2014-12-03	2014-12-04	1	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 7.05

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49003072945	BRT	6.90	12066	80122	877 259	2014-12-05	2014-12-09	1	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 6.97
49003087913	BRT	1.30	12066	10093	69 722	2014-12-06	2014-12-10	2	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.72
49003087997	BRT	217.80	12066	20060	181 618	2014-12-06	2014-12-10	2	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 40.55
49003087681	BRT	8.00	12066	20124	160 530	2014-12-09	2014-12-10	1	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.78
49003160242	BRT	7.00	12066	20122	157 818	2014-12-11	2014-12-15	2	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.77
RL26402247	TNT	16.00	96100	25039	1 402 380	2014-12-15	2014-12-18	3	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 7.90
49003211455	BRT	6.00	12066	80040	884 497	2014-12-15	2014-12-16	1	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.76
49003211549	BRT	4.70	12066	23020	319 886	2014-12-15	2014-12-17	2	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 10.55
49003236449	BRT	3.50	12066	37060	314 910	2014-12-16	2014-12-17	1	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.24
49003236016	BRT	2.00	12066	22030	230 568	2014-12-16	2014-12-19	3	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 6.94
49003247939	BRT	8.00	12066	06030	599 344	2014-12-17	2014-12-30	7	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.78
49003248122	BRT	4.40	12066	80048	868 961	2014-12-17	2014-12-19	2	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 7.94
49003247783	BRT	7.50	12066	33080	516 980	2014-12-17	2014-12-19	2	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 6.99
49003306175	BRT	1.40	12066	20151	166 682	2014-12-21	2014-12-24	3	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.73
49003306389	BRT	5.90	12066	00189	670 122	2014-12-21	2014-12-23	2	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 13.55
1491008014	Artoni	10.00	20080	37138	182 720	2014-12-22	2015-01-07	8	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 5.90
1492645414	Artoni	92.00	20080	20152	24 056	2014-12-29	2015-01-07	5	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 6.82
67000966614	BRT	19.00	80040	12066	886 735	2014-12-31	2015-01-05	2	€ 2 173.25	106.7	103.3	105.7	€ 46.83	7.36%	€ 23.09
20000005323	BRT	1.00	43122	30174	238 993	2015-01-05	2015-01-08	2	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 3.30
20000005204	BRT	1.00	43122	14100	191 976	2015-01-05	2015-01-07	1	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 3.30
2000418415	Artoni	225.00	20080	24124	82 507	2015-01-05	2015-01-09	3	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 17.05
2000341815	Artoni	19.00	20080	42124	158 824	2015-01-05	2015-01-08	2	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 5.81
45000001746	BRT	8.20	12066	07100	635 202	2015-01-08	2015-01-12	2	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 7.38
133000013709	BRT	3.00	31020	18017	570 686	2015-01-15	2015-01-16	1	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 4.32
20000059425	BRT	4.90	43122	12084	262 762	2015-01-16	2015-01-19	1	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 4.52
20000064639	BRT	1.00	43122	21020	187 712	2015-01-19	2015-01-20	1	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 3.30

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2033263815	Artoni	99.00	20080	35030	248 542	2015-01-22	2015-01-27	3	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 10.91
2033288315	Artoni	74.00	20080	22071	55 499	2015-01-22	2015-01-26	2	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 6.64
139000024155	BRT	1.00	35124	43122	204 542	2015-01-23	2015-01-26	1	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 3.00
62000043276	BRT	4.90	66100	43122	468 623	2015-01-26	2015-01-27	1	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 4.52
2044290515	Artoni	50.00	20080	72100	1 003 433	2015-01-28	2015-02-02	3	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 8.84
2049769015	Artoni	3.00	20080	35010	269 752	2015-01-30	2015-02-03	2	€ 2 110.87	107.4	103.4	100.9	€ 45.33	7.25%	€ 4.62
20000138080	BRT	0.50	43122	67039	521 832	2015-02-03	2015-02-04	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 4.90
2056696915	Artoni	47.00	20080	00185	580 957	2015-02-03	2015-02-05	2	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 10.22
20000139358	BRT	0.50	43122	09040	805 029	2015-02-03	2015-02-05	2	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 3.30
45000014064	BRT	9.10	12066	35010	390 380	2015-02-03	2015-02-04	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 7.39
45000014129	BRT	0.20	12066	10125	54 585	2015-02-03	2015-02-04	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 4.90
45000015278	BRT	5.70	12066	38030	438 970	2015-02-04	2015-02-05	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 7.36
57000009370	BRT	4.90	86030	43122	590 743	2015-02-05	2015-02-09	2	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 4.52
2061890415	Artoni	51.00	20080	28062	67 330	2015-02-05	2015-02-10	3	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 7.53
20000150814	BRT	0.50	43122	10095	249 277	2015-02-05	2015-02-23	12	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 3.30
116000112338	BRT	2.00	31018	29121	313 063	2015-02-06	2015-02-09	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 6.56
20000176145	BRT	5.80	43122	00198	451 506	2015-02-11	2015-02-12	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 4.52
20000178032	BRT	0.50	43122	07100	632 149	2015-02-11	2015-02-13	2	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 3.30
39000013149	BRT	1.70	15044	10123	84 519	2015-02-11	2015-02-12	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 5.21
2077102815	Artoni	27.00	20080	28021	94 976	2015-02-12	2015-02-17	3	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 6.51
2074773015	Artoni	63.00	22071	37059	204 543	2015-02-12	2015-02-13	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 7.17
20000188495	BRT	5.60	43122	87041	947 149	2015-02-13	2015-02-17	2	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 4.52
20000189141	BRT	5.70	43122	41100	63 219	2015-02-13	2015-02-19	4	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 4.52
19000047289	BRT	5.70	42019	43122	53 461	2015-02-17	2015-02-18	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 4.52
2091444715	Artoni	81.00	20080	24124	82 507	2015-02-19	2015-02-20	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 6.82
45000023519	BRT	1.00	12066	00175	677 768	2015-02-20	2015-02-23	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 5.51

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96000038194	BRT	1.20	22075	71013	821 932	2015-02-23	2015-02-25	2	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 5.51
2103411715	Artoni	233.00	20080	20831	56 010	2015-02-25	2015-02-26	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 17.05
2106267215	Artoni	22.00	20080	41037	217 173	2015-02-26	2015-03-02	2	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 6.77
20000242523	BRT	0.50	43122	35020	213 637	2015-02-26	2015-02-27	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 3.30
20000251771	BRT	5.70	43122	48100	621 052	2015-02-27	2015-03-11	8	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 4.52
20000250604	BRT	5.70	43122	40026	133 883	2015-02-27	2015-03-03	2	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 4.52
2108709715	Artoni	9.00	20080	20851	54 182	2015-02-27	2015-03-02	1	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 5.68
2108854915	Artoni	46.00	20080	00174	590 302	2015-02-27	2015-03-03	2	€ 2 004.66	107.4	103.4	100.6	€ 45.33	7.28%	€ 8.80
2110161215	Artoni	400.00	47822	26013	298 206	2015-03-02	2015-03-05	3	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 31.28
45000030518	BRT	5.60	12066	16154	142 675	2015-03-09	2015-03-10	1	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 7.36
2129763015	Artoni	4.00	20080	37138	182 720	2015-03-10	2015-03-11	1	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 4.62
2145924115	Artoni	30.00	20080	47121	300 220	2015-03-17	2015-03-18	1	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 6.29
45000036049	BRT	22.60	12066	35030	369 171	2015-03-19	2015-03-23	2	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 11.23
2153393015	Artoni	50.00	61122	37059	280 707	2015-03-20	2015-03-23	1	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 7.52
45000037608	BRT	9.70	12066	00184	673 027	2015-03-23	2015-03-24	1	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 7.40
2158875015	Artoni	350.00	20089	37059	187 023	2015-03-24	2015-03-25	1	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 27.37
2167483015	Artoni	70.00	20080	32036	395 492	2015-03-26	2015-04-03	6	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 5.00
39000030398	BRT	6.30	15044	37060	260 356	2015-03-30	2015-03-31	1	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 6.19
45000041167	BRT	10.60	12066	09126	915 490	2015-03-30	2015-04-01	2	€ 2 017.79	107.4	103.4	100.1	€ 45.33	7.28%	€ 7.41
3883605004188	SDA	0.25	43122	61034	283 493	2015-04-09	2015-05-08	20	€ 2 079.66	107.4	103.5	98.5	€ 45.17	7.28%	€ 3.73
2204760715	Artoni	119.00	20080	84035	891 219	2015-04-15	2015-04-22	5	€ 2 079.66	107.4	103.5	98.5	€ 45.17	7.28%	€ 15.33
2204772515	Artoni	44.00	20080	24027	89 330	2015-04-15	2015-04-20	3	€ 2 079.66	107.4	103.5	98.5	€ 45.17	7.28%	€ 6.16
2218148015	Artoni	20.00	15077	27014	90 302	2015-04-22	2015-04-24	2	€ 2 079.66	107.4	103.5	98.5	€ 45.17	7.28%	€ 7.60
2240863515	Artoni	80.00	88025	37059	1 084 860	2015-05-05	2015-05-08	3	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 14.70
39000043435	BRT	4.00	15100	10098	97 666	2015-05-06	2015-05-07	1	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 7.75
3883602010931	SDA	0.45	43122	20162	141 905	2015-05-07	2015-05-08	1	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 4.83

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2883603000818	SDA	5.85	43122	50036	170 819	2015-05-07	2015-05-08	1	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 5.33
2883604006688	SDA	0.15	43122	37135	108 520	2015-05-08	2015-05-11	1	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 3.73
2260843615	Artoni	1.00	20080	26866	32 591	2015-05-13	2015-05-21	6	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 5.00
2265920715	Artoni	4.00	20080	73046	1 090 379	2015-05-15	2015-06-01	11	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 5.00
3883603002603	SDA	1.85	43122	67051	532 604	2015-05-15	2015-05-18	1	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 5.03
2271473315	Artoni	17.00	47822	80014	538 409	2015-05-19	2015-05-22	3	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 6.91
45000064356	BRT	12.50	12066	12066	0	2015-05-19	2015-05-20	1	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 7.43
2277333215	Artoni	84.00	20080	76011	852 807	2015-05-21	2015-05-26	3	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 10.22
45000067024	BRT	14.20	12066	12066	0	2015-05-25	2015-05-26	1	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 7.44
2289552015	Artoni	39.00	20080	36028	265 573	2015-05-28	2015-06-01	2	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 6.16
2883603001101	SDA	0.33	43122	20143	128 464	2015-05-28	2015-05-29	1	€ 2 065.12	107.5	103.3	98.4	€ 45.17	7.28%	€ 3.73
2303973515	Artoni	126.00	15121	87064	1 104 175	2015-06-05	2015-06-12	5	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 54.40
45000071910	BRT	24.80	12066	12066	0	2015-06-05	2015-06-08	1	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 8.45
2306603915	Artoni	16.00	20080	20098	26 812	2015-06-08	2015-06-16	6	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 5.13
2.8836E+12	SDA	0.20	43122	46100	60 719	2015-06-09	2015-06-10	1	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 3.73
2315740315	Artoni	6.00	20080	20026	38 238	2015-06-11	2015-06-24	9	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 5.37
2315734915	Artoni	115.00	20080	24051	86 316	2015-06-11	2015-06-16	3	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 10.23
2323086115	Artoni	47.00	20080	12100	231 979	2015-06-15	2015-06-18	3	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 7.53
45000075678	BRT	20.50	15121	12066	77 100	2015-06-15	2015-06-16	1	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 8.41
3883603004009	SDA	0.34	43122	61121	238 031	2015-06-24	2015-06-25	1	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 4.83
2.8836E+12	SDA	0.50	43122	61029	267 298	2015-06-25	2015-06-26	1	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 3.73
2352869715	Artoni	586.00	20080	60131	444 000	2015-06-30	2015-07-06	4	€ 2 097.60	107.5	103.5	98	€ 45.17	7.28%	€ 53.40
2355821115	Artoni	16.00	20080	65127	597 270	2015-07-01	2015-07-03	2	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 7.00
2354743015	Artoni	20.00	20098	20080	19 505	2015-07-01	2015-07-01	0	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 5.68
39000063091	BRT	1.00	15122	48121	319 210	2015-07-02	2015-07-03	1	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 4.09
2363391115	Artoni	100.00	20090	19038	225 175	2015-07-03	2015-07-06	1	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 11.00

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2366230715	Artoni	40.00	20080	20020	50 202	2015-07-06	2015-07-07	1	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 6.16
2883604011825	SDA	0.50	43122	06124	331 308	2015-07-10	2015-07-13	1	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 3.73
2383223815	Artoni	215.00	20080	05100	533 644	2015-07-14	2015-07-17	3	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 25.55
2391765315	Artoni	32.00	20080	20851	54 182	2015-07-17	2015-07-23	4	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 6.16
39000070675	BRT	3.30	15122	00144	618 708	2015-07-23	2015-07-27	2	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 5.93
2421806715	Artoni	350.00	29122	37059	150 295	2015-07-31	2015-08-03	1	€ 2 094.94	107.6	103.4	96.8	€ 45.17	7.01%	€ 23.87
2883604013818	SDA	0.18	43122	54033	137 393	2015-08-04	2015-08-05	1	€ 2 068.95	107.6	103.5	96.9	€ 45.17	7.01%	€ 3.73
2883604014014	SDA	0.12	43122	06034	367 979	2015-08-06	2015-08-07	1	€ 2 068.95	107.6	103.5	96.9	€ 45.17	7.01%	€ 3.73
39000076400	BRT	1.90	15044	52100	429 048	2015-08-18	2015-08-19	1	€ 2 068.95	107.6	103.5	96.9	€ 45.17	7.01%	€ 5.31
2883604014867	SDA	0.15	43122	20161	144 085	2015-08-19	2015-08-20	1	€ 2 068.95	107.6	103.5	96.9	€ 45.17	7.01%	€ 3.73
2436552815	Artoni	147.00	20080	47924	339 253	2015-08-24	2015-08-28	4	€ 2 068.95	107.6	103.5	96.9	€ 45.17	7.01%	€ 10.38
2883603004082	SDA	12.40	43122	25030	125 230	2015-08-25	2015-08-27	2	€ 2 068.95	107.6	103.5	96.9	€ 45.17	7.01%	€ 7.57
2440746115	Artoni	300.00	38121	37059	126 012	2015-08-27	2015-08-28	1	€ 2 068.95	107.6	103.5	96.9	€ 45.17	7.01%	€ 28.26
3883603008057	SDA	0.20	43122	38123	188 483	2015-08-28	2015-09-01	2	€ 2 068.95	107.6	103.5	96.9	€ 45.17	7.01%	€ 4.83
2883604015721	SDA	1.24	43122	20015	152 384	2015-09-01	2015-09-02	1	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 3.93
3883603008373	SDA	0.30	43122	63821	358 147	2015-09-02	2015-09-03	1	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 4.83
3883605008502	SDA	0.10	43122	00040	498 297	2015-09-03	2015-09-04	1	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 4.83
3883603008570	SDA	0.20	43122	71030	651 695	2015-09-04	2015-09-08	2	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 4.83
3883603008675	SDA	0.10	43122	00040	498 297	2015-09-07	2015-09-08	1	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 4.83
2000760427	BRT	85.00	15121	47032	332 716	2015-09-08	2015-09-10	2	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 15.67
2470501515	Artoni	450.00	34070	37059	230 292	2015-09-11	2015-09-15	2	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 42.39
39000083979	BRT	115.00	15033	33019	485 096	2015-09-15	2015-09-17	2	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 51.91
3883605009599	SDA	0.14	43122	92026	1 385 985	2015-09-15	2015-10-13	20	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 3.73
3883605009752	SDA	0.10	43122	09030	734 313	2015-09-15	2015-09-17	2	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 4.83
3883603009343	SDA	0.12	43122	93100	1 346 323	2015-09-17	2015-10-20	23	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 3.73
2883604017422	SDA	0.55	43122	36010	230 097	2015-09-18	2015-09-21	1	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 3.73

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2493297415	Artoni	5.00	20080	21100	75 474	2015-09-22	2015-09-24	2	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 4.62
3883603009851	SDA	0.32	43122	48010	154 795	2015-09-24	2015-09-30	4	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 4.83
2503045215	Artoni	59.00	15121	43039	148 704	2015-09-25	2015-09-30	3	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 22.00
115000316619	BRT	8.40	15033	13900	77 104	2015-09-25	2015-09-28	1	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 7.99
2883603005201	SDA	0.10	43122	30125	245 429	2015-09-28	2015-09-29	1	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 142.67
3883603009981	SDA	0.10	43122	66054	529 663	2015-09-28	2015-09-30	2	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 4.83
2511402015	Artoni	87.00	20080	22071	55 499	2015-09-30	2015-10-07	5	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 5.00
89002955776	BRT	31.50	20037	15035	120 300	2015-09-30	2015-10-01	1	€ 2 016.16	107.6	103.5	96.9	€ 45.17	7.01%	€ 17.66
2518293215	Artoni	42.00	20080	40132	215 849	2015-10-02	2015-10-05	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 6.29
2518997515	Artoni	120.00	76016	37059	741 292	2015-10-02	2015-10-06	2	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 15.20
2883603005449	SDA	0.26	43122	86019	636 120	2015-10-02	2015-10-06	2	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 3.73
3883605011758	SDA	0.20	43122	04010	497 107	2015-10-08	2015-10-09	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 4.83
3883605011811	SDA	0.05	43122	10095	249 277	2015-10-08	2015-10-09	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 4.83
2883604019520	SDA	0.15	43122	00132	462 081	2015-10-08	2015-10-09	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 3.73
2883604019586	SDA	0.35	43122	35015	189 364	2015-10-08	2015-10-09	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 3.73
3883605011996	SDA	0.02	43122	35027	211 598	2015-10-12	2015-10-13	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 4.83
3883605012249	SDA	1.00	43122	37014	90 870	2015-10-12	2015-10-13	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 4.83
3883603011098	SDA	1.28	43122	02011	459 442	2015-10-12	2015-10-13	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 5.03
2539295415	Artoni	1.00	20080	20135	20 388	2015-10-13	2015-10-16	3	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 5.05
2883605001922	SDA	0.05	43122	72017	847 467	2015-10-14	2015-10-16	2	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 3.73
2545861215	Artoni	25.00	20080	32100	380 331	2015-10-15	2015-10-19	2	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 5.68
2548819115	Artoni	41.00	20080	25080	143 344	2015-10-16	2015-10-22	4	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 6.16
2883604020542	SDA	2.82	43122	24020	205 336	2015-10-16	2015-10-19	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 3.93
2551810015	Artoni	205.00	20080	15069	79 360	2015-10-19	2015-10-21	2	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 19.38
39000097028	BRT	1.80	15044	70043	972 830	2015-10-20	2015-10-23	3	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 6.29
2560469715	Artoni	244.00	20080	46100	171 157	2015-10-22	2015-10-27	3	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 17.05

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2561883615	Artoni	210.00	6083	00054	782 187	2015-10-22	2015-10-28	4	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 56.00
39000098254	BRT	1.10	15044	22069	131 210	2015-10-22	2015-10-23	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 6.28
2570243815	Artoni	6.00	20080	90045	1 507 707	2015-10-27	2015-11-02	4	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 12.47
2883603006122	SDA	0.05	43122	36045	143 613	2015-10-27	2015-10-28	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 3.73
2572419715	Artoni	79.00	34073	37059	229 470	2015-10-28	2015-10-30	2	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 7.27
LY01758616	TNT	1.00	15121	97100	1 479 550	2015-10-30	2015-11-03	2	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 0.00
120000457540	BRT	1.00	20068	37063	167 417	2015-10-30	2015-11-02	1	€ 1 977.43	108.5	103.6	97.4	€ 44.83	6.79%	€ 6.80
2583362015	Artoni	142.00	15121	31054	349 531	2015-11-02	2015-11-09	5	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 27.60
3883605014657	SDA	0.06	43122	97013	1 322 433	2015-11-04	2015-11-09	3	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 4.83
120000469407	BRT	8.30	20068	20159	18 329	2015-11-05	2015-11-06	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 9.60
83000178919	BRT	288.00	23823	01100	599 006	2015-11-05	2015-11-06	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 34.97
2600918015	Artoni	362.00	20080	10078	159 786	2015-11-10	2015-11-12	2	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 31.00
39000105216	BRT	6.30	15044	11020	163 073	2015-11-10	2015-11-16	4	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 6.84
2604619815	Artoni	76.00	20080	31041	290 913	2015-11-11	2015-11-13	2	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 7.27
2609627615	Artoni	100.00	40026	37059	167 960	2015-11-12	2015-11-13	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 6.82
2609783515	Artoni	5.00	20032	47521	322 974	2015-11-12	2015-11-13	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 7.95
2617310915	Artoni	20.00	20080	87100	1 083 442	2015-11-17	2015-11-30	9	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 5.13
120000492049	BRT	3.70	20068	25126	86 280	2015-11-17	2015-11-18	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 8.30
133000400575	BRT	6.20	31020	85027	827 163	2015-11-17	2015-11-19	2	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 6.07
RL33775380	TNT	7.25	84013	80069	46 340	2015-11-18	2015-11-20	2	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 0.00
2620386815	Artoni	30.00	22100	37059	214 913	2015-11-18	2015-11-19	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 7.17
3883605016252	SDA	0.10	43122	90011	1 339 136	2015-11-18	2015-11-20	2	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 4.83
2883604024170	SDA	0.10	43122	33074	312 026	2015-11-20	2015-11-23	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 3.73
2631659915	Artoni	6.00	20080	10034	132 985	2015-11-24	2015-12-02	6	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 4.75
3883605016838	SDA	0.05	43122	71121	645 577	2015-11-24	2015-12-21	18	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 3.73
12000102973	BRT	115.00	15100	47522	341 041	2015-11-25	2015-11-26	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 16.98

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3883605016941	SDA	0.04	43122	20010	151 197	2015-11-25	2015-11-26	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 4.83
3883603012785	SDA	0.64	43122	96100	1 289 108	2015-11-25	2015-12-01	4	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 4.83
2883604024708	SDA	0.22	43122	20147	135 558	2015-11-26	2015-11-27	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 3.73
RL34031571	TNT	1.00	15122	13900	111 536	2015-11-30	2015-12-01	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 0.00
45190159509	BRT	12.00	12066	00156	671 027	2015-11-30	2015-12-02	2	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 6.62
2883604025040	SDA	1.86	43122	70015	816 400	2015-11-30	2015-12-02	2	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 3.93
3883605017473	SDA	0.05	43122	86042	570 873	2015-11-30	2015-12-02	2	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 4.83
3883605017545	SDA	0.14	43122	17027	275 945	2015-11-30	2015-12-01	1	€ 1 965.80	108.6	103.4	97	€ 44.83	6.79%	€ 4.83
2883604025408	SDA	0.08	43122	09126	789 071	2015-12-02	2015-12-04	2	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
3883605018373	SDA	0.05	43122	16047	192 139	2015-12-07	2015-12-09	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 4.83
3883603013271	SDA	0.40	43122	40127	101 718	2015-12-07	2016-01-05	18	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
120000538244	BRT	8.00	20068	70125	882 942	2015-12-10	2015-12-11	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 6.70
2883604026309	SDA	0.60	43122	16035	185 916	2015-12-10	2015-12-11	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
2883605002512	SDA	0.10	43122	31010	299 392	2015-12-10	2015-12-11	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
49193399414	BRT	8.00	12066	20017	168 623	2015-12-11	2015-12-14	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 5.48
3883605019016	SDA	0.05	43122	42010	99 143	2015-12-11	2015-12-14	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 4.83
12000110106	BRT	5.00	15100	10156	118 489	2015-12-14	2015-12-15	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 6.86
2883604026898	SDA	0.30	43122	20136	122 982	2015-12-14	2015-12-16	2	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
2675328915	Artoni	14.00	20080	33100	400 825	2015-12-15	2015-12-21	4	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 5.90
45190171781	BRT	15.00	12066	27100	142 447	2015-12-15	2015-12-16	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 6.65
45190171734	BRT	5.00	12066	20121	159 516	2015-12-15	2015-12-16	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 5.45
12000110648	BRT	15.60	15100	10071	111 824	2015-12-15	2015-12-16	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 8.22
2883604027266	SDA	0.14	43122	46100	60 719	2015-12-15	2015-12-16	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
2883604027421	SDA	2.18	43122	90043	1 392 960	2015-12-16	2015-12-18	2	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.93
2682430115	Artoni	150.00	20090	27036	59 038	2015-12-17	2015-12-21	2	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 11.18
2883604028122	SDA	0.15	43122	96016	1 256 566	2015-12-18	2015-12-23	3	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73

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49193563736	BRT	19.20	12066	20900	181 973	2015-12-21	2015-12-22	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 10.64
2883603007716	SDA	0.06	43122	00178	470 562	2015-12-21	2015-12-22	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
2689450415	Artoni	80.00	6083	03047	288 749	2015-12-22	2016-01-11	11	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 20.00
133000452458	BRT	5.00	31020	18017	570 686	2015-12-22	2015-12-23	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 6.06
39000124306	BRT	2.10	15044	24055	161 796	2015-12-28	2015-12-29	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 6.29
2883603007882	SDA	0.06	43122	35127	209 686	2015-12-28	2015-12-29	1	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
2691124815	Artoni	58.00	20080	10144	179 640	2015-12-29	2016-01-07	5	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 7.53
120000574535	BRT	1.00	20068	37137	147 485	2015-12-30	2016-01-04	2	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 6.80
3883605021105	SDA	0.05	43122	70015	816 400	2015-12-30	2016-01-04	2	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 4.83
2883604029903	SDA	0.60	43122	41123	56 621	2015-12-30	2016-01-04	2	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
2883604029911	SDA	0.55	43122	90129	1 353 596	2015-12-30	2016-01-04	2	€ 1 957.92	108.8	103.5	97	€ 44.83	6.79%	€ 3.73
39000000642	BRT	3.60	15044	00139	608 258	2016-01-05	2016-01-14	6	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 7.49
1002079416	Artoni	11.00	20080	37045	219 447	2016-01-07	2016-01-11	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 5.68
2883604030415	SDA	0.10	43122	44123	149 458	2016-01-07	2016-01-08	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 4.14
1004973016	Artoni	1.00	20080	00144	601 811	2016-01-08	2016-01-19	7	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 5.05
1001015616	Artoni	330.00	43122	07100	632 149	2016-01-08	2016-01-15	5	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 52.80
3883605022637	SDA	0.05	43122	01100	393 793	2016-01-11	2016-01-14	3	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 5.03
3883605022799	SDA	0.10	43122	97014	1 333 951	2016-01-11	2016-01-13	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 5.03
45190004800	BRT	12.80	12066	38121	377 974	2016-01-13	2016-01-14	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 7.74
3883605023072	SDA	0.08	43122	09045	795 617	2016-01-13	2016-01-15	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 5.03
109020009294	BRT	31.70	00173	84013	245 768	2016-01-15	2016-01-19	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 15.85
2883604031451	SDA	1.62	43122	81100	630 046	2016-01-15	2016-01-18	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 4.14
3883605023775	SDA	0.15	43122	00157	454 528	2016-01-18	2016-01-20	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 5.03
120000026502	BRT	2.10	20068	66100	584 148	2016-01-19	2016-01-20	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 6.81
2883604031933	SDA	0.25	43122	00149	476 365	2016-01-20	2016-01-21	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 4.14
3883605024211	SDA	0.04	43122	16134	213 994	2016-01-20	2016-01-21	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 5.03

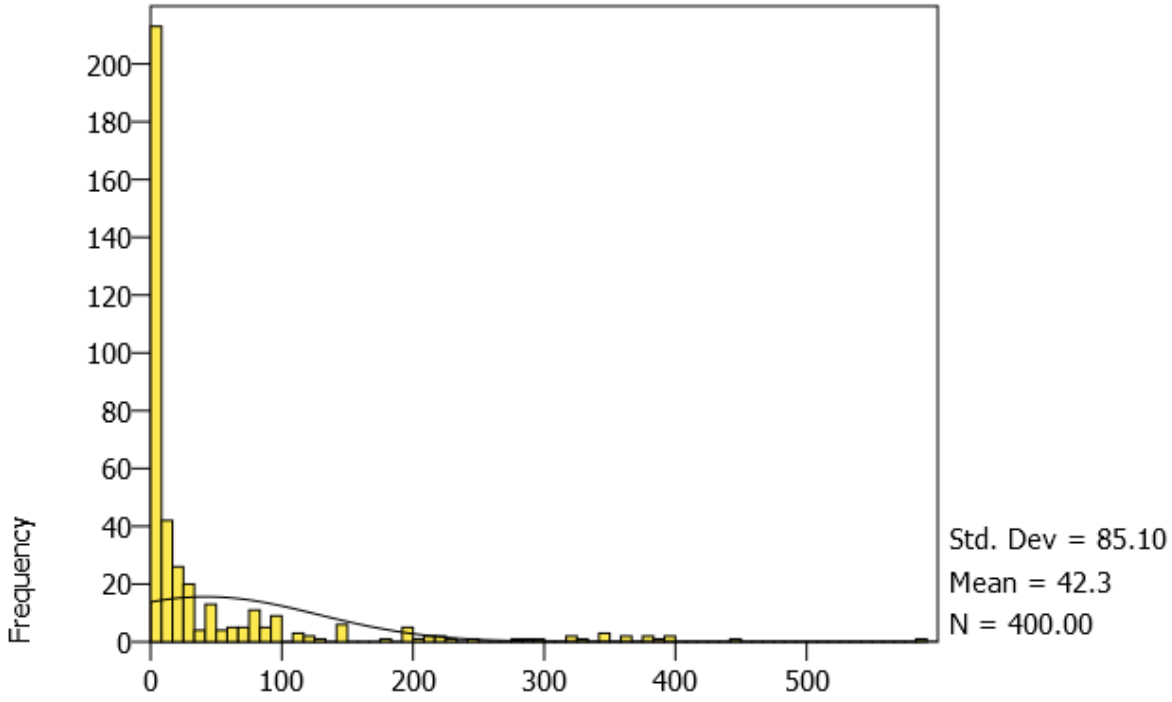
Shipment #	Courier	Weight	From	To	Distance	Created	Delivered	Business days	Fuel price[6]	Wages[7]	Capital Goods[8]	Electric energy[9]	Rent[10]	Credit rate[11]	Invoice Sum
1027605216	Artoni	20.00	20080	63100	545 300	2016-01-21	2016-01-27	4	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 6.08
3883605024489	SDA	0.10	43122	51100	205 043	2016-01-21	2016-01-22	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 5.29
45190010747	BRT	22.60	12066	88049	1 212 526	2016-01-25	2016-01-27	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 7.83
120000044177	BRT	7.20	20068	50136	310 832	2016-01-27	2016-01-28	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 5.41
2883604033059	SDA	0.08	43122	09030	734 313	2016-01-27	2016-01-29	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 4.14
1041427016	Artoni	5.00	20080	22038	71 873	2016-01-28	2016-02-01	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 4.62
1042603116	Artoni	11.00	20080	00124	612 560	2016-01-28	2016-02-01	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 7.00
1041408616	Artoni	9.00	20080	47042	316 009	2016-01-28	2016-02-01	2	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 4.75
1042504916	Artoni	70.00	20080	40131	220 947	2016-01-28	2016-01-29	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 6.77
2883604033451	SDA	0.15	43122	21037	211 799	2016-01-28	2016-01-29	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 4.14
1044270816	Artoni	30.00	33080	37059	213 709	2016-01-29	2016-02-01	1	€ 1 926.25	109.1	103.5	97	€ 45.00	6.73%	€ 7.96
RL35407754	TNT	17.00	15121	10024	85 122	2016-02-01	2016-02-02	1	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 6.87
45190016277	BRT	13.10	12066	22100	202 183	2016-02-03	2016-02-04	1	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 6.64
45190018211	BRT	33.20	12066	00161	668 690	2016-02-08	2016-02-09	1	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 10.79
RL35657066	TNT	7.65	15122	44042	240 036	2016-02-10	2016-02-11	1	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 5.48
1069864916	Artoni	24.00	20080	33010	462 971	2016-02-11	2016-02-15	2	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 7.17
2000111455	BRT	382.00	15121	90043	1 544 854	2016-02-11	2016-02-16	3	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 94.82
1073249316	Artoni	150.00	20090	40026	251 711	2016-02-12	2016-02-19	5	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 22.80
39000016122	BRT	3.10	15044	35027	328 526	2016-02-16	2016-02-17	1	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 6.30
120000089667	BRT	2.30	20068	20832	33 599	2016-02-18	2016-02-19	1	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 3.90
120000092273	BRT	1.20	20068	40050	221 831	2016-02-19	2016-02-22	1	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 3.90
1090974316	Artoni	80.00	06083	50065	174 889	2016-02-22	2016-02-26	4	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 26.00
5000776005	BRT	2.00	20137	10138	165 316	2016-02-22	2016-02-24	2	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 3.90
1104067116	Artoni	17.00	20080	43121	136 288	2016-02-29	2016-03-01	1	€ 1 850.22	109.1	103.3	97.5	€ 45.00	6.73%	€ 5.81

Table 21. Statistics of the examined variables

	Skewness	*Kurtosis*
Weight	-.59	10.48
log(Weight)	*-.33*	*-.59*
Distance	1.48	*2.05*
log(Distance)	*-.52*	.21
Business days	4.22	21.54
log(Business days)	*1.22*	*1.37*
Fuel price	*.01*	-1.45
log(Fuel price)	-.04	*-1.40*
Wages	.02	-1.28
log(Wages)	*.01*	-1.28
Capital goods	-.85	-.35
log(Capital goods)	-.85	*-.34*
Electric energy	.23	-1.73
log(Electric energy)	*.22*	-1.73
Rent	.32	-1.79
log(Rent)	.32	-1.79
Credit rate	*-.19*	*-1.41*
log(Credit rate)	-.23	-1.42
Invoice sum	5.77	46.52
log(Invoice sum)	*1.80*	*3.59*

Distribution charts

Figure 13. Distribution of the *Weight* variable (raw and log-transformed data)



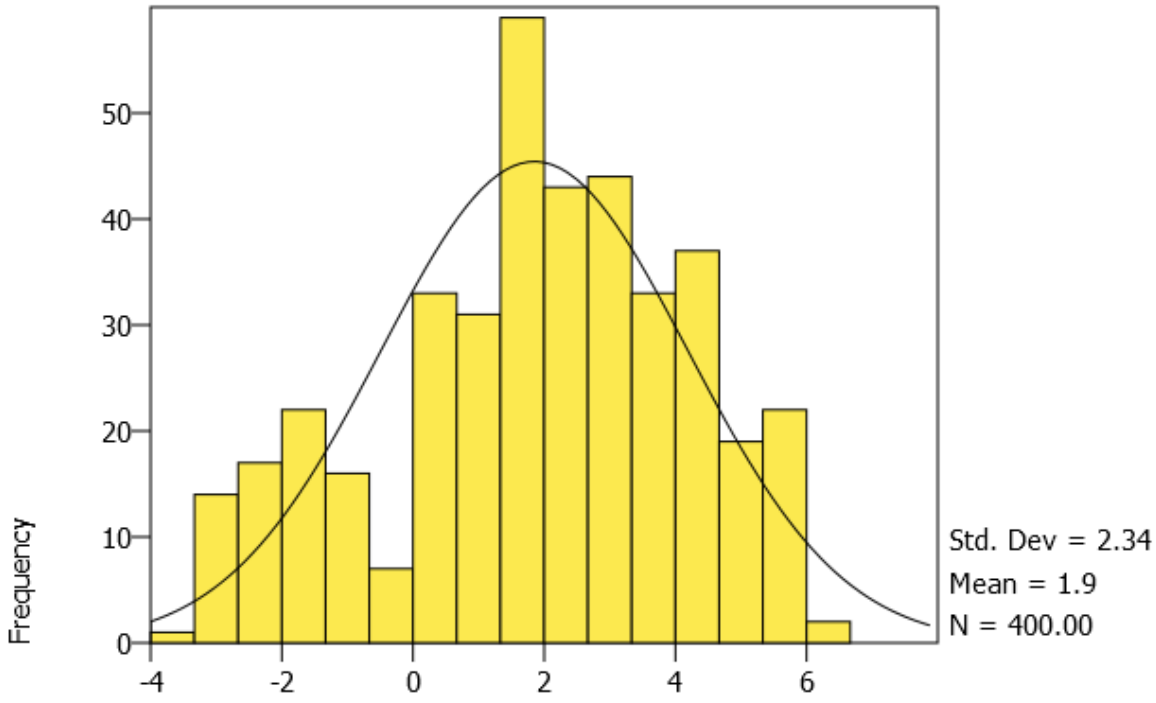
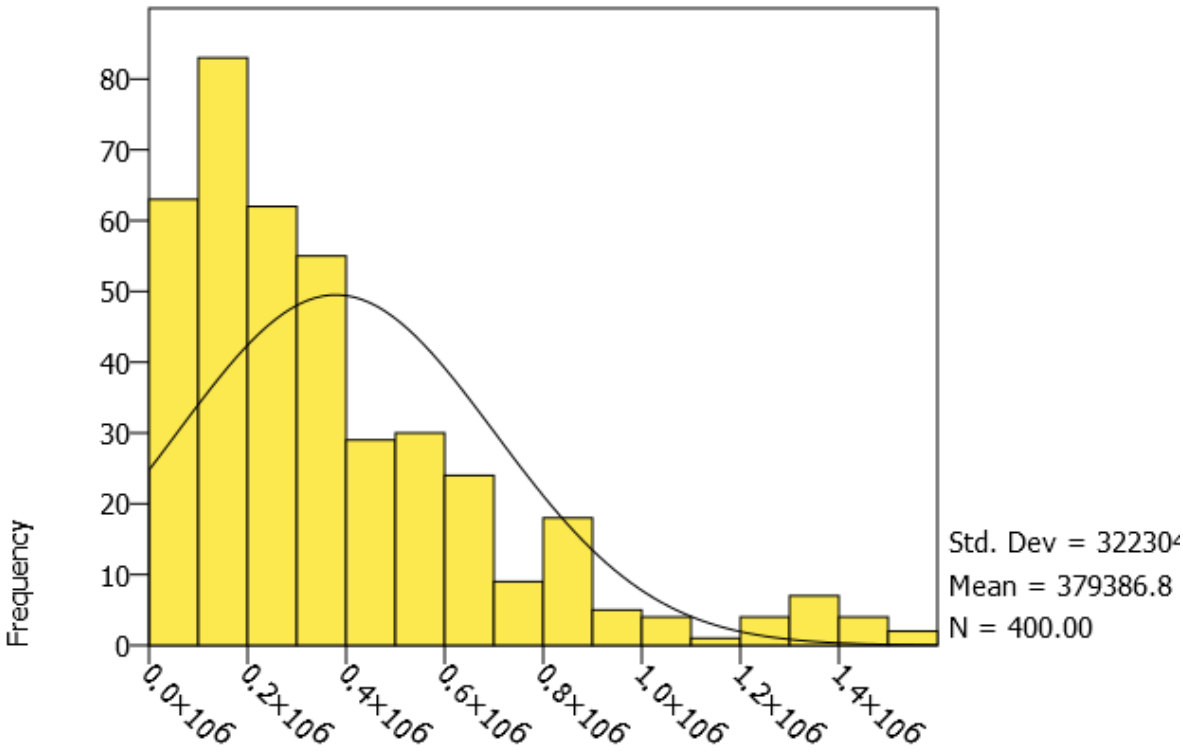


Figure 14. Distribution of the *Distance* variable (raw and log-transformed data)



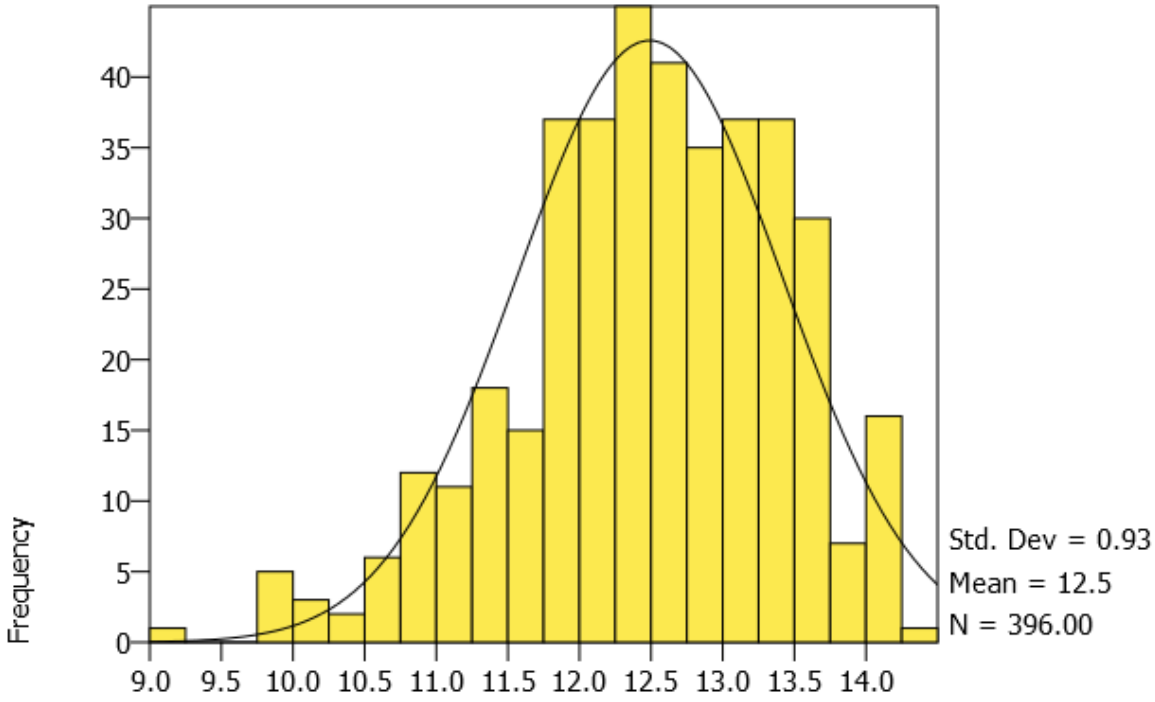

Frequency
40
35
30
25
20
15
10
5
0
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
Std. Dev = 0.93
Mean = 12.5
N = 396.00

Figure 15. Distribution of the *Business days* variable (raw and log-transformed data)

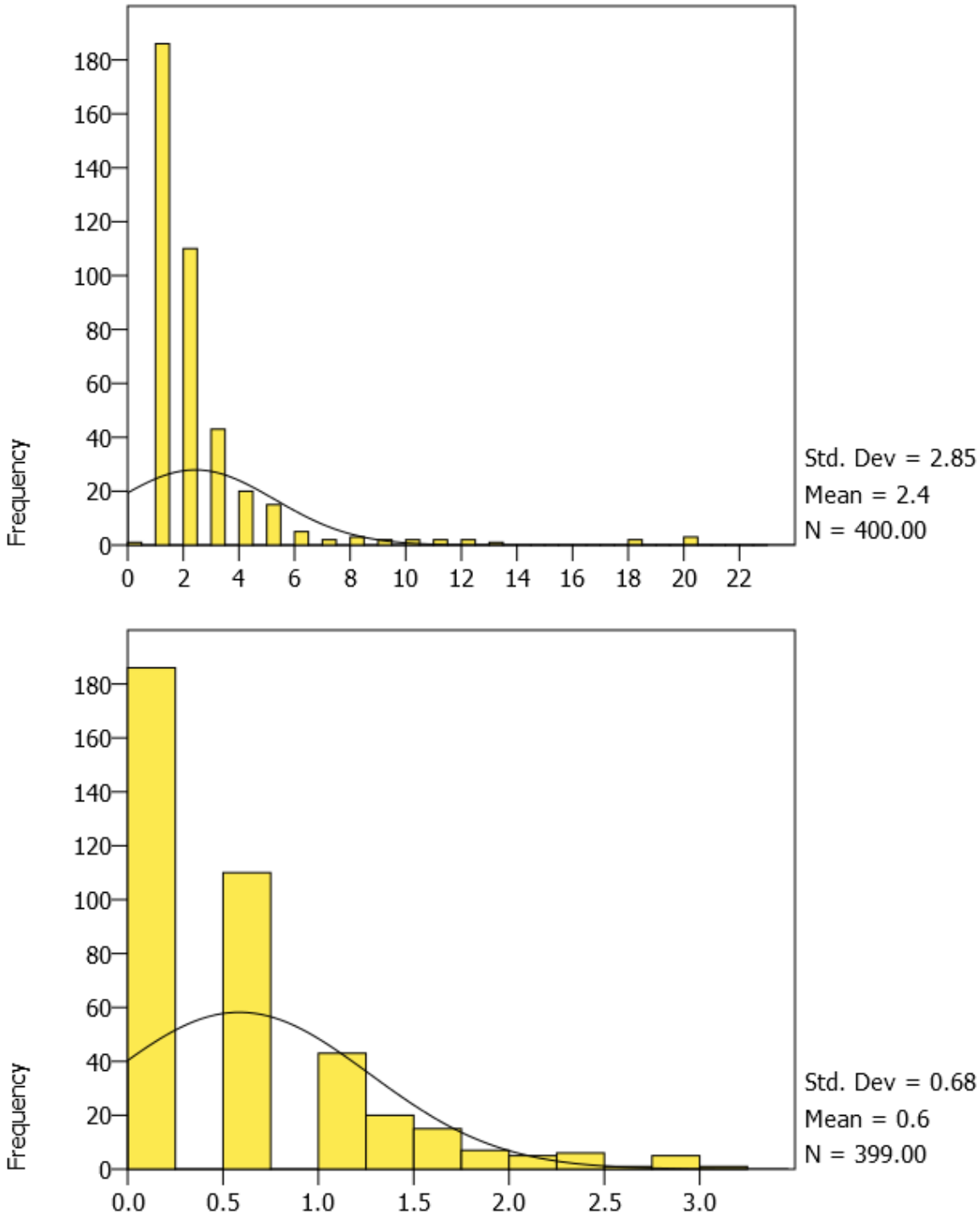


Figure 16. Distribution of the *Fuel price* variable (raw and log-transformed data)

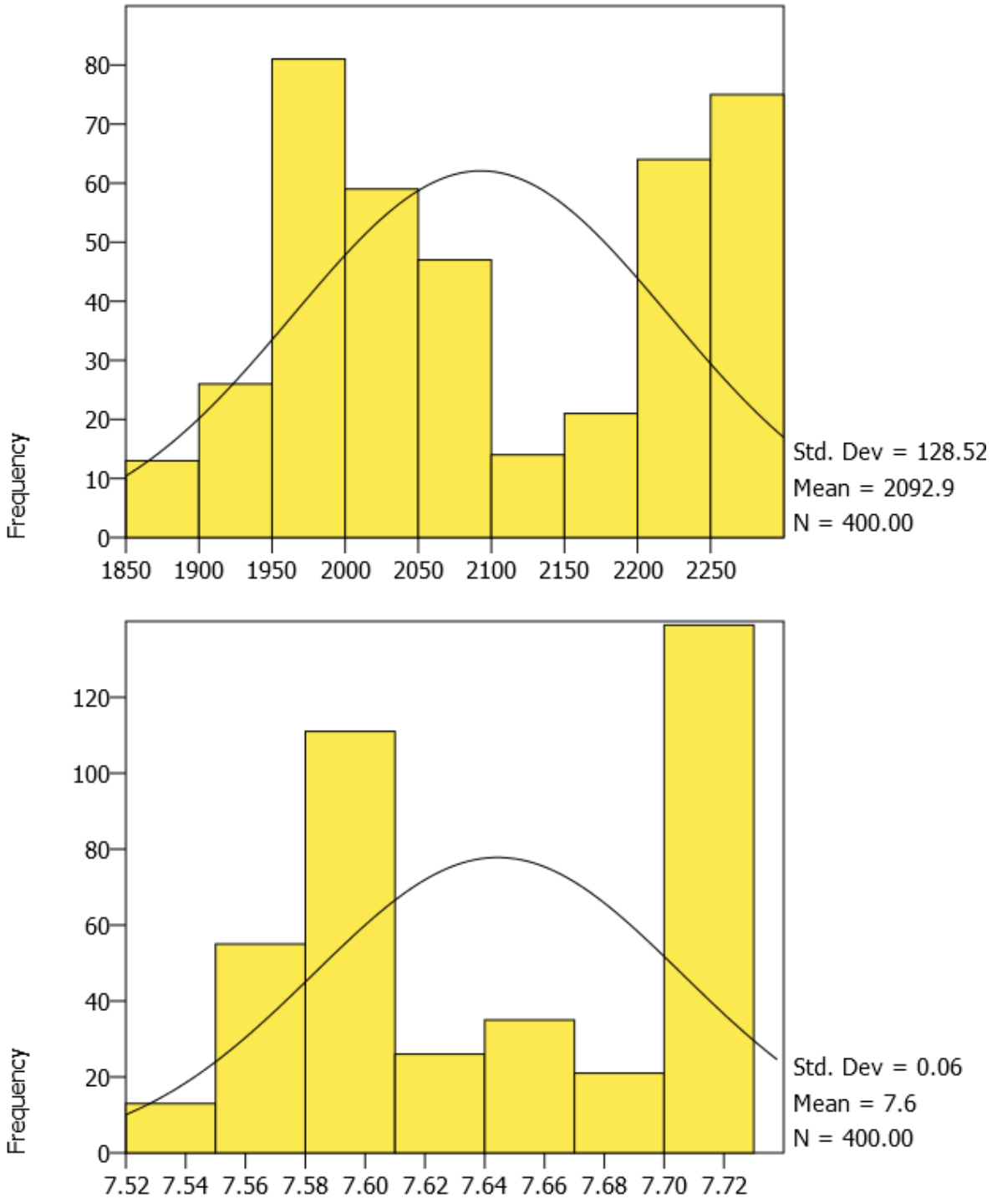


Figure 17. Distribution of the *Wages* variable (raw and log-transformed data)

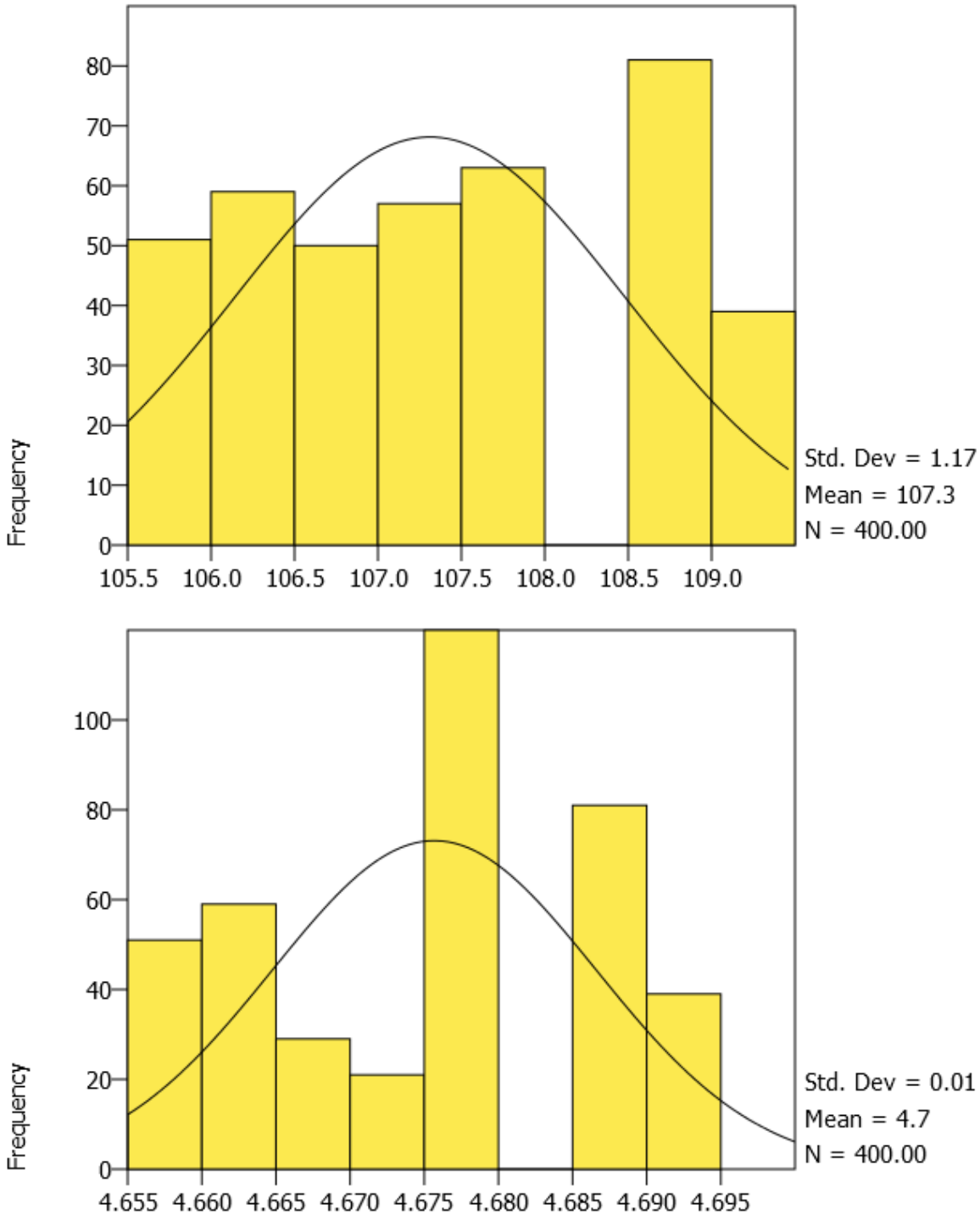


Figure 18. Distribution of the *Capital goods* variable (raw and log-transformed data)

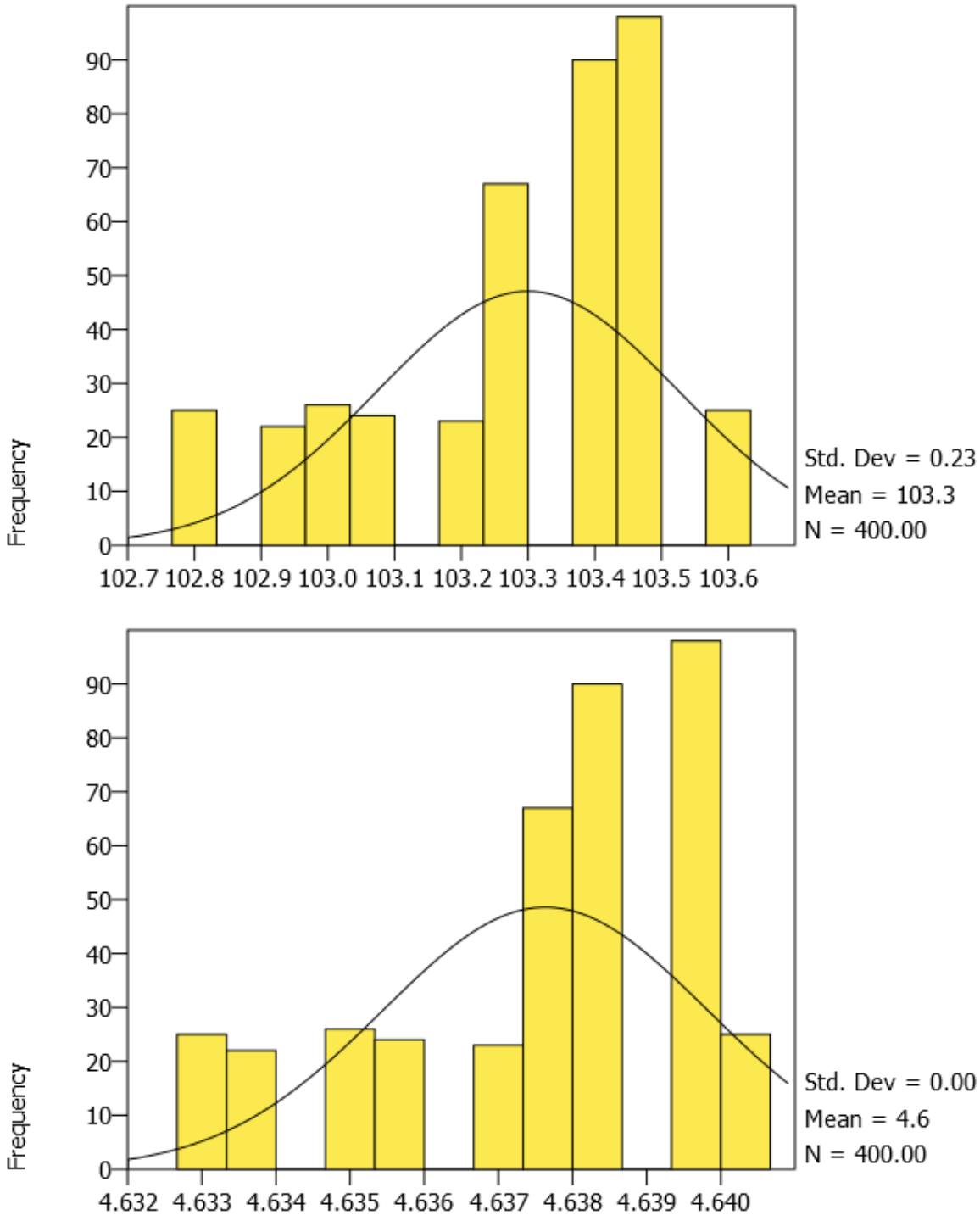


Figure 19. Distribution of the *Electric energy* variable (raw and log-transformed data)

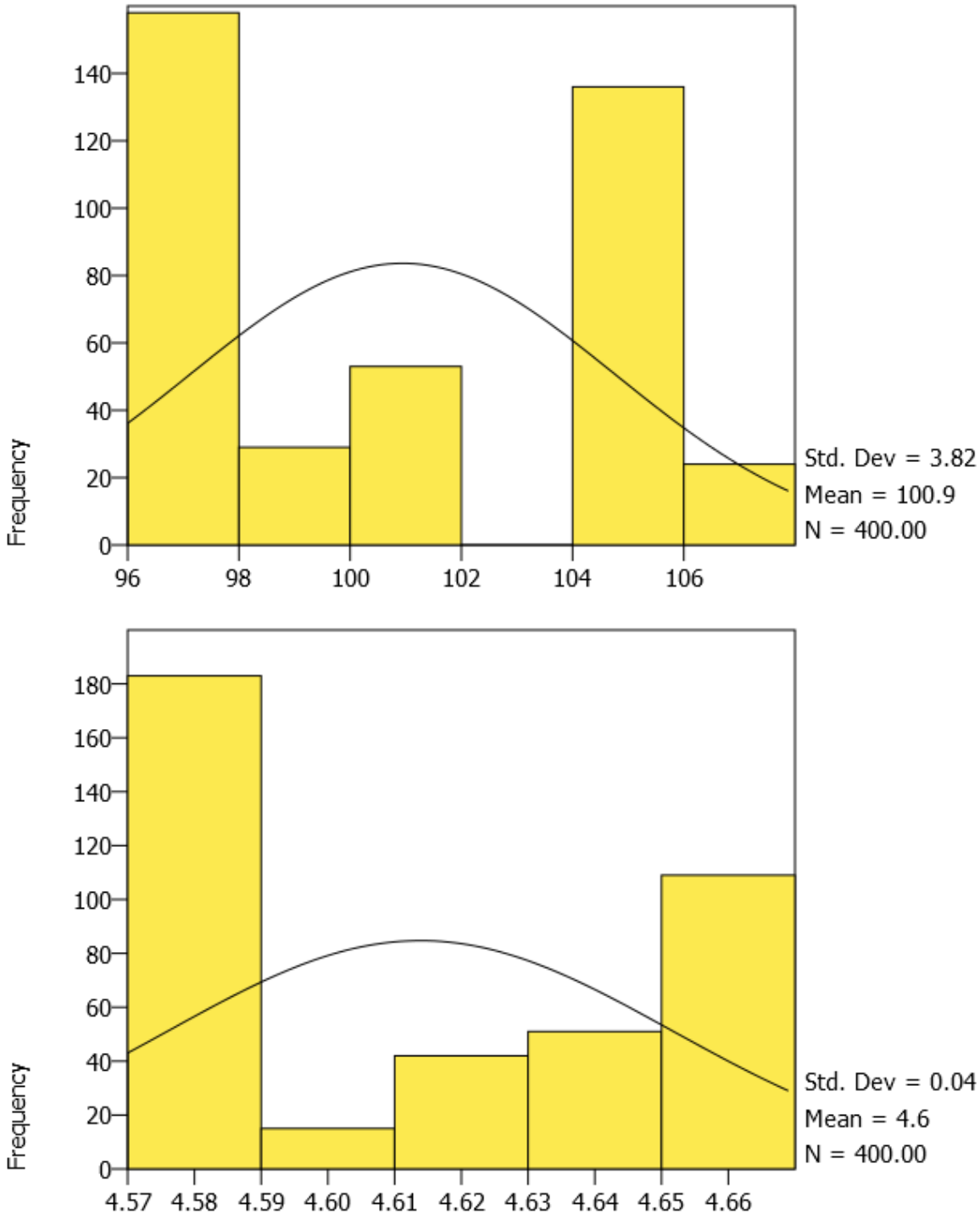


Figure 20. Distribution of the *Rent* variable (raw and log-transformed data)

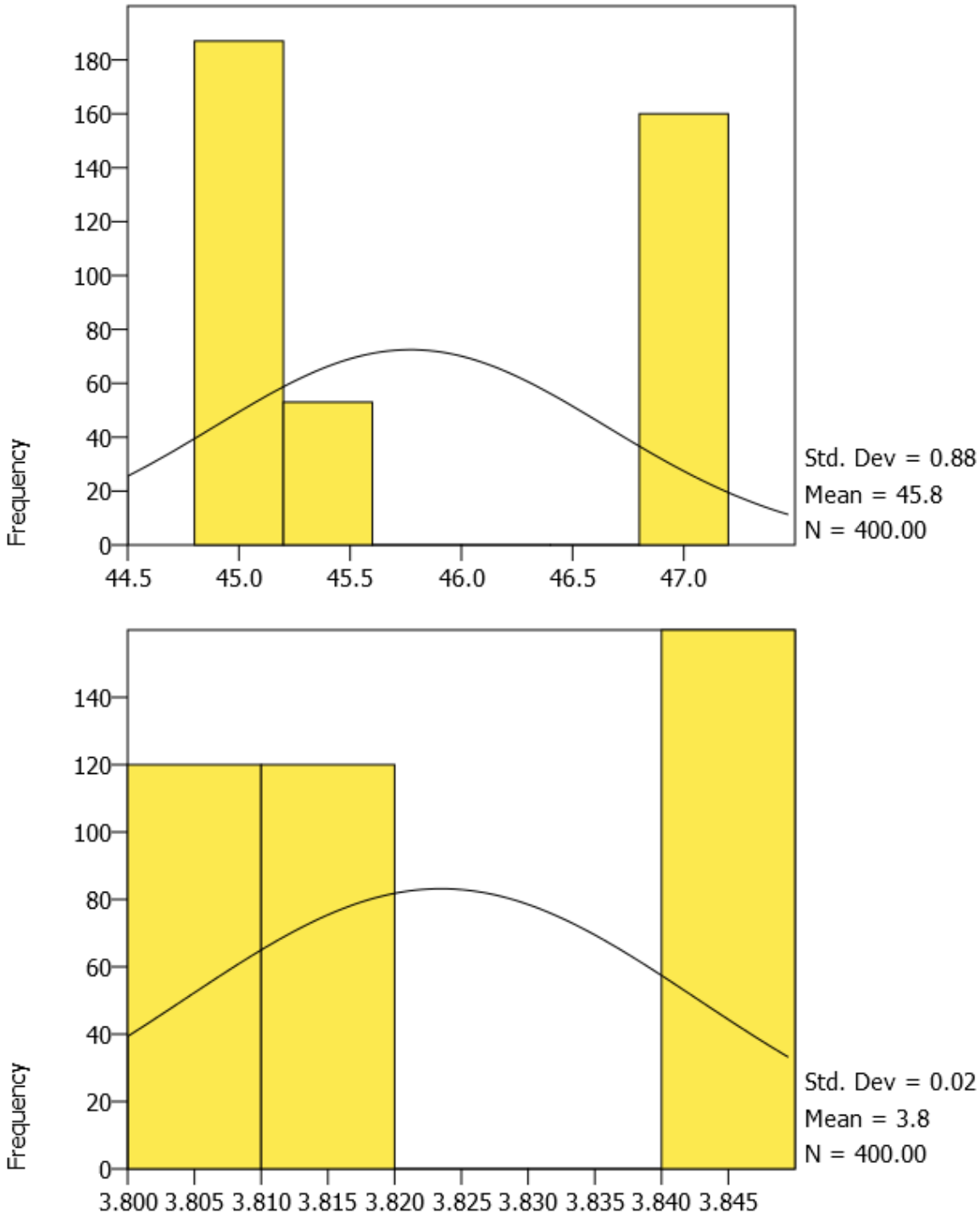


Figure 21. Distribution of the *Credit rate* variable (raw and log-transformed data)

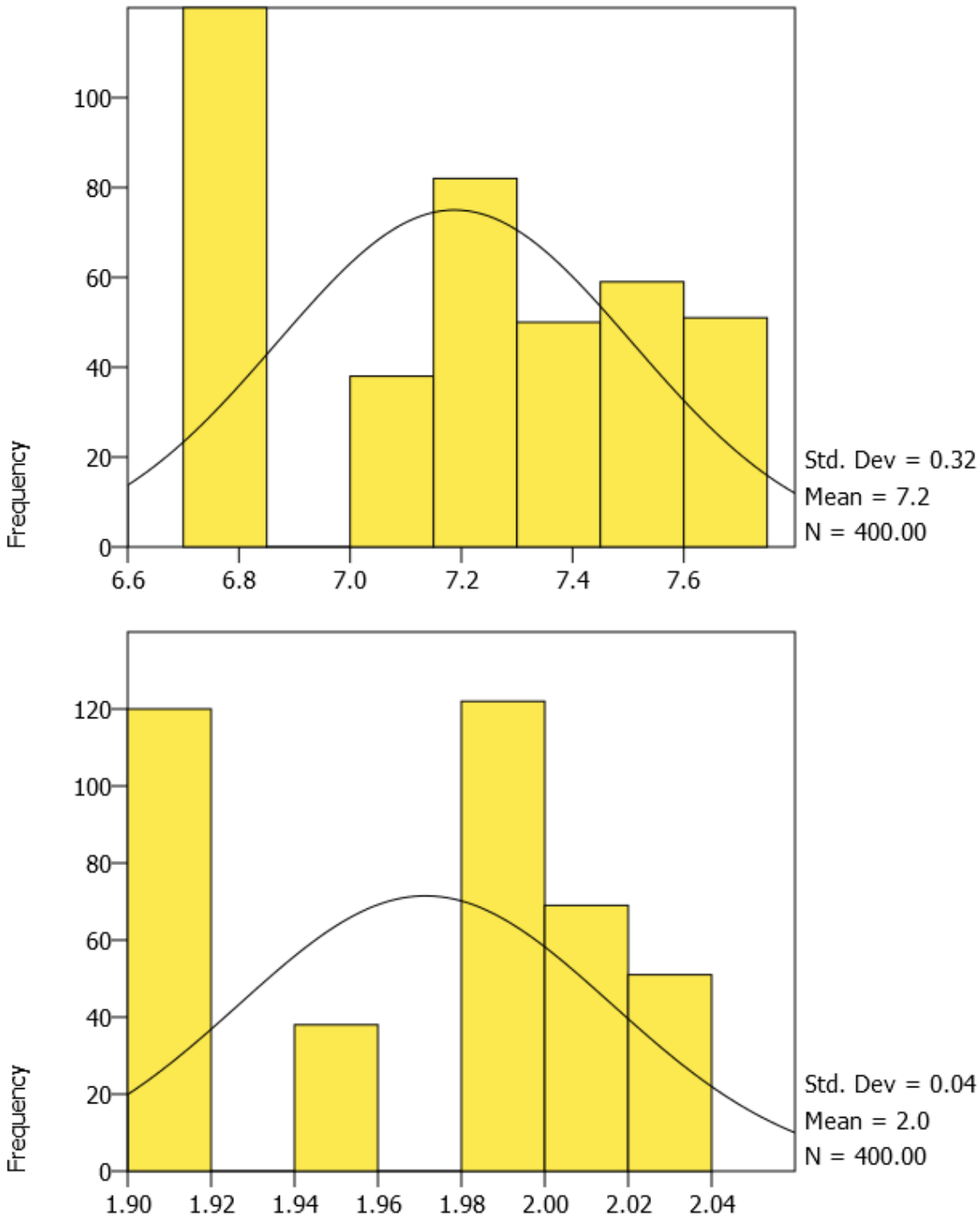
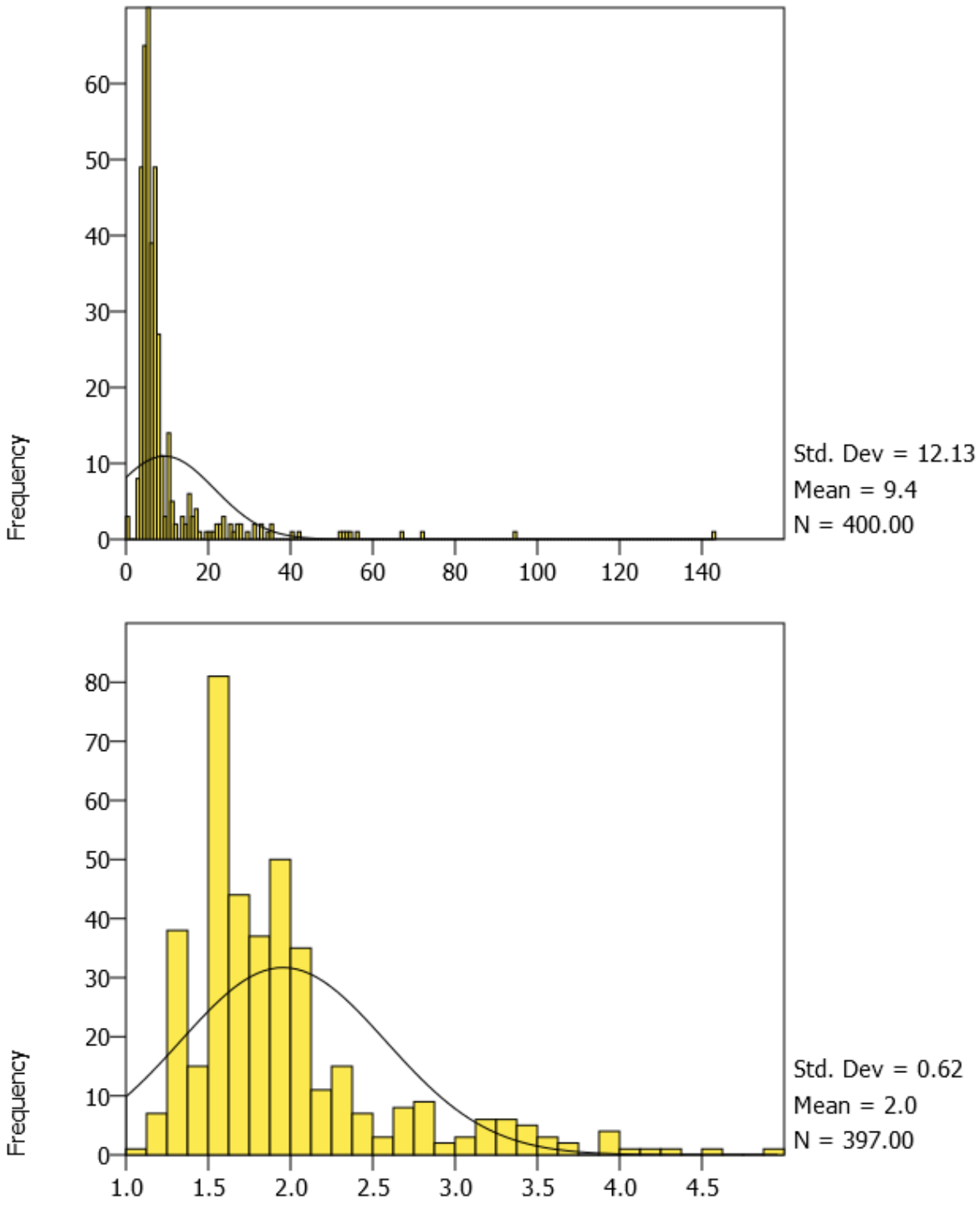


Figure 22. Distribution of the *Invoice sum* variable (raw and log-transformed data)



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