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Do maritime anti-corruption efforts affect economics? An analysis of waiting time in the Suez Canal

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Abstract

The purpose of this study was to investigate whether becoming member of the Maritime Anti-Corruption Network (MACN) comes with a monetary penalty in terms of longer waiting times for entering the Suez Canal. This thesis differs from earlier empirical studies on corruption by utilising data derived from Automatic Identification System (AIS) enabling a more objective measurement of corruption, compared to the more common measurement of perception. In addition, this is also one of the first studies to investigate how both technical and human factors affects waiting time in the Suez Canal.

The data set consist various data sources, including data derived from AIS, from Clarksons World Fleet Register (WFR) and from MACN, combined into a detailed vessel-level panel data set covering the Suez Canal from 2012 to 2016. Unobserved effect models, such as random and fixed effects models, are used to investigate whether there is a causal relationship between membership status and waiting time. Heterogeneity analysis and several robustness test are performed to verify the results.

This thesis finds no evidence of MACN membership affecting the waiting time to enter the Suez Canal. While there are many reasons that could explain the lack of significant effect, this thesis emphasises how the lack of significant effects stems from the fact that the MACN "say no"-campaign was not introduced before 2015. Thus, the effect of membership might not significantly affect the outcome of interest in the period studied by this thesis. Future research should therefore collect more detailed data, and data for a longer period of time, in order to understand if waiting times are longer for companies that become members of MACN.

The policy relevance of understanding how anti-corruption tools might affect (shipping) economics can therefore hardly be underestimated, but no clear answer has yet emerged from the literature.

Keywords: Shipping, Corruption, Maritime Anti-Corruption Network (MACN), Random Effects, Fixed Effects, Entropy Balancing.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AIS Automatic Identification System.

BAP Berth Allocation Problem.

BLUE Best Linear Unbiased Estimate.

CPI Corruption Perception Index.

DWT Dead Weight Tonnage.

ETA Estimated Time of Arrival.

EU European Union.

GPS Global Positioning System.

GT Gross Tonnage.

IMF International Monetary Fund.

IMO International Maritime Organization.

LOA Length Overall.

MACN Maritime Anti-Corruption Network.

MMSI Maritime Mobile Service Identity.

OLS Ordinary Least Square.

PATT Population Average Treatment effect on the Treated.

QCAP Quay Crane Allocation Problem.

SC.G.T Suez Canal Gross Tonnage.

SC.N.T Suez Canal Net Tonnage.

SCA Suez Canal Authority.

SDR Special Drawing Right.

SOG Speed Over Ground.

TI Transparency International.

VHF Very High Frequency.

VLCC Very Large Crude Carriers.

WB World Bank.

WFR World Fleet Register.

1 Introduction

Corruption and the fight against it, has received increased intention in recent year, both at a national (Wedeman, 2018; Transparency International, 2017) and international (G20, 2016) level. The cost of corruption is estimated to be US$2.6 trillion (Correa et al., 2016), with more than US$1 trillion paid in bribes (Kaufmann, 2005). Nevertheless, such measurements of corruption are usually prone to measurement errors (World Bank, 2007). For example, corruption is usually measured on the level of perception based on an individuals' actual experiences. Measuring the effect of anti-corruption efforts will therefore be prone to similar errors.

Borders and ports are typical areas where corruption and especially bribes are a common part of the daily operations. In some ports, "facilitation gifts" such as packets of cigarettes and alcohol, plays an integral part of ensuring good interaction on-board. In these ports, such gifts guarantees early approval of documents. If gifts are not provided, delays could happen (Sampson et al., 2016). The Suez Canal became so infamous for this type of behaviour that it was nicknamed "The Marlboro Canal" by the Lloyd's list in 2015 (Osler, 2015).

In the 1970s the cost of waiting to enter the Suez Canal was about US$1500 per day for a 10,000-ton ship (De Weille and Ray, 1974). In 2019 this would be equivalent to approximately US$7775 (Bureau of Labor Statistics, 2019). Due to the large costs, optimisation of shipping operations in ports have therefore sparked great interest among scholars for many years (see for example De Weille and Ray (1974) and Sheikholeslami et al. (2013)). Due to the focus on optimisation and simulation systems, however, the literature has focused mostly on technical aspects of port logistics rather than human factors. Similarly, while parts of the literature has focused on waiting time for entering the Suez Canal (Laih et al., 2015; Griffiths, 1995; Clark et al., 1983), none of them have studied the New Suez Canal (the nickname of the Suez Canal after the expansion in 2015).[1]

Modern information and communication technology provides lots of new data and enables

[1]In 2015 the Suez Canal was extended with a second shipping line of about 75 km which allows ships to sail in both directions for a large part of the Canal.

new insights that was previously not available to scholars. One such technology is Automatic Identification System (AIS), an automatic tracking system mainly used for anti-collision purposes, which allows storing of ships Global Positioning System (GPS) locations. Data derived from AIS enables more detailed tracking and investigations of ships and their behaviour.

What is not clear from the literature, however, is whether ships will experience delays even though some of the actors do not perceive corruption to be existent. For example, the Maritime Anti Corruption Network (MACN), a global business network whose main cause is fighting corruption within shipping, uses the case of the Suez Canal as one of their success stories. More specifically, the literature is not clear on whether strict zero-tolerance towards corruption comes with a monetary penalty. To the best of this author's knowledge, this thesis is the first to investigate whether becoming member of MACN has had a negative effect on the waiting time of a company's ship wanting to enter the Suez Canal. By using data derived from AIS, this thesis provides a more objective measurement of corruption, while also being one of the first works to investigate how both technical and human factors affects waiting time in the Suez Canal. Causality between such policies and waiting times might impact the way we think about fighting corruption on an international level, and the effectiveness of anti-corruption efforts.

The remainder of the thesis is organised as follows: In section 2, the conceptual framework of corruption and the Suez Canal is explained. In Section 3, the literature of waiting time and corruption in ports is reviewed. In section 4 the data is described. Section 5 explains the theory behind the empirical strategy used to identify waiting times. In section 6, the results are presented, followed by robustness check. Section 7 discuss the limitations of this thesis. Finally, section 8 contains concluding remarks.

2 Background

This sections will describe the Suez Canal and its convoy system thoroughly, and outline the cost of transiting the Canal, including the cost of waiting. Then, the concept of corruption will formally be defined followed by an outline of corruption in Egypt. Finally, collective action as an anti-corruption tool will be outlined followed by an illustration of how MACN has worked to fight corruption in the Suez Canal.

2.1 The Suez Canal

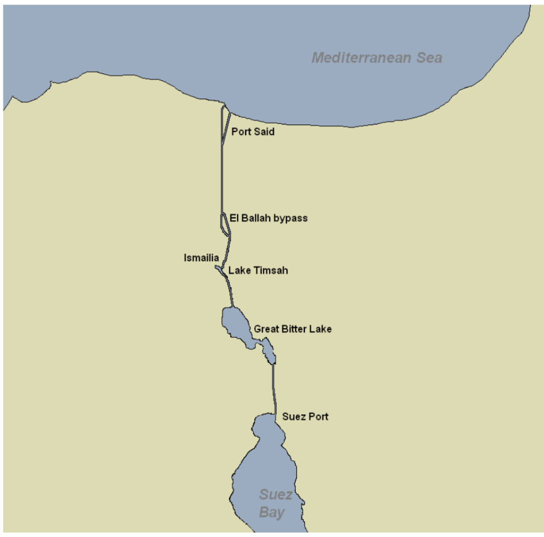
The Suez Canal, rivalled only by the Panama Canal, is one of the most important man-made waterways in the world. Almost 80 per cent percent of all seaborne trade between Asia and Europe goes through the Suez Canal, which is nearly 20 per cent pf all global seaborne trade (Laih et al., 2015). The Canal separates the African continent from Asia, and it provides the shortest maritime route between Europe and the lands lying around the Indian and western Pacific oceans. Ships sailing between Asia and Europe are not, therefore, required to make a long detour around the Cape of Good Hope. For example, the route between Tilbury, United Kingdom and Dammam in the Persian Gulf is approximately 11,300 nautical miles (20,900 km) via the Cape of Good Hope, but it is 6,400 nautical miles (12,000km) via the Suez Canal, which is 43% shorter (Earth Observation Research Center (EORC), 2005). Navigating at 20 knots, it will take 24 days via the Cape of Good Hope, but only 14 days via the Suez Canal (EORC, 2005). Thus, the Canal offers savings in distance, time and transportation costs, three major factors for planning in the shipping world.

The day-to-day control of the Canal is organised by the Suez Canal Authority (SCA). At present, the Canal is wide and deep enough to allow ship of 240 000 Dead Weight Tonnage (DWT) to transit, corresponding to a draught of 66 feet. When the Canal first opened in 1869 the maximum draught was 22 and 5000 was the maximum Dead Weight Tonnage (DWT). Suez Canal tariffs brought 5.3 billion in revenue to Egypt in 2017. Thus, the Canal, together with tourism, is a major source of revenue and foreign exchange for the country. Approximately 17 000 ships pass through the Suez Canal each year. Of these, about 21% of the tonnage passing through the Canal belongs to oil trade (Suez Canal Authority (SCA), 2017).

2.1.1 Physical characteristics of the Canal

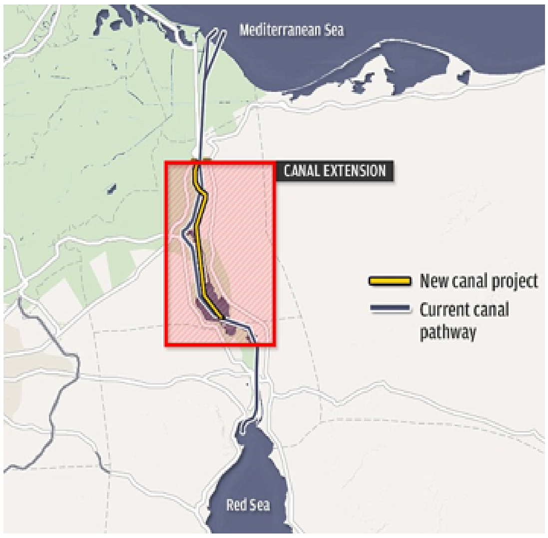
The Suez Canal lies in a North-South direction connecting the Mediterranean and Red Seas. Three main cities lie on the Canal: Port Said at the northern end, Suez (and the associated Port Tewfik) at the southern end, and Ismailia approximately midway between them, see Figure 2.1. In 2015 new additions were added to the Canal. In this thesis, the Old and New Suez Canal will be used to refer to the Canal before and after this expansion, when a distinction is considered necessary.

Figure 2.1: Ports and by-passes



Source: Leth Agencies (2019)

Figure 2.2: Canal extension



Source: Hall (2015)

The length of the Canal is 160 km, of which 121 km lie in the Canal proper, with the remainder being in the two main lake areas, namely Lake Timsah near Ismailia, and the Bitter Lakes. The width of the Canal at water level is 180-200 m, but the navigable channel is only about 110 m wide. For the Old Suez Canal this meant that as a consequence, there were insufficient room for vessels to pass one another either in the same or in opposing directions. Ships were therefore arranged in convoys that transited mainly in one-way direction. The New Suez Canal, with the its second shipping lane of about 75 km, allows ships to sail in both directions for a large part of the Canal. It was expected that the expansion would reduce waiting time to enter the Canal for most ships[2], and the total time of transit.

Figure 2.3: Before and after the expansion of the Canal

Source: NASA Earth Observatory (2016)

Since the Canal is cut through the sands of the desert, stone revetments and sheet-piles have been inserted in order to prevent erosion of the banks from the wash of ships (Griffiths, 1995). As a result, ships are imposed a speed limit in order to avoid long term damage of the Canal.

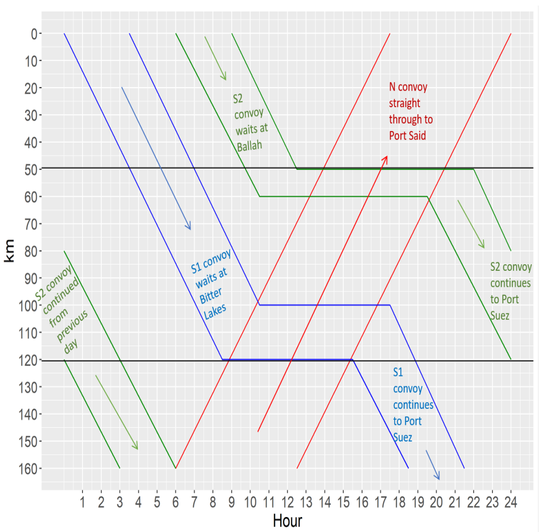
The lakes inside of the Canal are large, but shallow. They are mainly used for waiting areas for proceeding through the Canal, but it is also possible for ships to tie up if necessary. The Bitter Lake and Lake Timsah can accommodate 36 ships each to tie up, depending on size, although the latter is rarely used. A third area of importance, the Ballah-by-pass, is a man-made loop that accommodates 17 ships to tie up. The Ballah-by-pass is located just north of Lake Timsaha (see Figure 2.1).

[2]Depending on how waiting time is defined in the data set of this thesis, the average waiting time seem to be about the same or somewhat longer after the expansion.

2.1.2 Convoy system

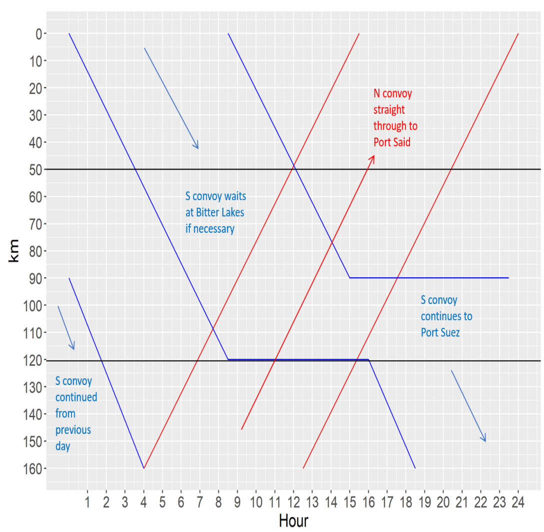
Although the major length of the Suez Canal now cater to two-way passage ships, there are still some parts that are one-way only. In order to avoid collisions, a convoy system regulates the traffic through the Canal. Before the expansion of the Canal a three-convoy system was in operation each day, two southbound and one northbound. The first southbound convoy (S1) started from Port Said at 01:00, the second southbound convoy (S2) started at 07:00 and the northbound convoy (N) from Port Suez at 06:00 (National Geospatial Intelligence Agency, 2007). The second convoy would only run if the demand was high, and was restricted to 17 ships (Griffiths, 1995). Today, there is one northbound convoy that starts at 04:00 and one southbound convoy that start at 03:30 (Suez Canal Authority (SCA), 2015). Figure 2.4 and Figure 2.5 illustrate the old and new convoy system diagrammatically.

Figure 2.4: The old convoy system



Source: Griffiths (1995)

Figure 2.5: The new convoy system



Source: Belledin (2017)

Each ship has to enter the Canal at a designated time in order to take its specified place in the convoy. Ships that are required to be ahead of the convoy will be deemed preferential in this thesis. Details regarding the different convoy groups can be found in the appendix (Table A1.4). The northbound convoy for the Old Suez Canal is divided into three groups; A(1), A(2), and B. When entering the Canal, A(1) leads, followed by A(2) and finally group B. The first southbound convoy (S1) in the Old Suez Canal convoy system is similarly divided into 3 groups; A, B and C. When entering the Canal, Group A goes first, followed by group B and C.

Sometimes, if there is lots of traffic in the Canal, a second southbound convoy (S2) may run. Due to limitations of the Ballah-by-pass there are certain limitation on ships that may *not* join the second convoy. These are mainly related to ships that carry goods that might be considered more dangerous or very large vessels over 90 000 Suez Canal Gross Tonnage (SC.G.T).

For the New Suez Canal for ships heading both north and south there is only one convoy per direction which are divided into ships that should be ahead, in the middle and at the tail of the convoy.

Each ship also has to maintain a certain speed and separation distance from the vessel ahead throughout the passage. The specified separation distance of ships in the convoys take account of such factors as the size of vessel and the type of cargo carried (Griffiths, 1995). Vessels carrying petroleum products and other potentially dangerous cargoes are required to maintain larger separation distances than general cargo ships. Thus, for example, two general cargo ships might have a minimum interval of 5 minutes (about 1 km) between them, whereas a vessel carrying nuclear waste might be required to be separated by 20 minutes (about 4 km) from the vessels ahead and astern (Griffiths, 1995). Thus, at what time a ship enters the Canal is dependent on how many other ships are in the queue and the types of ships they are.

The speed limit varies between 13 and 16 km/h (7-9 knots) depending on the type of vessel (Suez Canal Authority (SCA), 2015). The speed limit is determined by a number of factors. In particular, the speed is restricted so that the wake from the screw of a vessel does not cause damage to the banks of the Canal (Griffiths, 1995).

Finally, depending on the traffic situation, the SCA can allow an early group of ships to enter the Canal in both directions before the official entry time (Suez Canal Authority (SCA), 2015). Similarly, when several ships are ready to enter the Canal at the same time, the order of the sailing will be fixed by the SCA (Suez Canal Authority (SCA), 2015).

In summary, there are both technical factors (such as size and type of ships) and human factors (SCA personnel) that influences the Suez Canal convoy system, and therefore the waiting time of the ships.

2.1.3 Shipping economics

The cost for each one-way transit of the Suez Canal is comprised of approximately 11 separate charges. The main part of the cost is the actual transit fee, while the minority part are different service charges. The Canal dues are calculated based on ship type, size (in Suez Canal Net Tonnage (SC.N.T)) and whether the ship is ladden or in ballast. The transit due is not applicable for vessels less than 300 SC.G.T (Suez Canal Authority (SCA), 2015). The different fee types might have different names depending on the transit agency's invoicing method (R.K. Johns Associates Inc., 2005). These fees can be fixed, variable or calculated based on a percentage of SC.N.T. The following illustrate the fee types used by Wilhelmsen (2018), and the corresponding fees calculated for an average ship passing through the Suez Canal and a Very Large Crude Carriers (VLCC) (for illustrative purposes)

Table 2.1: Toll calculations (example)

	Fee (Example)	
Fee Type	Average ship	Large tanker
Pilotage	468	761
Suez Canal Dues	243 811	385 052
Total Light Dues	4 160	15 360
Port Dues	1 140	4 500
Port Authority Fees	450	700
Ministry Fees	1 825	5 075
Mooring/Unmooring	2 309	2 589
Garbage Dues (northbound only)	N/A	100
Extra Pilotage	N/A	1 800
Escort Tugs	N/A	13 786
First time Canal transit	2 550	N/A
Grand Total USD	256 713	429 723

Source: Wilhelmsen (2018)

To avoid major currency fluctuation, a special type of asset known as Special Drawing Right (SDR) is used to calculate the price of transiting the Suez Canal. SDR is calculated everyday based on a basket of the most important currencies in the world according to the International Monetary Fund (IMF). The basket of currencies is updated every five years to make sure it reflects the relative importance of currencies in the world's trading and financial systems (International Monetary Fund (IMF), 2018). Using SDR as a basis, shipping companies can easily calculate the price into US dollars or other relevant currencies.

Companies transiting the Canal are also facing other fees such as dues due to slow speed, towage dues and berthing dues. Of these, berthing dues is the most important for the cost of queuing. According to the Rules of Navigation, berthing dues are not payable by transiting vessels for the first 24 hours of their arrival in harbour. The free period can be extended if transit of the vessel is delayed due to traffic conditions in the Canal (Suez Canal Authority (SCA), 2015). Thus, a ship does not incur any additional berthing dues if it is placed far behind in the convoy. However, the statement does not state what happens if a ship is stopped due to inadequate documents, a common excuse among the controllers in the Canal (Sampson et al., 2016).

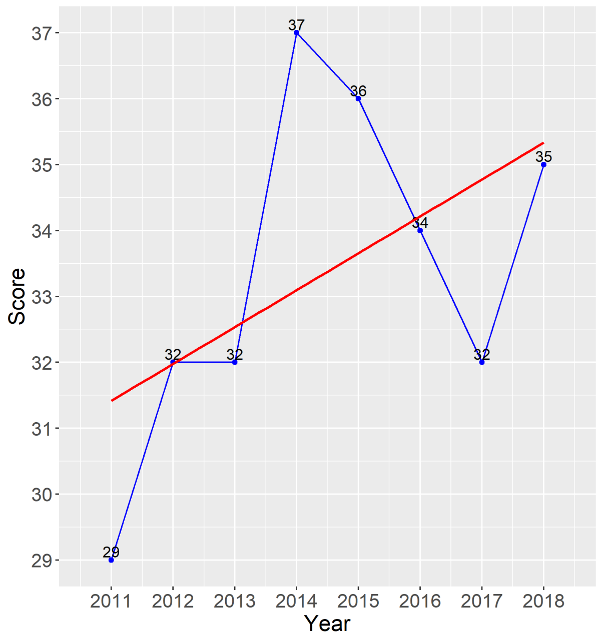
In addition to the dues imposed by the SCA, a ship faces other costs while waiting to enter the Canal. Laih et al. (2015) estimate the hourly cost of queuing of an average ship passing the Suez Canal to be US$944 per hour. They argue that the hourly cost of queuing at the anchorage can be considered as the fixed hourly cost, including depreciation allowance, interest, spare parts, maintenance, insurance, lubricants, manning, management and so on. This estimates exclude the cost directly related to crossing the Canal (Laih et al., 2015). Said simply, a ship still incurs costs such as wages to the crew when idle, which from an economic point of view would have been better spent sailing taking on new contracts.

2.2 Corruption in Egypt

The working definition of the concept of corruption used throughout this thesis will be the "abuse of entrusted power for private gain", a definition used by the World Bank (WB) and Transparency International (TI). Corruption can be classified into grand, petty, and political, depending on the amounts of money lost and the sector where it occurs (Transparency International, 2018b). Grand corruption consists of acts committed at a high level of government, petty corruption refers to everyday abuse of entrusted power by low- and mid-level public officials, and political corruption includes the manipulative actions by policy makers in the allocation of resources and financing (Transparency International, 2018b).

Corruption was one of the primary reasons that pushed the egyptian masses to rally in 2011 (Fayed, 2017). Corruption is often claimed to be a hinder for national economic development (Aidt, 2009), with some scholars claiming that corruption is more likely to occur in centralised developing countries than decentralised developed one (Fisman and Gatti, 2002). In 2018, Egypt - a highly centralised developing country - was given the score of 35 out of 100 in the CPI, with 100 being the least corrupt country and 1 being the most corrupt one ((Transparency International, 2018a)). Thus, companies doing business in andwith Egypt is likely to encounter corruption (Business Anti-Corruption Portal (BACP), 2018).

Figure 2.6: CPI scores for Egypt 2011-2018 and trend line



Egypt has a relatively strong legal framework to prevent and stifle corruption, despite the notable lack of a comprehensive anti-corruption law, freedom of information law and whistleblower protection (Fayed, 2017; Transparency International, 2015)) . The most important problem lies in the implementation of existing legislation (Fayed, 2017; Sequeira and Djankov, 2010). There are numerous institutions playing a role in fighting corruption, but their incentive structure make them more likely to focus on grand corruption cases than petty corruption incidents (Fayed, 2017). On the anti-corruption day (December 9th) of 2014, the government announced the launch of an anti-corruption strategy (Transparency International, 2015).

(Earth Observation Research Center (EORC), 2005). Navigating at 20 knots, it will take 24 days via the Cape of Good Hope, but only 14 days via the Suez Canal (EORC, 2005).

2.3 Anti-corruption

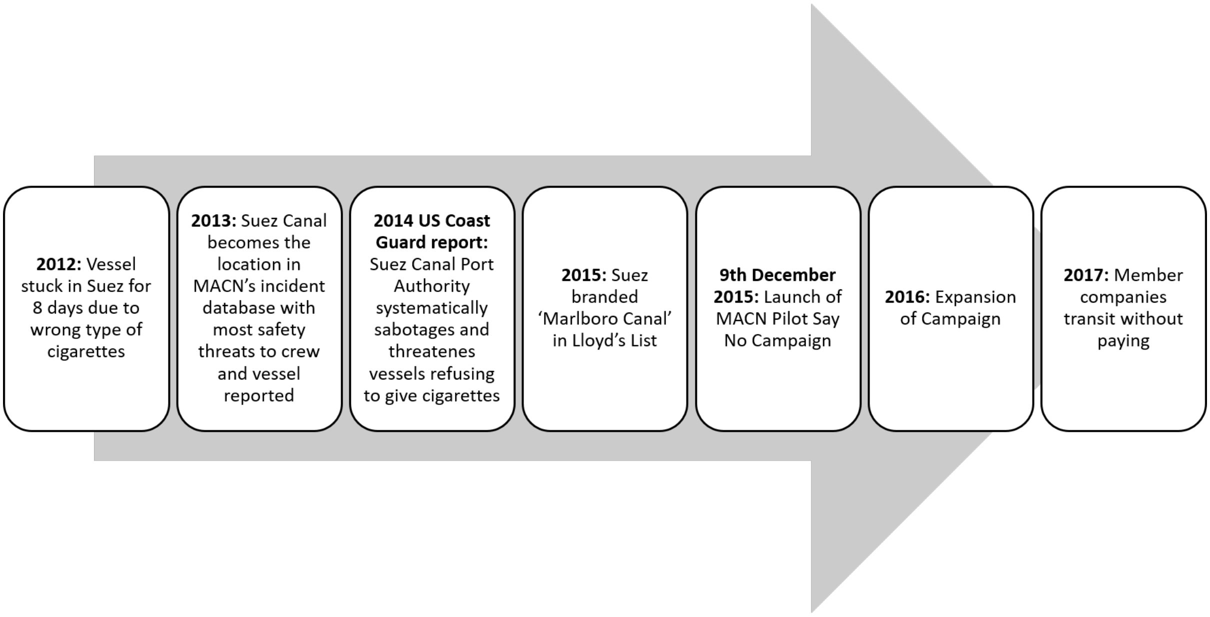
Anti-corruption initiatives aim at increasing integrity in the society by combating corruption. Anti-corruption work can usually be divided into four groups: laws and regulations, coordinated voluntary activities, uncoordinated voluntary activities and economic incentives (Søreide and Abramo, 2008)

Collective action refers to action taken together by a group of people whose goal is to enhance their status and achieve a common objective (Dowding, 2013). Collective action as an anti-corruption tool has the ultimate goal of changing the system by putting pressure on the receiver of the bribe, the system that condones it and institutions that fail to react. Thus, it is an important tool to help the private sector take proactive steps to tackle corruption. According to the World Bank Institute (2008, p.4) collective action, "increases the impact and credibility of individual action, brings vulnerable individual players into an alliance of like-minded organizations and levels the playing field between competitors". Collective action can complement and temporarily substitute for and strengthen weak local laws and anti-corruption practices (World Bank Institute, 2008).

MACN is a global business network that uses collective action as one of their tools to fight corruption in the maritime industry. MACN was formalised in 2012, and covers companies in the whole maritime industry, mainly consisting of vessel owning companies, but also including cargo owners and service providers. The goal of MACN is to identify and mitigate the root cause of corruption in the maritime industry and develop sustainable solutions (Bøhler, 2017). MACN collaborates with key stakeholders, including governments, authorities, and international organisations, towards the common goal of a corruption free maritime industry.

Egypt, and more specifically the Suez Canal, has become one of the preeminent examples of a successful industry-led anti-corruption collective action effort (Rabarijaona, 2017). Figure 2.7 illustrates major incidents reported by MACN and the development of their anti-corruption efforts.

Figure 2.7: From Marlboro Canal to zero tolerance transits



Source: Bøhler (2017)

3 Literature Review

This thesis wishes to bridge the gap in the literature by illustrating how human factors can affect waiting time in the Suez Canal, while simultaneously highlighting the possible cost of anti-corruption efforts such as collective action. In this section the most relevant literature regarding waiting time and anti-corruption efforts will be covered, and by so doing the gap in literature in the two fields will be identified. It will be shown how waiting time in ports is usually discussed within the field of port logistics, and that this field tend to study how technical factors affect waiting time rather than human factor. Similarly, it will be illustrated that there is a lack of literature concerning collective action as an anti-corruption tool within the field of corruption.

3.0.1 Waiting time in ports

An increasing number of publications investigates how port logistics can be improved through analysis using optimisation and simulation techniques. In this literature, waiting time is often used as a variable that can be considered as a proxy for procedural efficiency. This section will review the most relevant literature regarding waiting time in ports, and especially Suez if literature was available.

One way to minimise waiting time in ports is at the strategic level through deciding on the number of berths. For example, representing the earlier work in the field, De Weille and Ray (1974) investigates number of berth that optimises port capacity. Here optimal port capacity is defined as the equilibrium between ship waiting time and the cost of constructing and maintaining berths. Thus, waiting time is defined as the time a ship has to wait for a berth. In a similar study, Sheikholeslami et al. (2013), simulates berth allocation of the biggest container terminal in Iran, and find the optimal access channel depth and the number of berths to minimise waiting times. Here, waiting time is defined as all waiting times that are not related to ship operations, such as waiting for channel access, delays because of weather, waiting for tugs, etc.

Decisions to minimise waiting time can also be made at operational level, through allocating berths to vessels. This problem is known as the Berth Allocation Problem (BAP). Golias et al. (2009), for example, uses real data to optimise and proposes a berth scheduling policy that minimises the effect of late arrivals to the ocean carrier's schedule. Again, waiting time is defined as overall waiting time in port. This BAP is often discussed in relation to the Quay Crane Allocation Problem (QCAP). For example, Eltawil (2013) studies the whole container terminal operational supply chain in the Suez Canal region including decisions about terminal design, berth allocation, quay crane assignment, quay crane scheduling, container storage space allocation, container location assignment, retrieval, and pre-marshalling, as well as resource scheduling and terminal logistics in general. Naturally, waiting time in this article is defined as the turnaround time of ships at the container terminal. Abdelhafez and Eltawil (2013), also studying the Suez Canal, combines the BAP and QCAP while also considering convoy time schedule. In this article, waiting time is defined the total waiting time for all operations, including waiting time for berth, waiting time for unloading/loading, and waiting time to join a convoy.

Vessel traffic at waterway entrances gives rise to other challenging problems related to waiting time. For example, Franzese et al. (2004) present a simulation model of the Panama Canal traffic system. The authors incorporate vessel arrivals, traffic rules and vessel sequencing components into a model that is designed as a strategic planning tool with the objective to help the Panama Canal Authority. Waiting time is defined as time at anchorages and tie-ups, and is one of the key performance indicators presented in the article. In another simulation study, Almaz et al. (2006), illustrate the maritime transit traffic in the Strait of Istanbul, focusing on the modelling of the entrance procedures based on vessel types and lengths, prioritisation of vessels, pilotage and tugboat services, and the rules and regulations for entering the Canal. Studying the Suez Canal, Laih et al. (2015) suggest a non-queuing pricing system that they believe will reduce the waiting time to enter the Canal. The authors define the waiting time as the time required for registration plus the time queued at anchorage. The pricing model assumes a fair first come first basis for Canal entry. Using simulation tools, Clark et al. (1983) examine how optimisation of the Suez Canal vessel traffic management system can reduce waiting time for ships at Port Suez and Port Said and reduce baulking. The system will, according to the author, minimise the waiting time at the holding areas of Port Said, Port Suez and in Bitter Lake. Finally, Griffiths (1995) investigates the delays experienced by ships wanting to pass through the Suez Canal, and suggest a convoy allocation system for 48-hour cycle that minimises the queuing time. The author focuses on minimising total transit time, defined as the time of arrival at one end of the Canal to the exit of another end of the Canal.

In summary, the majority of the literature on waiting time in ports is related to BAP, QCAP or similar mathematical problems. Waiting time at waterway entrances have also been studied, but to a lesser extent. Studies focusing on waiting time for entering the Suez Canal is almost non-existent. Although mentioned in the limitations in much of the literature, hardly any of the scholars take into consideration the human factors that affect waiting time. Thus, how human factors, such as how different agents working in ports might have the power to affect waiting time in ports, have hardly, if at all, been studied within the field of port logistics.

3.0.2 Corruption in the maritime industry

The literature on corruption is huge, spanning a variety of disciplines such as economics (e.g. Blackburn et al. (2006)) , politics (e.g. Issacharoff (2010)), psychology (e.g. Rabarijaona (2017)), management (e.g. Sööt (2012)), and law (e.g Søreide (2016)). For this reason, this thesis will focus on the literature most closely related to the topic of this thesis.

Corruption in ports and borders involve a number of different actors. These actors, like guards, custom officials and port operators, have various opportunities to extract bribes due to their different level of discretionary power (power granted by statute or delegation). While there is extensive literature on corruption and anti-corruption in customs, there is little research specifically focusing on ports and borders, especially in Egypt.

Sampson et al. (2016) studies the relationship between ship personnel and shore-based personnel between the period of 2012 and 2016. The study shows that seafarers are vulnerable in ports, exposing an uneven balance of power between them. More specifically, Rabarijaona (2017, p.5) argue that, "ships earn money for owning companies when they are moving at sea; while anchored in ports, they incur huge costs. Aware that shipping companies are concerned about this issue, local officials might take advantage of the companies' desire to limit the time spent in port and usurp their authority to extort money or victuals from the ship's personnel. They could threaten them with delay, fines or with the tarnishing of the vessel's reputation".

Sequeira and Djankov (2010) documents the magnitude and determinants of bribe payments, and the impact of corruption, in essential public bureaucracy. More specifically, the scholars compare corruption in the ports of Maputo, Mozambique and Durban, South Africa. They identify three major consequences of corruption in ports: 1) a diversion effect where firms avoid the most corrupt ports to avoid bride extraction; 2) the revenue effect, as bribes reduce overall revenue, and 3) the congestion effect, as the "rerouting" of cargoes for avoiding bribes create regional imbalances in the regional transport network. Overall, there seem to be a broad consensus in the literature that port and border corruption have detrimental impact on shipping costs, trade, revenue collection, organised crime and security.

In order to curb corruption in ports, Igbanugo and Gwenigale (2011), suggest that the salaries of customer officials should be raised, custom procedures should be simplified and modernised, training and professionalism programs should be introduced, and routine inspections should be performed frequently. The author also suggest concrete steps that can be taken by companies operating in ports with corruption problems. These steps include adopting and enforcing clear policies prohibiting bribery, identifying and using low-bribery-level ports, introduce or enhance due diligence processes in selecting customs broker or clearing agent, require a written agreement that the agent will abide to the anti-corruption clause of the company, and finally engage a culturally competent auditor who can support the above processes.

Most governments declare zero tolerance for corruption and support international anti-corruption initiatives, but they fail when it comes to enforcing their criminal laws against foreign bribery. Michael and Polner (2008) illustrate the role national governments have played in introduction of anti-corruption programmes at borders and what has been the reason for their failure or success. Based on the successful cases the authors recommend that a system of guiding principles should be introduced rather than rigid rules, regulations should be reduced and finally, a system that enables investigation and successful prosecution of corruption must be in place in order for anti-corruption programmes to be effective. The latter is supported by Søreide (2018, p.22) who state that "unless governments are able to make their enforcement systems function effectively, the many softer anti-corruption initiatives will add up to nothing more than a pleasing façade of progress, behind which corruption will continue to wreak its damage".

Finally, literature on collective action within corruption tend to focus on how the problem of corruption might not be one based on the principal-agent problem, but instead might be based on the problem of collective action. This implies that in countries were corruption is perceived as 'normal' few may be willing to abstain from participating in corrupt exchanges or be reluctant to take the first step to enforce anti-corruption reforms (Marquette and Peiffer, 2015). However, there is a substantial lack of literature that covers collective action as an anti-corruption tool. The literature that seem to cover the topic in detail seems to be master theses (see for example Musopole (2017) and Beinset and Berger (2017)). To the best of this author's knowledge, there is no literature on the cost of anti-corruption efforts.

4 Data

This thesis consists of several data sources combined into panel data of vessels passing through the Suez Canal between 2012 and 2016. The data will be presented in further details below, and limitations of the data will be discussed.

4.1 Data sources

AIS

For information about ships passing the Suez Canal between 2012 and 2016, data derived from AIS is used. AIS data is registered when a satellite picks up the signal or when the ship is within reach of a land based antenna. There are two types of AIS data; dynamic and static. The length of a ship would serve as an example of static data, while time of observation would be an example of dynamic data. An AIS transceiver sends dynamic data every 2 to 10 seconds depending on a vessel's speed while underway, and every 3 minutes while a vessel is at anchor (International Telecommunication Union, 2014). The dynamic data gives information about the vessels Maritime Mobile Service Identity (MMSI) - a unique nine digit identification number - the date and time of observation, geographical coordinates, speed and so forth. Static data are broadcast every 6 minutes and include information about name, type, dimensions of ship, draught, destination, and Estimated Time of Arrival (ETA).

Several factors might influence the quality of AIS data. First of all, AIS is not the same as GPS. GPS is a satellite based navigation system that works in any weather conditions and in any positions in the world. AIS, on the other hand, is broadcast on Very High Frequency (VHF) radio waves which are sent in straight lines. This means that the signals that are picked up by land based receivers can be affected by atmospheric conditions and landmass (Xu et al., 2016). Amount of data being received by the land based antennas is also affected by number of ships in the area. In areas with many vessels, such as ports, signals may be lost due to signal interference (Xu et al., 2016).

If the data is based on satellite, then additional factors may affect the amount of data that is being picked up. Such factors include the quality of the satellite data, receiver, antenna and processing, how many satellites there are, the type of AIS transceiver on the vessel and so forth.

Furthermore, the AIS data is identified by MMSI number, which are allocated through flag registers. Therefore, MMSI numbers are not regulated and are not unique. For example, if a vessel change flag, their MMSI number may be reallocated to another ship. There are also cases where ships have shared the same MMSI number (Stewart et al., 2018). The result is that a vessels shows up with two locations at the same time, also known as "spoofing".

Finally, it is also possible to switch the AIS off, known as "going dark". Although this can be compared to driving down a busy highway without the car headlights on. This would be dangerous business as AIS is a collision avoidance system and Suez is a busy area. An alternative trick that can be used is to unplug or disrupt the GPS in the AIS, so that the vessel can see everyone, but no one else can see the vessel because it is transmitting incorrect coordinates. This is a trick that is used particularly by fishermen (Malarky and Lowell, 2018).

Clarksons WFR

The WFR provides detailed data about ships above 100 Gross Tonnage (GT) (Clarksons, 2018). It provides information about vessel specifications, machinery, flag, class, incident history, owner detail and builder details. Notice that the data acquired for this thesis is static, which means that it is constant over time.

MACN members

The list of members for 2016 was provided by MACN. Since the data for when companies joined was not available, the different members were contacted separately and the year of becoming MACN member was manually copied into the membership overview.

As a ship can change owners it was not possible to match the list of members by owner name. Therefore, the fleets of the MACN members were downloaded separately from the Clarksons World Fleet Register. However, this fleet represent the fleet they own as of today. Thus, a weakness of this thesis is that the specific ships that each companies owned for the separate years is not known. Nevertheless, a company is unlikely to change its fleet completely, so it should not affect the overall results significantly.

Some names of MACN members were not found in the database as they had merged with other companies since 2016. For example, the company Engie was not found in the database as its LNG part of the company has been acquired by Total (Europan Commission, 2018). However, Engie became member in 2017 so this did not cause a big problem. Furthermore, the list of members consisted of a mix of mother and daughter companies. This thesis, however, assumes that a membership in MACN concerns the whole company. For example, Maersk Line and Maersk Tankers are both listed in the list of members, and it is therefore assumed that all ships owned by the A.P. Moller–Maersk Group are guided by the same anti-corruption principles.

To the best of this author's knowledge, all of the ships that became members between 2012 and 2016 are still members today. The only exception was the company Engie which became part of MACN in 2017 and was no longer a member in 2018 as it was taken over by Total.

4.2 Data cleaning

Due to the large amount of data it was necessary to transform and clean the data to make it appropriate for analysis. The goal of the data cleaning was to end up with pairwise observations where the first would represent the first time the ship was observed in the anchorage area (north or south of the Canal), and the second would represent the entry into the Canal. The time within the pairs would represent the dependent variable, the waiting time.

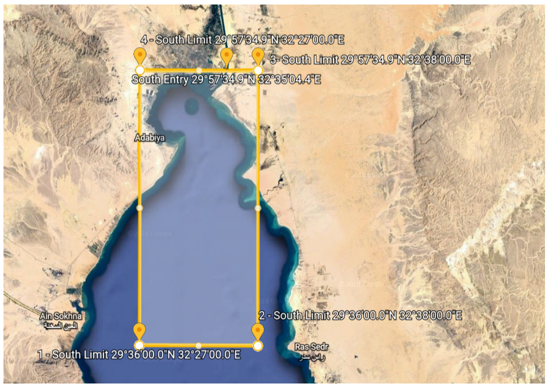
To make this happen, the following steps were taken:

First, the data sets, each representing a separate year, were joined together into one large data set containing about 3,5 million observations of ships' spatial positions in the Suez Canal area from 2012 to 2016.

All the observations contained data of geographical coordinates. Using the SCA rules of navigation the coordinates of the actual Suez anchorage area was determined. Observations outside of these coordinates were removed from the data set. Ships observed within latitude of 31.109 and 31.483 and longitude 32.350 and 32.467 was defined as being in the northern anchorage area, while vessels between latitude of 29.600 and 29.960 and longitude between 32.450 and 32.633 was defined as being in the southern entrance. Ships in between the latitudes of the northern and southern entrance were defined as being inside of the Canal. Thus, the latitude of 31.104 and 29.960 represent the entry lines for the northern entry and southern entry respectively. Ships are allocated to different anchorage points, some of which are close to the Canal whilst others are further away. This is not taken into account when determining the locations of the ships. However, anchorage location depends on the type and size of ships, which correlates with their preferential status. A ships preferential status will be used as one of the independent variables throughout the analysis in the later sections.

Figure 4.1: Polygon of northern anchorage

Figure 4.2: Polygon of southern anchorage



A ship could be observed several times in the anchorage area before it entered the Canal. As the thesis is concerned about waiting time, the start of this waiting time was defined as when the ship slowed down speed to less than 1 knot in the anchorage area. The timer would stop as soon as the ship was observed passing one of the entry lines to the Canal. Thus, this thesis defines waiting time as the first time a ship is observed at slow speed in the anchorage area of the Canal until it passes one of the defined entry lines. A ship observed in the north before entering the Canal was defined as southbound, and vice versa.

There were some special cases of ships that never slowed down the speed in the entry area. These ships were defined as direct ships and were given a waiting time of zero. However, some of these ships could spend several days and even weeks in the anchorage area before entering the Canal. Thus, an alternative waiting time, defined as the first time they were spotted in the anchorage area until they entered the Canal were saved for these ships. This would be used for robustness testing later in the analysis.

In some instances there were more than 30 days between each time a ship was observed. These observations were treated as outliers and therefore removed for the sample. For example, the same ship was observed in the north in January, in the north in February, inside in March and in the south in May. It was observed several times in January and May, but only once in February. Therefore, it was assumed that the observation in February represent a pass-by only, and would therefore be removed. However, since it would then be more than 30 days between the January observations and the observation inside in March these observations were also removed. The procedure is exemplified in Table 4.1 Since it takes 14 days for a ship to travel from Tilbury to Dammam through the Suez Canal (EORC, 2005), instead of around the horn of Africa which takes 24 days (EORC, 2005), it can be assumed that a ship is willing to wait 10 days or less to enter the Suez Canal. However, keeping only ships that waits less than 10 days might cause the waiting time to be artificially low. However, a ship waiting more than 30 days could imply that the ship is waiting for a new contract. Otherwise this would clearly be bad economics. In short, this thesis sample consists of ships with waiting time between 0 and 30 days. Not knowing the actually willingness to wait for ships is an important shortcoming of the data cleaning.

Table 4.1: Data set before and after removal of outliers (example)

Before			After		
IMO	**Time of observation**	**Location**	**IMO**	**Time of observation**	**Location**
1	14/01/2015 14:37:51	North	1	14/05/2015 23:57:51	South
1	14/01/2015 17:50:51	North	1	15/05/2015 03:45:51	South
1	15/01/2015 00:10:51	North	1	15/05/2015 04:37:51	South
1	15/02/2015 12:15:51	North	1	15/05/2015 15:00:51	Inside
1	15/03/2015 10:24:51	Inside	1	15/05/2015 16:11:51	Inside
1	14/05/2015 23:57:51	South			
1	15/05/2015 03:45:51	South			
1	15/05/2015 04:37:51	South			
1	15/05/2015 15:00:51	Inside			
1	15/05/2015 16:11:51	Inside			

Similarly, some of the ships were observed coming out of the Canal and entering the Canal again after a short time. Although there are ports less than one days sailing away from Suez it was determined that ships with less than than one day between an apparent exit and a new observation at the entrance again would be removed from the data set in order to avoid too many bunkering vessels, or vessels otherwise in very local trade, in the sample.

Furthermore, the vessels observed inside of the Canal were observed at different coordinates. Thus, the time of entry needed to be adjusted. As some ships was observed at speed zero inside the Canal while other was observed at speed 10, it was not possible to calculate exact entry time for each observation. Instead, the average speed of the main ships types inside the Canal were calculated. Using these averages, and the distance from the entrance line to the different coordinates, the time of entry was calculated and adjusted accordingly. However, calculating approximate time of entry based on average speed of ship type had some shortcomings. First, some ships that originally were observed very close to the entry line ended up with entry time earlier than the first time observed in anchorage. Second, some ships that were observed far inside of the Canal would would likely end up with an entry time calculated to be later than the actual time of entry. The former case was removed from the data set while the latter was kept.

Then, International Maritime Organization (IMO) (a unique ship identification number) was added to the data set based on a dynamic matching process. An IMO number remains unchanged upon transfer of the ship's registration to another country, while an MMSI number does not. Thus, it order to match the correct MMSIs in the two data sets to find the corresponding IMO, the MMSIs not only needed to be identical, but the time of the observation needed to fall within the time period of the MMSI. For example, a ship observed 2015-07-01 with an MMSI of 0001, would find its IMO number in the IMO data set for an MMSI match of 0001 and time period 2015-01-01 to 2015-31-12. Matches that resulted in different IMOs for ship at anchorage versus inside (pair of observations) were removed from the data set. For some ships it was not possible to find a matching IMO, or it was only found for one of the two observation pairs due to the time restriction of the MMSI. For such cases, which were few, the pair of observations were removed. All the remaining pairs of observations had the same pairs of MMSI and IMO.

Information about vessels such as DWT, Length Overall (LOA) and vessel type are provided by the Clarksons' WFR database. The Clarksons's WFR database also provide company identifiers, allowing to control for firm specific characteristics such as owner country. This is essential as it enables the possibility to identify treatment effects by looking at ships owned by the same company.

Additionally, the data set was joined with the list of MACN members. A dummy variable indicating MACN membership was created if there was a match between the IMOs of the two lists, and a variable indicating member year was appended to those instances.

To investigate whether there are differences between countries a variable representing owner country was added to the data set. Based on this, another variables representing owner region was made. Table 4.2 illustrate how countries are separated into the different regions.

Table 4.2: Regions classification

Region	**Countries (examples)**
EU	Germany, France, Greece, Spain, Italy, Sweden, Denmark, UK
Non-EU	Norway, Switzerland, Monaco, Ukraine,
North America	USA, Canada, Mexico, Bermuda, Cuba, Bahamas, Panama
Arab League	U.A.E., Jordan, Tunisia, Egypt, Iran
East Asia	China, Japan, S.Korea, Hong Kong, Taiwan
Asia Other	India, Philippines, Singapore, Russia, Malaysia, Azerbaijan, Uzbekistan
Other	Turkey, Israel, Angola, Chile, Australia, Fiji

Second to last, all vessels that had the vessel type 'work', 'service', 'service tug' or 'unknown' where removed from the data set. Since they are types of vessels that push or pull other ships, they do not represent ships that come to the Canal in order to avoid sailing around the Cape of Good Hope.

Finally, the four main dummy variables that would serve as the basis for the analysis was added to the data set. The first variable, *membership*, the main variable of interest, indicates whether the ship, or more specifically the owner company, was a MACN member at the time of observation. The variable takes the value of one if the ship observed was a MACN member at time of observations, zero otherwise. Companies and their corresponding ships who never joined MACN had a constant value of zero. The second variable, *northbound*, takes the value one if the ship at the time of observation was heading north, zero otherwise. The third variable, *preferential*, would take the value one if a ship was deemed preferential according to the SCA rules of navigation. As definition of preferential ship changed from before and after the opening of the Suez Canal, this would make it possible to control for possible changes in waiting time after the expansion. The final variable, *busy*, takes the value one if the number of ships in the anchorage area is above the average, and zero otherwise. The number of ships in anchorage is defined as the number of other ships in the anchorage area while a specific ship is waiting. For example, the specified ship would wait in anchorage from 10:00 to 20:00, and there could be 40 other ships in the anchorage area at the same time. If 40 is above the average number of ships in the waiting area than the variable takes the value one, zero otherwise. As dealing with dummies for above or below average could cause some loss of potential non linearity, the continuous equivalent of the variables are kept in the data set and will be used in the robustness analysis later in the analysis.

In summary, the data set originally consisting of 3,5 million individual observations of ships' spatial position were cleaned to consist of 57 942 pairwise observations that represents ships arriving at the anchorage area and entering the Suez Canal. The final data set serve as the basis for the descriptive statistics and analysis later on in this thesis.

4.3 Data shortcomings

The final data set has important shortcomings. First of all, as mention earlier in this thesis, there is variation in how often ships are observed. Some AIS data is broadcast every few seconds, while for other observations there can be several months between broadcast data. The uncertainty about whether this is an error in the data set or an actual representation of vessel behaviour, is a shortcoming of the data set.

The above shortcoming combined with not knowing the actual willingness to wait, might have led to artificial selection of the pairwise observations. In other words, a pair of observations might have 29 days between them, but it could be the case that the first observation in the anchorage area is a pass by only, and that the ship went straight into the Canal with zero waiting in anchorage area for the first observation inside.

The first observation in the anchorage area for the pairwise observations is, as a main rule, defined as the first time a ship is observed at slow speed within the polygon defining the anchorage area. However, ships are allocated to different anchorage points, some of which are close to the Canal whilst others are further away. Thus, the calculations of the waiting time does not take into account the location of the ship in the anchorage area. However, as discussed, this is likely to be accounted for in the analysis through the preferential variable.

As for the ships in the anchorage area, ships inside of the Canal are also observed at different coordinates. While the entry time is adjusted for this, the calculations of the entry time is not completely accurate. The main reason for this is that the speed of the ships are based on an average of all ships of the same ship type within the Canal. Since some ships are observed with Speed Over Ground (SOG) (measured in knot) 0, and other with SOG 8 it was not possible to adjust the entry time individually based on the speed of the separate vessels. As a result, some ships might have entered earlier than the adjusted time would imply, and some would have entered later. Also, a few ships are observed with SOG over 30. Considering that the speed limit within the Suez Canal is 16 km/h (approximately 9 knots) (Suez Canal Authority (SCA), 2015), this is most likely an error in the data set. However, since the average speeds for the different ship types were calculated to be between 7 and 9 knots, which is within the speed limit, this error did not have too much of an implication.

Because of the variation in data, it was not possible to control for ships that left the Canal. Some ships, for example, where observed in the north and the inside, but where never observed in the south. As the final data set only consist of pairwise observations of before entry and actual entry, this is not necessarily a problem. The shortcoming however, is that it might cause ships to be defined as passing the Canal, while in reality it might be a bunkering vessel. This is further complicated by the fact that the entry point of the Canal is set manually. For example, a ship sailing around in Port Said might wrongly be assigned as inside and outside the Canal, while it might not be passing through the Canal at all. The entry point was placed relatively far inside to try to avoid the latter problem, but the former problem is still a shortcoming in this thesis.

Service tugs and working vessels were also picked up by the AIS data and therefore removed from the final data set. However, since it is not known whether the ships that are being tugged turn of their AIS sender when being tugged, it might be that ships that are being tugged are removed from the data set simultaneously.

It can be assumed that ships that are loaded are less keen on waiting in line than ships that are not in a hurry. Therefore, it would have been useful to merge the dynamic AIS data set with the static AIS data set which include a variable for draught for the given observation. When attempting to merge the two data sets, however, only about half of the observations for this thesis' data set found a match in the static AIS data. There can be several reasons for this. First of all, there is a difference in how often the dynamic and static AIS data is broadcast. Finally, the static data sets had over 10 million observations for 2015, but only 1 million for the other years. As a consequence, most of the MMSI matches were found for the year 2015. However, since there were so few matches overall, the static data set was not included in the final data set in order to maintain a large sample for the analysis.

Details such as whether the ship was loaded or in ballast is also an important shortcoming that made it difficult to accurately classify ships as preferential or not according to the SCA rules of navigation. Similarly, some third and fourth generation container ships were deemed preferential under the Suez Rules of Navigation for the Old Suez Canal, but this thesis' data set had no such information. Therefore simplifications were made, which could result in ships being wrongly classified as preferential, and vice versa.

Only static data is provided from the Clarksons data set. Static data is also a weakness for the data provided by Clarksons. For characteristics that are constant, such as the length of a ship this is no problem. However, for characteristics that are constantly changing, such as the flag state of a ship or owner country, this causes a problem. This means that variables might not necessarily represent the flag state the vessel had at the time of observation. By definition, a flag state is the state in which a vessel is registered. In other words, the flag state of a vessel is the jurisdiction under whose laws the vessel is registered or licensed, and is deemed the nationality of the vessel (Anderson, 1996). The static variables are kept in the data set as it provides some insight, although having the more dynamic data would have made the variable much more interesting to analyse.

Finally, the legitimacy of the MACN membership might be questionable for some vessel. For example, Stena Sonangol is a MACN member and more importantly a joint venture between Stena and Sonangol. Stena, on the one hand, is another MACN member, while Sonangol, on the other hand, is a company which is accused of corruption in its home country (De Morais, 2010; Lewis, 2018). The anti-corruption stance of this company is therefore questionable. In other words, if the analysis of this thesis were to show that being a MACN member is significant for the waiting time in the Suez Canal, then this might weaken that result.

4.4 Descriptive statistics

The final data set combines information from various data sources into a detailed vessel-level data set covering the Suez Canal area. In the following, the data set will be described in more detail. Note that only the most important findings are reported here. More descriptive statistics can be found in the appendix.

Figure 4.3: MACN membership development (companies)

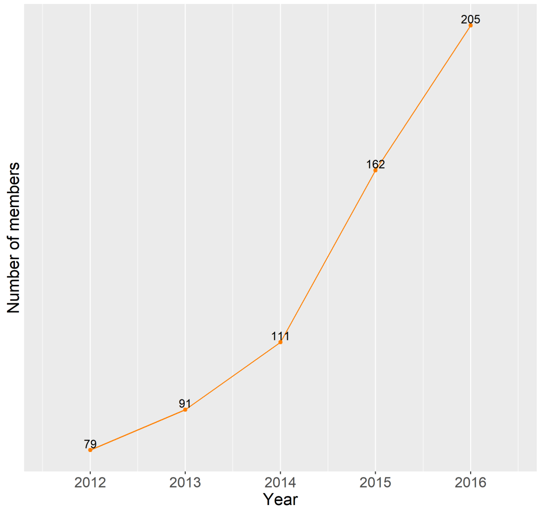


Figure 4.4: MACN membership development per owner region

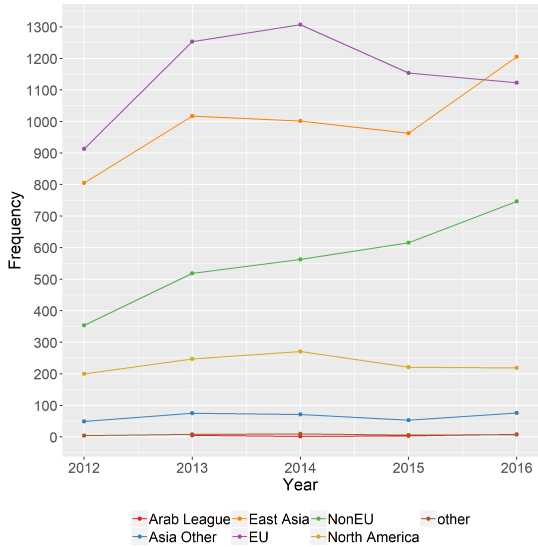


Figure 4.3 show the development of MACN members (companies) over time for this thesis' data. It shows that the growth of membership was initially slow, while it has pick up speed over the years. From 2012 to 2016 the membership rate had more than doubled. Please note that member company is defined somewhat differently than the official list of members as mentioned in the section on weaknesses.

The frequency of MACN members per year per region is displayed in Figure 4.4. It illustrates that the majority of MACN members come from European Union (EU) (Denmark, France), East Asia (Japan, China), Non-EU (Switzerland, Norway) and North America (United States)

Figure 4.5: Waiting time distribution MACN vs. non-MACN

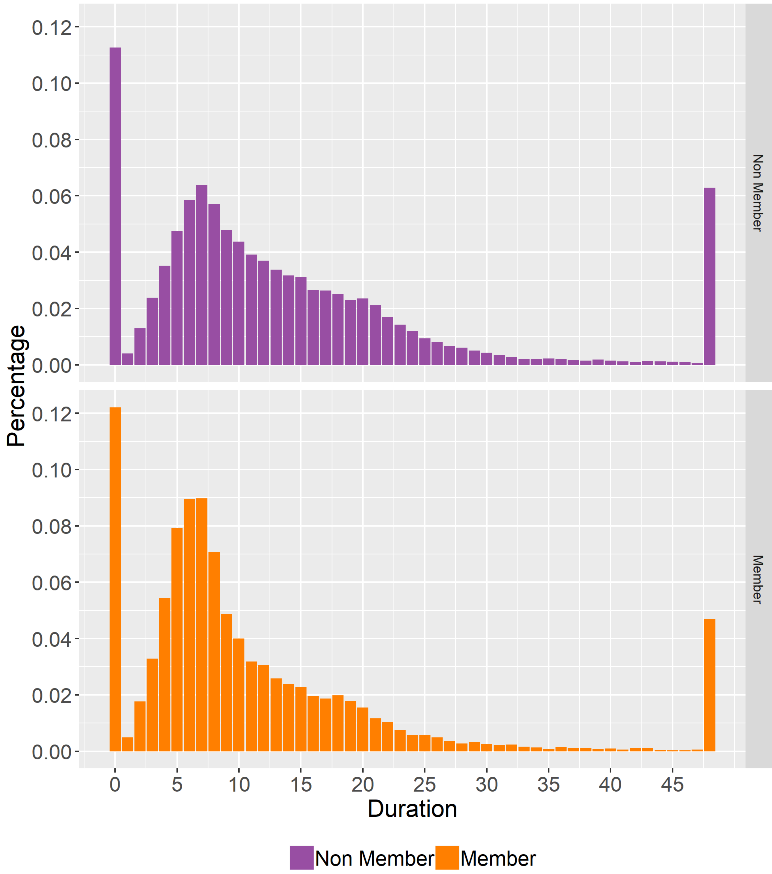


Figure 4.5 illustrate the distribution of waiting time in hours across MACN and non-MACN members. The figure shows that a large number of ships go straight to the Canal with no waiting, for both members and non-members alike. The possible weakness of vessel defined as direct has been discussed in the previous section. About 35% of MACN vessels wait between 0-4 hours, and about 27% of non-MACN members wait the same time. However, taking longer waiting times into account however, the difference in waiting time gets smaller and smaller. Nevertheless, in terms of the shortest waiting time there seems like MACN members has an advantage over non-MACN members.

Figure 4.6: Development waiting time (hours) per membership type

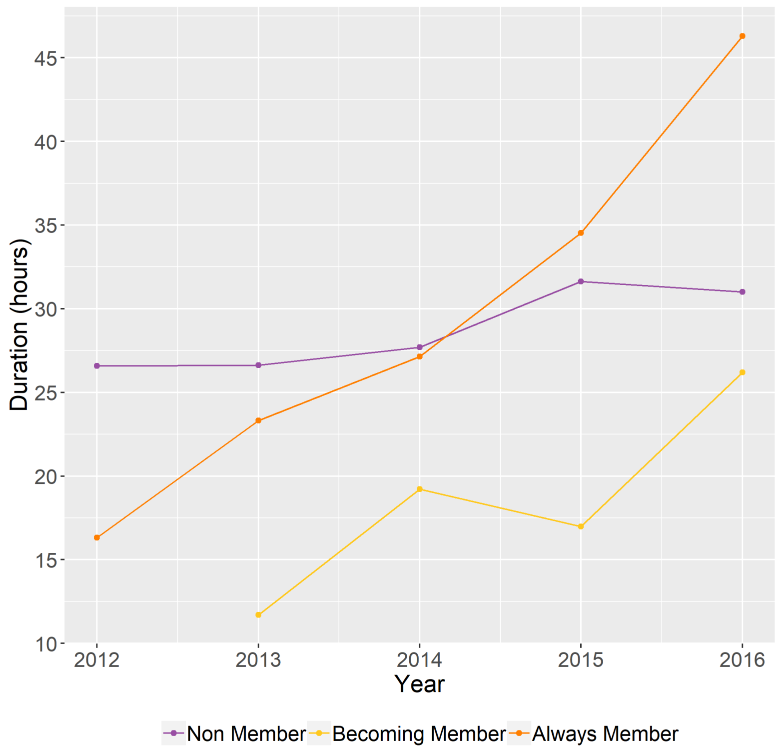


Figure 4.6 shows how waiting time has developed for initial MACN members of 2012, ships becoming part of MACN over the period, and ships never becoming members. More specifically, Figure 4.6 show how waiting time has increased steadily over time for the initial MACN members (always members). For non-MACN members the waiting time increased in 2014, before decreasing again in 2015. The figure also illustrates how waiting time has been affected as more and more ships become members. Overall, the waiting time seem to increase more for MACN members after 2015, the year of the initiation of the say-no campaign. Nevertheless, for the initial members the waiting time has increase to about the same level as non-MACN members. The possible implication of the increase after the introduction of the campaign will be discussed in more detail later.

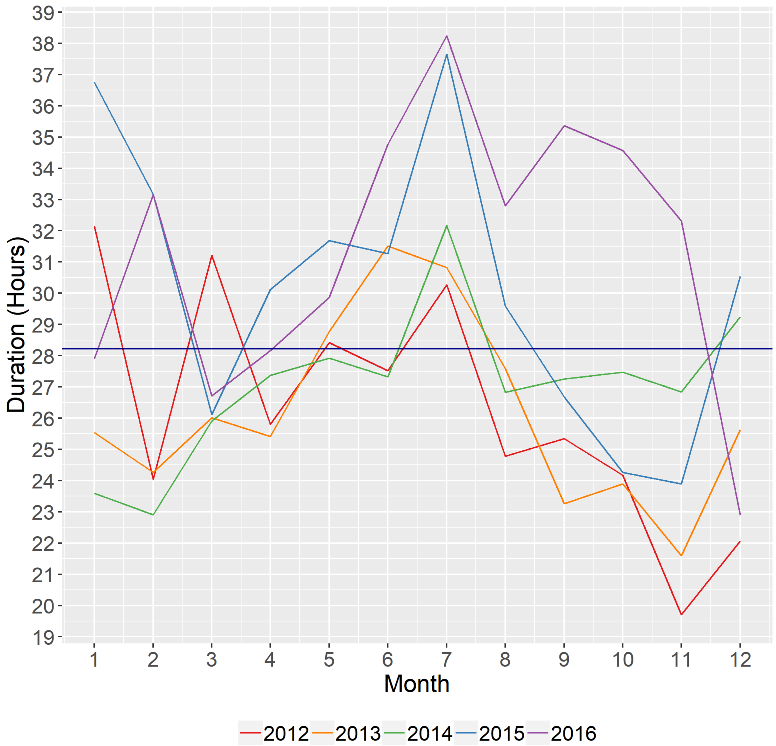
Table 4.3: Mean comparison test for static vessel characteristics

Variables		All	Not member	Member	Difference
Vessel type	Container	0.368	0.336	0.567	0.231***
	Bulker	0.168	0.191	0.026	-0.166***
	Tanker	0.118	0.126	0.067	-0.060***
	Chemical tanker	0.104	0.109	0.073	-0.036***
	Cargo general	0.073	0.084	0.009	-0.074***
	Liquefied gas	0.07	0.066	0.1	0.034***
	Vehicle	0.064	0.049	0.156	0.107***
	Roro	0.022	0.026	0	-0.026***
	Other	0.012	0.014	0.002	-0.012***
Deadweight	Less than 25,000	0.209	0.219	0.148	-0.071***
	25,000-50,000	0.147	0.151	0.122	-0.029***
	50,000-75,000	0.19	0.2	0.128	-0.073***
	75,000-100,000	0.135	0.118	0.24	0.121***
	100,000-125,000	0.144	0.135	0.199	0.063***
	125,000-150,000	0.071	0.079	0.022	-0.057***
	More than 150,000	0.104	0.097	0.142	0.045***
Owner region	European Union	0.429	0.417	0.508	0.092***
	East-Asia	0.226	0.221	0.254	0.033***
	Europe other	0.092	0.086	0.126	0.040***
	Arab League	0.084	0.098	0.001	-0.097***
	Asia other	0.07	0.077	0.021	-0.057***
	North America	0.054	0.048	0.089	0.040***
	Other	0.045	0.052	0.001	-0.051***
Number of observations	57,680	49,681	7,999		

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.3 illustrate selected static characteristics of vessel for MACN and non-MACN members. The table show that the difference in the characteristics of the two groups are significant and should be controlled for. In the analysis owner country will be used instead of region in order to get more accurate estimates.

Figure 4.7: Development of waiting time (hours)



In general, increased waiting time can be explained by factors such as the second south-bound convoy before the opening of the New Suez Canal (ships in the second convoy had to wait a longer period of time to enter), number of large ships wanting to enter the Canal (a slower speed limit is imposed on larger ships and will thus affect the time of entry for ships coming after), and how many ships are waiting to enter the Canal at the same time. However, Table 4.7 show that waiting times also seem to vary a lot per month and per year. There seems to be an overall increase in waiting time from June to July followed by a decrease from July to November. Hence, there seem to be some clear seasonality in the data set. It also looks like waiting time has increased over the years, indicating yearly differences. Thus, this time will need to be controlled for in the analysis.

5 Empirical strategy

5.1 Theoretical framework

This thesis aims to identify the causal interaction effect between waiting time at the Suez Canal and MACN membership. The inherent challenge with causal analysis is that each individual is observable only as treated (Y_{1it}) or as untreated (Y_{0it}), so that the individual causal effect of treatment, formally defined as $Y_{1it} - Y_{0it}$, is never observable (Angrist and Pischke, 2008). Instead, the outcome differences between treated and non-treated individuals are studied. The problem is, however, that unless the outcome of the two groups would have been equal absent of the treatment, the difference in outcome cannot be attributed to the treatment alone. Differences in the composition of the two groups may lead to what is called a selection bias, which which formally can be defined as differences in the expected outcomes absent treatment.

It is desirable that the treatment group and the control group to differ only in terms of their membership status and waiting time in order to identify the interaction between waiting time and MACN membership. In a ideal experiment, the waiting times and membership status would randomly be assigned across all the ships passing through the Suez Canal. With large-scale randomisation, it would be expected that the two groups would be statistically indistinguishable, meaning that any difference in outcome would be a result of the treatment only.[3] This is neither practically nor ethically possible. Nevertheless, the variation in waiting times, combined with different MACN subscription years in the shipping industry from around 2012, provide a natural experiment that goes a long way in removing any selection bias.

The two groups may be affected differently by other factors than just treatment, such as change in oil prices. Local changes, such as national anti-corruption campaigns, might also affect the treatment and control group differently. Therefore, it is important to ensure that the treatment and control group are as similar as possible, and, to the extent possible, to

[3]Notably, (Deaton, 2010) argues that randomisation should not be thought of as a 'gold standard'. It is beyond the scope of this thesis to discuss whether observational or experimental data would theoretically have been preferable. Therefore, this thesis simply note that the research question could not be studied with experimental data.

control for remaining differences. Time-invariant characteristics will be controlled for using random and fixed effects as will be explained below. Controlling for characteristics that vary over time introduced a potential problem since such characteristics may be affected by the treatment, introducing endogeneity.[4]. This thesis, therefore, use the common solution of time-invariant characteristics with a time indicator, which is a method to control for differential linear trends without introducing endogeneity.

In the following, this thesis will explain how suitable control groups can be created by the use of econometric techniques. These groups allows the view of waiting times and MACN membership status as exogenous shocks. More specifically, this thesis will show how an analysis based on unobserved effects models can control for unobserved differences between vessels with different waiting times. Next, it will be illustrated how entropy balancing solves the problem of self-selection. Finally, the Tobit model will be introduced and it will be explained how this model can control for the large number of zeros (caused by direct ships) in the data set.

5.1.1 Unobserved Effects Models

There might be a worry that the MACN subscription rate is not a completely exogenous shock. For instance, it may be expected that the ethical standards of companies (assumed constant) affects the MACN subscription rate. Ethical standards may also affect the outcome of interest because some companies might be free-riding for the reputation effects, while simultaneously behaving unethically. If variables that both affect the outcome and are correlated with the regressor, are not controlled for, the error term will no longer have zero conditional mean, and the Ordinary Least Square (OLS) estimator will no longer be unbiased (Wooldridge, 2016). For the case of this thesis, failing to control for the ethical standard of companies could lead to overestimation of the effect of MACN membership on waiting time.

However, there is no data on the ethical standards of companies. Instead, unobserved effects can be used to control for unobserved characteristics that are constant over time. The following exemplifies this; in a simplified setup MACN membership is as good as randomly assigned across the companies conditional on the unobservable fraction of

[4]'Bad controls' will be discussed in more detail in Section 6

companies with low ethical standards. Absent MACN membership, it is therefore expected that the outcome will be the same for those who join the MACN network and does who do not, conditional on their ethical standards. Formally, $E(Y_{0ijt}|c_j, \beta_{ijt}) = E(Y_{0ijt}|c_j)$ where the subscript 0 indicates the outcome without MACN membership, ij indicates the the vessel i belonging to company j and t the time, whereas β_{ijt} denotes the membership status and c_j denotes the ethical standard of company j.

The general unobserved effect model can be written as

$$Y_{it} = \alpha_t + x_{it}\beta + c_i + u_{it} \tag{5.1}$$

where x_{it} is $1 \times K$ and can obtain observable variables that change across t but not i, variables that changes across i but not t, and variables that changes cross i and t. c_i is the unobserved effect, such as ethical standards, sometimes also called the unobserved heterogeneity. If i indexed individuals (for a example a vessel), then c_i is sometimes called individual effects or individual heterogeneity. x_i is assumed to be constant over time. An unobserved effect is often interpreted as capturing features of an individual (for example a vessel), such as the relationship of the captain to the port personnel and the crew's previous experience with dealing with corruption, that, by assumption, are given and do not change over time.

Many methodological papers often discuss whether c_i should be treated as a random effect or fixed effect. c_i is called the "random effect" when used in a random effect model, and a "fixed effect" when used in a fixed effect model. In modern econometric, "random effect" is synonymous with zero correlation between the observed explanatory variables and the unobserved effects: $Cov(x_{it}, c_i) = 0$, while "fixed effects" allows for some correlation between the unobserved effect c_i and the observed explanatory variable x_{it}.

An important assumption behind the basic unobserved effect model is the strict exogenous assumption ($E(y_{it}|x_{it}, c_i) = x_{it}\beta + c_i$). Which means that once x_{it} and c_i is controlled for, x_{it} has no partial effect on y_{it}. Different ways of dealing with this assumption will be discussed later in this section.

For panel data there are two sources of variance: 1) the fact that companies are systematically different from one another (for example, company 1 is member of MACN, while company 2 is not), and 2) the fact that companies' behaviour varies between observations (for example, Company 1 was not a MACN member in 2013, but it was in 2015.) (Clarke, 2012). The former is known as between-group variation, while the latter is known as within-group variation. The between variation measures how much a group varies, on average, to the sample mean ($B = \sum_j \sum_t \bar{x}_j - \bar{j})^2$. In other words, the between variation measures the difference between the average waiting time for company j and the average waiting time of all companies. The within estimation measures how much a company varies at any particular point in time to its individual' mean $W = \sum_j \sum_t x_{jt} - \bar{x}_c)^2$. In other words, the within variation measures the difference in waiting time for company j at time t to its company j average.

Going back to the general panel model with modification

$$y_{jt} = a + x_{jt}\beta + u_j + \epsilon_{jt} \tag{5.2}$$

where u_j is company-specific, fixed over time, and ϵ_{jt} varies over time, and usual assumption apply (mean zero, homoscedastic, and uncorrelated with x, u or itself).

The between estimator is calculated taking the mean of all observations for company j

$$\bar{y}_{jt} = a + \bar{x}_{jt}\beta + u_j + \bar{\epsilon}_j \tag{5.3}$$

The within estimator (known as the fixed effect) is obtained by subtracting the mean

$$y_{jt} - \bar{y}_{jt} = (x_{jt} - \bar{x}_{jt})\beta + (\epsilon_{jt} - \bar{\epsilon}_j) \tag{5.4}$$

The random effect estimator is the weighted average of the within and between estimators

$$(y_{jt} - \theta\bar{y}_j) = (1-\theta)a + (x_{jt} - \theta\bar{x}_{jt})\beta + \{(1 - \theta u_j + (\epsilon - \theta\bar{\epsilon}_j)\} \tag{5.5}$$

where θ measures the weight given to between-group variation, and is derived from the variances of u_j and ϵ_j.

5.1.1.1 Random Effect Model

The random effect model can be written as

$$Y_{ijt} = x_{ijt}\beta + v_{ijt} \tag{5.6}$$

where $v_{ijt} \equiv c_{ij} + u_{ijt}$ are the composite errors.

If it is believed that companies would have joined MACN regardless of their ethical standards, in other words, that c_{ij} does not correlate with the regressors, then the random effect model would be appropriate. The random effects approach to estimating β effectively puts c_{ij} into the error term, under the assumption that c_{ij} is orthogonal to x_{ijt}, and then accounts for the implied serial correlation in the composite error $v_{ijt} = c_{ij} + u_{ijt}$ using GLS analysis (Wooldridge, 2011b).

Because c_{ij} is put into the error term, time-invariant characteristics can be added to the regression to account for vessel and company characteristics such as DWT, vessel type and owner country.

As the random effect model uses both within and between group variation, it makes the best use of the data and is therefore efficient. However, the model hinges on the assumption that u_{ij} is uncorrelated with x_{ij}, which is often highly unlikely (Clarke, 2012). In other words, unless the assumption holds that u_{ij} is uncorrelated with x_{ij}, the random effects model is inconsistent.

A random effect model is useful when one wants to draw inference about a population from which the treatments were sampled. As the random effects model allow for time-invariant characteristics, the model is useful for measuring difference between groups. Thus, in this thesis the random effect model will be used to estimate how the waiting time differs between companies that are members of MACN relative to the companies that are not.

5.1.1.2 Fixed Effect Model

The fixed effect model can be written as

$$Y_{ijt} = x_{ijt}\beta + c_{ij} + u_{ijt} \tag{5.7}$$

where c_{ij} is the unobserved effect.

As previously mentioned, it might be a worry that the ethical standards of companies is correlated with the membership status of a company. Lumping the unobserved c_{ij} together with the zero-mean error term u_{ijt}, would therefore violate the zero-conditional mean assumption, by giving an error term $\epsilon_{ijt} = c_{ij} + u_{ijt}$. Since ethical standards cannot be directly controlled for, in other word c_{ij} cannot be moved out of the error term, the fixed effect $\alpha_{ij} = \alpha + \gamma c_{ij}$ is included. Next, the following model is estimated:

$$Y_{ijt} = \alpha_{ij} + \theta\beta_{ijt} + u_{ijt} \tag{5.8}$$

Now, under the assumption that the causal effect of MACN membership on the outcome of interest is additive and constant, θ has a causal interpretation. Thus, fixed effects capture all characteristics that by assumption are constant over time. This makes it possible to estimate the relationship between MACN membership and the outcome of interest using only vessels and companies where the membership status varies over time.

Fixed effects can also be used for other units than vessels and companies. In general, fixed effects control for unobserved characteristics that vary on the time dimension and is constant on the unit dimension, or vice versa. For instance, month-year fixed effects control for characteristics that affect entire fleets in a given year in addition to controlling for seasonality affecting the entire fleet. Thus, the model controls for such things as new international shipping regulations and the construction work done before the opening of the New Suez Canal. With month-year fixed effects, the relationship of interest is estimated using only variations across units within each month and year.

Fixed effects can be included in a model in several ways. One way is to include dummies. In the example above, this would imply including dummies for all companies, years and vessels. Alternatively, fixed effects can be computed by within-group estimation, which is the deviation from the mean. In the MACN example, the the company averages could be calculated and subtracted from the model:

$$Y_{ijt} - \bar{Y_{ijt}} = (\alpha_{ij} - \bar{\alpha_{ij}}) + \theta(\beta_{ijt} - \bar{\beta_{ijt}}) + (u_{ijt} - \bar{u_{ijt}}) \tag{5.9}$$

Since α_{ij} is constant over time, it falls away. The last possibility is differencing:

$$\Delta Y_{ijt} = \Delta\alpha_{ij} + \theta\Delta\beta_{ijt} + \Delta u_{ijt} \tag{5.10}$$

Again, since α_{ij} has no time dimension, it falls away.

The fixed effect model ignores between-group variation, and it is therefore an inefficient estimator. However, as few assumptions are required, the fixed effects model is generally consistent and unbiased (Clarke, 2012). As the fixed effects model do not estimate time-invariant estimated, the model is useful for measuring differences within groups over time. Thus, in this thesis the fixed effect model will be used to estimate the effect of *becoming* member of MACN.

5.1.1.3 Hausman test

An Hausman test can be used to determine which of the random and fixed effects model are most appropriate for analysis (Wooldridge, 2016). The Hausman spesification test examines if the unobserved effects are uncorrelated with other regressors in the model. If the unobserved effects are uncorrelated with any other regressors, the random effect model violates a Gauss-Markov assumption and is no longer Best Linear Unbiased Estimate (BLUE). This is because unobserved effects are part of the error term in a random effect model.

Therefore, if the null hypothesis is rejected, a fixed effect model is favoured over the random counterpart. In a fixed effect model, unobserved effects are part of the intercept and the correlation between the intercept and regressors does not violate any Gauss-Markov assumption; a fixed effect model is still BLUE.

5.1.2 Entropy balancing

It may expected that larger publicly listed shipping companies, which are more scrutinised by the media and have more stakeholders, have incentives to become a member, and as a result increase the MACN subscription rate. Other companies might join the network because of the belief that MACN holds enough collective bargaining power to influence the waiting time of its members. Hence, companies that become part of MACN have self-selected themselves into the network rather than being randomly selected. Thus, there are likely to be differences in observed data between those who are members and those who are not. Entropy balancing can be used to control for such existing population differences. The method makes it possible to compare perfectly identical ships to one another.

Entropy balancing is used so that the group of vessels with no membership is reweighted to match the covariate means in the group of vessels with membership (Huang et al., 2017). This removes the problem of self-selection by removing pre-existing category of differences. Covariates used in preprocessing observational data should either be static indicators such as DWT or type of ship, or they should be measured prior in time to the treatment indicator on which balance is desired. This ensures that the covariates are not affected by the treatment. Covariates should be included when it is reasonable that they may simultaneously influence selection into treatment and the outcome measure (Huang et al., 2017).

Entropy balancing has several important advantages. The first is that entropy balancing directly balances covariates to preconditions (moments) set by the researcher (Huang et al., 2017). If the model converges, then balance has been achieved. Entropy balancing re-weights each observed case which is useful for panel data. In addition to directly balancing the covariates, this approach includes a second step in which the weights are redefined, with large weights being reduced to minimise the variance in the analysis that follow (Huang et al., 2017).

For convenience, the simplest scenario of entropy balancing, introduced by Hainmueller (2012), will be illustrated. The goal of entropy balancing is to re-weight the control group to match the preconditions (moments) of the treatment group in order to subsequentially estimate the Population Average Treatment effect on the Treated (PATT) $\tau = E[Y(1)|D = 1] - E[Y(0)|D = 1]$ using the difference in mean outcome between the treatment group and the reweighted control group (Huang et al., 2017). The counterfactual mean can then be estimated as

$$E[\widehat{Y(0)|D} = 1] = \frac{\sum_{(i|D=0)} Y_i w_i}{\sum_{(i|D=0)} w_i} \tag{5.11}$$

where w_i is the entropy balancing weight chosen for each control unit. These weights are chosen by the following reweighting scheme that minimised the entropy distance metric

$$\min_{w_i} H(w) = \sum_{(i|D=0)} x_i log(w_i/q_i) \tag{5.12}$$

subject to balance (equation 5.13) and normalising (equation 5.14) constraints

$$\sum_{(i|D=0)} w_i c_{ri}(X_i) = m_r \quad \text{with } r \in R, \text{ and} \tag{5.13}$$

$$\sum_{(i|D=0)} w_i = 1 \text{ and} \tag{5.14}$$

$$w_i \geq 0 \text{ for all } i \text{ such that } D = 0 \tag{5.15}$$

where $q_i = 1/n_0$ is a base weight and $c_{ri}(X_i) = m_r$ describes a set of R balance constraints imposed on the covariate moments of the re-weighted control group.

Because entropy balancing is conditional on static indicators this method will only be used with the random effects model later in the thesis. Nevertheless, it still serves the purpose of checking the robustness of the treatment and control groups.

5.1.3 Tobit Model

A large portion of the observations in this thesis' sample have waiting time of zero. A large amount of zeros in a data sample is known as censored data, and this could cause OLS to give biased upward estimates (Hopland, 2017). The Tobit model can be used in such cases.

Tobit is a maximum likelihood procedure that recognises the data set has data of two sorts, the limit observation (y=0) and the non-limit observation (y>0). The two types of observations that are observed, the limit observation and those that are positive, are generated by a latent (i.e. non observable) variable y^* crossing the zero threshold and not crossing that threshold. The latent variable can in a simplified model be written as

$$Y_i^* = \beta x_i + i_i \tag{5.16}$$

Following the approach of Hopland (2017), the observable variable can be defined as

$$Y_i = \begin{cases} y_i^*, & \text{if } y_i^* > 0 \Leftrightarrow \beta x_i + u_i > 0 \\ 0, & \text{if } y_i^* \leq 0 \Leftrightarrow \beta x_i + u_i \leq 0 \end{cases} \tag{5.17}$$

For the latent variable

$$E(y_i^*|x_i) = \beta x_i \tag{5.18}$$

$$\frac{E(y_i^*)|x_i}{x_i} = \beta \tag{5.19}$$

However, this is not observable. Instead, using Equation 5.16 and Equation 5.17 the expectation of the observed variable y_i can be written as

$$\begin{aligned} E(y_i|x_i) &= p(y_i = 0|x_i)(0) + p(y_i > 0|x_i)E(y_i|x_i, y_i > 0) \\ &= p(y_i > 0|x_i)E(y_i|x_i, y_i > 0) \end{aligned} \tag{5.20}$$

Defining a dummy, w_i, equal to 1 if $y_i > 0$ and 0 if y_i, and considering the probability that $y_i > 0$,$p(y_i > 0|x_i)$, it can be written that

$$\begin{aligned} p(w_i = |x_i) &= p(y_i > 0|x_i) \\ &= p(u_i > -\beta x_i|x_i) \\ &= p(\frac{u_i}{\sigma} > \frac{\beta x_i}{\sigma}|x_i) \\ &= \Phi(\frac{\beta x_i}{\sigma}), \frac{u_i}{\sigma}\ N(0,1) \end{aligned} \tag{5.21}$$

Equation 5.21 is the (probit) probability that $y_i > 0$ (Hopland, 2017).

In short, the likelihood for Tobit includes one term which gives the contribution from observations with $y_i = 0$ and one which gives the contribution for observations where $y_i > 0$

$$\Pi_{y_i=0}(1 - \Phi(\frac{\beta x_i}{\sigma}))\Pi_{y>0}(\frac{1}{\sigma}\phi(\frac{y_i - \beta x_i}{\sigma})) \tag{5.22}$$

Using Equation 5.21, Equation 5.22 can be written as

$$\Pi_{i=1}^{N}(1 - \Phi(\frac{\beta x_i}{\sigma}))^{1-w_i}(\frac{1}{\sigma}\phi(\frac{y_i - \beta x_i}{\sigma}))^{w_i} \tag{5.23}$$

and the log likelihood given by

$$\Pi_{i=1}^{N}\log(1 - \Phi(\frac{\beta x_i}{\sigma}))^{1-w_i}\log(\frac{1}{\sigma}\phi(\frac{y_i - \beta x_i}{\sigma}))^{w_i} \tag{5.24}$$

As the Tobit model does not rely on conditions such as static data, this model can be used for both random effects model and fixed effects models (Honoré, 1992).

5.2 Identification strategy

In order to analyse how waiting time interacts with MACN membership, this thesis estimate the following model:

$$\begin{aligned} Y_{ijt} &= \alpha_0 + \alpha_1 \times membership_{jt} \\ &\quad + \beta X_{ijt} + \lambda_j + \theta_t + \eta_c + u_{ijt} \end{aligned} \tag{5.25}$$

where

$Y_{ijt}T$: Waiting time (outcome) at time t for vessel i belonging to company j.

$Membership_{jt}$: a dummy that describes the membership status of company j at observed at time t (1 if member, 0 otherwise)).

X_{ijt} : a set of vessel level and company characteristics

λ_j : are company fixed effects, capturing time-invariant characteristics at the company level

θ_t : are month-year dummies, capturing common time shocks and seasonality

u_{ijt} : is a zero-mean error term

α_0 : is a constant given in the model

α_1 : measures how the effect of membership (in random effect model) and the effect of becoming member of MACN, conditional on no former MACN membership (in fixed effect model). The coefficient of interest

In Equation 5.25, implicit assumptions about the vessels are made. It is assumed that companies that become members of MACN and act according to MACN standards for the full year. Since the data does not include the exact date of membership, it is assumed that members joined on January 1st of the specific year.

The standard errors are clustered at the company level for two reasons. First, vessels within a group may have similar background and may be exposed to the same environmental factors (Wooldridge, 2016). In such cases, there might be substantial correlation between the outcomes within a group, which must be accounted for by adjusting the standard errors. This is particularly important when using regressor with little within-group variation, as the correct standard error may then be much larger than the conventional ones. Therefore, the standard errors are clustered at the company level, both in order to account for shared background characteristics, and because MACN membership vary only at company level. Since the sample used in this thesis consist of over 2000 companies, the consistency of the clustered estimator should not be an issue.

Clustering at company level also solves another problem, namely that of serial correlation in the error terms. With panel data, shocks that are common to all vessels within countries and years, such as financial shocks or local reforms, may confound the estimates since it will be hard to distinguish the causal effect of treatment from the effect of the local shocks (Angrist and Pischke, 2008). The problem can be mitigated by including multiple periods and/or multiple groups, increasing the chance of such shocks being zero on average. Still, it may be expected that shocks are serially correlated across time. The problem can be solved by clustering at a higher level, as long as the higher level includes at least 42 clusters. For this thesis, since the sample consist of a large number of companies, clustering at company level mitigate the problem of potential company-year-level shocks.

6 Results

Below, the results of the analysis is presented. First, the result are presented using random effects and fixed effects respectively. Then, the results for various subgroups are presented in order to investigate whether there may be heterogeneity by membership status, or geographical area. Lastly, by changing a variety of assumption the robustness of the results are verified.

6.1 Main results

6.1.1 Random effects model

Table 6.1 present the random effects results of ships that passed the Suez Canal from 2012 to 2016. In the random effect model the variable *membership* illustrate the difference between MACN members and non-MACN members. For waiting time, logs is used in order for the linearity assumption to be more closely satisfied, and to make the estimates less sensitive to outliers (Wooldridge, 2016). All regressions include dummy variables combined of month and year. In addition, all regressions include dummy variables indicating whether the ship is heading north, is preferential according to the SCA rules of navigation, and whether the number of ships in the anchorage area where above average. Standard errors are clustered at company level. Column 1 show the results using the main independent variable only. Column 2 presents the estimate obtained from the specification that includes month-year dummies. Column 3 shows the result using all control variables. Finally, column 4 show the Tobit results. Pseudo R^2 is reported for the Tobit result.

For column (1) membership is negative and significant, indicating that MACN member have shorter waiting time at the Suez Canal. In column (2), membership is still negative, and even more significant when including a month-year time trend. This indicate that there are certain seasonal characteristics that can explain some of the difference in waiting time. Column (3) illustrate that waiting time become somewhat less significant when controlling for other variables such as preferential status, how many other ships that are waiting, individual vessel characteristics and owner country. However, the results remain

Table 6.1: Random effects results

	(1) RE	(2) RE	(3) RE	(4) Tobit
Membership	-0.0495**	-0.0682***	-0.0244*	-0.0267*
	(0.0182)	(0.0171)	(0.0102)	(0.0109)
Northbound			0.0506**	0.0923***
			(0.0166)	(0.0166)
Preferential			0.000866	0.00252
			(0.0195)	(0.0208)
Busy			1.182***	1.176***
			(0.0568)	(0.0596)
Constant	0.468***	0.392***	0.309***	0.163***
	(0.0107)	(0.0402)	(0.0404)	(0.0495)
Month-Year Dummies	no	yes	yes	yes
Vessel: Type+DWT+Flag	no	no	yes	yes
Owners: Country	no	no	yes	yes
Observations	57680	57680	57680	57680
R^2 - pseudo R^2	0.0001	0.0160	0.415	0.2390

Notes: Each column represents a separate regression where the outcome of interest is regressed on a dummy indicating whether the vessel was part of MACN at the time of entering the canal. All regressions include time dummies. In addition, all regressions include dummies specifying whether the ship was northbound, was preferential according to the SCA rules of navigation, and whether the traffic was above average. The dependent variable is the number of days waited to enter the canal. Vessel and firm characteristics indicates what control variables are included in the specification. The sample includes all non-missing observations for vessels entering the canal between 2012 and 2016. Robust standard errors clustered at the owner level are shown in parentheses. Pseudo R^2 is reported for the Tobit result. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

negative and somewhat significant. Finally, in column (4) when controlling for a large amount of zeros in the data set, it can be seen that waiting time remains negative and somewhat significant. This confirms that even though the data has an upward bias that the findings are robust. All in all, the results seem to indicate that MACN members overall has lower waiting times than non-MACN members.

For the other variables, column (3)-(4) show that the coefficients for northbound, preferential and busy are positive, but differ in terms of significance level. For column (3) for example, if a ship is northbound, preferential and coming at a busy time period, the waiting time is likely to increase by 5.06%, 0.08% and 118.2% respectively.

6.1.2 Entropy balancing results

Table 6.2: Entropy balancing results

	(1) RE	(2) RE	(3) RE	(4) Tobit
Membership	-0.0154*	-0.0154*	-0.0254***	-0.0271***
	(0.00704)	(0.00695)	(0.00720)	(0.00802)
Northbound			-0.00352	0.0295***
			(0.00532)	(0.00601)
Preferential			0.0123	0.0180*
			(0.00764)	(0.00847)
Busy			1.246***	1.239***
			(0.0294)	(0.0312)
Constant	0.434***	0.416***	0.350***	0.216
	(0.00373)	(0.101)	(0.0902)	(0.116)
Month-Year Dummies	no	yes	yes	yes
Vessel: Type+DWT+Flag	no	no	yes	yes
Owners: Country	no	no	yes	yes
Observations	57680	57680	57680	57680
R^2	0.0002	0.0232	0.431	

Notes: Each column represents a separate regression where the outcome of interest is regressed on a dummy indicating whether the vessel was part of MACN at the time of entering the canal. All regressions include time dummies. In addition, all regressions include dummies specifying whether the ship was northbound, was preferential according to the SCA rules of navigation, and whether the traffic was above average. The dependent variable is the number of days waited to enter the canal.Vessel and firm characteristics indicates what control variables are included in the specification. The sample includes all non-missing observations for vessels entering the canal between 2012 and 2016. Robust standard errors clustered at the owner level are shown in parentheses. Statistics such as pseudo R^2 and Chi^2 are inappropriate for the balanced Tobit.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6.2 show the exact same regressions as in Table 6.1, but with entropy balancing. In other words, the ships now have completely identical characteristics. The selected covariates for entropy balancing are DWT (8 dummies), type of vessel (9 dummies), month-year dummies, preferential and busy. Neither Chi^2 nor pseudo R^2 is reported for the balanced Tobit because the assumption that cases are independent of each other is violated (Williams, 2015).

Column (1) show that the effect of MACN membership on waiting time is negative and somewhat significant. However, the effect is less than when using the unbalanced sample in Table 6.2. Column (2) show the exact same results as Column (1) because month-year dummies also have been balanced. The coefficients in column (3) and (4) have almost the same value as in Table 6.1, but the effect of membership is highly significant. Thus, when the characteristics among MACN members and non-MACN members are completely identical, the effect of being a MACN member becomes highly significant. Thus, the results in Table 6.1 remain robust when accounting for self-selection.

6.1.3 Fixed effects model

Table 6.3 present the fixed effects results of ships that passed the Suez Canal from 2012 to 2016. All specifications remain the same as with the random effects model. However, the interpretation of the membership variables has changed. Now, the variable *membership* illustrate how *becoming* member of MACN affects waiting time. Column 1 show the results using the main independent variable only. Column 2 presents the estimate obtained from the specification that includes month-year dummies. Column 3 shows the result using all control variables. Finally, column 4 show the fixed effects Tobit results. Chi^2 is reported for the Tobit fixed effect regression.

For column (1) membership is positive, indicating that becoming a MACN member increases the waiting time. However, the result is not significant. In column (2), membership is negative, but still not significant when including a month-year time trend. Column (3) illustrate that the difference in waiting time becomes somewhat lower when controlling for other variables. Nevertheless, the result are still not significant. Finally, when controlling for a large amount of zeros in the data set, it can be seen that the waiting time remains negative, but becomes significant. This suggest that there is an upward bias in the data set. This will further be analysed in the robustness analysis later in the analysis.

As with the random effects model, columns (3)-(4) show that the coefficients for northbound and busy, are positive, and preferential is negative. The significance level of northbound and preferential increases under Tobit. The direction a ship is heading is less significant in the fixed effect model (column (3)) than under the random effect model (column (3)).

Table 6.3: Fixed effects result

	(1) FE	(2) FE	(3) FE	(4) FE Tobit
Membership	0.0571	-0.0415	-0.0266	-0.0254**
	(0.0298)	(0.0312)	(0.0175)	(0.00831)
Northbound			0.0435*	0.0305***
			(0.0191)	(0.0049)
Preferential			-0.0154	-0.0213**
			(0.0226)	(0.0327)
Busy			1.097***	2.002***
			(0.0627)	(0.0327)
Constant	0.454***	0.372***	0.249***	
	(0.00413)	(0.0488)	(0.0357)	
Month-Year Dummies	no	yes	yes	yes
Vessel: Type+DWT+Flag	no	no	no	no
Owners: Country	no	no	no	no
Observations	57680	57680	57680	57689
R^2 - Chi^2	0.000	0.017	0.355	7124.8

Notes: Each column represents a separate regression where the outcome of interest is regressed on a dummy indicating whether the vessel was part of MACN at the time of entering the canal. All regressions include time dummies. In addition, all regressions include dummies specifying whether the ship was northbound, was preferential according to the SCA rules of navigation, and whether the traffic was above average. The dependent variable is the number of days waited to enter the canal. Additionally, owner fixed effects are controlled for. Effects are therefore identified as deviations from the trend. Vessel and firm characteristics indicates what control variables are included in the specification. The sample includes all non-missing observations for vessels entering the canal between 2012 and 2016. Robust standard errors clustered at the owner level are shown in parentheses. Chi^2 is reported for the FE Tobit regression.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.1.4 Hausman test

In order to determine which unobserved effect model is most appropriate, a Hausman test is performed.

Table 6.4: Hausman test

	Coefficients			
	(b) Fixed	(B) Random	(b-B) Difference	sqrt(diag(V b-V B)) S.E.
Membership	-0.0266	-0.0244	-0.00212	0.0109
Northbound	0.0435	0.0506	-0.00710	0.00196
Preferential	-0.0154	0.000866	-0.0163	0.00457
Busy	1.097	1.182	-0.0851	0.00337

b = consistent under Ho and Ha;
B = inconsistent under Ha, efficient under Ho;

Test: Ho: difference in coefficients not systematic

chi2(63) = 715.3
Prob > chi2 = 0.000

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The Hausman test illustrated by Table 6.4 strongly reject the null hypothesis with a p-value of 0.000. This means that the unobserved effect c_{ij} correlates with one or more of the independent variables. As a consequence, a random effects model will not be consistent and the results indicate that a fixed model is the preferred analytical tool to analyse the Suez Canal data. Thus, based on the Hausman test, regression (3) in Table 6.3 will serve as the base for the heterogeneity and robustness analysis to come.

6.2 Heterogeneous effects

In this subsection, a heterogeneity analysis is testing whether there are differences between the different subgroups. More specifically, whether there are differences between southbound or northbound ships, preferential and non-preferential ships, and busy and non-busy times in the anchorage area is tested. The interaction terms test whether the effects of being a member is different between subgroups, while the linear combinations estimate the effect of membership for the specified subgroup.

Table 6.5: Heterogeneity analysis on waiting time

	(1) FE	(2) FE	(3) FE	(4) FE
Membership	0.00338 (0.0274)	-0.0247 (0.0192)	-0.0246 (0.0223)	-0.000815 (0.0512)
Membership × Northbound	-0.0526 (0.0499)			-0.208 (0.115)
Membership × Preferential		-0.00353 (0.0223)		0.103 (0.0845)
Membership × Busy			-0.0287 (0.142)	-0.203 (0.256)
Constant	0.244*** (0.0344)	0.249*** (0.0357)	0.249*** (0.0358)	1.301*** (0.0966)
N	57680	57680	57680	57680
Adj. R^2	0.355	0.354	0.355	0.147
Membership(B)	-0.0492 0.0323	-0.0283 0.0220	-0.0534 0.128	

Notes: Each column represents a separate regression where the outcome of interest is regressed on a dummy indicating whether the vessel was part of MACN at the time of entering the canal. The linear combination is the effect of being in subgroup B, which is the subgroup interacted with "Membership" in the relevant column. The sample includes all non-missing observations for vessels entering the canal in between 2012 and 2016. Robust standard errors clustered at the owner level are shown in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Column (1)-(5) in table 6.5 show the heterogeneity analysis for the different subgroups. Column (1) shows the estimated coefficients from the main empirical specification with an interaction term between the variables "Northbound" and "Membership". The estimated effect of membership on southbound ships is 0.338% increase in waiting time. However, the result is not significant. The corresponding effect for northbound ships is -4.92%, indicate that being a MACN member and heading north reduces the waiting time, but that the effect is not significant. This could indicate that changing membership status has a more significant effect for ships heading north than south. However, since the difference among them, represented by the interaction term, -5.26%, is not significant, no so such conclusion can be drawn.

From column (2), it can be observed that the effect of membership is negative for both preferential (-2.83%) and non-preferential ships (-2.47%). None of the results are significant. Again, as in the previous case, no significant heterogeneity is observed between the subgroups.

Column (3) for busy and non-busy periods show similar results as in the previous cases. The effect of membership is negative for both busy (-5.34%) and non-busy periods (-2.46%), but not significant for any of them. Again, since the difference among them is not significant, no conclusion can be drawn about the significant effect of membership in this case.

Column (4) illustrate the regression result with all interaction terms included confirming that none of the control variables drive the result. Thus, there is no evidence that effect of membership on the waiting time depends on the direction, the status of a ship, or a busy period. Hence, there are reassuring evidence that the lack of significant interaction effects does not hide substantial effects for southbound ships, non-preferential ship, or non-busy.

6.3 Sensitivity analysis

In this subsection a variety of robustness checks are presented. First, the main assumptions made in this thesis will be changed in order to test how they affect the results. Lastly, the robustness of the results are verified by excluding selected observations that may differ from the rest of the sample. To avoid clutter, only the coefficient of main interest, that is, how waiting time is affected by membership, is reported. The row name describes which assumption is changed.

6.3.1 Basic robustness test

Table 6.6 shows how the results are affected by changing various assumptions. In the analysis presented in first row of Table 6.6, the assumption of time of membership is changed. By assuming that a company and its ship became members at the end of the year instead of the beginning, a different membership "treatment" is implicitly assumed. The effect of membership remains negative and insignificant.

In rows two and three,waiting time is transformed into non-log-transformed and into hours respectively. This is to verify that the results are not driven by how the waiting time is

Table 6.6: Basic robustness tests

	(1) FE
Member at the end of the year	-0.00608
	(0.0244)
Observations	57680
R^2	0.354
Not log-transformed	-0.0128
	(0.108)
Observations	57680
Adjusted R^2	0.359
Hours	-0.0083
	(0.0631)
Observations	57680
Adjusted R^2	0.101
Non-direct ships	-0.0157*
	(0.00797)
Observations	57680
Adjusted R^2	0.798
Anchorage continuous	-0.00908
	(0.0200)
Observations	57680
Adjusted R^2	0.398

Notes: The row name describes which assumption is changed. Only the coefficient for the effect of membership is reported. All regression include month-year dummies. The dependent variable is the number of days waiting to enter the canal. All specifications include dummies for northbound, preferential, and busy. Additionally, owner fixed effects are controlled for. Effects are therefore identified as deviations from the trend. The sample includes all non-missing observations for vessels entering the canal between 2012 and 2016. Robust standard errors clustered at the owner level are shown in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

specified. These changes in assumption does not seem to change the significant effect of MACN membership on waiting time.

How the result is affected by changing the assumption of direct ships, is displayed in the fourth row. In the main results direct ships are assumed to have a waiting of zero. In the fourth row waiting time for direct ships are based on the first time the ship is observed in the waiting area until it enters the Canal. Changing the assumption of waiting time for direct ships does not change the negative effect on waiting time, but makes the effect significant.

In the final row, the dummy variable indicating whether the number of ships in the anchorage area were above or below average is replaced by a continuous variable representing the number of ships at anchorage. The effect of membership remains remains negative and insignificant.

6.3.2 Selected parts of sample

This thesis then turn to excluding parts of the sample in order to verify that particular observations do not drive the results. In table 6.7, each row represents a different regression. The specifications are unchanged from the main analysis.

The first and second row of Table 6.7, verify that the results are not driven by outliers in waiting time. The 1st and 99th percentile of the outcome are removed respectively, before re-running the analysis. Every column therefore represents a separate sub-sample. Since the independent variables are dummies, removing outliers from these make no sense. Both coefficient remain negative, and insignificant. This verifies that the lack of significant effect identified in the main analysis is not driven by outliers.

Table 6.7: Removing selected part of the sample

	(1) FE
Removing 1st percentile outcome	-0.0266
	(0.0175)
Observations	57680
Adjusted R^2	0.354
Removing 99th percentile outcome	-0.0167
	(0.0177)
Observations	57104
Adjusted R^2	0.291
Removing large ships	-0.0272
	(0.0175)
Observations	57030
Adjusted R^2	0.355
Removing most busy periods	-0.0145*
	(0.00615)
Observations	52482
Adjusted R^2	0.114

Notes: The row name describes which assumption is changed. Only the coefficient for the effect of membership is reported. All regression include month-year dummies. The dependent variable is the number of days waiting to enter the canal. All specifications include dummies for northbound, preferential, and busy. Additionally, owner fixed effects are controlled for. Effects are therefore identified as deviations from the trend. The sample includes all non-missing observations for vessels entering the canal between 2012 and 2016. Robust standard errors clustered at the owner level are shown in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Finally, data investigation (see Figure A2.11) revealed possible outliers consisting of ships larger than 233 592 DWT, and when the number of ships at anchorage are above 73 ships (see Figure A2.9). The third and fourth row illustrate the result with these outliers removed. This verifies that the lack of significant effect is not driven by larger ships in the sample. However, when removing the most busiest periods, which, as discussed in Figure A2.9 and Figure A2.10, is likely caused by data error, the coefficient turn somewhat significant.

7 Discussion

In this section, the limitations of this thesis, not already covered in previous sections, will be covered. Based on the limitations, suggestions for further research is suggested.

The underlying hypothesis of this thesis was that becoming member of MACN is likely to have a negative effect on the waiting time for ships wanting to enter the Suez Canal. This was based on the assumption that human factors play a role on the waiting time. More specifically, it was assumed that the Egyptian shore-bases personnel might want to take advantage of companies' desire to limit time at ports and therefore earn some additional income. When the personnel lost this income they would prioritise other (non-MACN) companies that would still be willing to pay bribes. The descriptive statistics in section 4, more specifically Figure 4.6, show that the waiting times for MACN members has indeed increased as more members have become members. However, it also shows that the waiting time has just increased to a level of the non-MACN members for companies that were always members of MACN.

In sum, this thesis finds no evidence that becoming a MACN members has any effect on the waiting time for entering the Suez Canal. However, Baltagi and Pinnoi (1995) note that fixed effects model tend to estimate short-run reaction if the long-run impact of MACN membership is smaller than the short-run impact. In other words, if the effect of MACN membership is somewhat lagged it is possible that the model produce a negative sign (reduced waiting time) even though the expected estimate (the long term effect) would be positive (increased waiting time) (Kennedy, 2002).

It is also possible that the effect of membership is underestimated which is a common problem for the individual-level panel data (Wooldridge, 2011a). For example, it might be that companies with lower ethical standards join the MACN network in order to free-ride on the reputation effect (such as the case of Stena Sonagol as mentioned previously). If these companies continue to act unethically by paying bribes, the effect of membership would be underestimated.

The result of the descriptive statistics could imply that companies that became part of MACN had an advantage (shorter waiting time) that they now, to some extent, have lost. For example, it might be that the non-MACN members are poorer companies which cannot afford to be corrupt in the first place, or more generally weaker companies (or crew onboard) that can more easily be taken advantage of. Thus, further search should take into account the economic state of the companies and countries involved. For example, knowing the economic state of the different shipping companies at time of entry would not only provide additional insights into a companies ability to pay bribes, but also possibly provide useful insight into what differentiates MACN members from non-MACN in terms of economic status.

The results of this thesis are based on extensive data cleaning. As have been emphasised on several occasions throughout this thesis, the results presented are dependent on the quality of the cleaning process and the assumptions made. Thus, for future research more accurate data for when a ship is arriving at anchorage and later entering the Canal could provide more accurate results.

It might also be that the lack of significant effects stems from the fact that the MACN "say no"-campaign was not introduced before 2015. In addition, this campaign was introduced gradually. Thus, the effect of membership might not significantly affect the outcome of interest in the period studied by this thesis. Further research should therefore collect more data for the period after 2015 in order to understand if waiting time is longer for companies for MACN members after the full introduction of the campaign. The literature on corruption and waiting time in ports is still rather small. Further research should therefore use the new data available from AIS to investigate how anti-corruption efforts affects waiting time, in other ports in addition to the Suez Canal. This would allow a comparative country analysis which again could produce useful insights into the usefulness of anti-corruption efforts.

8 Conclusion

A large literature documents the cost of corruption. However, little is known about the cost of anti-corruption efforts. Because corruption is usually measured based on perception, it is usually assumed that as long as the actors do not presume corruption to be existent (for example because they no longer have to pay bribes), then the effect of the anti-corruption effort has been positive. However, little is known about whether such initiatives comes with a monetary penalty identified by longer waiting times at ports. The policy relevance of understanding how anti-corruption tools might affect (shipping) economics can therefore hardly be underestimated, but no clear answer has yet emerged from the literature.

This thesis utilise data derived from AIS to study ships passing the Suez Canal between 2012 and 2016 in order to shed light on the effect of collective action as an anti-corruption tool. More specifically, this thesis ask whether MACN membership influences the waiting time to enter the Canal, and thus, the economy of its members.

Using detailed vessel-level data, this thesis finds no evidence of MACN membership affecting the waiting time to enter the Suez Canal. However, the lack of significant effect could stem from the fact that the "say no"-campaign was not introduced before 2015, thus the effect of membership might not significantly affect the outcome of interest in the period studied by this thesis. Future research should therefore collect more detailed data, and data for a longer period of time, in order to understand if waiting times are longer for companies that become members of MACN.

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Appendix

A1 Tables

Table A1.1: Summary statistics numerical variables

Statistic	N	Mean	St. Dev.	Min	Max
Duration (days)	57 942	1.186	3.560	0	29.983
Duration (days, no direct ships)	57 942	1.846	5.041	0.0002	29.985
Duration (hours)	57 942	28.469	85.445	0	719.601
Duration (hours,no direct ships)	57 942	44.312	120.974	0.005	719.638
Number at anchorage	57 942	69.827	185.369	1	1347
GT	57 942	64 337	45 532	199	195 636
DWT	57 942	76 417	54 310	110	323 527
LOA (m)	57 942	246.81	78.976	45	400
Beam (m)	57 942	36.557	10.223	8	70
Draught (m)	57 942	12.679	3.003	1.050	24.6
SOG (Anchorage)	57 942	1.108	2.824	0	48.4
SOG (Inside)	57 942	8.356	2.207	0	22.9
Longitude (Anchorage)	57 942	32.451	0.123	32.250	32.633
Latitude (Anchorage)	57 942	30.553	0.774	29.6	31.483
Longitude (Inside)	57 942	32.461	0.124	32.175	32.588
Latitude (Inside)	57 942	30.394	0.418	29.96	31.109

Table A1.2: Summary statistics date-time variables

Function	Start Time	End Time
Min. :	2012-01-01 08:35:14	2012-01-01 20:50:54
1st Qu.:	2013-06-19 23:03:15	2013-06-21 06:32:48
Median :	2014-08-31 03:14:38	2014-09-03 05:59:04
Mean :	2014-08-28 17:12:39	2014-08-30 13:31:23
3rd Qu.:	2015-11-29 01:47:19	2015-11-30 07:05:04
Max. :	2016-12-31 10:48:02	2016-12-31 22:54:50

Table A1.3: Summary statistics categorical variables

MMSI		IMO		Membership		Member Year	
Value	Frac	Value	Frac	Value	Frac	Value	Frac
271042575:	108	7811329:	108	0:	49 884	2012:	4719
311038000:	107	9325697:	107	1:	8048	2013: :	244
311133000:	102	9325702:	102			2014 :	2527
636012400:	101	9265500:	101			2015: :	2456
311468000:	99	9325685:	99			2016 :	2212
240386000:	72	9302499:	72			0 :	45 784
(Other) :	57 353	(Other):	57 353				

Owner		Owner country		Owner region	
Value	Frac	Value	Frac	Value	Frac
Maersk Line:	2363	Greece:	8753	EU:	24930
MSC:	1434	Germany:	6971	East Asia:	13053
CMA-CGM:	1216	Japan:	4986	Non EU:	5318
Mitsui O.S.K. Lines:	1162	China P.R.:	3307	Arab League:	4879
Danaos Shpg.:	899	Denmark:	3097	Asia Other:	4019
Nippon Yusen Kaisha:	890	Singapore:	2712	North America:	3124
(Other):	49 978	(Other):	28 116	(Other):	2619

Vessel type		Detailed vessel type	
Value	Frac	Value	Frac
Container:	21396	Fully Cellular Container:	21396
Bulker:	9729	Bulk Carrier:	8885
Tanker:	6830	Pure Car Carrier:	3683
Chemical tanker:	6016	Chem Parcel Tanker:	3651
Cargo general:	4229	Tanker:	3487
Liquefied gas:	4064	Product Carrier:	3274
(Other):	5678	(Other):	13 566

Flag state		Northbound		Preferential		Busy	
Value	Frac	Value	Frac	Value	Frac	Value	Frac
Panama:	8833	0:	27 215	0:	38 982	0:	52 340
Liberia:	8700	1:	30 727	1:	18 960	1:	5 602
Marshall Is.:	6200						
Hong Kong:	4351						
Singapore:	3730						
Malta:	3650						
(Other):	22 478						

Table A1.4: Suez convoy overview

Canal	Direction	Group	Type of ships	Preferential
Old Suez	Northbound	Group A(1)	Naval vessels, third and fourth generation container ships, LPG and LNG, and LASH vessels over 40 000 SCGT.	Yes
		Group A(2)	Loaded tankers and heavy bulk carriers (bulk with draught of more than 11.6 meter or length between perpendiculars of greater than 289.7 meters)	No
		Group B	All other vessels anchored in the Suez anchorage	No
	Southbound (S1)	Group A	Deep-draught vessels with draught over 12.8 meters	Yes*
		Group B	Vessels with draught between 11.9 meters and 12.8 meters, third and fourth generation container vessels, VLCC in ballast, LPG, LNG and NGF vessels, whether loaded or in ballast, LASH vessels of over 40 000 SC.G.T	No
		Group C	Vessels with draught up to 11.9 meters	No
	Southbound (S2)	Not allowed to join	Vessels carrying goods considered more dangerous (such as LPG, LNG, vessels carrying petroleum A, liquid bulk chemicals, radioactive materials, and heavy lift vessels)	No
New Suez	Northbound	Ahead	Warships, passenger ships, car carriers, RoRo, container ships with tonnage over 60 000 SCGT or draught over 42 ft, vessels and tankers in ballast with tonnage over 60 000 SCGT	Yes
	Southbound	Ahead	Warships, passenger ships, car carriers, RoRo, container ships with tonnage over 40 000 SCGT	Yes
		Tail	LPG and LNG vessels loaded or ballast-NGF, tankers and loaded bulk cargo ships with draught over 44ft	No

*If also allowed to join S2

Table A1.5: Mean comparison test for all variables

Variables		All	Not member	Members	Difference
Vessel type	Container		0.336	0.567	-0.231***
	Bulker	0.168	0.191	0.026	0.166***
	Tanker	0.118	0.126	0.067	0.060***
	Chemical tanker	0.104	0.109	0.073	0.036***
	Cargo general	0.073	0.084	0.009	0.074***
	Liquified gas	0.070	0.066	0.100	-0.034***
	Vechile	0.064	0.049	0.156	-0.107***
	Roro	0.022	0.026	0.000	0.026***
	Other	0.012	0.014	0.002	0.012***
DWT	Less than 25 000	0.209	0.219	0.148	0.071***
	25 000-50 000	0.147	0.151	0.122	0.029***
	50 000 - 75 000	0.190	0.200	0.128	0.073***
	75 000 - 100 000	0.135	0.118	0.240	-0.121***
	100 000 - 125 000	0.144	0.135	0.199	-0.063***
	125 000 - 150 000	0.071	0.079	0.022	0.057***
	More than 150 000	0.104	0.097	0.142	-0.045***
Owner region	European Union	0.429	0.417	0.508	-0.092***
	East Asia	0.226	0.221	0.254	-0.033***
	European other	0.092	0.086	0.126	-0.040***
	Arab League	0.084	0.098	0.001	0.097***
	Asia other	0.070	0.077	0.021	0.057***
	North America	0.054	0.048	0.089	-0.040***
	Other	0.045	0.052	0.001	0.051***
Owner country	Greece	0.151	0.175	0.004	0.170***
	Germany	0.120	0.134	0.035	0.099***
	Japan	0.086	0.073	0.169	-0.095***
	China P.R.	0.057	0.058	0.049	0.009***
	Denmark	0.053	0.005	0.348	-0.343***
	Singapore	0.047	0.051	0.021	0.030***

Table A1.5 continued from previous page

Variables		All	Not member	Members	Difference
	Hong Kong	0.038	0.043	0.005	0.038***
	Norway	0.035	0.024	0.105	-0.081***
	United States	0.034	0.029	0.060	-0.031***
	United Kingdom	0.031	0.034	0.011	0.023***
	Turkey	0.030	0.035	0.000	0.035***
	Switzerland	0.028	0.033	0.000	0.033***
	Taiwan	0.023	0.027	0.000	0.027***
	France	0.022	0.012	0.085	-0.073***
	South Korea	0.021	0.020	0.032	-0.012***
	Qatar	0.020	0.023	0.000	0.023***
	Bermuda	0.018	0.017	0.027	-0.010***
	Italy	0.015	0.018	0.001	0.017***
	Kuwait	0.015	0.018	0.000	0.018***
	Netherlands	0.014	0.017	0.001	0.016***
	Monaco	0.013	0.011	0.022	-0.010***
	U.A.E.	0.011	0.013	0.001	0.012***
	Isle of Man	0.010	0.012	0.000	0.012***
	Israel	0.010	0.011	0.000	0.011***
	Lebanon	0.009	0.010	0.000	0.010***
	India	0.008	0.009	0.000	0.009***
	Russia	0.007	0.009	0.000	0.009***
	Iran	0.007	0.008	0.000	0.008***
	Saudi Arabia	0.006	0.007	0.000	0.007***
	Sweden	0.006	0.004	0.017	-0.013***
	Ukraine	0.005	0.005	0.000	0.005***
	Belgium	0.004	0.005	0.000	0.004***
	Other	0.045	0.051	0.007	0.043***
Flag state	Panama	0.153	0.161	0.101	0.059***
	Liberia	0.150	0.168	0.040	0.128***

Table A1.5 continued from previous page

Variables		All	Not member	Members	Difference
	Marshall Is.	0.107	0.116	0.051	0.066***
	Hong Kong	0.075	0.070	0.105	-0.035***
	Singapore	0.064	0.057	0.112	-0.056***
	Malta	0.063	0.070	0.018	0.052***
	Bahamas	0.042	0.037	0.067	-0.030***
	Danish Int.	0.027	0.001	0.186	-0.185***
	United Kingdom	0.025	0.020	0.057	-0.037***
	Greece	0.024	0.028	0.000	0.028***
	Antigua & B.	0.020	0.024	0.000	0.024***
	Norway Int.	0.019	0.011	0.071	-0.060***
	Germany	0.017	0.020	0.001	0.019***
	China P.R.	0.016	0.016	0.016	0.000
	Italy	0.014	0.016	0.000	0.016***
	United States	0.014	0.007	0.055	-0.048***
	Madeira	0.013	0.015	0.001	0.014***
	Turkey	0.012	0.014	0.000	0.014***
	Cyprus	0.011	0.012	0.000	0.012***
	Cayman Islands	0.011	0.011	0.007	0.005***
	Reg Int. Francais	0.009	0.005	0.032	-0.027***
	Isle of Man	0.008	0.007	0.014	-0.006***
	Netherlands	0.008	0.007	0.016	-0.009***
	India	0.006	0.007	0.000	0.007***
	Saudi Arabia	0.006	0.007	0.000	0.007***
	South Korea	0.006	0.005	0.010	-0.005***
	Japan	0.005	0.003	0.022	-0.020***
	Other	0.076	0.085	0.019	0.066***
	2012	0.159	0.171	0.088	0.083***
	2013	0.201	0.213	0.126	0.087***
	2014	0.208	0.207	0.214	-0.007

Table A1.5 continued from previous page

Variables		All	Not member	Members	Difference
	2015	0.203	0.196	0.248	-0.052***
	2016	0.229	0.213	0.324	-0.111***
N	57 680	49 681	7 999		

Notes: All characteristics are significant except "China P.R" and the year 2014.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A2 Figures

Figure A2.1: Mean daily entry

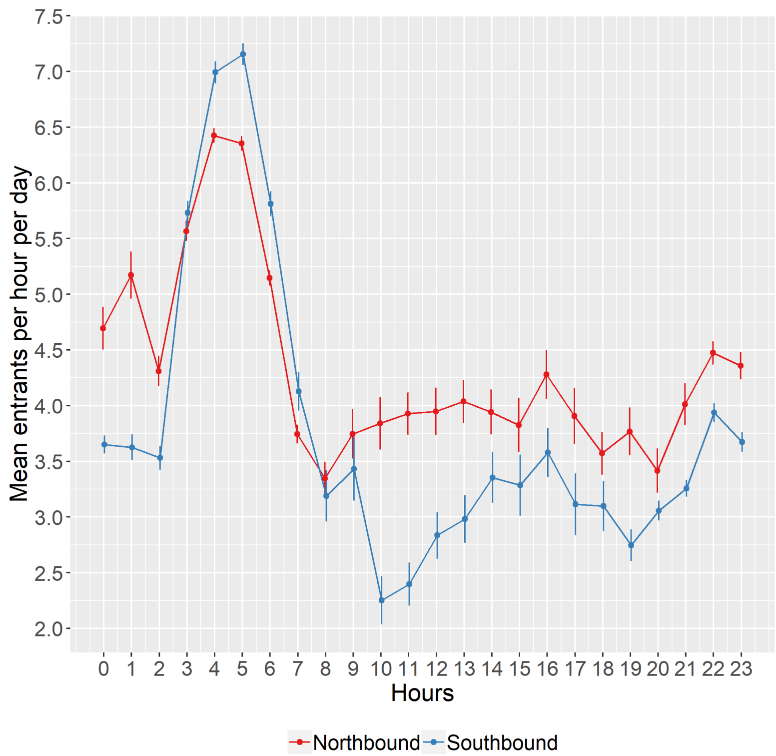
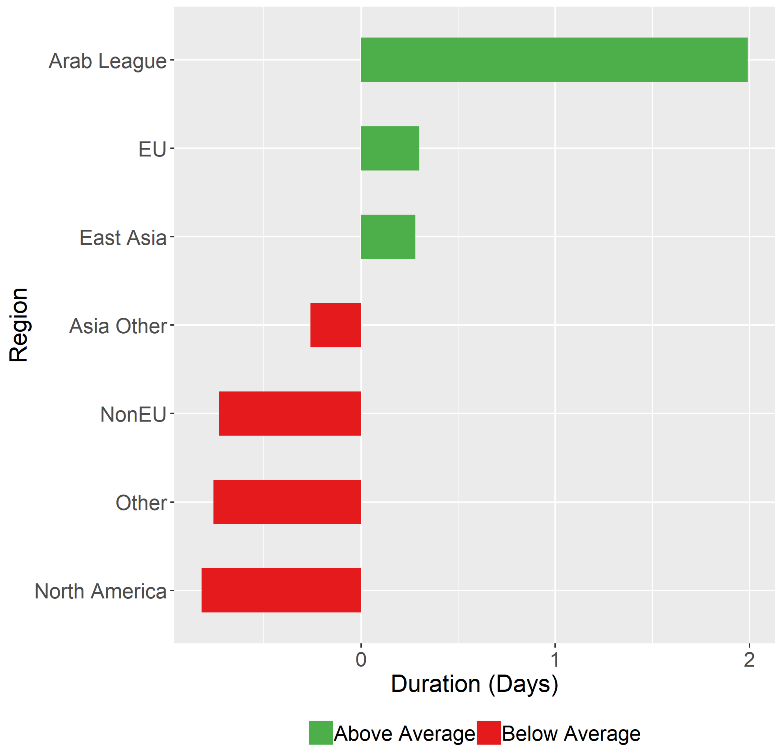


Figure A2.1 show how many ships on average enter the Canal during the day. The figure show that the majority of the ships enter the Canal between 3 and 6 o'clock in the morning for both southbound and northbound ships. Some more northbound ships than southbound ships enter between 9 and 13.

Figure A2.2: Waiting time (days) for owner region



Notes: Figure A2.2 depict normalised waiting time based on the owner region of the companies. The figure show that ships with companies based in the Arab League, EU, and East Asia on average wait for a longer time, while ships from Asia Other, Non EU, North America and all other regions on average wait for a shorter time.

Figure A2.3: Number of ships and direction per year

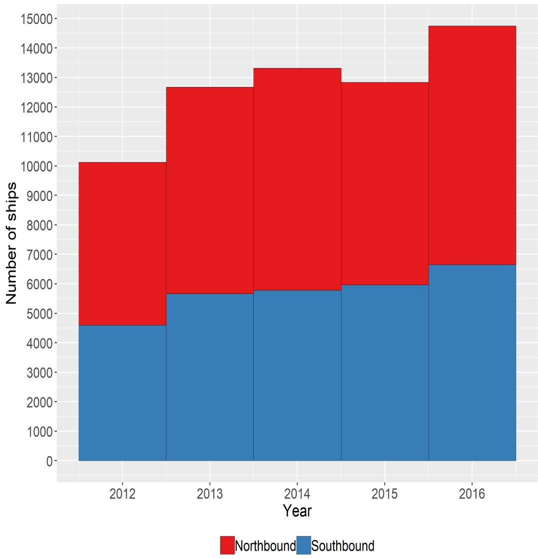
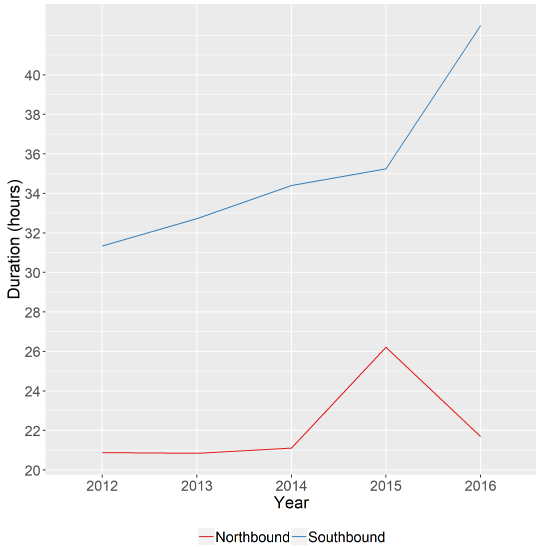


Figure A2.4: Development of waiting time (hours) for ships per direction



Notes: Table A2.3 illustrate how many ships that passed through the Suez Canal each year and in which direction they were heading, while Figure A2.4 demonstrate the difference in waiting time depending on whether the ship is heading north or south. The difference could be explained partly by the fact that the southbound convoy was divided into two convoys before 2015 which could lead some southbound ships to wait longer on average, and the fact that late exiting of the Canal can result in delays for ships wanting to enter the Canal. The latter is especially true for Port Suez where there is only one Canal exit/entry compared to Port Said that has two.

Figure A2.5: Number of ships and preferential status per year

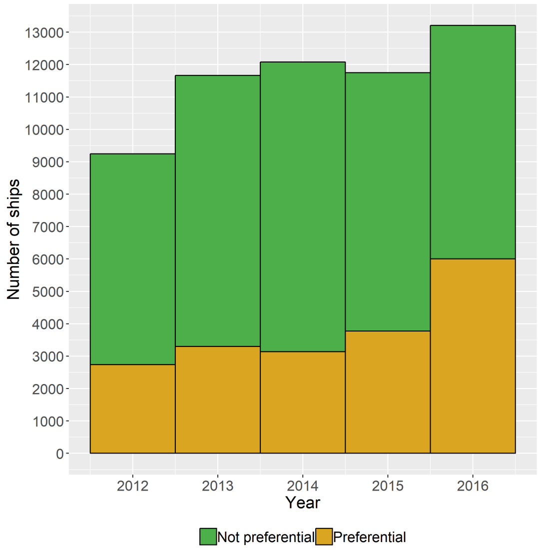
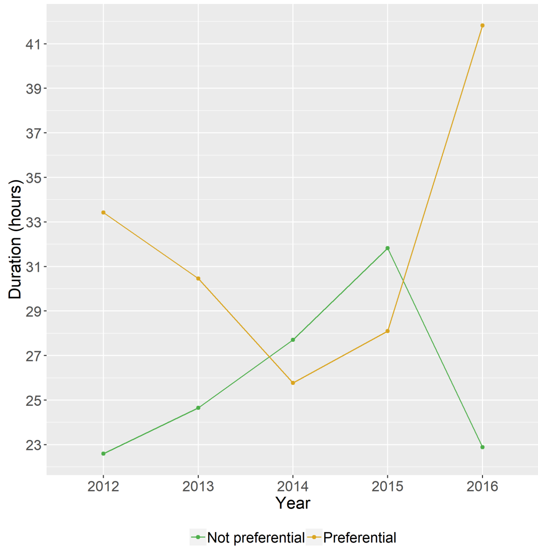


Figure A2.6: Development of waiting time (hours) for preferential ships



Notes: Figure A2.5 show the number of ship with preferential status for each year, while Figure A2.6 show how waiting time has develop over time for preferential and non-preferential ships. The figures seem to demonstrate to a certain extent that waiting time has increased with the number of ships being categorised as preferential. Whether a ship is categorised as preferential according to SCA depends mainly on the vessel's size and type.

Figure A2.7: Waiting time (days) relative to number of ships at anchorage

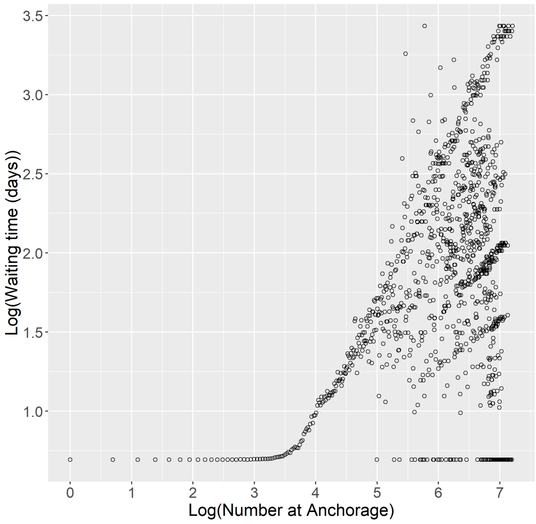
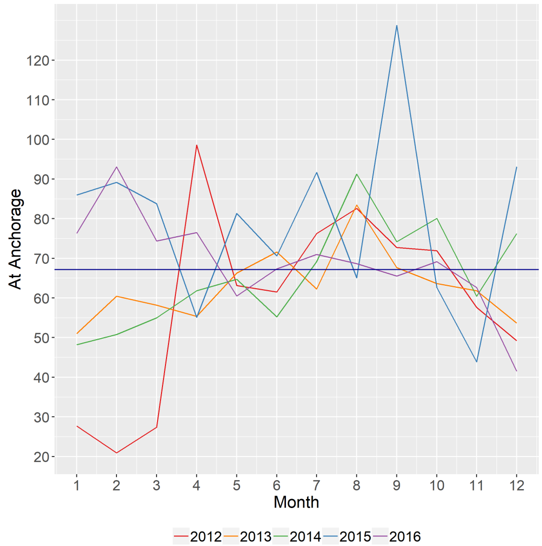


Figure A2.8: Development of number of ships at anchorage



Notes: Figure A2.7 and Figure A2.8 show how waiting time is related to number of ships waiting to enter the Canal at the same time. More specifically, Figure A2.7 shows how waiting time increases with number of ships in the queue. While Figure A2.8 show the development of number of ships at anchorage at the same time. The figure demonstrates how in the first quarter of 2012 the number of ships waiting to enter the Canal at the same time were below average, while in September 2015, just after the opening of the Suez Canal the amount of ships at anchorage were above average.

Figure A2.9: Outliers number at anchorage

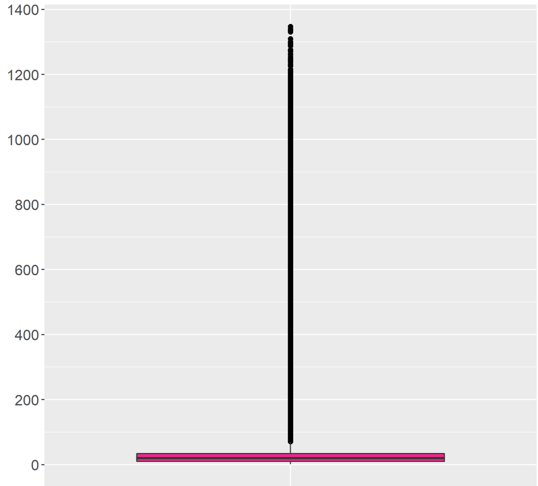
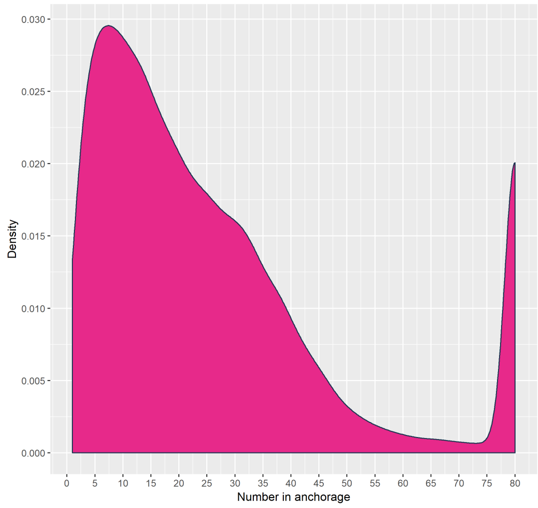


Figure A2.10: Density plot number at anchorage



Notes: Figure A2.9 show that are outliers in number at anchorage (> 73). The maximum at anchorage is especially large which is likely caused by data error. Nevertheless, the outliers have been kept in the data set as they will be controlled in the robustness analysis. Figure A2.10 show the density distribution of number at anchorage. All number at anchorage >80 are grouped together.

Figure A2.11: Outliers DWT

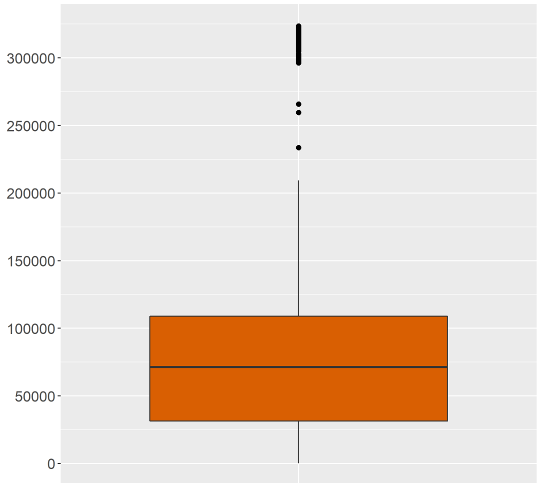
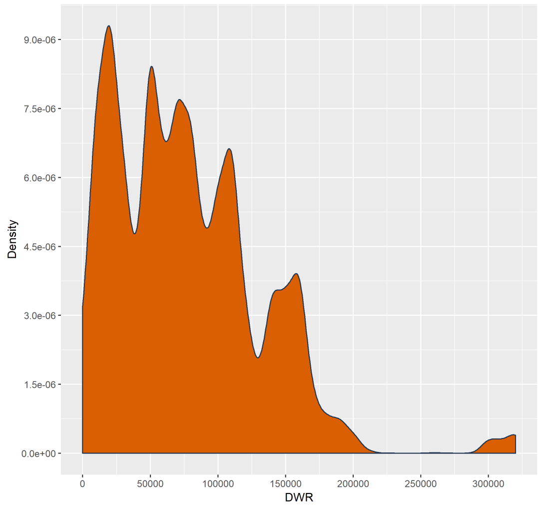


Figure A2.12: Density plot FWT



Notes: Figure A2.11 show that are outliers in DWT (> 233 592). The outliers have been kept in the data set as they will be controlled in the robustness analysis, and are likely not caused by data error. Figure A2.12 show the density distribution of DWT.