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Cruise Port Competition: the case of the Port of Venice and the Port of Trieste

by

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Abstract

The cruise sector represents a prominent component in shipping as well as one of the most dynamic markets in seaport activities. However, the extraordinary growth of cruise tourism in the last twenty years has resulted in increased market and geographical concentration. This has spurred cruise lines to seek new alternative destinations triggering competition between cruise ports. In this study we assess the competition between the port of Venice and the port of Trieste by using a game theoretical approach. Starting from the assumption that overcrowding and/or congestion phenomena constitute a negative externality, given by the difference between social costs and private costs, and that this can affect the attractiveness of a port from a passenger perspective, we developed a simple penalty function that disincentives the excess use of capacity. Then, we create a practical framework for the Cournot competition between cruise ports. By comparing the results of different Cournot-Nash equilibria, this study demonstrates how a marginal shift in Trieste's port capacity does not affect Venice's throughput and its capacity utilisation. Moreover, the model shows that for the current capacity of the port of Trieste, there is no competition with the port of Venice; therefore, Trieste does not represent a promising alternative at this time. However, if Trieste decided to pursue an expansive strategy by enlarging considerably its capacity, then competition between the two ports would come back into the game.

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1. Introduction

1.1 Background and problem statement

The cruise sector is considered as one of the fastest growing and the most dynamic markets in shipping and seaport activities. The rapid increase in the number of passengers together with the enlargement of the global fleet has led to high level of market concentration and geographical concentration. This results in increasing congestion and overcrowding phenomena at the port of destination, which, in turn, create concerns about the loss authenticity of historic towns and threat the future of cruising in several destinations (Santos et al., 2019). Moreover, the intensification of the cruise traffic in certain destinations prompted cruise lines to include in their itineraries new ports located in the proximity of the main destination, creating thereby a complex interdependent relationship between ports, better known as coopetition (Perez and Garcia Sanchez, 2018). The situation explained above clearly recalls the case of the port of Venice and the port of Trieste. Venice is one of the most visited cruise destinations in the world, which is why the port of Venice represents the fifth cruise port in the Mediterranean and the first in the Adriatic in terms of passenger movements and cruise calls. Nevertheless, the exceptional growth of cruise traffic within the lagoon has been severely criticised in recent years because it poses a threat to the city itself as well as for the delicate environment of its lagoon. The uncertainty about the future of cruising in Venice, opens new opportunities for the near port of Trieste as an alternative destination.

1.2 Purpose of the research

The aim of the research is to assess the competition, in terms of output produced, capacity utilisation and profit generated, between the port of Venice and the port of Trieste and to what extent this latter may represent a valuable option to the port of Venice. By doing this, it will be possible to acquire useful insights regarding the future of the cruise sector in Venice and in Trieste.

1.3 Research Questions

Based on the aforementioned problem statement, the following research question and sub-research questions were developed:

<u>Main Research Question:</u> Which are the optimal levels of output that maximise the profits of the two ports when these are in competition and when social costs are taken into account?

Sub-Research Questions:

1) How does the port's attractiveness change from a passenger perspective when overcrowding and/or congestion occurs in the port of destination?
2) Does port of Trieste currently represent an alternative to the port of Venice?
3) What would be the potential direct economic impact of cruise tourism if the two ports were to maximise their profits?
4) What actions could the two ports take to maximise their throughput?

1.4 Relevance of the research

With the rapid growth of the cruise sector worldwide, cruise ports have been increasing in importance, becoming subjects of several studies for academics and professionals. Despite this, the competition among cruise ports is practically an under-researched topic. Indeed, the existing literature assessing port competition mainly focuses on commercial ports. For this reason, we have sought to differentiate ourselves by adapting an existing economic model to a specific cruise context, which is the competition between the port of Venice and the port of Trieste. The fundamental contribution of this research is that the optimal output quantities produced by the model accounts also at least in part for public costs. Indeed, port authorities when choosing the quantity of output, do not consider the problem of overcrowding and/or congestion which can be deemed as a negative externality resulting from the difference between social costs and private costs.

Therefore, this study provides valuable insights that can be used by the port authorities and cruise lines in their strategic decisions.

1.5 Thesis structure

The structure of this research acquires crucial importance in order to reach the proposed objective encompassed in the research question and the sub-research questions. Therefore, the research is organised as follows:

Chapter 2 includes the literature review, which provides fundamental insights required to understand, from an empirical and theoretical point of view, the framework on which the research is based.

Chapter 3 involves the methodology, where the economic model is introduced, and the main calculations are reported. Moreover, in this chapter, the author justifies the choice of the model and relevant data were collected.

In Chapter 4, the findings resulted from the model are presented and analysed. Then, after selecting the optimal results, the author estimates the potential implications deriving from them and he will go on to explore the possible actions that the ports might take.
Ultimately, in chapter 5, the conclusions are presented. Moreover, the limitations of the research as well as the recommendation for further research are discussed.

2. Literature Review

2.1 The Development of Cruise Tourism and new challenges

The emergence of cruise tourism dates back to the late 1960s and early 1970s. Initially, cruise tourism was perceived as an elite privilege just for wealthy people. However, in the last thirty years, with the advent of the economies of scale, cruise industry has become more accessible and it has progressively gained importance up to cover a considerable niche of the global tourism. According to Cruise Lines Association (CLIA, 2019), cruise companies worldwide moved over 28.5 million passengers throughout 2018, with an increase of 7% compared to the previous year. This figure is almost threefold higher with respect to the number of passengers recorded in 2000 and more than sevenfold higher with respect to 1990.

Year	Tourist arrivals in mil.	Annual growth rate (%)	Cruise passengers in mil.	Annual growth rate (%)
1980-1985	285,9 – 327,2	2.3	1,8 – 2,8	7.7
1986-1990	338,9 – 458,2	6.2	3,3 – 4,5	6.4
1991-1995	463,9 – 565,5	4.0	4,92 – 5,67	2.9
1996-2000	596,5 – 681,3	2.7	6,5 – 9,72	8.5
2001-2005	680, 3 – 802,0	3.3	9,92 – 14,47	7.8
2006-2010	846,0 – 952,0	3.0	15,11 – 18,8	5.6
2011-2018	983,0 – 1326,0	5.1	20,6 – 28,5	5
1980 -2018	285,9 – 1326,0	4.9	1,8 – 28,5	7.6

Table 1: International arrivals and the number of cruise passengers in the world, 1980 – 2018 , source: Perucic, 2019

Furthermore, the cruise industry significantly contributes to the international economy as well as to the employment. According to CLIA, just in 2017, cruise industry generated a total output worldwide of

$134 billion (combined direct, indirect and induced contributions) and it created 1,108,676 jobs translated in $45.6 billion in wages (CLIA, 2019).

CLIA (2019) listed the three major cruise regions in 2018, which accounted for 62% of the deployed capacity. The Caribbean was the main region, with a share of 34,4%, followed by the Mediterranean and Northern Europe, with 17,3% and 11,1% of the deployed capacity, respectively. In the period 2004-2014, Europe was the foremost region for cruising, recording an increase of 136.2% in the total number of passengers. Over the last decade, the Mediterranean has been the most dynamic region with an average annual growth rate of 9,4%, with Italy and Spain reporting the highest cruising activity (Perez and Garcia Sanchez, 2018).

	1997		2007		2018	
	No ships	**GT % share**	**No ships**	**GT % share**	**No ships**	**GT % share**
Up to 20,000 GT	111	19	92	6	64	3
20,000-50,000 GT	66	36	69	17	62	10
50,000-80,000 GT	35	43	53	29	63	21
80,000-100,000 GT	-	-	31	22	46	20
100,000-150,000 GT	1	2	24	26	56	33
>150,000 GT	-	-	-	-	16	13
Total	**213**	**100**	**269**	**100**	**307**	**100**

Table 2: Cruise ships by size, 1997 - 2018, source: Perucic, 2019

The progressive increase in demand for sea cruises has prompted companies to order new and larger vessels. As can be observed from Table 2, from 1997 to 2018, the size of the vessels has substantially increased. The great majority of the “new entries”, in 2018, were large vessels over 80,000 GT. According to the order book, this trend will continue in the future since over 100 new cruise ships, with an average size of approximately 90,000 tons, are expected to be delivered within the period 2020 -2027. The high level of market concentration, the fast pace increase in the number of passengers and the geographical concentration of passenger flows along with the enlarging of the fleet pose new great challenges for the cruise destinations and their ports. Holloway (2002) claimed that the overall growth of cruise tourism and cruise traffic led to increasing congestion phenomena and delays in handling cruise vessels and passenger services as well as the fact that they have a negative impact both on the environment and society. Especially, when large vessels visit small destinations, the congestion phenomena are greatly amplified, directly impacting the environment and residents.

The above mentioned issues call for new tailor-made sustainable policies as well as for an improved coordination, cooperation and vertical integration of all the cruise activities in order to enhance the performance of main actors (terminal operators, cruise lines, cruise providers and service providers) as well as to tackle the impact of cruising on the destinations and on the environment.

2.2 The economic impact of the cruise sector

As already stated in the previous chapter, cruise industry has a very significant economic impact, both globally and at regional and local levels. Vayá (2008, 2013) analysed the economic impact of cruise industry following the traditional methodology, which identifies three types of effects: direct impact, indirect impact and induced impact. The direct impact includes three dimensions: the expenditure of cruise passengers in the destination city, cruise ships' expenditures (such as mooring and pilot services, terminal services, bunkering supply, waste management etc.) and crew expenditures in the destination city. Therefore, the direct effect not only involves the port, but it also affects the other businesses in the city (for instance transport providers, hotels, cultural attractions, leisure, retail, etc.). In this regard, Notteboom (2015) provide an in-detail table where the main cluster components and supporting businesses are listed (Appendix 2). The direct impact plays a crucial role because it determines, in its turn, the indirect impact and the induced impact. The indirect impact is the effect on other sectors of the economy, derived from the demand for goods and services generated by cruise business. For instance, an hotel, in order to accommodate cruise passengers, needs a range of goods or services (like food products, cleaning, spa service, etc.) to fulfil customers' needs and to offer a good experience. Thus, passengers, shipping companies' and crew's expenditures not only have an impact on all those activities in the city of destination, but they generate a 'multiplier effect', which involves all economic sectors at a local, regional and national level. Finally, the induced impact is *"the effect derived from consumer spending of revenue generated employment (directly and indirectly) in cruise activities"* (Vayá, 2016). In other words, induced impact derives from the spending of the wage incomes earned by workers (within cruise sector or in correlated activities) to consume goods and services in their daily life. Therefore, this establishes a chain of intersectoral relationships that result in an enhanced revenue flow within different economic sectors (Vayá, 2016).

2.3 Overtourism in cruise destinations

The cruise tourism has witnessed a substantial growth worldwide in the last decade. Europe is the cruise region that has recorded the highest increment of cruise tourism passing from 4.05 million passengers in 2007 to 6.96 million in 2017 (CLIA, 2017). However, the rapid expansion of the cruise sector, characterized by an considerable surge in the number of passengers as well as in the size of cruise ships, has been labelled as one of the main causes of overtourism in several cruise destinations such as Amsterdam, Barcelona, Dubrovnik, Lisbon, Venice and many others.

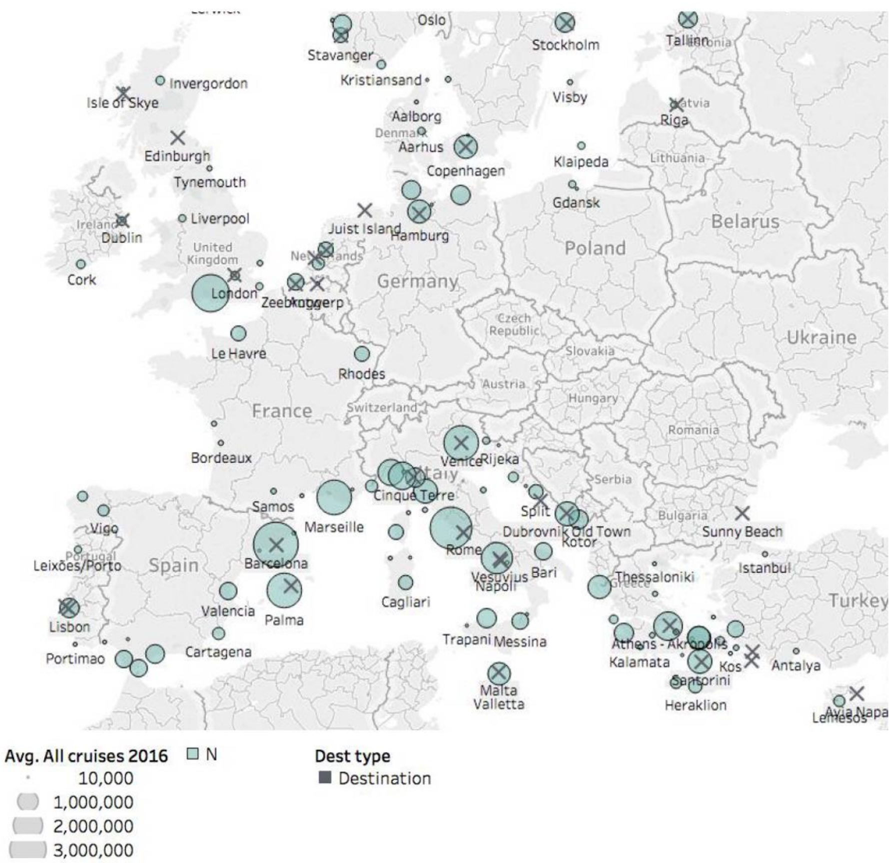


Figure 1: Overtourism in the main European cruise ports

The Figure 1 above illustrates the main cruise port in Europe. The destinations in a state of overtourism are indicated as red crosses and the bubble size (indicated by the bars in the legend) represents the annual number of passengers between 10,000 and 3 million (Peeters et al., 2018).

Peeters et al. (2018) summarised in the Table 9 (presented in the Appendix) the main impacts deriving from overtourism and explain the consequences linked to them such as overcrowding and congestion.

Stokols (1972) states that there is a situation of overcrowding when the presence of others affects with one's comfort. Therefore, it is crucial to explore how visitors perceive the crowd of tourist as it can alter the overall experience in the port of destinations and can negatively affect their opinion regarding the itinerary (i.e recommending or not the cruise itinerary).

As Esser explains (1972) *"crowding produces stimulus overload, occurring when there is inappropriate or unpleasant contact with other individuals"*. Besides, crowding can be seen as a situation in which the presence of numerous people limits individual's range of choices and impedes one's ability to undertake certain activities and fulfil all his needs (Stokols, 1972). In this regard, the issue of overcrowding and congestion is often associated with the city and port capacities (Vaske, 2002). Indeed, crowding occurs normally when the carrying capacity of the city and/or port is overloaded. Therefore, overcrowding implies that when the number of people that can visit a destination simultaneously exceeds the maximum capacity of the destination, this has significant environmental, economic and social cultural (Neuts, 2012).

According to the existing literature, tourists' perception of crowding depends on several factors such as: personal characteristics (e.g., motivations, expectations, previous experience, nationality, length of stay); economic factors (income and expenditure); the characteristics of other tourists encountered (i.e., behaviour, interaction with others and similarity); as well as the situational variables of the environment (i.e., quality of the facilities, number of tourists, destination design, availability of resources and places of contact). Generally, overcrowding negatively affects the quality of the experience and therefore the overall passengers' satisfaction. However, Manning (1980) and Shelby (1980) demonstrated that, in some cases, there is a weak, or even non-significant correlation, between overcrowding and passengers' satisfaction. Surprisingly, it has been demonstrated that, sometimes, there is also a positive correlation between the two variables; especially when visitors seek hedonic experiences (Noone, 2009), when the level of crowding does not exceed or when the perception of crowdedness is relatively low (Palau-Saumell et al., 2014). Eventually, it can be stated that crowding perception is not necessarily negative but can even enhance tourists' experience and providing satisfaction.

Lately, overcrowding in certain destinations is associated even more frequently with cruise tourism. Indeed, when an excessive number of cruise ships arrive at the port bring economic benefits to the destination, on one hand, and negative externalities, such as congestion and overcrowding, on the other hand; which, in their turn, result in environmental and social issues. All these aspects mentioned above affect the residents 'quality of life as well as passengers' experience and consequently their satisfaction.

Therefore, the rapid growth of cruise tourism should be founded on principles of sustainability implying that ports and their clusters should not care only profits, but also become aware of their social and environmental responsibilities.

2.4 Port Categories and port attractiveness

The two main components of the cruise industry are maritime affairs and tourism. The maritime component is embodied, in the specific, by the cruise ships and cruise ports. Cruise ports play a key role when designing an itinerary since they connect the ship and the tourist destinations (Perez and Garcia Sanchez, 2018). Moreover, as Rodrigue and Notteboom (2013) argue: *"cruise industry sells itineraries, not destination"*, which call for a major flexibility when selecting ports, but without neglecting important operational aspects such as sailing vs. port time. Therefore, given the fast growth of the cruise industry, cruise ports have acquired further importance, becoming the subject of several research studies.

Marti (1990) identifies three different types of cruise ports which cruise companies can include in their itineraries: the port of call, the homeport (or turnaround) and the hybrid port.
A port of call is a stopover destination included in an itinerary, where usually ships stop for supplies, for ship repairs or for other service procurement. The homeport is the most important of the three since it is usually the port where the cruise itinerary starts and/or ends. There are several factors that may influence the decision of cruise companies when selecting a homeport. The first factor is the geographic area where the port is located and whether its location is attractive or not for cruise itineraries. As Perez and Garcia Sanchez (2018) state: *"A port cannot be attractive if it is not located close to or in an area where there are other available cruise ports with which to design an itinerary. Thus, a cruise port needs to be located close to or within an area where cruise ships operate"*. Port characteristics and adequate infrastructures (such as the depth of the seabed at the dock, the length of the pier, the availability of passenger terminals, etc.), the efficient provision of services to the passengers and the ship, the availability of an airport in the proximity and other means of transport represent further important requirements for a homeport. Nevertheless, there are many other factors which contributes to the attractiveness of a cruise port. In this regard, Lekakou (2010) identified in total 12 categories of factors and 81 unique factors which can influence the attractiveness of a homeport and, therefore, the port selection by the cruise lines (Appendix 1). Among these it is worth to be mentioning the importance of the port management as well as of the political conditions and the regulatory framework. Cruise lines, when drawing up their itineraries, select

new destinations by considering geopolitical factors and the institutional stability of the destination itself. Indeed, an unstable or uncertain political environment may represent a threat for the investments made by cruise lines; which is why the regulatory framework has the duty to support the development of the port rather than raise barriers to the cruise companies willing to invest. Finally, the hybrid ports are those ports that act as both ports of call and homeports. Notteboom (2013) make a further distinction between cruise ports depending on the role they serve within their regions: destination cruise port, gateway cruise port and balanced cruise port. A destination port usually coincides with a "must see" city which constitutes "the crown jewel" in the itineraries offered by the cruise lines. This is the case, for instance, of Venice and Barcelona, where there are so many attractions that tourists have little incentive to see anything else in the vicinity of the city (Santos et al., 2019). Instead, a gateway port does not normally coincide with a tourist destination, but it is a transit place where converge the majority of the passengers, goods and ships. It is, thereby, a port nearby touristic attractions easily reachable with shuttle services, trains or other transport means. Finally, the balanced port is a halfway type, where the port can be the destination, but it can also be located in the proximity of other touristic attractions or cities (Santos et al., 2019).

2.5 Port governance and Vertical and Horizontal Integration

The port governance has changed over the years as consequence of the growth of the cruise industry. With the expansion of the cruise market, port governance has been reformed by allowing the participation of third parties (such as cruise lines, terminal operating companies, banks, insurance companies, airports and other investors) in the management and in the administration of cruise terminals (Pallis, 2015). Even though the public sector still plays a pivotal role in the governance and in the operation of cruise ports, especially in Europe, the cruise activity has progressively gained operational autonomy with the public authorities which allowed the creation of partnerships in order to gather more financial resources thus improving port competitiveness.

In this regard, Notteboom (2004) and Van de Voorde and Vanelslander (2009) studied the importance of vertical and horizontal integration within the cruise sector and they pinpointed different types of strategic cooperation such as the creation of joint-ventures, dedicated terminals, shared ownership and consortia. "*Port authorities are more likely to have concessions for dedicated terminals with shipping companies, joint-ventures with the terminal operating companies, and alliances with other port authorities. Hinterland operators cooperate with shipping companies in either capacity sharing or acquisitions"*

(Notteboom, 2015, p. 3). Existing literature shows that the drivers for vertical and horizontal integration considerably differ. Vertical integration is usually driven by the customers' demand for more integrated services and by the willingness of cruise lines to differentiate from competitors as well as by the need to generate higher revenues and margins. Hence, vertical integration enhances the interaction between cruise ship operations and other business interests, it spurs product diversification, and emphasizes the connection between cruise terminal operations and shore-based activities (i.e. shore excursions or cruise port resorts) (Notteboom, 2015). Conversely, horizontal integration is known to be a particularly helpful tool when competitive advantage wants to be achieved, as it enhances the economies of scale and scope through cost savings and by offering a wide service network to the customer. Moreover, *"horizontal integration determines the optimal size of operations through merger and acquisitions and forms of horizontal cooperation"* (Notteboom, 2015, p.3). Thus, horizontal integration is characterized by lower barriers compared to vertical integration since the cruise company, which wants to expand the scale of its activity, already has the necessary knowledge and know how (Notteboom, 2015). Ultimately, vertical integration seems to be a more difficult strategy to adopt within cruise industry since cruise companies expand their business moving beyond their core activity, which call for *"the accumulation of new knowledge and know-how and the operational integration and synchronization of different types of activities"* (Notteboom, 2015, p. 4).

2.6 Port coopetition

The outstanding growth of cruise traffic over the last decade, particularly in the Mediterranean, has resulted in increased congestion both on the maritime side (piers) and on the land side (overcrowding at terminals and mass tourism at destination). This has prompted cruise lines to include new ports in their itineraries in order to meet the new demand and to differentiate their offer. As Perez and Garcia Sanchez (2018) claimed: *"The itinerary system of cruise traffic makes the cruise ports depend on one another to design an itinerary. This feature results in both complex geographic relationships in the design of a cruise itinerary and complex competitive/cooperative relationships between ports".*

Ports compete amongst each other with the aim to be included in the itineraries designed by cruise lines operating within a specific cruise region and, usually, competition is more amplified for those ports belonging to the same category and located close to each other (Pallis, 2015). Nowadays, cruise lines tend to include in their itineraries, ports of different sizes since each type of port has a different attractiveness and offers a variety of different experiences to the passengers. The increasing number of ships and passengers spur new ports to enter into the market, therefore triggering competition. Usually, competition is more intense between homeports which do not compete so much in terms of geographical location as in terms of quality and variety of services offered (Pallis, 2015).

However, in some cases, both competition and cooperation may simultaneously occur between cruise ports. Indeed, while competing, cruise ports can also draw up cooperative relationships aimed at developing their mutual positions. According to Perez and Garcia Sanchez (2018): *"In the case of cruising, the close relationship that is necessary between ports to create attractive itineraries can be described as the perfect case of 'coopetition'*. As it can be deduced, the definition of 'coopetition' results from the mix of 'cooperation' and 'competition'. It represents the 'win-win' strategy adopted by adjacent ports which compete and cooperate at the same time with the aim to retain a sustainable market share. The key notion behind coopetition is that the ports within a certain region can benefit from the growth of the cruise industry as a collectivity, instead of as individual ports. In this regard, ports can collaborate through the coordination of the key activities as well as the promotion of regions as a cruise destination. Likewise, given the rapid growth of the cruise market, ports are also expected to cooperate by sharing knowledge on best practices on cruise ports development and management. Song (2002), argued that 'coopetition' is a way of *collaborating to compete*. In other words, cooperation and collaboration among ports allows these latter to fulfil their general interests and to strengthen their market power by preventing, at the same time, mutually destructive competition. Moreover, this strategy can be extremely beneficial, especially if applied to those cruise itineraries which involve ports of different sizes, technical features and tourist attractiveness (Perez and Garcia Sanchez, 2018).

2.7 Introduction to the Port of Venice and the Port of Trieste

It has already been stated that the Mediterranean represents the second most important cruise market globally with a 17,3% deployed capacity in 2018, after the Caribbean (34,4%). The Mediterranean region may be divided into four further sub-regions: the Western Mediterranean, the Eastern Mediterranean, the Southern Mediterranean and the Adriatic (Rodrigue and Notteboom, 2013). With 2.4 million passengers in 2018, the Adriatic is ranked second, just after the Western Mediterranean (Risposte Turismo, 2019). Italy and Croatia are the most visited countries in the Adriatic (followed by Greece, Montenegro and Slovenia) and they boast the most important ports, which together accounted for approximately 80% of all cruise passengers (Žlak et al., 2015). In this scenario, Venice represents the main port and the biggest attraction in the Adriatic, with over 1.5 million passengers just in 2018, which is why it is the first cruise port in the Adriatic and the fifth in the Mediterranean (Risposte Turismo, 2019). However, cruise traffic in Venice has seen a significant decrease over the past years and this trend could probably continue in the future due to environmental and social issues. This will open new chances for small ports, especially for those located in the proximity of Venice, by triggering new investments in port facilities and by improving port capacity in order to attract more passengers and larger ships and, therefore, to gain a greater market share. One port that might benefit from this situation is the port of Trieste, which is already gaining importance and it may represent a good alternative to the port of Venice (Žlak et al., 2015).

In this chapter, a general overview of the two ports, first the port of Venice and then the port of Trieste, is provided with detailed description of their respective managements, technical features and port facilities, the aspects that determine their different attractiveness as well as their economic impact.

2.7.1 The Port of Venice

As previously mentioned, Venice is the first cruise port in the Adriatic and the fifth in the Mediterranean for passenger movement, with around 1.5 million passengers just in 2018 (Risposte Turismo, 2019). Moreover, Venice is the largest European port for cruise turnaround passengers meaning that almost 85% of the passengers start and end their journey in Venice (Risposte e Turismo, 2019), which makes the port of Venice one of the foremost homeports in the Mediterranean. Indeed, this share has no equal in the Mediterranean; only Savona and Genoa come close to a similar percentage with 66% and 69% respectively (Risposte e Turismo, 2019). As a homeport, the port of Venice has more economic benefits than other ports since a longer permeance of the ship in the port implies greater average expenditure by both the passengers and the shipping company. Despite the outstanding numbers, it must be pointed out that cruise passengers' contribution to Venice tourism is considerably small, roughly 5%. In this regard, Venice is also known as the capital of mass tourism. With an average of 25 million tourists every year, Venice has detached by far other overcrowded cities such as Barcelona, Amsterdam and Bangkok (Hardy, 2019).

Port Governance

Founded by the Venice Port Authority in 1997, Venezia Terminal Passeggeri S.p.a (V.T.P. S.p.A) manages 10 multifunctional terminals, 1 provisions storehouse, 6 parking lots and 7 quays across the areas of Marittima, St. Basilio and Riva dei Sette Martiri. The acronyms S.p.a stands for "Società per azioni" meaning that the passenger terminal is a public limited company by shares, equivalent to an S.A in other countries. The major shareholder, with 53% shares, is the APVS S.r.l company owned by Venice Port Authority and by Veneto Sviluppo, operational company of the Veneto Region. Other 44,36% shares are equally divided between Finpax S.r.l (22,18%) and SAVE S.p.a (22,18%) and the remaining 2,64% is owned by Venice, Rovigo, Delta Lagunare Chamber of Commerce (VTP, 2016) This form of corporation (S.p.a) better suits the needs of large businesses with high economic requirements, such as a passenger terminal. In this regard, consistent investments (almost €70 million) were made by the V.T.P between 1997 and 2015 aimed to improve the efficiency of the port facilities, to limit the impact of port activities on the environment and to ensure the highest experience to the passengers in terms of comfort and safety. All the investments made over the past years, ensure that Venice maintains a prominent position among the best worldwide cruise ports and destinations (VTP, 2016).

Technical Features and Facilities of the Port

Venice cruise port extends over a ground area of 290,000 square metres and an indoor area of 93,000 square metres distributed between ten dedicated terminals. It is equipped with 7 quays, which are able to berth up to 12 ships at time (VTP, 2016). The quays present different lengths listed as follows:

- Tagliamento 726,70 m
- Piave 722,50 m
- Isonzo 630,00 m
- S. Marta 465,24 m
- Riva Sette Martiri (river cruises only) 360,40 m
- S. Basilio 342,57 m
- Testata Marmi 203,00 m

Figure 2: Technical Features of Venice Cruise Terminals

The cruise vessels allowed to enter in the port must be within 340 m. length overall (LOA) and they must have a maximum draught of 8.90 m due to the tidal changes which may vary on average of one metre. When it comes to the port's services, all the essential services for the ships and their passengers are provided by private companies, such as pilot and tug service, ship repair, bunkering, garbage disposal, freshwater provision, handling provisions. Moreover, the port has parking areas with enough capacity for 2,234 cars and 40 buses (VTP, 2016).

Attractiveness of Venice as a Cruise Destination

The attractiveness of Venice as a cruise port is mainly due to its uniqueness worldwide. Entered in UNESCO World Heritage List in 1987, Venice has become over the years one of the world's top tourist attractions because of its enormous historical and artistic value as well as the unique environment of the lagoon where it is located (UNESCO, 2019). In addition, Venice is situated nearby other tourist attractions like the historical cities of Treviso, Padua and Verona as well as different unrivalled landscapes such as Lake Garda, the Dolomites and the Euganean Hills. At the light of these particular features, it can be safely stated that a cruise experience in Venice has no real competitors as it cannot be replicated anywhere else (OECD, 2016).

Besides Venice's cultural and artistic nature, it is crucial to point out the technical features of the port's infrastructure and facilities as well as the excellent service offered to cruise companies and their passengers. Thanks to the continuous investments made by Venice Port Authority and Venezia Terminal Passeggeri (almost 70 million since 1997), the port's berth capacity has been considerably increased up to 12 cruise ships, supported by ten terminals able to welcome 2.5 million passengers per year (more than the actual number of cruise passengers). Moreover, the secular maritime experience of the port cluster contributes to provide high standard services and, thus, to fulfil all customer needs. Additionally, it must be said that the cruise port is located in an excellent position just a few steps from the Ponte della Libertà, a bridge which connects the cruise terminals with Piazzale Roma where the historical city centre starts.

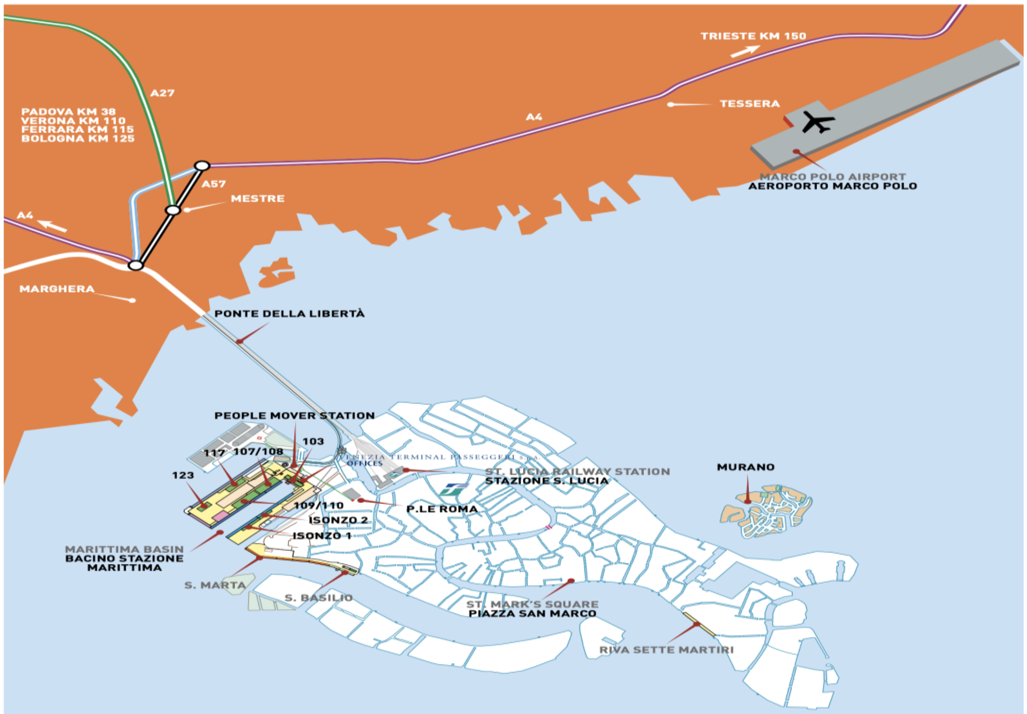


Figure 3: The port of Venice: strategically linked

In this respect, it worth mentioning that the Marco Polo International Airport is located just 13 kilometres from the port and can be easily reached by rail, road and waterways. With more than 200 daily flights, Venice Marco Polo is the third biggest airport in Italy and is used by 99% of cruise passengers. Moreover, SAVE S.p.a (Venice Airport owner and operator), is also one of the major shareholders of Venice Passenger Terminal (OECD, 2016).

All this explains why several cruise companies choose Venice as homeport; not only for its uniqueness as tourist destination but also for the excellent quality of the infrastructure and of the services provided.

The Venice cruise ban proposal: looking through the crystal ball

In the early 80s, cruise tourism was deemed as an elite privilege just for a few because of the high operational costs borne by the cruise companies and the limited capacity of the ships. But, since then, cruise tourism has constantly increased in popularity also thanks to the progressively enlarging ships which has made cruise tourism much more affordable for passengers and reduced operational costs for cruise companies by exploiting the economies of scale. According to Liu (2015), world's cruise fleet capacity has increased by 18% from 2009 to 2013.

However, the outstanding dimensions of today's cruise ships, able to embark as many passengers as the inhabitants of a small town (over 5000 passengers), have provoked several criticisms for their negative impact on the society and the environment.
When big ships arrive at small destinations such as Venice, not only do they pose a serious threat for the delicate ecosystem of the lagoon and for its beautiful historical buildings (examples of ancient engineering which already face problems with saltiness, mud and frequent high-water events); but has also a dramatic impact on traditions and social behaviour of local residents due to mass tourism to which Venice is subject. (Asero and Skonieczny, 2017).

On 2nd June 2019 a cruise ship struck a tourist river boat in the Giudecca Canal. This happened when the 65 591 GT, MSC Opera collided with River Countess, a small river vessel, injuring four people, renewing the debate to ban the access of all big cruise ships into the lagoon. In the last forty years, various attempts have been made to limit the traffic in the lagoon as well as to reduce the impact that cruise ships have on the environment. The only important legislation worth mentioning is the Clini-Passera Decree 79/2012 issued in 2014 which stated the Italian government's intention to ban cruise ships over 40,000GT from the Venice lagoon. This, solution however, proved to be unfeasible as cruise ships have no other way to reach port as the Giudecca canal is the only viable way in terms of depth. This decree was subsequently changed to consider only ships over 96,000GT, but yet again the Veneto Regional Administrative Tribunal overturned this decision in early 2015. It specified that the ban could be implemented only if an alternative access route was found (OECD,2016). However, CLIA has voluntary committed not to bring ships over 96,000 GT and it proactively cooperates with the Italian Ministries of Infrastructure and Transport in order to find alternative solutions.

Moreover, during the last decade, the astonishing growth of cruise ships visiting Venice has fuelled the discontent of the local community, which has led to the birth of movements such as "No Grandi Navi" and attracted more attention from "Italia Nostra", the National Association for the Safeguard of the Italian Historical, Artistic and Environmental Heritage. The criticisms arisen by these latter, not only concern the indisputable environmental impact of big cruise ships passing through the lagoon but they also blame the detrimental impact of mass tourism on the city of Venice, to which cruise tourism partially contributes. Indeed, it has been demonstrated how the phenomenon of mass tourism represents a great threat for the preservation of the city's fragile structure and how it has obliged a part of the local community to move to the hinterland (Venezia Mestre) as consequence of the increasingly limited availability of real estate.

Therefore, the issues above discussed pose an unprecedented challenge for both the local community and the stakeholders regarding the sustainability of the city of Venice. As Davis and Marvin (2004) stated in their research, what appears to be good for Venice in the short term – revenue from tourism – clearly contradicts the risks of irreparable damage to the city in the long term (mass tourism).

The impact of cruise shipping on the port and the city

The impact of cruise shipping on the port and city of Venice may be analysed under three main impacts: traffic, economic and environmental impacts.

Traffic impact

The port of Venice has always been ranked in the top-five ports in the Mediterranean for cruise traffic and second at national level, just after Civitavecchia.
Risposte e Turismo (2018) presented the pattern of cruise traffic in Venice from 2013 to 2017.

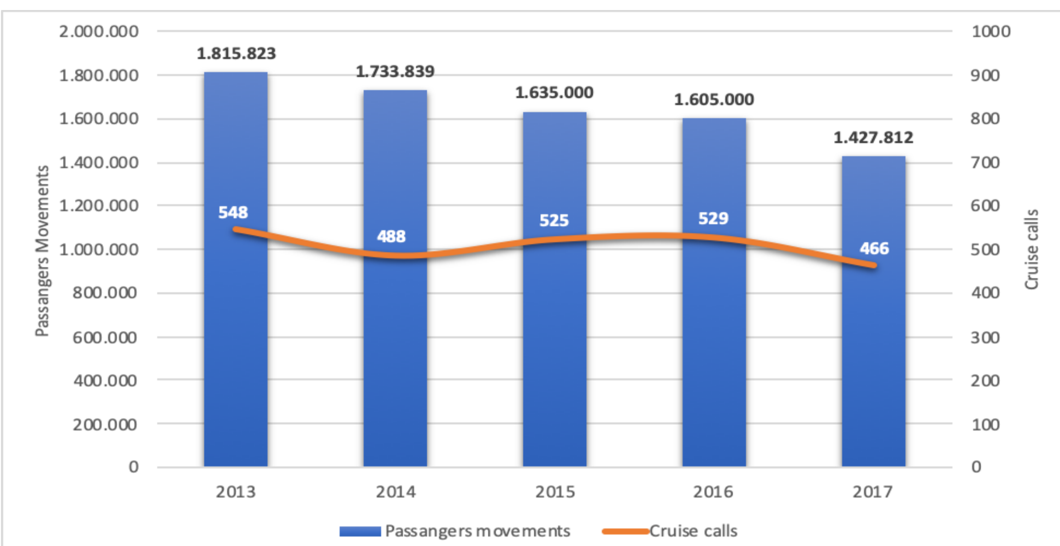


Figure 4: Passengers movements and Cruise calls in Venice from 2013 to 2017

Figure 3 shows that 2013 was the year with highest traffic in Venice, with 548 cruise calls and 1.815.823 passenger movements. Nevertheless, the following years were characterized by a steady decline as a

consequence of the criticisms against cruise traffic in the lagoon arisen from the local community and the political movements, which led to the enactment of the Clini-Passera Decree in 2014.
What emerges from the analysis conducted by Risposte e Turismo (2018) is that, in the period 2013-2015, the cruise calls decrease by 15% whereas passenger movements by 21,4%. It is interesting to notice how cruise call and passenger movements did not decrease proportionally. Especially, in 2015 and 2016, when, although there was a decline in the number of passengers, the number of cruise calls was approximately the same as in 2013. This means that cruise lines employed smaller ships in Venice in order to comply with traffic restrictions.

Despite, over the last years, the number of ships visiting Venice has slightly decreased, the cruise traffic in the lagoon still constitutes a challenge for the port authority and pilot services, which are called to ensure smooth traffic flows. A ship, when arriving in Venice, accesses to lagoon from the Lido inlet and then reaches the cruise terminal passing through the Giudecca canal and therefore through the city centre. The probability of congestion in this stretch of lagoon, which separate the open sea from the cruise terminal, increases significantly during the peak hours, that is to say when the majority of cruise ships arrive or leave the port. Normally, over 63% of arrivals is concentrated in the early morning between 6am and 9am. Similarly, 63% of departures take place during the evening between 6pm and 9pm. Venice port authority has also developed a system called Hydra, which is able to monitor vessel speed, traffic density, visibility conditions and other parameters by using a satellite. Thus, it contributes to prevent congestions and any potential threat (OECD, 2016).

Turning to congestion in the city, cruise passengers are generally not responsible for considerable congestions, considering also the fact that cruise tourism accounts just 5% of the overall tourism in Venice. The only exception is the transit passenger, who usually leaves the ship for few hours in order to visit the city. Therefore, transit passengers generally create congestions in the terminals and in the waterways as they use water transports to go to the city, given the limited time available to visit Venice.

Economic Impact

Although the port of Venice has limited dimensions it is placed in the top ten cities for the highest GDP, with €5,6 billion in 2018. In fact, the cruise industry together with the various tourism activities made up for approximately 3% of the overall GDP (Cottone, 2019). It is therefore obvious that the cruise industry represents a key source of income by creating a demand for goods and services both at a local and national level.

According to Risposte e Turismo (2018), cruising in Venice generated more than €410 million including direct, indirect and induced contribution and created more than 4,000 local jobs (more than 7,000 jobs at national level) for an overall income earned of €85.7 million. By looking more in detail into the total direct impact of cruising – divided in direct expenditure of cruise tourists, crew members and cruise ships – it can be observed that it has considerably decreased (almost 22%) from 2013 to 2017 as a result of the enactment of Decreto Clini-Passera 2012 and the consequent uncertainty regarding the future of cruising in Venice.

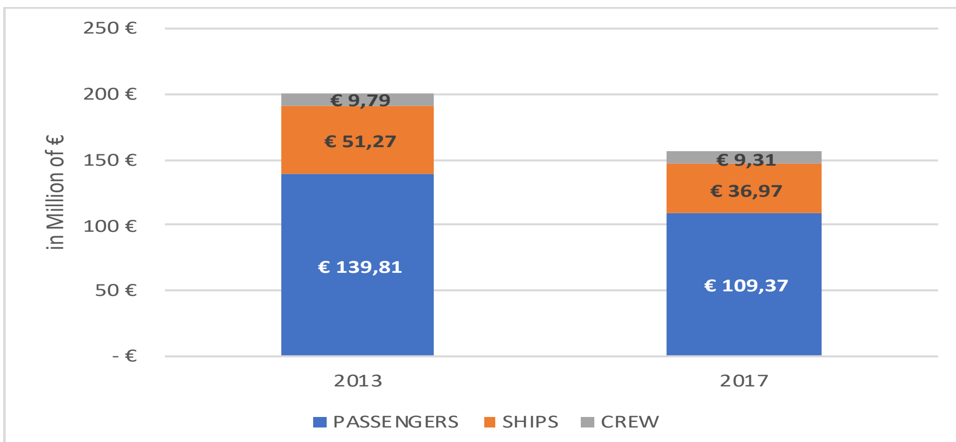


Figure 5: Cruise expenditures in Venice in 2013 and in 2017

In 2017 cruising in Venice generated more than €150 million in direct expenses, about 45 million less than 2013, when the revenues were about €200 million. Of that expenditure, passengers and crew expenditures still represent the main part of the income of the Venetian economy by covering over 77% of total cruise ship expenses. However, since 2013, these expenses have annually decreased by €7,7 million and an overall loss higher than €73 million. Moreover, the costs involved in the maintenance of ships drastically dropped from €51 million in 2013 to €37 million in 2017, with an average loss of €3,55 million each year and an overall loss reaching to more than €50.2 million.

Environmental Impact

The impact of cruise traffic on Venice's environment may be analysed under two aspects: air emissions and waves (OECD, 2016).

Several studies have been carried out in order to assess the level of emission generated by cruise ships in Venice. ARPAV (the regional agency for the prevention and safeguard of the environment) conducted, an extensive research, also known as APICE project, where the level of emission was recorded from 2007 to 2012. The results showed that cruise ships, in 2011, generated 46 tonnes of particular matter (PM), 589 tonnes of NO_x and 338 tonnes of SO_2. When it comes to the commercial traffic, during the same year, it generated 108 tonnes of PM, 2049 tonnes of NO_x and 535 tonnes of SO_2. Thus, by observing these results, it can be noted how cruise traffic did not contribute significantly to air emission with respect to commercial traffic, even though cruise shipping represented 30% of the total ship calls in Venice in 2011 (OECD, 2016). Furthermore, the findings showed that the average daily emission of NO_x and SO_2 decreased considerably over the period from 2007 to 2012 (ARPAV, 2013). These achievements were obtained also thanks to subscription of the Venice Blue Flag Agreement (renewed yearly since 2007), which impose the use of low sulphur fuel (less than 0.1%) within the lagoon (OECD, 2016).

Moving to the waves-effect, it is crucial to make first a distinction between two types of waves. A ship, when sailing through the lagoon, due to its displacement, generates surface waves and depression waves (under the water surface). According to Rapaglia (2015), the generation of surface waves is irrelevant. Apparently, cruise ships, when passing along the Giudecca Canal and through St. Mark's Basin, generate less surface waves than small vessels due to the ship's hull features and the low speed kept when the ship is towed. On the other hand, depression waves have a greater impact on the lagoon environment as they accelerate processes like erosion and deepening (OECD, 2016). Indeed, ships, when entering into the lagoon inlet (for instance Malamocco), sail at higher speed generating, thereby, significant depression waves which can have a vertical displacement of up to 2.5 m and can disperse to 500 m away from canals to reach shallow areas (Parnell et al., 2015). Moreover, depression waves are strictly related also to other effects such as sediment resuspension and reduction of sunlight in the water, which have a detrimental effect on the biodiversity of the lagoon (Rapaglia et al., 2015).

2.7.2 The Port of Trieste

Trieste has strengthened its position as a cruise port over the last decade. In 2012, it was ranked in the top ten of the major Italian cruise ports and ninth in the Adriatic basin in terms of cruise calls and passenger movements. Thanks to its strategic location at the top of the Adriatic corridor, its century-old history as port and its proximity to the north-eastern countries (i.e. Austria, Slovenia, Croatia) and especially to Venice, Trieste may become an alternative destination port to the port of Venice, given also the uncertainty of the future of cruise ships in the Venice lagoon. Nevertheless, cruise traffic in Trieste has never showed a constant trend until today; conversely, it has sometimes been characterized by significant declines (Risposte e Turismo, 2014).

Port Governance

Since January 1st, 2008, Trieste Terminal Passeggeri S.p.A (TTP) manages, with a 25-year concession, the two cruise terminals located on the Bersaglieri Pier and Pier IV respectively. These two piers are just a few steps away from Piazza dell'Unità d'Italia, the central square and heart of the city of Trieste. Additionally, the company manages the parking areas along the port's bank and on Pier IV as well as the Trieste's waterfront.

At the end of 2010, 60% of the shares of the TTP S.p.A were acquired by the Trieste Adriatic Marine Initiatives S.r.l (T.A.M.I) which is comprises four companies: MSC, Costa Crociere, Giuliana Bunkeraggi and Assicurazioni Generali. The objective behind this acquisition is to relaunch the cruise industry in the city of Trieste by creating new infrastructures able to host more ships and to improve the overall experience for both passengers and cruise companies with an eye to the sustainability of the city itself. In this regard, MSC expressed its intention to develop homeporting operations in Trieste starting in summer 2020 as stated in an announcement: "*This investment will support MSC Cruises' long-standing objective of providing enhanced and seamless experiences for cruise guests right from the point of embarkation onwards*". (Coulter, 2019)

Technical Features and Facilities of the Cruise Port

The Maritime Station extends over an outdoor area of 9,900 square metres and indoor area of 7,700 square metres. It offers two berths which can accommodate two modern cruise ships. Berth 29 is 220 metres long with a maximum draught of 9.14 metres whereas Berth 30 is 240 metres long with a maximum draught 7.92 metres. Both the jetties are provided with a *mooring dolphin* which allow two ships with an overall length over 300 metres to moor. Eventually, new investments and the creation of new infrastructures are expected in the following years as stated by the TTP on its website: "Further investments are planned in the next future in order to provide berth for bigger ships and to increment the passenger arrivals in Trieste".

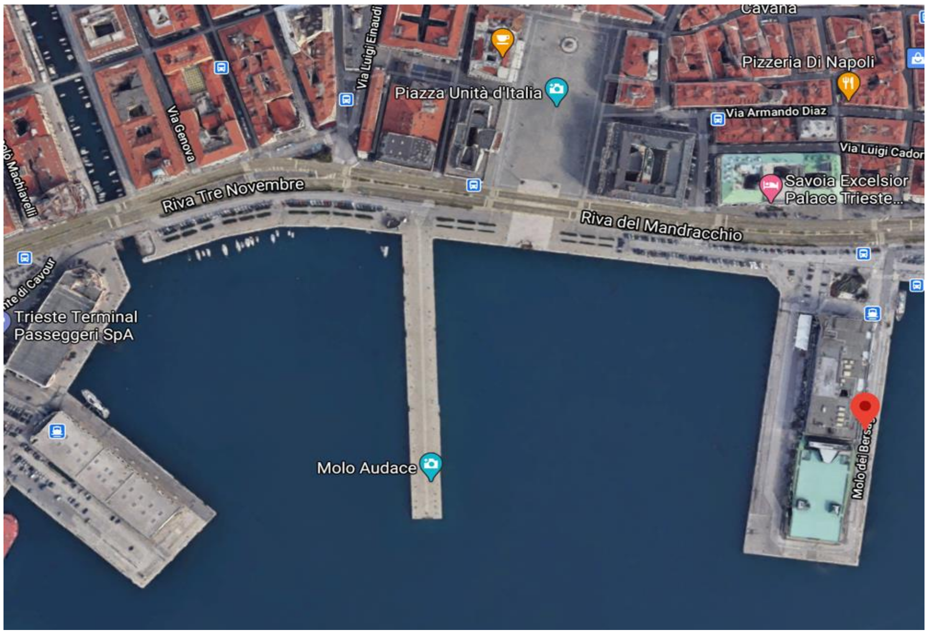


Figure 6: TTP and Pier Bersaglieri

Attractiveness of the Port

The history and the near future of Trieste is strictly linked with its strategic position between the Mediterranean and Central Europe, just a few kilometres from Slovenia, Croatia, Austria and Hungary.
Indeed, Trieste has always been an important trade gateway from the Middle Ages until today, which explains the cosmopolitan and international tradition of the city originating from the meeting of different cultures (European, Mediterranean and Balkan). Trieste is especially famous as a commercial port because, under the Austro-Hungarian Empire, it acquired the privilege of free port, meaning that it is exempted from national taxes on trades and, therefore, enjoys tax relives. As stated previously, in the last years, Trieste has also drawn the attention of several cruise companies, which have included it in their itineraries as port of call or have chosen it as homeport (see MSC and Costa Crociere).
This can be explained by the port's natural and technical features as well as its infrastructure, which offers easy berth for big modern cruise ships with a direct access to the city centre and by the presence of a local airport, Ronchi dei Legionari Airport, located 40 kilometres from Trieste and it is connected

by a direct train line as well as by dedicated shuttle services. Despite the limited number of flights, which diminishes its potential, Ronchi Airport can still represent a key-asset for the future development of cruise tourism in Trieste. Another upside of Trieste is its proximity to Venice (although the latter can also be considered a relative criticality), which is 150 kilometres away and it is easily reachable either by rail or by road (approximately 1h 45min with both transport means).When it comes to touristic attractiveness, Trieste and its region, Friuli Venezia Giulia, offer a vast selection of activities be they cultural or open-air activities. The wide variety of landscapes corresponds to an equally rich and varied cultural heritage, determined by a complex history and the confluence, in this land, of different populations. Among the excellences of the region, the ancient city of Aquileia, one of the most important centres of the Roman Empire, the city of Cividale, whose history dates back to the Lombard reign, and the Dolomites all need mentioning; all three have been declared UNESCO World Heritage Sites. Last but not least; Friuli Venezia Giulia is worldwide famous for its food and wine culture, which is why, in 2016, it was listed in the Lonely Planet Top 10 Regions.

Cruise Traffic in Trieste

Trieste has gained greater importance as cruise port which has led it to be ranked in the top ten of the Italian cruise ports and ninth within the Adriatic Sea (Risposte e Turismo, 2014).

Nonetheless, cruise traffic in the port of Trieste has shown erratic patterns and, sometimes, significant declines such as in the period 2008-2009 and more recently between 2013 and 2014.

Figure 7: Cruise Traffic in Trieste from 2004 to 2014

Figure 6 above illustrates, the inconstant trend of cruise traffic in Trieste in the period 2004-2014 characterized by ups, like in 2008, 2012 and 2013 and downs (period 2009-2011).

Figure 6 drafted just refers to the period 2004-2014 but, according to Statista (2020), the biennium 2015-2016 has been the best period with over 130,000 passengers each year. Ultimately, 2019 has been the best year in terms of passenger movements, with over 177,000 passengers, who visited Trieste.

The Economic Impact

Cruise Passenger Expenditures	€ 4,582,925
Cruise Ship Expenditures	€ 1,250,600
Crew Expenditures	€ 222,214
Direct Impact	€ 6,055,739
Indirect Impact	€ 5,034,700
Induced Impact	€ 7,199,964
National Economic Impact (direct + indirect + induced)	€ 18,290,403

Table 3: Economic impact of cruise sector in Trieste in 2013

Risposte e Turismo (2014) conducted a survey on the economic impact of the cruise sector in Trieste in terms of direct, indirect and induced effects. It resulted that, in 2013, during which 32 cruise calls and 70.244 passenger movements were recorded, the cruise industry generated an overall direct expenditure of € 6,055,739 allocated as follows: € 4,582,925 direct expenditure of cruise passengers, € 222,214 direct expenditure of cruise members and € 1,250,600 direct expenditure of cruise companies.

The overall national economic impact deriving from cruising in Trieste in 2013 amounts to roughly € 18 million, which is virtually 23 times lower than the overall economic impact generated by cruising in Venice in 2018 (€ 410 million).

3. Methodology

The choice of the research methodology, which best fits with the research question is a difficult task and it is crucially important. Mackenzie and Knipe (2006, p.1), state that: "*the methodology is the overall approach to the proposed research linked to the paradigm or theoretical framework to be used, whereas the method refers to the systematic modes, procedures or tools used for the collection and analysis of data".*

The two main ways in research that can be conducted are: quantitative and qualitative (Opoku., 2016). The qualitative methodology uses an inductive approach and it focuses on processes and meanings. Usually, it uses in-depth interviews, focus groups and participant observation. These are examples of techniques used for qualitative research (Sale, 2002).

Conversely, the quantitative methodology uses a deductive approach and entails *"a systematic scientific investigation of quantitative phenomena and their relationships by employing mathematical models to test theories and hypothesis"* (Opoku, 2016, p.5). For this research, a quantitative methodology was considered as the most suitable and is the most appropriate to investigate whether there is competition between the port of Venice and the port of Trieste concerning the cruise sector. The second aim is to find the optimal quantity of output for each port when they are operative.

3.1 Game Theory Approach

Ports represent a pivotal component in transportation systems as they provide an essential gateway between land and sea (Stopford, 2013). It has been demonstrated that, in the great majority of cases, the regional port industry is characterized by an oligopolistic market. By assuming this, game theory models provide useful analytical models when analysing intra-port competition and cooperation (Park, 2010). The game theory approach has been used in several studies to analyse port competition. Game theory is a flexible method since it allows for a large number of players, information and processes, to be taken into account, which then enables the analysis of different conflicting problems (Park, 2010). Nevertheless, a perfect game model for solving strategy decisions on the conflict problems of ports does not exist, since numerous factors influence the port economy, and the supply and demand of ports varies significantly from region to region, therefore not easily quantifiable. In this research, the game theory approach is used to analyse the best strategy for competitive situations, where the outcome deriving from a single participant's choice depends on the actions of the other participants, and vice versa. In detail, the Cournot model is used and applied to our data to find out the optimal output quantity when two-cruise ports compete, specifically Venice and Trieste.

3.2 Port Industry as an Oligopoly

According to existing theory, perfect competition is a market where several enterprises provide the same (or nearly the same) goods and there is free competition. However, when there is only one firm in the market, there is a monopoly. Perfect competition and monopoly represent two extreme markets and most firms are in the middle of these two extremes. This condition is called imperfect competition, which includes oligopoly and monopolistic competition. Oligopolistic markets are characterized by having a few firms, which produce similar or identical products, and which are interdependent in their pricing and output policies (Varian, 1992). Port markets are mostly considered an oligopoly market, where usually only a few ports stand out in a certain market-region. This is mainly due to geographical factors, large economies of scales as well as port and governmental policies.

3.3 Model Choice

In the previous subchapter, it is stated that port market may be considered as an oligopoly market characterized by significant interdependence among ports. According to Varian (1992), there are three main oligopoly models which explain both output and pricing related decisions: the Cournot model (1838), the Bertrand model (1883) and the Stackelberg model (1934). The existence of more than one model is due to the complex interaction and the complex nature of interdependence between firms in an oligopoly market. The choice of model depends on four key aspects: the product typology (whether the product is homogeneous or differentiated), competing in output or in price terms, the existence/absence of hierarchical structure (whether there is a dominant firm or not) and the timing of the competitors' movements (simultaneous or sequential) (Rusescu et al., 2020). Hence, the market performance and the profit distribution will vary depending on which of the above-mentioned aspects are selected.

In both Cournot and Bertrand, the firms adopt strategies simultaneously. However, in Cournot, firms compete on the output quantity, maximising profit given their beliefs on the strategy adopted by the rival firm and by setting the marginal revenues to equal marginal costs. On the other hand, in Bertrand, firms compete on price, which then determines the quantity supplied. Hence, each firm has to consider the

price that charged by the competitor. Moreover, according to Bertrand the product may be either homogenous or differentiated whereas, in Cournot, products are solely homogeneous.
Finally, the Stackelberg model is a hierarchical model meaning one firm is the leader (this firm has a bigger market share and a higher profit share) and other firms have minority market shares. This model can be applied when firms produce homogeneous products. Competition is based on output and firms choose their output levels sequentially. Stackelberg believes that usually the leader firm is the first mover, that is to say, the first firm to choose the output level before competitors take a decision accordingly (Varian, 1992).

The model presented in this research is based on the Cournot model, to which has been applied a new variable that reflects the difference in output quantities when considering not only private costs but also part of the social costs (presented in subchapter 3.6). There are two reasons behind this choice. The Cournot model perfectly fits with the purpose of the research, whose aim is to analyse the competition between two Italian cruise ports in the North Adriatic basin. Indeed, in this research it has been taken into account only the Italian cruise market in the North Adriatic Sea. Therefore, in this specific geographic area, only two cruise ports may be pinpointed; thus, the market can be approximated as a duopoly. In detail, the port of Venice and the port of Trieste are supposed to produce homogeneous services and they compete on the output quantity. Critiques may argue that the Stackelberg model would be better suited as it reflects the hierarchical market structure, where the port of Venice dominates over the port of Trieste in terms of both market share and profits. The second reason behind the author's choice towards Cournot instead of Stackelberg is that: "*Stackelberg markets yield total quantities which are even higher than theoretically expected, while Cournot markets match the theoretical predictions very accurately"* (Huck, 2001, p.750).

3.4 Data collection

Regarding data collection practices, the author has opted for Multiple Sources Methods.
This method is particularly useful when developing a quantitative methodology since it entails a vast variety of existing sources, which allows the author to acquire understandings about the background's context as well as to gain more certainty with the model that is being used. The sources used include academic books, such as Intermediate Microeconomics by Hal R. Varian (1992 and 2010), researches published on national and international journals such as Maritime Policy & Management and

Transportation Research as well as researches presented at international conferences. These studies supported the author in identifying key concepts during the research process and enhanced his knowledge on the proposed topic. Besides these sources, most of the data was gathered through explicit key words search process such as: game theory models, oligopoly, duopoly, Cournot competition, coopetition between cruise ports, etc.

3.5 The Cournot Model- Quantity Competition

The Cournot model is a classic game theory model, which was developed in 1838 by the French economist Antoine Agustin Cournot. This economic model is appropriate to describe and analyse the dynamics of an oligopoly, especially when studying duopoly markets.

In the case of port competition, the following assumptions are made:

- Ports compete by selecting quantity
- Ports produce similar or identical products
- Ports decide their quantity of output at the same time

In oligopolistic market, where there are *n* cruise ports, the throughput is measured in terms of cruise calls and passenger movement. The total output is given by:

$$Q = q_1 + q_2 + q_i + q_n$$

The market price, **P**, associated with this output (also known as the inverse demand function), is expressed below:

$$P = P(Q) = a - Q$$

where **a** is a coefficient, $a > 0$.

By assuming that the Port *i* cost function is $c_i(q_i)$, where $c < a$, the profit maximization for Port *i* can be written as follows:

$$\pi_i = P(Q)q_i - c_i(q_i) = q_i\,[a - c - (q_1 + q_2 + q_i + q_n)]$$

The Cournot model is used to describe a market where firms produce homogenous goods and/or services and they compete on the amount of output produced. Regarding the port industry, each port may set its quantity of output according to this strategy $[0, Q_{MAX}]$, where Q_{MAX} represents the maximum output that a port is able to produce (upper limit of productive ability) (Park, 2010).

Therefore, the Cournot-Nash Equilibrium corresponds to the optimal level of output q_i^*, in which each firm adopts its profit-maximizing output level by taking into account the other firm's choice.

$$\begin{cases} \max \pi_1 = P(Q)q_1 - cq_1 = (a - q_1 - q_2 - q_i - q_n - c)q_1 = \ aq_1 - q_1^2 - q_1q_2 - q_1q_i - q_1q_n - cq_1 \\ \max \pi 2 = P(Q)q_2 - cq_2 = (a - q_1 - q_2 - q_i - q_n - c)q_2 = \ aq_2 - q_1q_2 - q_2^2 - q_2q_i - q_2q_n - cq_2 \\ \max \pi_i = P(Q)q_i - cq_i = (a - q_1 - q_2 - q_i - q_n - c)q_i = \ aq_i - q_1q_i - q_2q_i - q_i^2 - q_nq_i - cq_i \\ \max \pi_n = P(Q)q_n - cq_n = (a - q_1 - q_2 - q_i - q_n - c)q_n = \ aq_n - q_1q_n - q_2q_n - q_iq_n - q_n^2 - cq_n \end{cases}$$

According to this theory, by assuming the existence of an interior optimum for each port, it is implied that the Cournot-Nash equilibrium must satisfy the first-order condition (f.o.c):

$$\frac{d\pi_i}{dq_i} = 0$$

The first-order condition for port 1, for instance, is that port 1's optimal level of output is a function of its beliefs about the other ports' output choices. This relationship is better known as a reaction curve since it depicts how port 1 reacts to the changes in output production undertaken by the competitors' ports (Varian, 2010).

$$\begin{cases} a - 2q_1^* - q_2^* - q_i^* - q_n^* - c = 0 \\ a - q_1^* - 2q_2^* - q_i^* - q_n^* - c = 0 \\ a - q_1^* - q_2^* - 2q_i^* - q_n^* - c = 0 \\ a - q_1^* - q_2^* - q_i^* - 2q_n^* - c = 0 \end{cases}$$

Therefore:

- The Equilibrium quantity of output is: $q_1^* = q_2^* = q_i^* = q_n^* = \frac{a-c}{n+1}$
- The Total Quantity for the market is: $Q = \frac{n\,(a-c)}{n+1}$
- Price: $P = \frac{a-cn}{n+1}$
- Profit of Port *i*: $\pi_i = \frac{(a-c)^2}{(n+1)^2} - C_i'$
- Total profit: $\pi = \frac{(a-c)^2}{(n+1)^2} - \sum_{i-1}^{n} C_i'$

3.6 A new interpretation of Attractiveness

Before applying the Cournot model, it is crucial to define the port attractiveness. As discussed in the literature review, the port attractiveness varies depending on several factors such as natural port characteristics, port infrastructure, port services, city amenities, etc (Lekakou, 2010).
However, in this research the author attempted to describe the port attractiveness from a passenger perspective. In the chapter 2.3 of the literature review, it has been discussed how passengers experience and satisfaction in a certain destination changes depending on the number of people visiting simultaneously the destination. Therefore, it can be assumed that a passenger considers a destination attractive as long as the number of passengers and ships in the port do not result in overcrowding phenomena at the terminals and in the city. As a consequence, overcrowding and congestion can be seen as a negative externality that reduce the attractiveness of a port.

An externality occurs when an economic entity performs an action that has effects on another subject without the latter paying or receiving compensation. The effect may be such as to reduce well-being, negative externalities, or increase it, positive externalities. Besides, externalities can be produced by either consumers or producers and may influence the well-being of both consumers and producers.

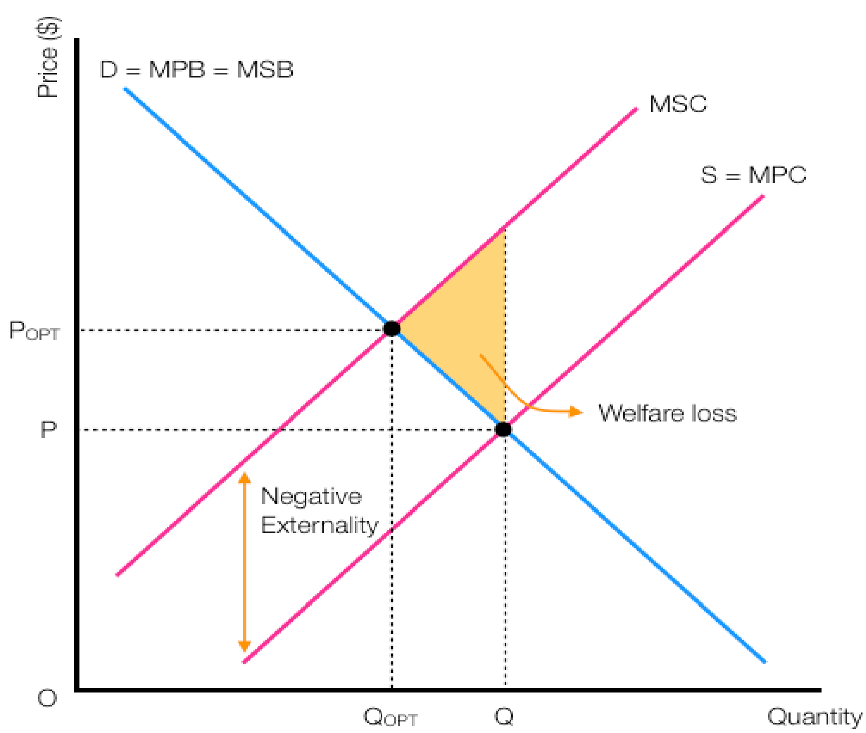


Figure 8: Negative Externality

Figure 7 illustrates the effect of a negative externality on the output quantity and on prices.

The Q represents the level of output that a port produces at a price P. On the other hand, Q_{OPT} would be the optimal level of output at the optimal price P_{OPT} according to the consumer, which in this case would be the optimal quantity of passengers and ships in the port. In this point, the marginal social cost is equal to the marginal social benefit (MSC = MSB). Therefore, the effective quantity produced by a port is greater than the optimal quantity according to the passenger (social optimal quantity). The reason for this inefficiency is that the market equilibrium reflects only the private costs of production. Therefore, the difference between marginal private cost (or the supply) and the marginal social cost generates a negative externality, which in our case is overcrowding and/or congestion, consequently affecting the port attractiveness from a passenger perspective (welfare loss).

In this model, the author provides a new interpretation of the attractiveness T by expressing it as a function of the outputs (q1, q2):

$$f_1 = T_1(q_1) \text{ and } f_2 = T_2(q_2).$$

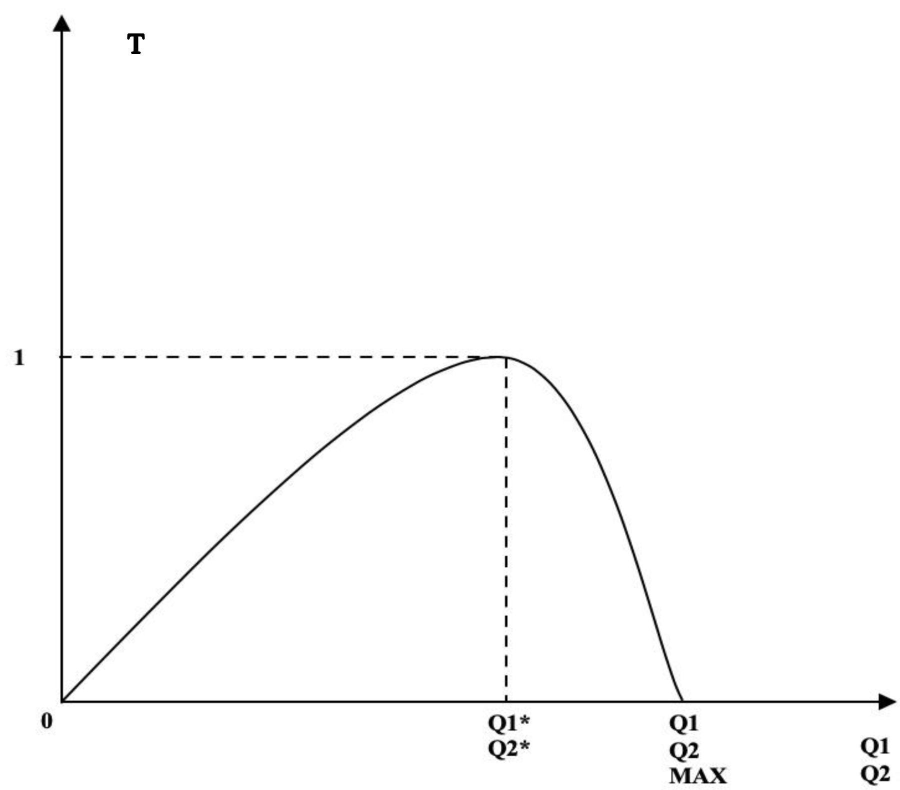


Figure 9: Port Attractiveness Curve

The author has decided to represent the trend through a polynomial function of third degree, depicted graphically by the concave curve. This curve is equal to zero at the intersection of the axes and when the output level is at its maximum (mandatory condition). The function increases for all those values of q between 0 and q* (0 ≤ x ≤ q*). The q* represents the optimal annual quantity in terms of number of passengers and ships in the port for which the attractiveness of the port itself is utmost. For simplicity, we set the maximum attractiveness equal to 1 for both ports (T=1). Above this optimal quantity ($q^* \leq x \leq q^{MAX}$), the attractiveness T will decrease until it becomes 0 in q^{MAX}, which represents the upper limit of productive ability for each port. This representation of the attractiveness partly reflects the fact that passengers' satisfaction is greater when a certain number of passengers is already in the port. Moreover, it has also been discussed how the overcrowding is often associated with an excess use of the port capacity. Therefore, as q^{MAX} represents the maximum output that each port is able to produce in one year, it also seems reasonable to look at it as the maximum yearly capacity for each port. In order to ease the resolution of the model, it is also assumed that Venice's maximum output is equal to 1 ($q_1^{MAX} = 1$) since, as explained in the literature review, it represents the main cruise port in terms of throughput and capacity within the Adriatic basin. Through the calculations it has been found that Venice reaches the peak of its attractiveness (q*) when it utilises approximately the 58% of its maximum capacity (q^{MAX}) (Appendix 3). On the other hand, Trieste's maximum capacity q_2^{MAX} is expressed in function of Venice's maximum capacity q_1^{MAX}. Therefore, q_2^{MAX}value will range between 0 and 1.

In conclusion, the definition of q* is crucial in our model as it depicts the point where the capacity deployed determines the maximum attractiveness for each destination. Indeed, most evaluations that have been carried out by port authorities do not account for the problem of overcrowding. This is shown by the fact that, empirically, we observe that most ports utilize at 85% of their capacity on average, which because of seasonality might imply that destinations are heavily overcrowded in some periods (Rodrigue and Notteboom, 2013). The new interpretation of the attractiveness proposed above can be deemed as a penalty function, which disincentives the excess use of capacity by assuming that cruise passengers are willing to visit a cruise destination as long as the total number of passengers in the terminals does not result in overcrowding. Therefore, the new attractiveness will be expressed as follows (see Appendix 4):

$$T(q) = bq(q - \mathrm{q}^{\mathrm{MAX}})(q + q^{MAX}) \rightarrow \boldsymbol{T = bq(q^2 - \mathbf{q}^{\mathbf{MAX}^2})} \quad \text{where } b < 0$$

3.7 Cournot application: quantity competition between Venice and Trieste

It has been said that, in our case, the two ports constitute a duopoly where they set quantities and prices independently. So, given the new definition of the attractiveness presented in the former subchapter, the author assumes that the inverse demand function is expressed as follows:

$$P = P(q_1, q_2, T_1, T_2) = a - \frac{q_1}{T_1} - \frac{q_2}{T_2}$$

where q_1 and q_2 denote the outputs, in terms of cruise calls and/or passenger movements, that each port can produce in a year. Whereas, the T_1 and T_2 denote the different attractiveness of the ports (from a passenger perspective) and the parameter **a** is the maximal reservation price, which, on the demand side, is the highest price that a buyer is willing to pay; and on the supply side, is the lowest price a seller is willing to accept for a good or a service. Thus, the author expects the price charged by ports to vary depending on the quantity produced and the attractiveness of the port. However, from the price function, it can be noted that consumers are willing to pay higher prices for a more attractive port. Whereas, for a higher level of output, the consumer is less willing to pay a higher price. Therefore, by substituting $T_1, T_2 = bq(q^2 - \mathrm{q}^{\mathrm{MAX}^2})$ at the denominator, we obtain the new inverse demand function:

$$P = a - \frac{q_1}{b_1 q_1 \left(q_1^2 - q_1^{MAX^2}\right)} - \frac{q_2}{b_2 q_2 \left(q_2^2 - q_2^{MAX^2}\right)}$$
$$= \frac{1}{b_1\left(q_1^2 - q_1^{MAX^2}\right)} - \frac{1}{b_2\left(q_2^2 - q_2^{MAX^2}\right)}$$

The profit maximisations for Venice and Trieste respectively, will be (Cournot-Nash equilibrium):

$$max\ \pi_1 = aq_1 - \frac{1}{b_1}\frac{q_1}{\left(q_1^2 - q_1^{MAX^2}\right)} - \frac{1}{b_2\left(q_2^2 - q_2^{MAX^2}\right)}q_1 - cq_1$$

$$\max \pi_2 = aq_2 - \frac{1}{b_1\left(q_1^2 - q_1^{MAX^2}\right)}q_2 - \frac{1}{b_2}\frac{q_2}{\left(q_2^2 - q_2^{MAX^2}\right)} - cq_2$$

Then, first-order condition $\frac{d\pi_1}{dq_1}; \frac{d\pi_2}{dq_2}$ are calculated:

$$\begin{cases} a - \frac{1}{b_1}\frac{q_1^2 - {q_1^{MAX}}^2 - 2q_1^2}{\left(q_1^2 - {q_1^{MAX}}^2\right)^2} - \frac{1}{b_2\left(q_2^2 - {q_2^{MAX}}^2\right)} - c = 0 \\ a - \frac{1}{b_1\left(q_1^2 - {q_1^{MAX}}^2\right)} - \frac{1}{b_2}\frac{q_2^2 - {q_2^{MAX}}^2 - 2q_2^2}{\left(q_2^2 - {q_2^{MAX}}^2\right)^2} - c = 0 \end{cases}$$

$$\begin{cases} a - c + \frac{q_1^2 + {q_1^{MAX}}^2}{b_1\left(q_1^2 - {q_1^{MAX}}^2\right)^2} - \frac{1}{b_2\left(q_2^2 - {q_2^{MAX}}^2\right)} = 0 \\ a - c - \frac{1}{b_1\left(q_1^2 - {q_1^{MAX}}^2\right)} + \frac{q_2^2 + {q_2^{MAX}}^2}{b_2\left(q_2^2 - {q_2^{MAX}}^2\right)^2} = 0 \end{cases}$$

By substituting the coefficients $b_1 = -\frac{(3\sqrt{3})}{2{q_1^{MAX}}^3}$, $b_2 = -\frac{(3\sqrt{3})}{2{q_2^{MAX}}^3}$ and $q_1^{MAX} = 1$ within the system, the following relations between q_1 *and* q_2 were found (see calculations in Appendix 5):

$$q_1^2 = \frac{(1-k)\left(q_2^2 - {q_2^{MAX}}^2\right)^2 + {q_2^{MAX}}^3\left(q_2^2 + {q_2^{MAX}}^2\right)}{{q_2^{MAX}}^3\left(q_2^2 + {q_2^{MAX}}^2\right) - k\left(q_2^2 - {q_2^{MAX}}^2\right)^2}$$

where $k = \frac{3\sqrt{3}}{2}(a-c)$

$$q_2^2 = \frac{{q_2^{MAX}}^3(q_1^2 - 1)^2}{q_1^2 + 1 - k(q_1^2 - 1)^2} + {q_2^{MAX}}^2$$

3.8 Model Simplification

Given the difficulty in the calculations that resulted during the development of the model, the author has not been able to achieve a definitive formula for $q_1 and\ q_2$. However, we found another correlation between q_1 and q_2^{MAX}, which is expressed in the following equation (see calculations in Appendix 6):

$$q_1^2 q_2^{MAX}(q_1^2-1)^2 = [(q_2^{MAX}-k)(q_1^2-1)^2+(q_1^2+1)](q_1^2+1-k(q_1^2+1-k(q_1^2-1)^2)$$

In order to simplify the equation, we assume that:

- $q_1^2 - 1 = x$
- $q_1^2 = x + 1$
- $q_1 + 1 = x + 2$

Hence, the equation will change as follows:

$$q_2^{MAX}x^2(x+1) = [(q_2^{MAX}-k)x^2+x+2][x+2-kx^2]$$

After that all the substitutions were made, the simplified equation obtained is the following:

$$(\boldsymbol{kx^2-x-2})^2 = \boldsymbol{q_2^{MAX}x^2}(\boldsymbol{kx^2-1})$$

The simplified equation was rewritten in order to be studied and analysed on Geogebra, an interactive mathematics software. The equation inserted was split into two functions, $f(x)\ and\ g(x)$, that were expressed as following:

- $(kx^2-x-2)^2 \rightarrow \boldsymbol{f(x) = (ax-x-2)^2}$
- $q_2^{MAX}x^2(kx^2-1) \rightarrow \boldsymbol{g(x) = bx^2(ax^2-1)}$

It resulted that the model produces two Cournot-Nash equilibria. Eventually, the author decided to proceed with the calculation of individual cases, which will be presented and commented in the next chapter, Results and Analysis.

4. Results and Analysis

4.1 Coefficient variation

From the model simplification, which led to the simplified equation presented in the previous chapter, $(kx^2 - x - 2)^2 = q_2^{MAX} x^2 (kx^2 - 1)$, it has been found that the two functions intersect in two points, one inferior (A) and one superior (B), B > A (see Appendix 7).

In order to carry out an in-detail analysis of the case, the author provides an Excel spreadsheet, where multiple optimal quantities are depicted (see complete table in the Appendix 8). The table gathers approximately 200 optimal quantities, which are expressed as percentages of the ports' maximum capacities. The optimal quantities were obtained by changing the two coefficients on Geogebra: q_2^{MAX}, Trieste's maximum productive ability (or its maximum capacity), and $k = \frac{3\sqrt{3}}{2}(a - c)$, which includes the reservation price, **a**, and the cost function, **c**.

The q_2^{MAX} was varied for values between 0 and 1. Notably, Trieste's maximum capacity, q_2^{MAX}, is expressed as a function of Venice's maximum capacity, q_1^{MAX}. Thus, $0{,}1 \leq q_2^{MAX} \leq 1$.

At the same time, the coefficient k was changed for values above 1, $k = \frac{3\sqrt{3}}{2}(a - c) > 1$.

It is crucial to say that the model, in most of the cases, produces two equilibria, where the optimal quantities significantly differ from one equilibrium to the other. However, in some cases, the model yields only one equilibrium or even none. In this regard, the author omitted some equilibria since the output quantities produced by the model exceeded the maximum capacity of the ports, which is unrealistic (this occurred especially for high values of q_1^{MAX}). The optimal quantities presented are expressed as follows: $\mathrm{eq}^-(q_1^-; q_2^-)$ and $\mathrm{eq}^+(q_1^+; q_2^+)$, which refer respectively to the lower and the upper equilibria (in the cases where two equilibria were obtained).

In addition to the spreadsheet with the optimal quantities, the author created another Excel table, which shows the profits generated by each port in relation to its respective optimal quantities.

4.2 Observations

On first observation of Table 4, which includes the optimal quantities, it can be noted that Venice produces the higher outputs as well as boasting a greater utilisation of its capacity city compared to Trieste. Consequently, Venice dominates the market by yielding greater output quantities.

QUANTITIES				
q2MAX (b)	0,1	0,2	0,3	0,4
K (a)				
1				
2	-eq (0.43- 0.01); +eq (0.49-0.02)	-eq (0.4 - 0.02); +eq (0.5 - 0.08)	-eq (0.38 - 0.03); +eq (0.5 -0.2)	-eq (0.36 - 0.04); +eq (0.51 - 0.39)
3	-eq(0.55 - 0.01) ; +eq (0.6 - 0.01)	-eq (0.54 - 0.02); +eq (0.6 - 0.06)	-eq (0.52 - 0.04); +eq (0.6 -0.16)	-eq (0.51 - 0.07); +eq (0.61 - 0.31)
4	-eq(0.62 - 0.01); +eq (0.65 - 0.01)	-eq (0.61 - 0.03); +eq (0.66 - 0.06)	-eq (0.6 - 0.05); +eq (0.66 -0.14)	-eq (0.59 - 0.08); +eq (0.66 - 0.27)
5	-eq (0.66-0.01); +eq (0.69 - 0.01)	-eq (0.65 - 0.03); +eq (0.69 - 0.06)	-eq (0.65 - 0.06); +eq (0.7 -0.13)	-eq (0.64 - 0.09); +eq (0.7 - 0.25)
6	-eq (0.69-0.01); +eq (0.72 - 0.01)	-eq (0.69 - 0.03); +eq (0.72 - 0.05)	-eq (0.68 - 0.06); +eq (0.72 -0.13)	-eq (0.68 - 0.1); +eq (0.73 - 0.24)
7	-eq (0.72-0.01); +eq (0.74 - 0.01)	-eq (0.71 - 0.03); +eq (0.74 - 0.05)	-eq (0.71 - 0.06); +eq (0.74 -0.12)	-eq (0.7 - 0.1); +eq (0.75 - 0.23)
8	-eq (0.74-0.01); +eq (0.76 - 0.01)	-eq (0.73- 0.03); +eq (0.76 - 0.05)	-eq (0.73 - 0.06); +eq (0.76 -0.12)	-eq (0.73 - 0.11); +eq (0.76 - 0.23)
9	-eq (0.75-0.01); +eq (0.77 - 0.01)	-eq (0.75 - 0.03); +eq (0.77 - 0.05)	-eq (0.75 - 0.07); +eq (0.77 - 0.12)	-eq (0.74 - 0.11); +eq (0.78 - 0.22)
10	-eq (0.77-0.01); +eq (0.78 - 0.01)	-eq (0.76 - 0.03); +eq (0.78 - 0.05)	-eq (0.76 - 0.07); +eq (0.79 - 0.12)	-eq (0.76 - 0.11); +eq (0.79 - 0.22)
		Impossible		
		No competition		

Table 4: Optimal Quantities for 0,1 ≤ Trieste capacity ≤ 0,4

By looking the table in greater detail, it can be observed that both the equilibria, $\text{eq}^-(q_1^-; q_2^-)$ and $\text{eq}^+(q_1^+; q_2^+)$, follow similar patterns as the port of Trieste enhances its maximum capacity, q_2^{MAX}. It is logical that Trieste's outputs and profits, (q_2^-, q_2^+), grow as the port capacity increases. Indeed, the creation of new terminals as well as the improvement of the existing infrastructures allow Trieste to accommodate more ships and more passengers that implies thereby greater profits. In addition, according to the new concept of attractiveness proposed by the author, Trieste becomes more attractive as the number of ships and passengers in the port increases within a certain limit. Conversely, Venice productivity is partially affected by changes in Trieste's capacity. In the lower equilibrium, Venice's output, q_1^-, slightly decreases as Trieste, in its turn, considerably increases its maximum capacity. Whereas, in the upper equilibrium, Venice optimal quantities remain almost unaltered even when Trieste considerably increases its capacity.

Currently, Trieste's capacity q_2^{MAX} is estimated to be approximately 10% of Venice's maximum capacity, $q_2^{MAX} \approx 0{,}1$. Therefore, the equilibria produced by the model (for the actual capacity of Trieste: $q_2^{MAX} = 0{,}1$) correspond to the optimal quantities for which, both the ports, maximise their respective profits without reducing or affecting one another's profit. From a game theory perspective, in these equilibria, there is not a dominant strategy as none of the ports has an incentive to change its strategy, given the combination quantity/price; in other words, there are not payoff for both the ports.

PROFITS				
q2MAX (b)	**0,1**	**0,2**	**0,3**	**0,4**
K(a)				
1				
2	-eq (0.11- 0.00); +eq (0.11-0.00)	-eq (0.09- 0.00); +eq (0.08-0.01)	-eq (0.08- 0.01); +eq (0.02-0.01)	-eq (0.06 - 0.01); +eq (0.07 - 0.0)
3	-eq (0.31- 0.00); +eq (0.31-0.00)	-eq (0.29- 0.01); +eq (0.28-0.03)	-eq (0.27- 0.02); +eq (0.23-0.06)	-eq (0.24 - 0.03); +eq (0.11 - 0.05)
4	-eq (0.54- 0.01); +eq (0.54-0.01)	-eq (0.52- 0.02); +eq (0.51-0.05)	-eq (0.49- 0.04); +eq (0.47-0.1)	-eq (0.47 - 0.06); +eq (0.38 - 0.15)
5	-eq (0.79 - 0.01); +eq (0.79-0.01)	-eq (0.77- 0.03); +eq (0.76-0.06)	-eq (0.74- 0.06); +eq (0.72-0.14)	-eq (0.71 - 0.1); +eq (0.64 - 0.23)
6	-eq (1.06- 0.02); +eq (1.06-0.02)	-eq (1.03- 0.04); +eq (1.03-0.08)	-eq (1- 0.09); +eq (0.98-0.18)	-eq (0.97 - 0.14); +eq (0.91 - 0.3)
7	-eq (1.34- 0.02); +eq (1.34-0.02)	-eq (1.31- 0.05); +eq (1.3-0.09)	-eq (1.28- 0.11); +eq (1.26-0.21)	-eq (1.24 - 0.18); +eq (1.19 - 0.37)
8	-eq (1.62- 0.03); +eq (1.62-0.03)	-eq (1.59- 0.07); +eq (1.59-0.11)	-eq (1.56- 0.14); +eq (1.54-0.25)	-eq (1.52 - 0.22); +eq (1.47 - 0.44)
9	-eq (1.91- 0.03); +eq (1.91-0.03)	-eq (1.88- 0.08); +eq (1.88-0.12)	-eq (1.85- 0.16); +eq (1.83-0.28)	-eq (1.81 - 0.27); +eq (1.77 - 0.5)
10	-eq (2.2- 0.03); +eq (2.2-0.03)	-eq (2.17- 0.09); +eq (2.17-0.14)	-eq (2.14- 0.19); +eq (2.13-0.32)	-eq (2.1 - 0.31); +eq (2.06 - 0.57)
	(red)	Impossible		
	(orange)	No competition		

Table 5: Profits maximised for 0,1 ≤ Trieste Capacity ≤ 0,4

Let us now suppose that Trieste doubles its capacity, q_2^{MAX}, passing from 0,1 to 0,2.

Table 4 shows that Trieste manages to increase its output level by 2% to 5%, depending on which equilibria is chosen. On the other hand, Venice undergoes slight changes in the output level, around 1%, but it still maintains an enormous advantage over Trieste in terms of throughput generated and capacity utilisation. This disparity between the two ports can also be noted by observing the profit trend in Table 5. If Trieste doubles its capacity, it improves its profits but without creating a significant imbalance in Venice.

On several occasions, professionals have discussed the opportunity to reroute a part of the cruise traffic from Venice to Trieste. It has been said that a port, in this case Trieste, has to offer a certain level of capacity in order to become attractive and to gain market share. However, this model shows that a minimum increase in Trieste's capacity will not have any consequence on Venice's throughput and, therefore, no competition can be detected between the two ports. Therefore, the current intention to expand the port of Trieste in order to reduce the traffic in Venice is not supported by the model's findings. Furthermore, it can be stated that, in a duopoly situation, the enhancement of the capacity of a port, does not necessarily lead to a reduction in capacity utilisation in the competing port.

Nevertheless, Trieste's attractiveness and, consequently its output increases only by a substantial increase in its maximum capacity. Indeed, Table 4 shows that Trieste makes better use of its capacity and therefore produces greater output quantities as well as yields higher profits when its capacity exceeds 30% of Venice's capacity, that is to say, for all those values of $q_2^{MAX} \geq 0{,}3$. As observed previously, the lower equilibrium generates smaller output quantities compared to the upper equilibrium, where both the ports present a higher capacity utilization. Moreover, it is interesting to note that Venice's profits in the upper equilibrium are often smaller than in the inferior equilibrium, although in the upper equilibrium Venice shows a greater output level compared to the lower equilibrium.

This difference in profits is also due to the introduction of the port attractiveness variable presented in chapter 3.6. The author introduced the variable of the attractiveness in the model; specifically within the inverse demand, $P = P(q_1, q_2, T_1, T_2) = a - \frac{q_1}{T_1} - \frac{q_2}{T_2}$. By expressing the inverse demand function in this way, the author aimed to reflect the change in passengers' satisfaction when the port of destination is overcrowded. Indeed, the passengers are expected to pay higher prices for higher level of port attractiveness; whereas lower prices when the number of passengers in the port is excessive. Therefore, the model takes into account in part the social costs. Therefore, it can be argued that, in most of the cases, the lower equilibrium seems to be more favourable to the port of Venice as it keeps an advantage upon Trieste in terms of throughput and profit generated. Conversely, the upper equilibrium is more beneficial for the port of Trieste as it enhances consistently its throughput and profit. Hence, the dominant strategy for Venice is mainly embodied in the lower equilibrium whereas the dominant strategy for Trieste is encompassed in the upper equilibrium. In conclusion, the analysis of the results revealed that the model generally produces equilibria where a common dominant strategy lacks for both ports meaning that the Nash equilibrium is not defined.

4.3 Potential Optimal Equilibrium for Venice and Trieste

According to the research question, one of the main aims of this study is to find out the potential optimal output, which maximises the profit for both the ports of Venice and Trieste and which accounts also at least in part for public costs. The author conducted a careful analysis of over 200 optimal quantities. In the selection process, three main considerations were taken. Firstly, all those quantities that yield the highest profits for both ports were selected. Secondly, Rodrigue and Notteboom (2013) demonstrated that several cruise ports, especially in the Caribbean and in the Mediterranean Sea, employ over 85% of their capacity. However, during the development of the new interpretation of the attractiveness (expressed as a penalty function which disincentives the excess use of capacity) it has been found that the attractiveness should be maximised when the port of Venice produces around 58% of its maximum capacity. Moreover, the cruise traffic seasonality represents another important aspect in the port market as the number of port calls is not uniform throughout the year. Although the Mediterranean may be considered as a perennial itinerary (this itinerary is serviced all year round), cruise port activity in the North Adriatic is usually concentrated over six months, between May and October (OECD, 2016). By following the above-mentioned selection criteria, the author pinpointed the best equilibrium quantities when $q_2^{MAX} = 0{,}6$ and $k = 5$. In Table 6, the cell containing the optimal quantities is highlighted in green and bold. It can be observed that, in the upper equilibrium, Venice and Trieste yield almost the same quantities of output by using 70% and 63% of their capacities, respectively.

QUANTITIES			
q2MAX (b)	**0,5**	**0,6**	**0,7**
K (a)			
1			
2	-eq (0.33 - 0.05); +eq (0.51 - 0.67)	-eq (0.3 - 0.5); +eq (IMP.)	-eq (0.26 - 0.05); +eq (IMP.)
3	-eq (0.5 - 0.09); +eq (0.61 - 0.51)	-eq (0.49 - 0.11); +eq (0.61 - 0.78)	-eq (0.47 - 0.14); +eq (IMP.)
4	-eq (0.58 - 0.11); +eq (0.66 - 0.45)	-eq (0.58 - 0.15); +eq (0.67 - 0.68)	-eq (0.57 - 0.19); +eq (0.67 - 0.97)
5	-eq (0.64 - 0.13); +eq (0.7 - 0.42)	**-eq (0.63 - 0.17); +eq (0.7 - 0.63)**	-eq (0.62 - 0.22); +eq (0.7 - 0.89)
6	-eq (0.67 - 0.14); +eq (0.73 - 0.39)	-eq (0.67 - 0.19); +eq (0.73 - 0.59)	-eq (0.66 - 0.25); +eq (0.73 - 0.83)
7	-eq (0.7 - 0.15); +eq (0.75 - 0.38)	-eq (0.7 - 0.2); +eq (0.75 - 0.57)	-eq (0.69 - 0.26); +eq (0.75 - 0.8)
8	-eq (0.72 - 0.16); +eq (0.76 - 0.37)	-eq (0.72 - 0.22); +eq (0.76 - 0.55)	-eq (0.72 - 0.28); +eq (0.77 - 0.77)
9	-eq (0.74 - 0.16); +eq (0.78 - 0.36)	-eq (0.74 - 0.22); +eq (0.78 - 0.53)	-eq (0.73 - 0.29); +eq (0.78 - 0.75)
10	-eq (0.75 - 0.17); +eq (0.79 - 0.35)	-eq (0.75 - 0.23); +eq (0.79 - 0.52)	-eq (0.75 - 0.3); +eq (0.79 - 0.73)

Table 6: Optimal Output Quantities Equilibria

PROFITS			
q2MAX (b)	**0,5**	**0,6**	**0,7**
K(a)			
1			
2	-eq (0.05 - 0.01); +eq (0.25 - 0.33)	-eq (0.03 - 0.01)	-eq (0.02 - 0.00)
3	-eq (0.22 - 0.04); +eq (0.27 - 0.13)	-eq (0.2 - 0.05); +eq (0.54 - 0.68)	-eq (0.44 - 0.79)
4	-eq (0.44 - 0.09); +eq (1.23 - 1.07)	-eq (0.41 - 0.11); +eq (1.11 - 1.13)	-eq (0.39 - 0.13); +eq (0.76 - 1.1)
5	-eq (0.68 - 0.14); +eq (0.38 - 0.23)	**-eq (0.65 - 0.18); +eq (2.71 - 2.41)**	-eq (0.62 - 0.22); +eq (1.13 - 1.43)
6	-eq (0.94 - 0.2); +eq (0.72 - 0.39)	-eq (0.2 - 0.05); +eq (0.54 - 0.68)	-eq (0.87 - 0.32); +eq (1.56 - 1.78)
7	-eq (1.21 - 0.26); +eq (1.02 - 0.52)	-eq (1.17 - 0.34); +eq (1.01 - 0.63)	-eq (1.14 - 0.43); +eq (2.05 - 2.18)
8	-eq (1.49 - 0.32); +eq (1.33 - 0.64)	-eq (1.45 - 0.43); +eq (0.6 - 0.73)	-eq (1.41 - 0.55); +eq (2.66 - 2.67)
9	-eq (1.77 - 0.39); +eq (1.63 - 0.75)	-eq (1.73 - 0.53); +eq (1.09 - 0.75)	-eq (1.69 - 0.67); +eq (3.48 - 3.33)
10	-eq (2.07 - 0.46); +eq (1.93 - 0.86)	-eq (2.02 - 0.62); +eq (1.49 - 0.99)	-eq (1.98 - 0.68); +eq (4.79 - 4.42)

Table 7: Optimal Profit Equilibria

Besides, the choice of this equilibrium as the best, is also confirmed by the profits generated. Table 7 depicts the maximised profits corresponding to the same values of q_2^{MAX} and k. It can be observed that, in the upper equilibrium the profit of both the ports are maximised: 2.71 for Venice and 2.41 for Trieste respectively. Therefore, this equilibrium can be considered as a Cournot-Nash equilibrium since the output strategies adopted by the ports maximise their respective payoffs.

The potential consequences

In this chapter, the author attempts to analyse the potential implications both on the port and on the market side, that would derive if Venice and Trieste succeeded in achieving the targeted equilibria.

Increment in passenger movements and cruise calls

It has been said that the model provides the best results in terms of throughput and profits in the case where Trieste maximum capacity was nearly 2/3 of Venice's maximum capacity. The port of Venice declared that the passenger terminals were projected to accommodate approximately 2,500,000 passengers per year. Although there is no relevant information regarding the highest number of cruise ships that could call the port of Venice, by looking at past trends, it is safe to state that the port of Venice can manage over 700 cruise calls per year. In the light of these considerations, the port of Trieste should invest consistently in new infrastructures in order to enhance its maximum capacity, so as to be able to accommodate approximately a maximum of 1,500,000 passengers and 420 ships per year. According to the optimal quantities obtained from the model, Venice should manage around 1,750,000 passengers and 525 cruise calls per year, which corresponds to 70% of its total capacity. In its turn, the port of Trieste should deal with roughly 945,000 passengers and 230 cruise calls per year, which is equivalent to 63% of its utmost capacity. It must be said that the number of passengers and ships that visit the two ports is a mere approximation, since it mainly depends on the demand for cruise itineraries in the region as well as on the size of the vessels employed by the cruise lines in their itineraries and the stayover in the port.

The potential economic impact

The growth of cruise tourism in both the ports could have significant implications on the cities' economy, on the maritime clusters as well as on all those activities related with cruise tourism. In this section, the author provides an estimation of the potential economic impact that would result if the two ports succeed in reaching their optimal production levels. In the literature review, it has been said that the economic impact deriving from cruise tourism can be divided into three main dimensions: direct, indirect and induced effect. Currently, there is an enormous disparity in economic relevance between Venice and Trieste, which sees Venice dominating the market within the Adriatic. Suffice it to say that, in 2013, the cruise tourism in Venice generated over €200 million of direct expenditures against the mere €6 million generated in Trieste. However, this difference could be filled with the progressive expansion of Trieste. The author estimated that if Trieste reaches the target capacity resulted from the model, cruise tourism is expected to generate roughly €80 million in direct expenditures. Assuming that the passenger expenditure represents the main component in direct expenditure (75%), followed by cruise ship expenditure (20%) and crew expenditure (5%), therefore, the total direct expenses for Trieste will be distributed as follows: €60 million in passenger expenditure, €16 million in cruise ship expenditure and €3 million in crew expenditure. On the other hand, Venice's revenues are expected to be slightly lower than those recorded in 2013. Specifically, the total direct expenses will amount to around €195 million, which, by following the same reasoning as before, will be divided into: €146 million in passenger expenditures, €39 million in cruise ship expenditure and €9 million in crew expenditures.

Increased direct expenditure in Trieste will be translated, through the multiplier effect, into new investments and employment opportunities. Indeed, when cruise vessels visit a port, they create new job positions within the port cluster such as mooring and pilot services, tugs, fuel suppliers, passenger services, luggage services, food, beverages and drinking water providers, etc. Today, port activities in Trieste, linked to the cruise sector, employ 138 workers for an overall income of €3 million; however, the enlargement of the port will provide more than 1,700 new positions increasing, thereby, the overall income up to €40 million. Besides, the expansion of the existing terminal together with the creation of a new terminal in the proximity of the historical city centre, will foster all those activities linked with cruise tourism such as hotels, bars, restaurants, shops, travel agencies, tour operators, local attractions and other tourist activities not only in the port area but also in the rest of the region. Additionally, further employment will be provided by inland transportation involving cruise passengers including air, private car, shuttle services and taxis.

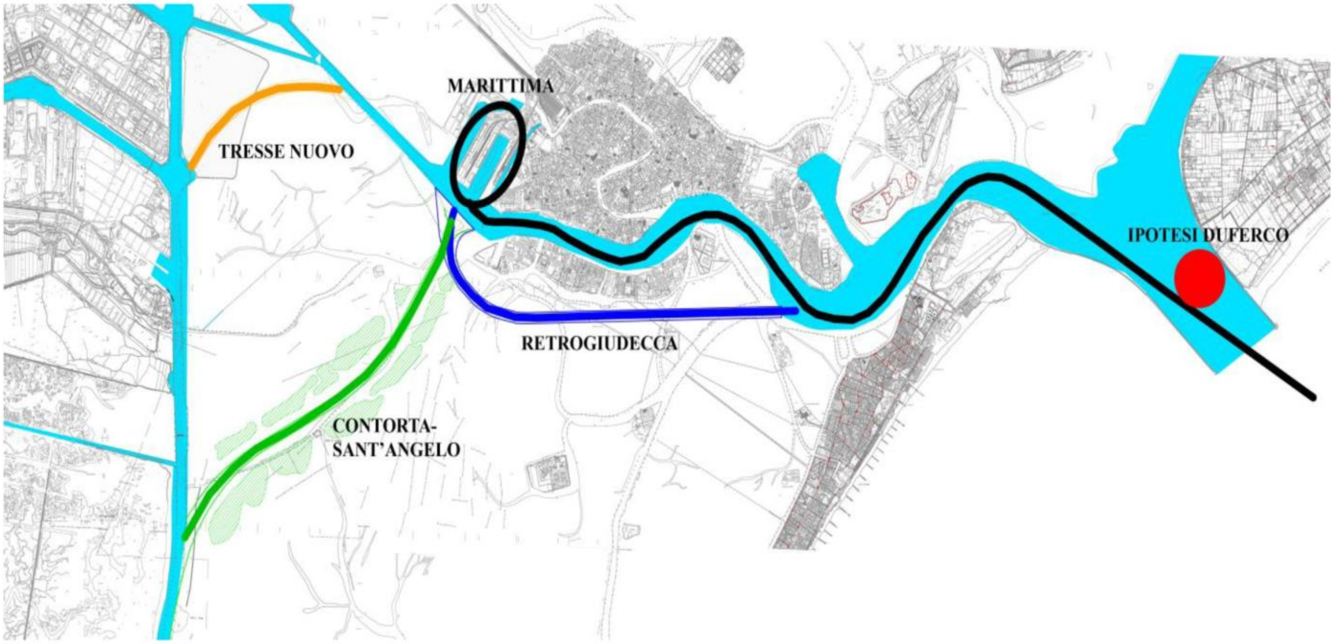
Potential Future Actions

In order to achieve these optimal throughputs, both the port of Venice and the port of Trieste are required to stand considerable investments either on the land side or on waterside. In this chapter, the author explores some of the potential actions that the ports could undertake in future.

Sustainable solutions in Venice

The model projections contrast with the traffic trends occurred in the last years in Venice. 2013 has been the best year for cruising in Venice, with over 1.8 million passengers and 547 cruise calls. Thereafter, the traffic within the lagoon has progressively decreased as consequence of the CLIA's decision, which asked cruise lines to refrain from bringing ships over 96.000 GT in Venice. This study demonstrates that the capacity of the cruise terminal is currently underutilised (approximately Venice used 60% of its capacity in 2017) and that the traffic limitations are, thereby, detrimental for the port's productivity. This also explains why the Passera-Clini Decree (2012) never entered definitively into force. Hence, it becomes of crucial importance to find a solution addressed to improve the cruise traffic within the lagoon and which puts all the parts in agreement, specifically, Veneto region , Venice's Port Authority, the cruise companies represented by CLIA and the local and national association such as No Grandi Navi and Italia Nostra. Three solutions have been presented so far to the competent institutions and all of the three were designed to exclude the passage of the ships through the Giudecca canal and San Marco basin (the heart of the city). The first proposal implies a rerouting of the ships via a new canal called Contorta Sant'Angelo. The vessels would access the lagoon through the Bocca di Porto di Malamocco (instead of the Bocca di Lido) to then continue through Canale dei Petroli, which is currently used by commercial vessels to reach the port of Marghera. Before getting to the commercial port, cruise ships would move eastwards into the new canal Contorta Sant'Angelo, which would lead to the Passenger Terminals. This canal would be 100 meters wide and 10.5 meters deep over a stretch of 4 kilometres. The realization cost should be about €130 million, and it would take from one to two years to be completed (OECD, 2016). However, in 2015, the Veneto Regional Administrative Tribunal (TAR) rejected this proposal following the environmental associations which criticised the project for the dramatic effects it would have on the lagoon (i.e. sediment loss) (OECD, 2016). Similarly, the second project, called 'Tresse Nuovo', involves the creation of a new canal. This latter would allow cruise ships to access to the lagoon through the Malamocco inlet. Compared to the previous proposal, this canal would significantly decrease the likelihood of congestions within the lagoon as cargo traffic would not interfere with cruise traffic.

Moreover, the 'Tresse Nuovo' canal would be shorter than the Contorta Sant'Angelo one and, according to the port authority, its realization would have less environmental effects. This project is still being evaluated by the Veneto Region and the Ministry of Environment (OECD, 2016).



Source: Port of Venice Authority.

Figure 10: Contorta Sant'Angelo and Tresse Nuovo projects

Eventually, the last proposal is the less feasible of the three. It implies the creation of a new offshore cruise port outside the Lido inlet, better known as Venice 2.0 project. The new terminal would be provided with a long pier 734 m length (945 m including mooring dolphins) and 34 m in width that would allow to accommodate up to four ships. Moreover, the terminal would be equipped with *"the most advanced technologies in terms of logistics, energy (such as cold ironing) and environmental sustainability"* (European Commission, 2017). The realisation of the offshore cruise terminal is estimated around 2 years for a total investment of roughly €170 million. However, this project raises technical concerns between professionals related with the limited capacity of the port, the weather conditions which would make difficult mooring procedures and the logistic issues with the passengers and with the supply of the ships, given the distance from the city. As a matter of fact, so far, no decision has been taken in this regard.

Figure 11: Project Venice 2.0 offshore terminal

Additionally, Venice must continue its efforts to mitigate the impact of cruise shipping on the environment by developing new green port policies. In this regard, Venice may already be considered a frontrunner in sustainability, referring in particular to air emissions. Indeed, the Blue Flag Programme has brought significant enhancements in sulphur emissions. Pursuing this objective, the port of Venice has undertaken new measures to reduce energy consumption at the cruise terminals; these latter have been recently equipped with 18,000 squares metres of photovoltaic panels. In the following years, other two projects will be carried out. The first concerns the development of algae biomass energy plant for powering and heating the terminals; and, the second, implies the use of electric vehicles within the terminal's areas (OECD, 2016).

The first step towards a new beginning for Trieste

Venice is one of the most visited tourist destinations in the world, which is why tourism is part and parcel of the city's economy. Moreover, it can be safely stated that the port of Venice is already a developed port, which boasts great infrastructures and facilities providing excellent services. On the other hand, Trieste has a great potential to become a touristic destination known at international level; but, 'the journey is still very long'. The relaunch of cruise tourism represents a good springboard to develop and reinforce both the local and regional tourism industry. Moreover, the development of cruise tourism would contribute to improve the image of the port by fulfilling the inhabitants' aspirations in terms of employment and quality of life and revamping the city.

The first step is to improve the attractiveness of the port by expanding its capacity and creating new facilities so as to welcome more ships and more passengers. Indeed, the natural features of the port of Trieste, such as the sea-bed depth, make it particularly suitable to berth big modern cruise ships. Currently, the port can count only on one pier able to berth just two vessels per time. However, the port authority is evaluating new options to increment the capacity. A good opportunity is represented by Trieste's old port, a dismissed area which extends over 60 hectares. Among all the proposals for the relaunch of this abandoned area of the city, there is a project for the creation of a new passenger terminal, which would be equipped at least with two piers of 420 metres and 350 metres length respectively.
Given the proximity with the train and bus station (800 metres), this solution would allow to create a single logistic hub by gathering together the Railway station, Bus station and Cruise Terminal. The new terminal would be also provided with a duty-free shopping area, hotels and parking spaces for over 2000 cars. The costs to build up the new terminal still remain unknown, but it would see the participation of both public and private investors. MSC and Costa Crociere (which are already shareholders of the TTP), already expressed their interest in this project, given also the mutual intention to make of Trieste a modern homeport.

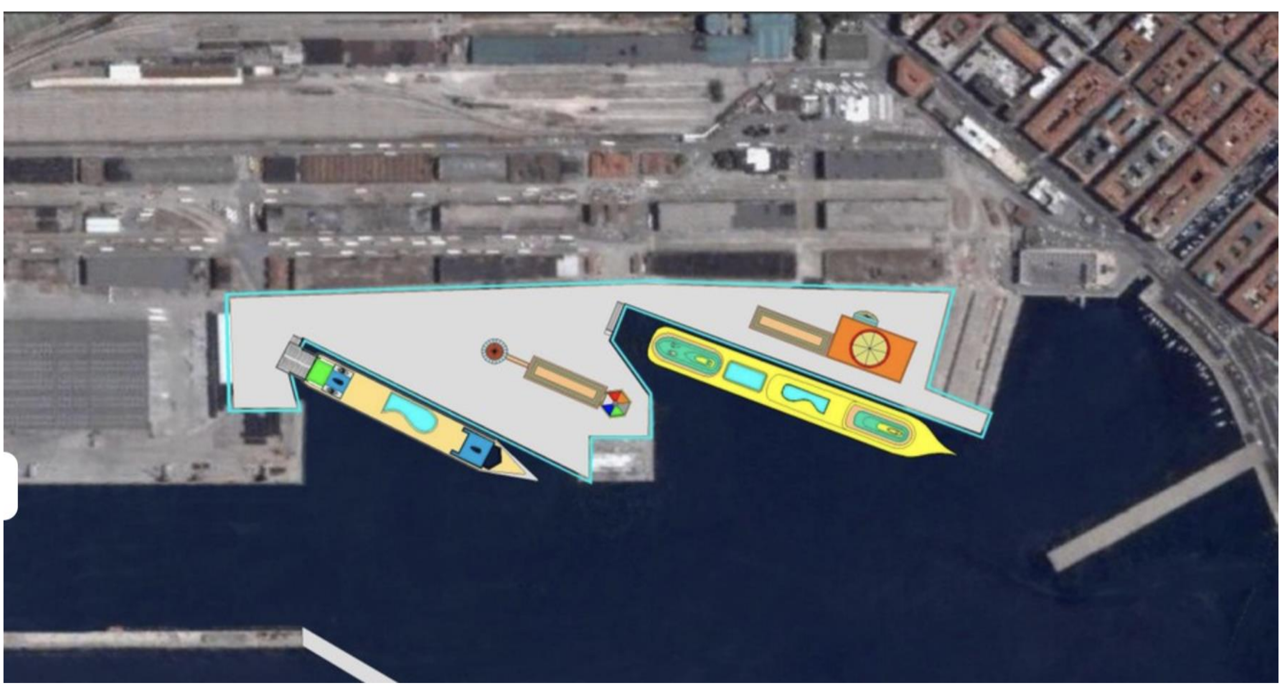


Figure 12: Project for the new cruise terminal in the old port

Another strategic opportunity, which is essential for the development of Trieste's port, is for Trieste to improve the existing connections and links with its airport Ronchi dei Legionari. It is crucial for Trieste to have an airport located in the proximity of the port, which is very well connected to a wide international flight offer. In this regard, Ronchi Airport is located just 40 kilometers from Trieste, and it is connected either by a shuttle service or by high speed railway connection with Western Italy as well as with Austria and Slovenia. Ronchi Airport currently offers just 12 direct flights; specifically, 8 national flights from/to Rome, Naples, Bari, Cagliari, Olbia, Catania, Palermo and Lamezia Terme, and 4 international flights from and to London, Valencia, Frankfurt and Munich. The airport moves a mean of 770.000 passengers and 15.000 flights per year (the peak was reached in 2012 with 882.146 passenger movements and 15.762 flights (Trieste Airport, 2020).

However, these figures cannot be considered enough when a port aims to attract new passengers and, therefore, to increase its performances. Then, it becomes vital to improve air connections by adding new destinations, especially with the Northern and Eastern European countries (Germany, Austria, Croatia, Slovenia, Hungary, Poland, Czech Republic and others), which represent a promising market for cruising. It is the author's belief that Trieste Airport should follow the example Venice's airport, which became over the years an important stakeholder in the development and facilitation of the cruise business in Venice so as to end up as one of the major shareholders of Venice Passenger Terminal. This aspect acquires further importance for those cruise lines, such MSC and Costa Crociere, which 'gambled' on Trieste as their future homeport. Thus, it would be reasonable if cruise lines, Trieste's port authority, FVG region (owner of the airport) and some air companies could collaborate by establishing a joint partnership with the intent to boost the cruise tourism in Trieste. Likewise, the railway connections should be further improved by encouraging flows to and from Trieste towards Slovenia and East-European countries. Moreover, cruise lines and Trenitalia (primary train operator in Italy) are called to improve their collaboration with the aim to intensify the connections between Trieste and other Italian cities, which may represent a touristic attraction for cruise passengers. In this direction, new dedicated trains should be implemented between Trieste and Venice in order to allow passengers to visit the lagoon city, which still remains a 'must see' destination. Finally, the municipality of Trieste is called to undertake a requalification of some of the city areas, particularly the waterfront and areas related to the seacoast. Indeed, the waterfront is the city's most peculiar feature. Consequently, it assumes foremost importance to increase the accessibility between the cruise terminals and the city centre by creating new pedestrian connections and by redesigning the traffic flow.

5.0 Conclusions

Over the last 60 years, the cruise sector has been subjected to significant changes. The rapid growth of cruise tourism worldwide has resulted in high level of market and geographical concentration. The increasing number of passengers along with the considerable expansion of the global cruise fleet, both in number of vessels and size, has led to increasing congestion and overcrowding phenomena in the ports of destination. This prompted cruise lines to seek for alternative ports to include in their itineraries, triggering therefore competition between cruise ports.

This study addresses exactly this issue and focuses on the competition between cruise ports: the port of Venice and the port of Trieste. Besides, this research explores the opportunities for Trieste to become an alternative port to Venice. Indeed, the possibility to reroute part of the cruise traffic in Venice (surplus traffic) on Trieste has been object of discussion between port authorities and cruise lines.

The model developed in this research is based on the Cournot model. Ports are supposed to produce homogenous services and compete on the amount of output that maximise their respective profits.

Each port may decide its quantity of output according to this strategy $[0, Q_{MAX}]$, where Q_{MAX} represents the upper limit of productive ability, which can also be considered as the maximum capacity of the port. Moreover, the author has attempted to include in the model a negative externality such as overcrowding, which is supposed to affect the port attractiveness from a passenger perspective. This has been represented through a penalty function which disincentives the excess use of capacity (not over the 58%).

In most of the cases, the model produces two equilibria that correspond to the optimal quantities for which both the ports maximise their respective profits; however, there are also cases where there is only one equilibrium or even none as the output quantities produced exceeded the maximum capacity of the port. In most of the equilibria analysed, it has been observed that Venice boasts a better capacity utilisation compared to Trieste. Moreover, Venice's productivity does not seem particularly affected by slight changes in Trieste's output strategy. A marginal increase in Trieste's capacity slightly improves its productivity and its profit. Similarly, Venice's output as well as its profit remain virtually unchanged for minor changes in Trieste's capacity. Currently, the capacity of the cruise terminal in Trieste is estimated to be approximately 10% of the maximum capacity of the cruise terminal in Venice. The model demonstrates that, at this time, there is no competition between the two ports and, therefore, the proposal to expand Trieste in order to reduce the traffic in Venice is very unlikely. Indeed, even if it doubles its actual capacity, Trieste would not benefit neither in terms of throughput nor in terms of profit.

However, the situation would change if Trieste decided to invest consistently in the creation of new terminals and new infrastructures. According to the equilibria produced by the model, both the ports would be able to maximise their profits if Trieste expanded its capacity six-fold. In this case, the port of Trieste would be attractive enough to compete with the port of Venice and the economic and social implications not only for the city but for the whole region would be tremendous. The journey for Trieste is still very long; however, prominent cruise companies such as MSC and Costa Crociere have already demonstrated their interested to build up a modern homeport by becoming TTP's shareholders. Therefore, it becomes crucial for TTP not only to attract interested actors within the cruise industry but also to accelerate its global exposure in order to push the boundaries of productivity and gain its right into the "Olympus" of the cruise ports in the Mediterranean.

5.1 Limitations of the research

At this point, it must be mentioned that such a research presents potential limitations.

First, the lack of previous research studies on the topic covered, the competition between cruise ports, did not provide the author with the theoretical foundations required to develop the study. The model developed in this research, is based on a pre-existing economic model (Cournot model). However, the author made adjustments by adding a new variable in the model.

The second limitation concerns the new interpretation of attractiveness presented in Chapter 3.6. The author's aim, when developing this new concept, was to represent analytically an externality, such is the attractiveness of a cruise port, but from a passenger perspective. Hence, the new attractiveness has been defined as function of the output quantity of each port and the trend has been represented through a polynomial function of third degree, which is graphically depicted by a concave curve. However, this representation of the attractiveness does not necessarily reflect the passengers' real perception. The same considerations apply to the inverse demand function illustrated in Chapter 3.7, where it is assumed that the price charged by each port increases as the port attractiveness increases, whereas it decreases as the output quantity increases.

The third and last limitation involves the model simplification. Given the complexity of the calculations emerged throughout the development of the model, the author has not been able to achieve a short formula for the optimal quantities of each port. Subsequently, he proceeded to simplify the model through a simplified equation. Therefore, it is likely that this adaptation of the model may have altered the results obtained.

5.2 Recommendation for future research

This study can be deemed a pioneering attempt to asses competition between cruise ports. Therefore, opportunities for further research are abundant. The study suggests the following future research directions. First, a normal Cournot model could be performed in order to observe how results would change with respect to our model, where the attractiveness variable is applied. By doing this, it could be possible to observe how the attractiveness variable influence ports' quantities and profits.

Secondly, the Stackelberg model could be adopted as it better reflects the hierarchical market structure, where Venice has been proved to prevail as port leader. In Stackelberg, Venice would be the first mover, that is to say the first port to decide the output level; whereas Trieste would be the follower, meaning that this latter would adjust its quantities as a result of Venice's strategic decision.

Thirdly, it could be assumed that both ports cooperate (or collude), by forming a cartel. Therefore, the market would turn from a duopoly into a monopoly and the ports would be considered as a single entity.

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APPENDIX

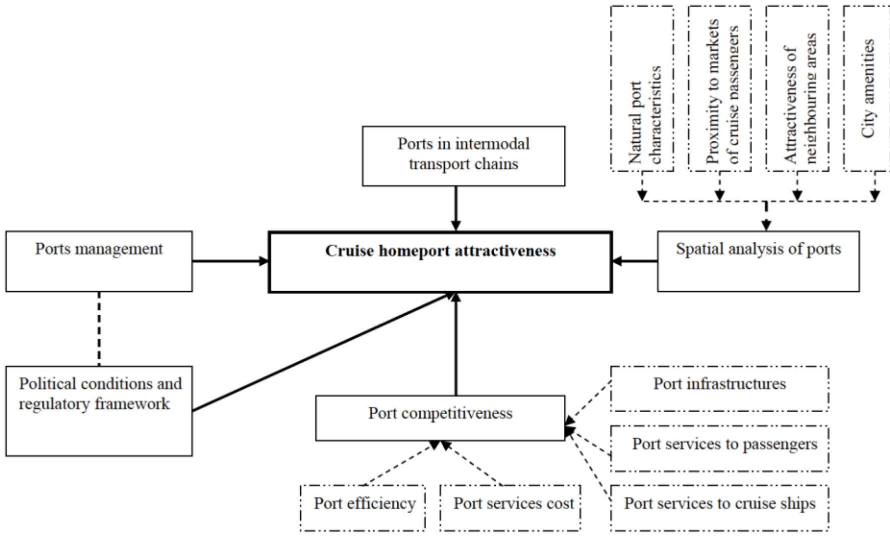

Figure 13: Framework of cruise port attractiveness (author: Lekakou, 2010)

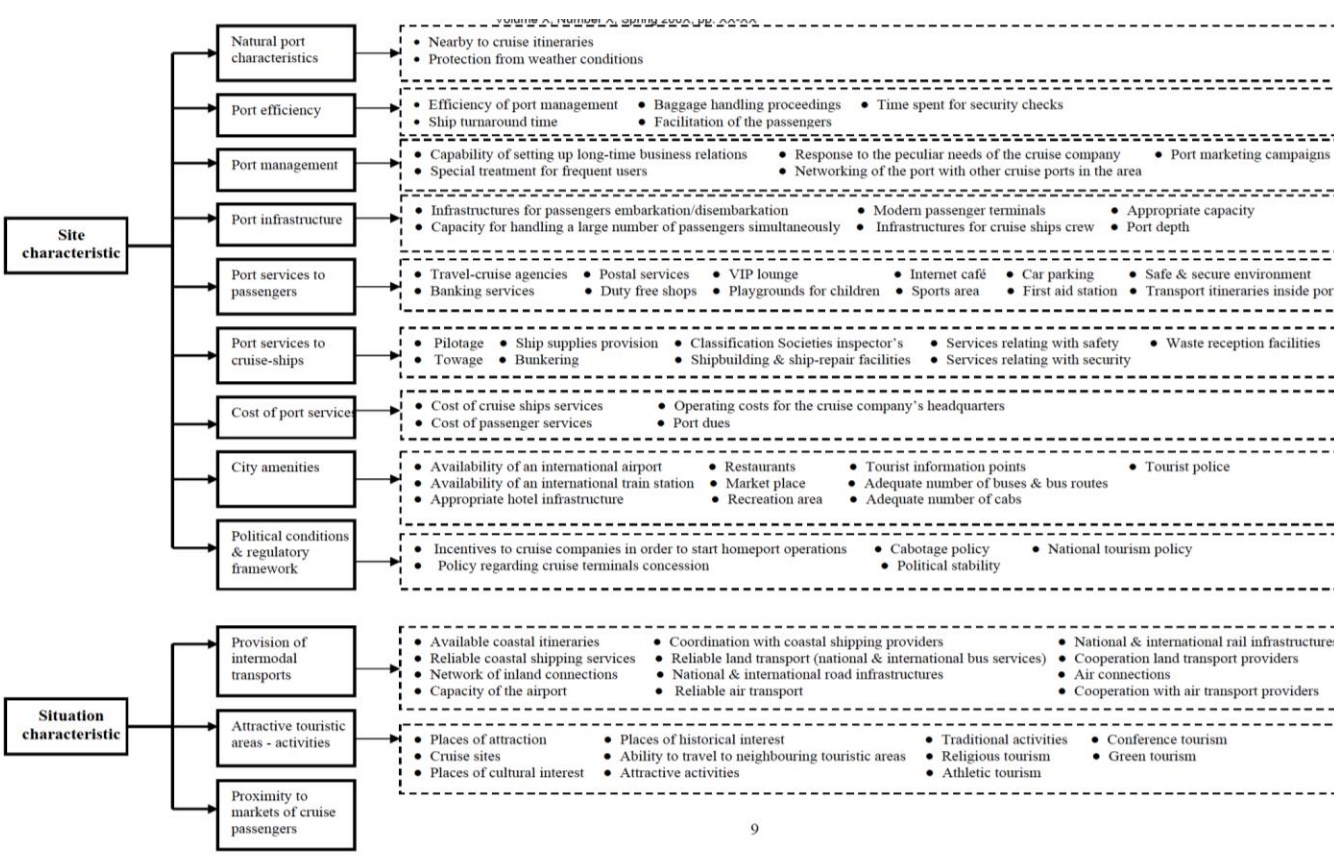

Figure 14: Cruise homeport's attractiveness criteria (author: Lekakou, 2010)

Major business segments	Detail of the core activities
Port operation	• Dedicated terminal/pier, tug and tow boats, cranes, and port basin • Dedicated vessel services provided by marine chandlers, port agents, and terminal agents: mooring and berthing, line handling, harbour pilot, breakwater, and signalling • Stevedoring services provided by longshoremen and warehouse unions • Utility services and anti-pollution equipment: hydroelectric power plants • and cold ironing • Communication and navigation services • Safety and security services: law enforcement and surveillance systems • Fuel supply and lubricants • Waste management and garbage disposal services
Cruise line operation	• Cruise operators • Passenger processing procedures and baggage logistics • Human resource management of vessel crew • Personnel for customs and Port State Control, luggage service, security patrols • Product suppliers for food, beverage, and other supplies such as linens and cleaning products • Technical personnel: sanitation, laundry, heating and cooling, and inspections • Supply chain distributors • Ship maintenance and repair • Waterfront development companies
Ground transportation	• Parking space management companies with various daily rates • Cabs/car rental services: rental cars, tour buses, limousines, and taxi services • Shuttle services in handling passenger transfers • Public transport companies offering scheduled train/metro and bus services • Airport activities linked to the arrival and departure of (overseas) cruise passengers. This only include airports in vicinity of so-called turn ports in the cruise schedule)
Tourism	• Travel agencies, tour guides, booking agency, and IT services • Packaging recreational activities and shore-side excursions: land-side tour, • waterfront sightseeing, small boat tour, whale watching, fishing, hunting. • Hotels and resorts • Hospitality: souvenir shops, restaurants and bars, foreign exchange, and duty-free shops • Entertainment: movies, amusement parks, ball parks, and football games
Others	• Finances: financial intermediation, insurance, accounting/bookkeeping, legal services • Health care: hospitals and disability facilities • Real estate: real estate development and leasing apartment management • Connectivity: airport and train transportation hubs connectivity services • Wholesale and retail • Machinery manufacturing, etc.

Table 8: Port Maritime Cluster and Core Activities (source: Notteboom, 2015)

Impact	Processes	Description
Environmental		
Pollution	Increasing usage of natural resources (land, water, and energy)	Strong and noticeable contribution to pollution of water, land, air and noise and/or solid waste disposal problems
Infrastructure	Increasing (sometimes sudden) demand for and usage of (tourism-directed) infrastructure, facilities and (commercial) activities	Tourism-generated investments in tourism-specific infrastructure impair the investments in infrastructure needed by residents and the wider destination community
Visual	Construction of) tourism infrastructure like airports, cruise ports and hotels disturb natural or cultural landscapes	Visual (aesthetic) pollution of natural or cultural landscapes
Damage	Increased visitation of natural, historical, and architectural sites	Damage to natural, historical and architectural sites
Overcrowding	High numbers of tourists at natural, historical, and architectural sites	Overcrowding at natural, historical, and architectural sites
Economic		
Inflation	Increasing demand for certain specific tourism goods and services and production factors (intermediaries, land, capital, labour, real estate (gentrification) causing increased prices and disappearance of supply for inhabitants	Inflation of prices and reduction of the availability of certain goods, services, and factors of production aimed at inhabitants and for other sectors and functions (industry, agriculture, housing, etc.).
Economic dependence on tourism	Seasonal changes in tourist visitation and/or change in forms and types of jobs created/demanded	Economic dependence on tourism, including being strongly impacted by seasonality and the degradation of other sectors/types of employment
Accessibility	Overcrowding leading to a reduction of accessibility of infrastructure, sites and facilities	Reduced accessibility of infrastructure, sites and facilities for both residents and visitors, inhibiting the regular performance of activities of both residents and visitors may not be able to reach for instance shops or work in their daily local travel
Destination image	Increasing awareness of non-residents at the destination, possibly leading to negative visitor experiences	Degradation of destination image as perceived by visitors
Socio-cultural		
Degradation of infrastructure	Increasing demand for (tourism-directed) infrastructure, facilities and (commercial) activities (including gentrification)	Degradation of infrastructure, facilities and (commercial) activities specifically directed at residents
Marginalisation of residents	Increasing number of visitors vs. residents	Marginalisation of resident population (excessively high number of tourists per resident)
Loss of cultural identity	Changes in the structure, values and behaviour of resident population (incl. family structures and consumption patterns)	Relinquishment/weakening of cultural traditions, values and moral standards leading to a loss of community spirit and pride and a loss of cultural identity

Table 9: Overtourism impacts (source: Peeters et al., 2018)

(3)

$$T = bq\left(q^2 - {q^{MAX}}^2\right)$$

$$T' = b\left(q^2 - {q^{MAX}}^2\right) + 2bq^2 = 3bq^2 - b{q^{MAX}}^2$$

$$T' = 0 \rightarrow q^2 = \frac{b{q^{MAX}}^2}{3b}$$

$$q^* = \frac{q^{MAX}}{\sqrt{3}} \approx 58\%\ q^{MAX}$$

(4)

As we assume that the attractiveness for both the ports is equal to 1 when is maximum,

$$T_1(q_1^*) = 1\ and\ \ T_2(q_2^*) = 1$$

$$T(q^*) = bq^*\left(q^{*2} - {q^{MAX}}^2\right) = 1$$

$$b = \frac{1}{q^*\left(q^{*2} - {q^{MAX}}^2\right)} = \frac{1}{\frac{q^{MAX}}{\sqrt{3}}\left(\frac{{q^{MAX}}^2}{3} - {q_1^{MAX}}^2\right)} = \frac{1}{\frac{q^{MAX}}{\sqrt{3}}\left(-\frac{2}{3}{q^{MAX}}^2\right)} = \frac{1}{-\frac{2}{3\sqrt{3}}{q^{MAX}}^3}$$

$$= -\frac{\mathbf{3\sqrt{3}}}{\mathbf{2{q^{MAX}}^3}}$$

Thus, it results that $b_1 = -\frac{(3\sqrt{3})}{2{q_1^{MAX}}^3}$

$$b_2 = -\frac{(3\sqrt{3})}{2{q_2^{MAX}}^3}$$

(5)

By substituting the coefficients $b_1 = -\frac{(3\sqrt{3})}{2q_1^{MAX^3}}$ and $b_2 = -\frac{(3\sqrt{3})}{2q_2^{MAX^3}}$ and $q_1^{MAX} = 1$ within the first order conditions, we obtain:

$$\begin{cases} a - c - \frac{2(q_1^2+1)}{3\sqrt{3(q_1^2-1)^2}} - \frac{2q_2^{MAX^3}}{3\sqrt{3\left(q_2^2 - q_2^{MAX^2}\right)}} = 0 \\ a - c + \frac{2}{3\sqrt{3(q_1^2-1)}} - \frac{2q_2^{MAX^3}\left(q_2^2 + q_2^{MAX^2}\right)}{3\sqrt{3\left(q_2^2 - q_2^{MAX^2}\right)^2}} = 0 \end{cases}$$

$$\begin{cases} \boldsymbol{I.} \quad \frac{3\sqrt{3}}{2}(a-c) - \frac{q_1^2+1}{(q_1^2-1)^2} + \frac{q_2^{MAX^3}}{q_2^2 - q_2^{MAX^2}} = 0 \\ \boldsymbol{II.} \quad \frac{3\sqrt{3}}{2}(a-c) + \frac{1}{q_1^2-1} - \frac{q_2^{MAX^3}\left(q_2^2 + q_2^{MAX^2}\right)}{\left(q_2^2 - q_2^{MAX^2}\right)^2} = 0 \end{cases}$$

Then, we establish that $k = \frac{3\sqrt{3}}{2}(a-c)$ and we get q_2^2 by taking the first order condition of Venice's profit maximisation $\frac{d\pi_1}{dq_1}$:

$$\boldsymbol{I.} \quad \frac{q_2^{MAX^3}}{q_2^2 - q_2^{MAX^2}} = \frac{q_1^2+1}{(q_1^2-1)^2} - k$$

$$\frac{q_2^{MAX^3}}{q_2^2 - q_2^{MAX^2}} = \frac{q_1^2 + 1 - k(q_1^2-1)^2}{(q_1^2-1)^2}$$

$$\frac{q_2^2 - q_2^{MAX^2}}{q_2^{MAX^3}} = \frac{(q_1^2-1)^2}{q_1^2 + 1 - k(q_1^2-1)^2}$$

$$\boldsymbol{q_2^2 = \frac{q_2^{MAX^3}\left(q_1^2 - 1\right)^2}{q_1^2 + 1 - k\left(q_1^2 - 1\right)^2} + q_2^{MAX^2}}$$

In order to obtain q_1^2, in the first order conditions, we subtract (II. – I. = $\frac{d\pi_2}{dq_2} - \frac{d\pi_1}{dq_1}$), as follow:

$$\frac{q_1^2 + 1}{(q_1^2 - 1)^2} + \frac{1}{q_1^2 - 1} = \frac{q_2^{MAX^3}\left(q_2^2 + q_2^{MAX^2}\right)}{\left(q_2^2 - q_2^{MAX^2}\right)^2} + \frac{q_2^{MAX^3}}{q_2^2 - q_2^{MAX^2}}$$

$$\frac{q_1^2 + 1 + q_1^2 - 1}{(q_1^2 - 1)^2} = \frac{q_2^{MAX^3} q_2^2 + q_2^{MAX^5} + q_2^{MAX^3} q_2^2 - q_2^{MAX^5}}{\left(q_2^2 - q_2^{MAX^2}\right)^2}$$

Therefore, we obtain:

$$\textbf{III.} \qquad \frac{q_1^2}{(q_1 - 1)^2} = \frac{q_2^{MAX^3} q_2^2}{\left(q_2^2 - q_2^{MAX^2}\right)^2}$$

Now, we substitute $\boldsymbol{q_2^2 = \frac{q_2^{MAX^3}\left(q_1^2 - 1\right)^2}{q_1^2 + 1 - k\left(q_1^2 - 1\right)^2} + q_2^{MAX^2}}$ within equation III. :

$$\frac{q_1^2}{(q_1 - 1)^2} = \frac{\frac{q_2^{MAX^6}(q_1^2 - 1)^2}{q_1^2 + 1 - k\left(q_1^2 - 1\right)^2} + q_2^{MAX^5}}{\left(\frac{q_2^{MAX^3}\left(q_1^2 - 1\right)^2}{q_1^2 + 1 - k(q_1^2 - 1)^2}\right)^2}$$

$$\boldsymbol{q_1^2 = \frac{(1 - k)\left(q_2^2 - q_2^{MAX^2}\right)^2 + q_2^{MAX^3}\left(q_2^2 + q_2^{MAX^2}\right)}{q_2^{MAX^3}\left(q_2^2 + q_2^{MAX^2}\right) - k\left(q_2^2 - q_2^{MAX^2}\right)^2}}$$

(6)

Model Simplification:

Starting from the equation III., obtained by subtracting $\frac{d\pi_2}{dq_2} - \frac{d\pi_1}{dq_1}$:

$$\textbf{III.} \qquad \frac{q_1^2}{(q_1-1)^2} = \frac{q_2^{MAX^3} q_2^2}{\left(q_2^2 - q_2^{MAX^2}\right)^2}$$

Equation III. can be rewritten as follow:

$$\textbf{III. bis} \quad q_1^2 \left(q_2^2 - q_2^{MAX^2}\right)^2 = q_2^{MAX^3} q_2^2 (q_1^2 - 1)^2$$

Previously, it has been found that: $$\boldsymbol{q_2^2 = \frac{q_2^{MAX^3}\left(q_1^2-1\right)^2}{q_1^2+1-k\left(q_1^2-1\right)^2} + q_2^{MAX^2}}$$

Therefore, we substitute q_2^2 in III. Bis:

$$q_1^2 \left(\frac{q_2^{MAX^3}(q_1^2-1)^2}{q_1^2+1-k(q_1^2-1)^2}\right)^2 = q_2^{MAX^3}\left(\frac{q_2^{MAX^3}(q_1^2-1)^2}{q_1^2+1-k(q_1^2-1)^2} + q_2^{MAX^2}\right)(q_1^2-1)^2$$

$$\frac{q_1^2 q_2^{MAX^{\cancel{6}}}(q_1^2-1)^{\cancel{4}\,2}}{(q_1^2+1-k(q_1^2-1)^2)^{\cancel{2}}} = \frac{\cancel{q_2^{MAX}}^{5}[q_2^{MAX}(q_1^2-1)^2 + (q_1^2+1) - k(q_1^2-1)^2]\cancel{(q_1^2-1)}^2}{\cancel{q_1^2+1-k(q_1^2-1)^2}}$$

$$q_1^2 q_2^{MAX}(q_1^2-1)^2 = [(q_2^{MAX}-k)(q_1^2-1)^2 + (q_1^2+1)](q_1^2+1-k(q_1^2-1)^2)$$

In order to simplify the equation, we assume that:

- $q_1^2 - 1 = x$
- $q_1^2 = x + 1$
- $q_1 + 1 = x + 2$

then, the equation will change as follows:

$$q_2^{MAX} x^2 (x+1) = [(q_2^{MAX} - k)x^2 + x + 2][x + 2 - kx^2]$$

After all the substitutions have been made, the simplified equation obtained is the following:

$$\boldsymbol{(kx^2 - x - 2)^2 = q_2^{MAX} x^2 (kx^2 - 1)}$$

(7)

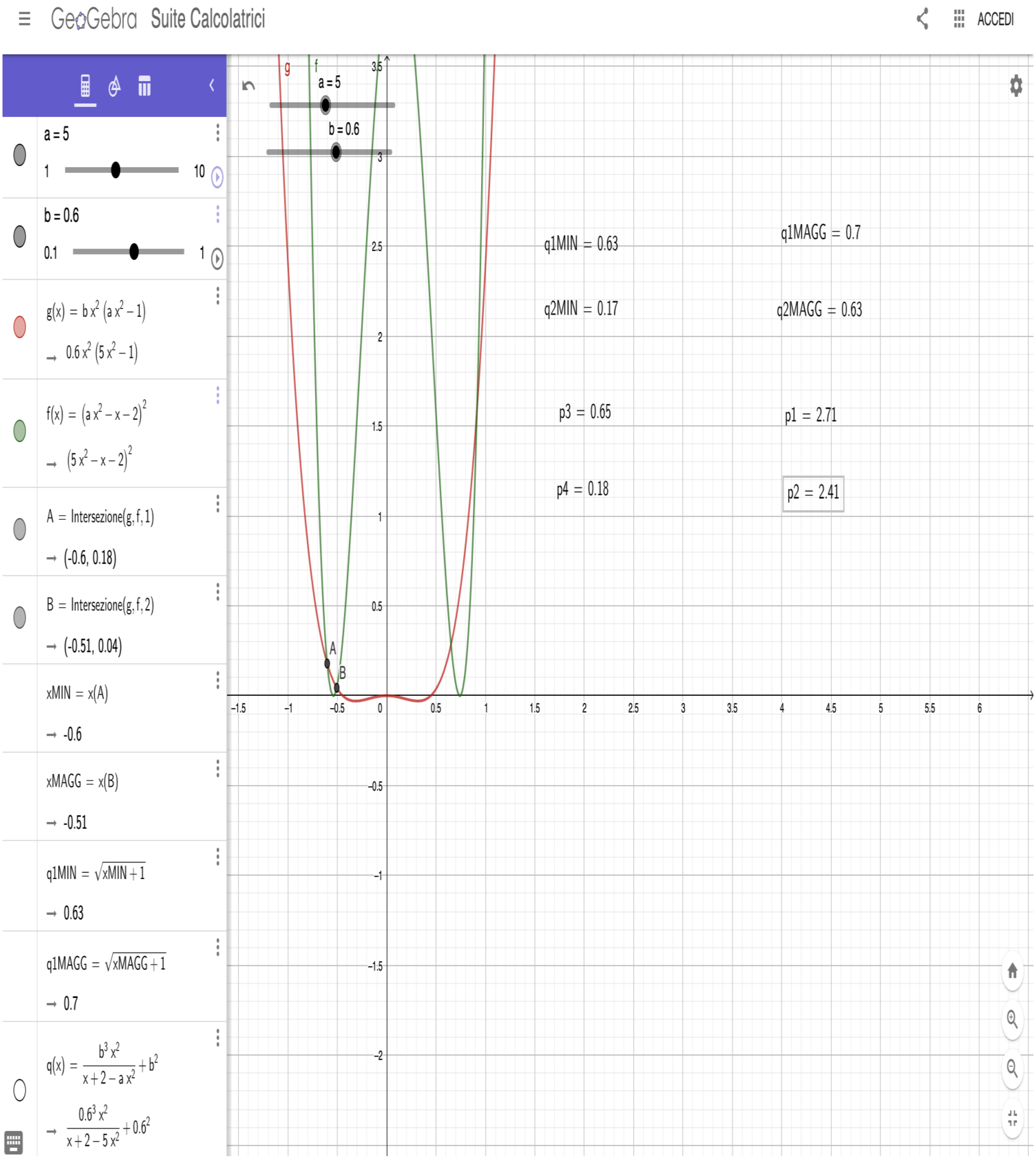

Figure 15: Simplified Equation findings on Geogebra

(8)

Table 10: Complete Table with optimal quantities and profits

QUANTITIES					
q2MAX (b)	0,1	0,2	0,3	0,4	0,5
K (a)					
1					
2	-eq (0.43-0.01); +eq (0.49-0.02)	-eq (0.4 - 0.02); +eq (0.5 - 0.08)	-eq (0.38 - 0.03); +eq (0.5 -0.2)	-eq (0.36 - 0.04); +eq (0.51 - 0.39)	-eq (0.33 - 0.05); +eq (0.51 - 0.67)
3	-eq(0.55 - 0.01) ; +eq (0.6 - 0.01)	-eq (0.54 - 0.02); +eq (0.6 - 0.06)	-eq (0.52 - 0.04); +eq (0.6 -0.16)	-eq (0.51 - 0.07); +eq (0.61 - 0.31)	-eq (0.5 - 0.09); +eq (0.61 - 0.51)
4	-eq(0.62 - 0.01); +eq (0.65 - 0.01)	-eq (0.61 - 0.03); +eq (0.66 - 0.06)	-eq (0.6 - 0.05); +eq (0.66 -0.14)	-eq (0.59 - 0.08); +eq (0.66 - 0.27)	-eq (0.58 - 0.11); +eq (0.66 - 0.45)
5	-eq (0.66-0.01); +eq (0.69 - 0.01)	-eq (0.65 - 0.03); +eq (0.69 - 0.06)	-eq (0.65 - 0.06); +eq (0.7 -0.13)	-eq (0.64 - 0.09); +eq (0.7 - 0.25)	-eq (0.64 - 0.13); +eq (0.7 - 0.42)
6	-eq (0.69-0.01); +eq (0.72 - 0.01)	-eq (0.69 - 0.03); +eq (0.72 - 0.05)	-eq (0.68 - 0.06); +eq (0.72 -0.13)	-eq (0.68 - 0.1); +eq (0.73 - 0.24)	-eq (0.67 - 0.14); +eq (0.73 - 0.39)
7	-eq (0.72-0.01); +eq (0.74 - 0.01)	-eq (0.71 - 0.03); +eq (0.74 - 0.05)	-eq (0.71 - 0.06); +eq (0.74 -0.12)	-eq (0.7 - 0.1); +eq (0.75 - 0.23)	-eq (0.7 - 0.15); +eq (0.75 - 0.38)
8	-eq (0.74-0.01); +eq (0.76 - 0.01)	-eq (0.73- 0.03); +eq (0.76 - 0.05)	-eq (0.73 - 0.06); +eq (0.76 -0.12)	-eq (0.73 - 0.11); +eq (0.76 - 0.23)	-eq (0.72 - 0.16); +eq (0.76 - 0.37)
9	-eq (0.75-0.01); +eq (0.77 - 0.01)	-eq (0.75 - 0.03); +eq (0.77 - 0.05)	-eq (0.75 - 0.07); +eq (0.77 - 0.12)	-eq (0.74 - 0.11); +eq (0.78 - 0.22)	-eq (0.74 - 0.16); +eq (0.78 - 0.36)
10	-eq (0.77-0.01); +eq (0.78 - 0.01)	-eq (0.76 - 0.03); +eq (0.78 - 0.05)	-eq (0.76 - 0.07); +eq (0.79 - 0.12)	-eq (0.76 - 0.11); +eq (0.79 - 0.22)	-eq (0.75 - 0.17); +eq (0.79 - 0.35)

Impossible

No competition

PROFITS					
q2MAX (b)	0,1	0,2	0,3	0,4	0,5
K(a)					
1					
2	-eq (0.11-0.00); +eq (0.11-0.00)	-eq (0.09- 0.00); +eq (0.08-0.01)	-eq (0.08-0.01); +eq (0.02-0.01)	-eq (0.06 - 0.01); +eq (0.07 - 0.0)	-eq (0.05 - 0.01); +eq (0.25 - 0.33)
3	-eq (0.31-0.00); +eq (0.31-0.00)	-eq (0.29- 0.01); +eq (0.28-0.03)	-eq (0.27-0.02); +eq (0.23-0.06)	-eq (0.24 - 0.03); +eq (0.11 - 0.05)	-eq (0.22 - 0.04); +eq (0.27 - 0.13)
4	-eq (0.54-0.01); +eq (0.54-0.01)	-eq (0.52- 0.02); +eq (0.51-0.05)	-eq (0.49-0.04); +eq (0.47-0.1)	-eq (0.47 - 0.06); +eq (0.38 - 0.15)	-eq (0.44 - 0.09); +eq (1.23 - 1.07)
5	-eq (0.79 - 0.01); +eq (0.79-0.01)	-eq (0.77-0.03); +eq (0.76-0.06)	-eq (0.74-0.06); +eq (0.72-0.14)	-eq (0.71 - 0.1); +eq (0.64 - 0.23)	-eq (0.68 - 0.14); +eq (0.38 - 0.23)
6	-eq (1.06-0.02); +eq (1.06-0.02)	-eq (1.03- 0.04); +eq (1.03-0.08)	-eq (1-0.09); +eq (0.98-0.18)	-eq (0.97 - 0.14); +eq (0.91 - 0.3)	-eq (0.94 - 0.2); +eq (0.72 - 0.39)
7	-eq (1.34-0.02); +eq (1.34-0.02)	-eq (1.31- 0.05); +eq (1.3-0.09)	-eq (1.28-0.11); +eq (1.26-0.21)	-eq (1.24 - 0.18); +eq (1.19 - 0.37)	-eq (1.21 - 0.26); +eq (1.02 - 0.52)
8	-eq (1.62-0.03); +eq (1.62-0.03)	-eq (1.59- 0.07); +eq (1.59-0.11)	-eq (1.56-0.14); +eq (1.54-0.25)	-eq (1.52 - 0.22); +eq (1.47 - 0.44)	-eq (1.49 - 0.32); +eq (1.33 - 0.64)
9	-eq (1.91-0.03); +eq (1.91-0.03)	-eq (1.88- 0.08); +eq (1.88-0.12)	-eq (1.85-0.16); +eq (1.83-0.28)	-eq (1.81 - 0.27); +eq (1.77 - 0.5)	-eq (1.77 - 0.39); +eq (1.63 - 0.75)
10	-eq (2.2-0.03); +eq (2.2-0.03)	-eq (2.17- 0.09); +eq (2.17-0.14)	-eq (2.14-0.19); +eq (2.13-0.32)	-eq (2.1 - 0.31); +eq (2.06 - 0.57)	-eq (2.07 - 0.46); +eq (1.93 - 0.86)

Impossible

No competition

0,6	0,7	0,8	0,9
-eq (0.3 - 0.5); +eq (IMP.)	-eq (0.26 - 0.05); +eq (IMP.)	-eq (0.22 - 0.04); +eq (IMP.)	-eq (0.16 - 0.02); +eq (IMP.)
-eq (0.49 - 0.11); +eq (0.61 - 0.78)	-eq (0.47 - 0.14); +eq (IMP.)	-eq (0.46 - 0.16); +eq (IMP.)	-eq (0.44 - 0.17); +eq (IMP.)
-eq (0.58 - 0.15); +eq (0.67 - 0.68)	-eq (0.57 - 0.19); +eq (0.67 - 0.97)	-eq (0.56 - 0.22); +eq (IMP.)	-eq (0.56 - 0.26); +eq (IMP.)
-eq (0.63 - 0.17); +eq (0.7 - 0.63)	-eq (0.62 - 0.22); +eq (0.7 - 0.89)	-eq (0.61 - 0.32); +eq (IMP.)	-eq (0.62 - 0.27); +eq (IMP.)
-eq (0.67 - 0.19); +eq (0.73 - 0.59)	-eq (0.66 - 0.25); +eq (0.73 - 0.83)	-eq (0.66 - 0.3); +eq (IMP.)	-eq (0.65 - 0.36); +eq (IMP.)
-eq (0.7 - 0.2); +eq (0.75 - 0.57)	-eq (0.69 - 0.26); +eq (0.75 - 0.8)	-eq (0.69 - 0.4); +eq (IMP.)	-eq (0.69 - 0.33); +eq (IMP.)
-eq (0.72 - 0.22); +eq (0.76 - 0.55)	-eq (0.72 - 0.28); +eq (0.77 - 0.77)	-eq (0.71 - 0.35); +eq (IMP.)	-eq (0.71 - 0.42); +eq (IMP.)
-eq (0.74 - 0.22); +eq (0.78 - 0.53)	-eq (0.73 - 0.29); +eq (0.78 - 0.75)	-eq (0.73 - 0.37); +eq (IMP.)	-eq (0.75 - 0.46); +eq (IMP.)
-eq (0.75 - 0.23); +eq (0.79 - 0.52)	-eq (0.75 - 0.3); +eq (0.79 - 0.73)	-eq (0.75 - 0.38); +eq (0.79 - 0.98)	-eq (0.73 - 0.44); +eq (IMP.)

0,6	0,7	0,8	0,9
-eq (0.03 - 0.01)	-eq (0.02 - 0.00)		
-eq (0.2 - 0.05); +eq (0.54 - 0.68)	-eq (0.44 - 0.79)		
-eq (0.41 - 0.11); +eq (1.11 - 1.13)	-eq (0.39 - 0.13); +eq (0.76 - 1.1)		
-eq (0.65 - 0.18); +eq (2.71 - 2.41)	-eq (0.62 - 0.22); +eq (1.13 - 1.43)		
-eq (0.2 - 0.05); +eq (0.54 - 0.68)	-eq (0.87 - 0.32); +eq (1.56 - 1.78)		
-eq (1.17 - 0.34); +eq (1.01 - 0.63)	-eq (1.14 - 0.43); +eq (2.05 - 2.18)		
-eq (1.45 - 0.43); +eq (0.6 - 0.73)	-eq (1.41 - 0.55); +eq (2.66 - 2.67)		
-eq (1.73 - 0.53); +eq (1.09 - 0.75)	-eq (1.69 - 0.67); +eq (3.48 - 3.33)		
-eq (2.02 - 0.62); +eq (1.49 - 0.99)	-eq (1.98 - 0.68); +eq (4.79 - 4.42)		