A Work Project, presented as part of the requirements for the Award of a Masters Degree in Management from the NOVA – School of Business and Economics

A CASE STUDY: EXAMINATION OF THE ECONOMIC CONSEQUENCES OF A REJECTED FAIRWAY ADJUSTMENT FOR THE PORT OF HAMBURG

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A Project carried out on the Operations Management course,

under the supervision of:

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4th January 2016

“As an international port city the Free and Hanseatic City of Hamburg, due to its history and location, has a special task to perform for the German people. In the spirit of peace it strives to be an intermediary between all continents and people of the world.”

(Preamble of the constitution of the Free and Hanseatic City of Hamburg, HPA 2012)

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App.	Appendix
DWT	Dead weight tonnage
EA	East Asia
GVA	Gross value added
NR	North Range
TEU	Twenty foot equivalent unit

1 Introduction

The city Hamburg emerged in the 9th century on the northern shore of the river Elbe, in its original appearance as Hammaburg. The port`s official first day of operation was the 7th of May in 1189, the point in time when former emperor Friedrich Barbarossa, allegedly, issued a customs-free declaration for the city (Altenmüller 2015). The additional privilege of the city´s suitable location on the Elbe in close proximity to the North Sea enabled Hamburg to actively participate in the forthcoming development of trade commerce. Joining the Hanse union in 1321 further distinctively fostered Hamburg`s extent of trading and the port was henceforth able to almost continuously stimulate the city`s economy (Oßenbrügge 2014). Hamburg permanently adjusted the port`s structural conditions to the needs of the global shipping industry and consequently established the port as the second biggest in Europe after Rotterdam in terms of container handlings (NDR 2015). Yet this superior position is in jeopardy as the tidal dependent water level of the Elbe imposes a serious obstacle for the contemporary fleet. In order to decrease the costs per freight ratio, container vessels have drastically increased in size. In particular, the respective vessel`s draught and width reach the river´s limits and force the usage of the tidal wave or a decrease in capacity utilization. Furthermore, the largest vessels are in general deployed on the central route for Hamburg, the connection between East Asia and North Europe. To counteract this development, port officials and the government aim to adjust the river´s fairway but environmental organization sued against its implementation with a final ruling of the federal court to be expected in 2016 (Oßenbrügge 2014). This case study examines the qualitative as well as quantitative consequences of a possible rejection of the fairway adjustment. Based on the empirical results of the comparable port Bremen, the determinants of interest prove to be the annually handled freight volume and the effects on port dependent employment. Subsequently, the impact on gross value added and national income is analyzed.

2 Methodology approach

The topic of this report concerns a contemporary event without any external control and a strong real life contextual connection. The chosen method of analysis is therefore reflected by the case study. It is based on both qualitative and quantitative evidence and follows an interpretative approach, expressed in a narrative report. The case study´s purpose is mainly exploratory, but accompanied by a descriptive introduction (Yin 2014). A second case is embedded to further support the achieved results. The leading research question is: What will be the consequence for the port of Hamburg if the fairway adjustment must not be realized? To adequately examine the results this case study solely focuses on Hamburg´s central means of transport, the container trade. The following four levels of analyses include the effects on container trade dependent turnover, employment, gross value added and national income (Eisenhardt 1989).

3 The Port of Hamburg

3.1 Fairway characteristics

The port of Hamburg is today located in the inland at the upper arm of the river Elbe approximately 130 kilometers from the North Sea. Even though it is not directly located at the sea, the inland port possesses a distinct advantage. Due to substantially lower transportation costs on the waterway, compared to the road or railway, goods can be imported significantly cheaper to a point far inside the country and closer to the end-markets (Bräuniger/Otto/Stiller 2010). Furthermore, the proximity to the Kiel Canal and the Baltic Sea economic area benefits the port (HPA 2012). Appendix (App.) A and App. B display the port´s location. The port`s construction includes an open access to the sea, avoiding the usage of gates (Altenmüller 2015). Accordingly, the river`s water level and varying depth is significantly influenced by the tides, which define the water level above or below the mean. In general, the duration of each tide is approximately 12.25 hours (Fickert/Strotmann 2007). The following flotation

depths always refer to saltwater and normal height null. Saltwater implies a higher density than fresh water and hence a lower flotation depth of 30 cm. Even though the terminals are located in fresh water, all draught indications for vessels are expressed for saltwater. This means, the actual draught of ships increases in the fresh water of the port by 30 cm. But this fact is dealt with in the port´s announcements and the following examinations. Normal height null refers to the mean high-water level in Amsterdam and represents the official height dimension in Germany. The possible draught depends on the ship`s width and length. Furthermore, it differs for arriving and departing vessels. Arriving vessels can use the incoming tide wave and thus increase their draught (Project office 2007). The incoming tide wave takes about 3.5 hours to reach the port, which simplistically implies that this provides a daily time frame of one hour to expand the flotation depth (Boehlich 2003; Wellinski 2015). This time frame is, due to the contrary movement of tide wave and vessels, too short for outgoing ships (BSH 2015). App. C indicates the complex relation. In order to provide for a valid examination in the following, a general assumption, of 12.50 m tidal independent and 13.50 m tidal dependent movement is defined. The possibility to access the port with a draught of up to 14.80 m by using the tidal wave is also considered. However, it must be remembered that this only applies to ships with a smaller width and length and a time frame of one hour daily. Furthermore, ships possessing an additional width over 90 m cannot pass each other in the fairway and are forced to delay their passage (Project office 2007).

3.2 Trade development

The world economy has experienced significant growth in recent decades partially due to increasing international trade activity, which has been led by the dynamic development of emerging countries, and in particular China. Access to international trade organizations and the opening of domestic markets for the transfer of goods enabled the world economy to implement a global production chain. Consequently the amount of transported intermediate

products grew considerably and the international trade could achieve significantly higher growth rates than the production. The reduction of transport costs, based on the development of the container, the increasing ship sizes, the implementation of hub-and-spoke networks and the usage of intermodal transportation further supported this development, of which Hamburg clearly benefitted (Bräuniger/Otto/Stiller 2010). Hamburg`s favorable location, as the most eastern port of the North Range[1] (NR) and 130 km inside the country, enabled the universal port to emerge to a crucial interface for different trade flows. It is the biggest bulk cargo port in Germany and contains a central relevance for the national steel and energy industry. Moreover, Hamburg represents the most important container trading port for broad parts of Germany, Czech Republic, Slovakia and Austria. The handled freight in the harbor is composed of 68 % containers and 32 % dry and liquid bulk cargo (Maatsch/Tasto 2015). Accordingly, the container embodies the main means of trade in Hamburg and therefore represents the core element of this case study. The port was able to emerge as a central cargo delivery and distribution site, also defined as a hub (HPA 2012). This implies that containers are transferred in the port of Hamburg from extensive container ships to other modes of transport, depending on the final destination. In contrast to bulk transportation, the container trade is significantly characterized by its strict timetable (OECD/Eurostat 2014).

3.3 Hamburg`s trade relations

Hamburg`s most important container trading area is East Asia (EA). Considering trade data from the year 2013, which always combines ex-and imports, the region was responsible for 4,512,000 twenty foot equivalent units[2] (TEU), representing half of the total cargo volume handled in the North German port. East and North Europe follow with a trade participation of 14 % and 11 %, respectively. The remaining 35 % were allocated to North and South

[1] The NR contains, in terms of cargo handlings, the most important northern European ports, located at the North Sea (Port technology 2011).
[2] One TEU represents the standard container and the capacity descriptive determinant (Handwerk 2015).

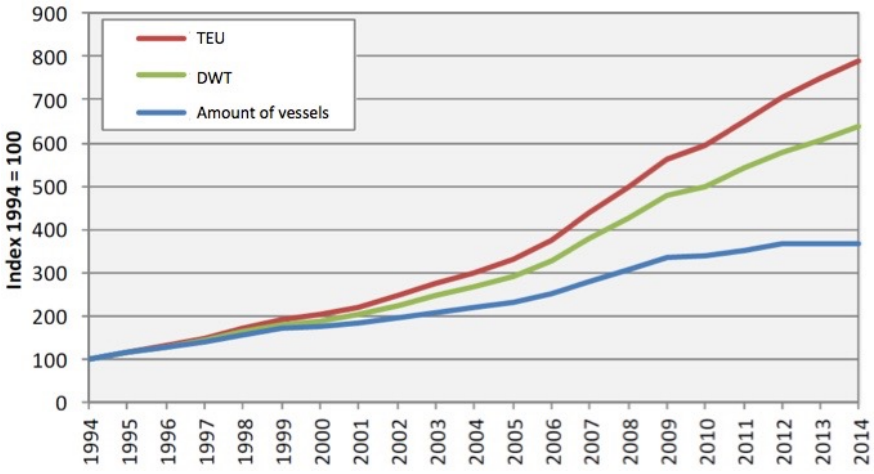
America, West Europe and -Asia, each possessing around 6 %, as well as Africa and Oceania (Maatsch/Tasto 2015). App. D and E display the full trade data and list the corresponding countries for each comprehensive region. The main trade pattern of Hamburg can be described as the following: Large container ships from EA access the port of Hamburg and use its function as a hub. Smaller feeder ships and ferries take over the imported cargo and supply the ports in Scandinavia and the Baltic Ocean, and vice versa (HPA 2012). Considering the EA traffic as crucially responsible for the East and North European trade even increases its valuable influence (Bräuniger/Otto/Stiller 2010). Alternatively, the railway is used for the East European mainland and trucks supply the metropolitan area (HPA 2012). In fact, in 2013, 40 % of the cargo was moved on by transshipments, while the remaining 60 % of containers were transported to the hinterland (HK 2015). The respective loco quote, indicating the share of containers transported to the metropolitan area Hamburg, represents 30 % of the hinterland movements (Schröder 2015). Hamburg´s efficient and extensive infrastructure, especially the excellent link to the continental railway network, clearly support the port´s function as hub (HK 2015). App. F displays the hinterland and transshipment connections as well as the specific modes of transport. The modal choice depends, as represented by App. G, on the distance and the transport costs per unit. The fact that cargo is delivered to Hamburg and then forwarded to European regions, neighbored by smaller domestic ports, can be based on the economies of scale, realized through high turnover volumes, and the efficient handling systems. Both parameters reduce costs to such an extent, that Hamburg represents the most economic solution. Additionally, highly frequented hubs provide the advantage to combine containers with specific destinations, in order to freight the subsequent carriers more efficiently. Consequently, a high container turnover offers a quantitative as well as a qualitative benefit (Rodrigue 2013 a; United Nations 2014).

4 The operating fleet

4.1 Development of vessel dimensions

In line with the great expansion of the trade, the correspondent fleet capacity grew remarkably. Measured in deadweight tonnage (DWT), it rose by 75 % since 1993, including bulk, tank- and container vessels. The latter vessel category experienced especially substantial growth, caused by the over proportional increment of container trade, as App. H displays. The fleet gained capacity by a growing amount- and more importantly, an increasing size of ships. Between 1994 and 2014 the number of running vessels increased by 265 %, while the TEU capability even grew by 760 % (Maatsch/Tasto 2015). The largest container vessels today achieve a capacity of 19,000 TEU, a length of 400 m, a width of 59 m and a maximum draught of 16 m (Handwerk 2015). As can be seen in graphic 1, the TEU capacity progressively grows in excess of the growth in number of existing vessels.

Graphic 1 Container fleet and the TEU capacity

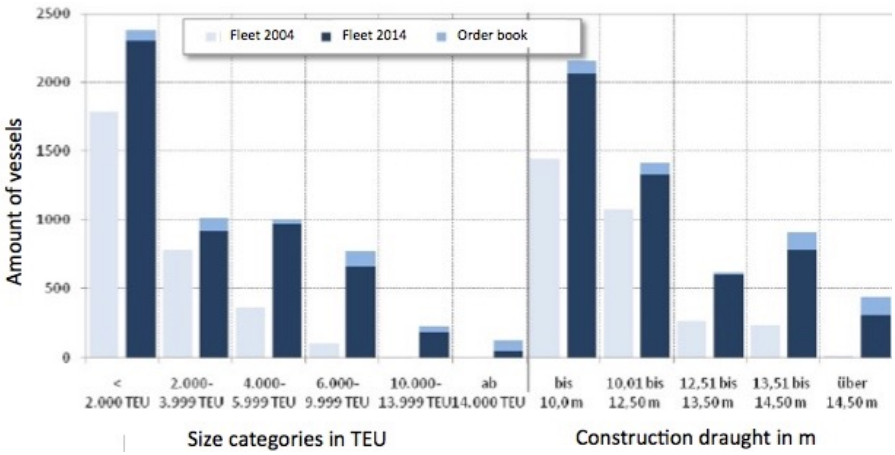


Source: Maatsch/Tasto 2015

App. I displays the vessels` evolution, which in general, can be simply explained through economies of scale. Moreover, the boom in the market through 2008, including exaggerated freight rates, motivated ship owners to increase their fleet capacity. The result of new technological opportunities and objectives to reduce fix costs fostered the expanding TEU capacity per ship (Oßenbrügge 2014). As shown in App. J, the increasing capacity reduces the

costs per TEU in terms of capital-, bunker fuel- and operating costs. However, the gained cost advantages through increasing volumes are not linear and increments provide only a diminishing marginal benefit (Monkenbusch 2015). Logically, the size expansion influences the global fleet composition. Comparing the container fleets from the year 2004 and 2014 in graphic 2, primarily illustrates the clear growth in the quantity of ships and secondly the shift to higher TEU capacities. Furthermore, the recorded orders of new ships are displayed and demonstrate the continuous trend. Expressed in numbers, the percentage of ordered ships with a capacity over 8,000 TEU equates to 52 % of all current orders. Positively correlated to the capacity, the vessels` construction draught increases. In particular, the number of ships with flotation depths above 13.50 m is growing meaningfully and is responsible for 56 % of all new orders. Forecasting the new fleet, this flotation depth class will represent 24 % of all running container vessels by 2019, including 5% of all ships with a draught over 14.8 m. The contemporary fleet, the order book and the prognosticated fleet, referring to both TEU and draught categories are respectively indicated by App. K and L.

Graphic 2 Container fleet in 2004, 2014 and the order book



Source: Maatsch/Tasto 2015

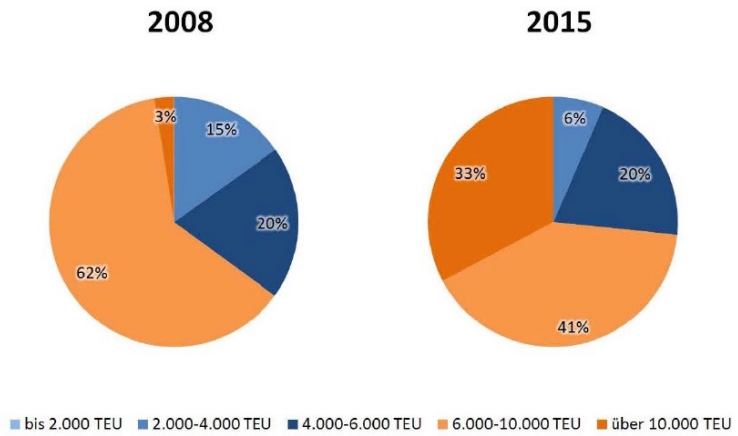
The fleet forecast is slightly conservative as it neglects the cascade effect, which describes the expulsion of small container ships, due to their absence of competitiveness. Big container ships, representing a lower cost per freight ratio, are used on the longest routes to effectively leverage their scale. Smaller ships cannot compete and are forced to service shorter distances

and therefore replace even smaller ships themselves (Van Marle 2013). As a result of these shifting trends, and further influenced by the shipping crisis and issue overcapacity, old and smaller container vessels are being scraped in order to reduce costs (Bräuniger/Otto/Stiller 2010). All ordered vessels are expected to launch by 2019 (Alphaliner 2015).

4.2 Fleet composition on the route to East Asia

Based on the high transport volumes and the long distance, the largest ships are generally used on routes between EA and Europe (United Nations 2014). By 2008, 80 % of all vessels with a capacity of 6,000 TEU or higher serviced this connection (Bräuniger/Otto/Stiller 2010). Graphic 3 displays the fleet composition on this route in the year 2008 and provides a forecast through 2015. Seventy-four percent of vessels on this connection were predicted to provide a capacity over 6,000 TEU. The category over 10,000 TEU was supposed to experience some of the most significant growth. The diminishing share of vessels below 4,000 TEU, as well as below 10,000 TEU, help demonstrate the Cascade Effect (Lempert/Maatsch 2009).

Graphic 3 Composition of the container fleet on the route North Europe – East Asia



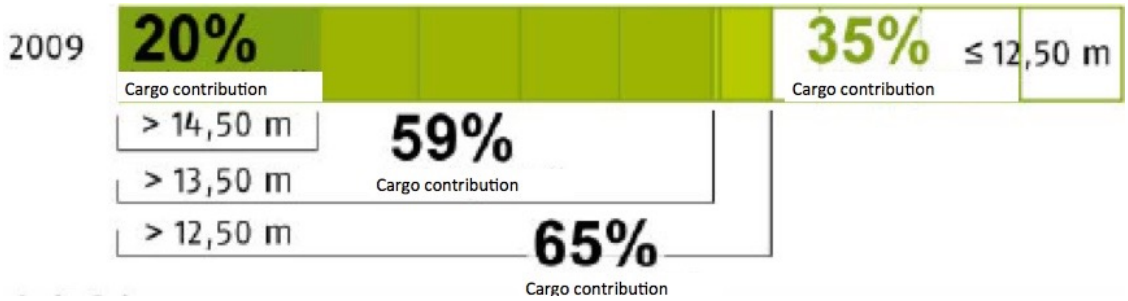
Source: Lempert/Maatsch 2009

Today, the development proves to be even more drastic. The minimum capability to remain competitive is expected to be around 8,000 TEU. In fact, the majority of vessels on this route display a capacity between 12,000 and 14,000 TEU (Maatsch/Tasto 2015; Davidson 2014).

4.3 The impact of large containerships on the port of Hamburg

Considering the substantial amount of East Asian trade volume in the port of Hamburg indicates the meaningful influence for the city. According to the named size restrictions of the river Elbe, only ships with a maximum draught of 12.50 m can access and exit the port independently from the tides. Referencing ship movements in 2014, 1,477 vessels indicated a construction draught over 12.5 m, including 1,198 ships exceeding the 13.5 m mark. Out of all 6,329 containership movements in 2014, this results in 23 % tidal dependent traffic. Nineteen percent of the servicing vessels could not even enter the port fully loaded (data available in the attached excel file in the sheet "Container Vessel Movements"). This ratio may seem acceptable, but as previously noted, a key share of the remaining trade movements strongly depends on the incoming cargo from the EA traffic, which deploys the largest container ships. Furthermore, graphic 4 displays the amount of handled TEU by each construction draught category and demonstrates the significant impact of tidal dependent vessel activities. They transport about 65 % of all TEU handled in the port. The flotation depth categories over 13.50 m and 14.50 m are responsible for 59 % and 39 % accordingly. The tidal independent vessel class carries only the last third of TEU (Project office 2010).

Graphic 4 Cargo contribution of the draught categories



Source: Project office 2010

5 Case problem

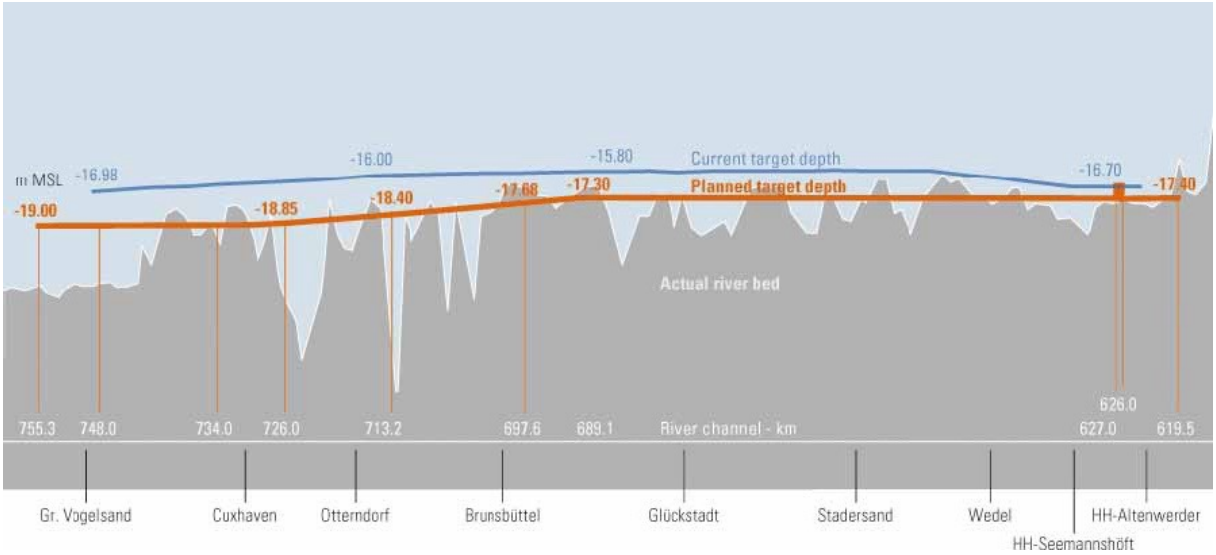
As described earlier, the port has two key advantages. Primarily, it benefits from its location more than 100 km inside the country and close to the Baltic markets, which lowers transportation costs. Second, the high turnover volume implies economies of scale as well as the possibility to accumulate cargo for transshipments. However, both factors may be in jeopardy in the long run (Bräuniger/Otto/Stiller 2010). As examined, the majority of vessels running the crucial route from EA to Hamburg increased drastically in size. Referring to the fairway´s restrictions, especially the achieved dimensions of the vessels` draught and width, serve as the critical components. These considerable large vessels cannot enter the port fully loaded and have to respect the tides. Delays on the sea or in the terminal are thus, due to the potential tidal mismatch, especially harmful (Handwerk 2015). For example, the operating costs for a 19,000 TEU vessel are estimated at around 50,000 USD per day. The potential half-day delay to match the tidal wave consequently raises costs by 25,000 USD (Bossy 2015). Moreover, the underutilization of capacity diminishes the profit (Preuß 2014).

5.1 Intended adjustment

Since 2002, the respective authorities have had a plan in place to react to the new size requirements by adjusting the river´s fairway for the tenth time (Bossy 2015). The dimensions of this intended adjustment refer to the measurements of a model ship, namely a length of 350 m, a width of 46 m and a draught of 14.50 m. In order to achieve this goal and enable this ship to pass through the waterway, using the up tide, the fairway must be lowered by about 1 m at several locations along the river. The tides are intended to create a two-hour time frame, during which the waterway can be utilized. This would enable three ships, one from each central terminal, to start the passage. Graphic 5 indicates the actual depth and the planned adjustments. These depths differ from the provided flotation depths, due to the required free space. Additionally, local differences in terms of salt and fresh water composition, as well as

swell and wind, require distinctive depressions (Project office 2010).

Graphic 5 The intended fairway depression



Source: HPA 2012, 42

Furthermore, the width of the fairway should be extended in order to allow two ships of the model size to pass each other with the additive measurement of 92 m. Referring to the current circumstances of the fairway`s width, the expansion will include adjustments of up to 20 m. Additionally, an encounter box for extraordinary big ships should be implemented. Considering the harmful delays the current width restrictions will cause, this adjustment is as important as the depression (Project office 2007). The overall expansion work would take about 21 months and cost 400 million € (HPA 2012; Schwartz 2015). Regarding the significant increase in vessel sizes over time, especially the draught, the proposed adjustment may seem insufficient. However, while all calculations and prognostications consider the only measurable parameter, the scantling draught, few ships actually hit their maximum depth and instead hit the design draught. The scantling draught embodies the maximum flotation depth regulated by the classification agencies by complete capacity utilization. The design draught, on the other hand, accounts for 0.5 to 1.5 m less and represents the most efficient draught in terms of fuel usage as well as speed (Project office 2010). Moreover, vessels accessing the port of Hamburg, coming from EA, have usually unloaded part of their cargo already in prior

ports of the North Range, due to Hamburg´s northeastern location (Monkenbusch 2015). Nevertheless, these factors do not support argument against the fairway adjustment. As described, the vessels have reached a scantling draught of up to 16 m, which implies a design draught of 14.5 – 15.5 m. Considering the intended adjustment to enable tidal dependent passages of 14.5 m and the probability of partly unloaded container vessels, this measure seems just appropriate. Obviously multiple questions remain; will the vessel`s draught continuously increase in the future? Will the fairway adjustment need to be repeated again soon? As seen in graphic 6, a trend can be recognized. In the years up until 2007, the growing TEU capacity was in general accompanied by an increasing draught. But thereafter, the container ships experienced a drastic gain in TEU capacity, while the draught did not exceed the 16 m boundary.

Graphic 6 Development of vessel dimensions

Year	Max. capacity TEU	Max. draught m	Max. length m	Max. width m
1994	4,469	13,62	294,1	39,4
1997	6,418	14,03	318,2	42,9
2000	7,226	14,52	347,0	43,5
2003	7,506	14,83	347,0	43,5
2004	8,063	15,03	352,6	43,5
2007	12,508	16,00	397,7	56,4
2010	14,000	16,00	397,7	56,4
2012	15,550	16,00	397,7	56,4
2014	18,000	16,00	400,0	59,0
Order book	19,000	16,00	400,0	59,0

Source: Maatsch/Tasto 2015

Additionally, as stated by Klaus-Dieter Peters, managing director of the most important terminal operator in Hamburg, HHLA, the following factors serve as arguments against significant further dimension increases: The noted diminishing marginal cost benefits, the disproportionally rising insurance rates and the difficult handling of large container vessels in the terminals. (Preuß 2015). Additionally, App. M illustrates rising diseconomies of scale related to growing obstacles of the cargo forwarding process. Consequently, in particular the flotation depth will probably balance around the current maximum of 16 m. Based on the

limited amount of deep-sea ports, an ongoing increasing draught reduces the number of accessible harbors to an uneconomical extent (Preuß 2015). The fairway adjustment thus refers to the requirements of today´s container vessels, considers the cost benefit ratio and, maybe more importantly, the effects on nature. But the environmental care is primarily imposed by the environmental organizations BUND and NABU (Schwartz 2015).

5.2 Legal objections

According to the BUND and NABU, the fairway expansion would significantly deteriorate the surrounding nature. They prognosticate siltation and salinization of the river, which would diminish the respective oxygen content and hence destroy the habitat of fish and plants. Furthermore, the increasing water depth is supposed to expand the tidal range and the current. The latter would likely affect the safety of the regional dikes as well as the shores and breeding areas of the birds. The managers of the fairway adjustment´s project tried to respond to these objections by negating their relevance and by suggesting environmental protective solutions (Purtul 2013). Nevertheless, the adjustment of the Elbe depends on a juristic decision, due to the lawsuit against its realization from BUND and NABU. The environmental organizations additionally sued at the European Court of Justice against the depression of the river Weser and the legal decision is similarly representative for the case of the Elbe (Bossy 2015). The European Court of Justice ruled in 2015 that the adjustment must not be realized, if, according to the European water framework directive, the water condition will consequently deteriorate. The impact of the ruling is that deterioration is only considered significant when the water quality will be downgraded to a lower category. Therefore, a quality decline inside one category is acceptable. Furthermore, the judges included a possible exception. If the intervention supports a greater public interest, it can be realized, even with the deterioration of the water quality, when all required and possible measures will be implemented to protect and rebuild the nature. A final ruling for both the Weser and Elbe is

expected in 2016 from the federal court in Leipzig (Zeit 2015). The court´s decision is uncertain and both parties, the environmental organizations and the port officials, are intensely working on their arguments (Kopp 2015). One key argument could be the effects of the last conducted fairway adjustment. The completion of the last expansion in 2001 distinctly fostered Hamburg´s market share among the NR ports in terms of deep-sea connections, as is seen in App. N. Following years of depression, the adjustment enabled ships to employ the contemporary maximum draught and henceforth increased the port´s market share rapidly by over 10 % (Maatsch/Tasto 2015). Moreover, the estimated negative environmental effects never came to fruition (Purtul 2013).

This case study aims to examine the consequences for the port of Hamburg and the nation, if the federal court in Leipzig rules in 2016 against the fairway adjustment. In the following, this should explore, whether or not the fairway adjustment is in the greater public interest.

6 Examination of the port Bremen

The port Bremen displays an empirical example and will be analyzed to indicate possible results for the comparable port of Hamburg. The port Bremen is located at the Weser, 106 km inside the country and around 100 km south of Hamburg. It used to be a high traffic-volume universal port, but the restrictive fairway of the Weser, despite several adjustments, could not handle the increasing ship size (Staats/Henke 2015). Following the development of the container around 1960, the port continuously lost market share to the neighboring port Bremerhaven. Graphic 7 indicates this development. While Bremen handled around 100,000 TEU in 1970, 4,000 TEU more than Bremerhaven, the port quickly lost its volume dominance. Bremerhaven, on the other hand, significantly increased its container turnover up to almost 6,000,000 TEU in 2014. Bremen therefore not only lost turnover volume, but also could not realize benefits from the drastic gain in container handlings (Ferreira/Lattner 2015).

Graphic 7 Container throughput in Bremen and Bremerhaven

Year	Bremen TEU	Bremerhaven TEU	Difference TEU
1970	100000	96000	4000
1975	52000	353000	-301000
1990	169000	1029000	-860000
2000	31000	2721000	-2690000
2010	17000	4859000	-4842000
2014	19000	5758000	-5739000

Source: Ferreira/Lattner 2015, 14

The existence of the port Bremerhaven at the estuary of the river Weser illustrates a different situation than the one in Hamburg. Bremen is not sufficiently able to use its geographic or logistic advantage due to the critical proximity of the neighboring and also cooperative terminals. Thus, the effect cannot solely be based on the fairway adjustment, though this measure represents the central factor for the effect. The chart further indicates that shipping companies are not willing to decrease their profit by reducing capacities when other suitable opportunities exist. Due to the unique features of Hamburg´s port, the extent of exchangeability is significantly lower. However, on a certain degree of unrealizable capacity utilization, vessels will seek other ports and Hamburg will, like Bremen, lose container turnover. Furthermore, the effects on employment can be examined. While Bremerhaven could crucially increase the level of port dependent engagement, due to the increasing container turnover, Bremen´s relevant employment remained static (Gabriel/Salot/Ludwig 2015). In fact, due to the increase in efficiency, a stable container turnover causes a diminishing activity level. The proximity of both ports increases the correlation to employment effects and impedes an adequate quantification. For example, cargo handled in Bremerhaven is forwarded by logistic companies based in Bremen. Nonetheless, the statement by labor director Hartmut Mekelburg indicates the trend. According to Mr. Mekelburg, the terminal operators Bremer Lagerhaus Gesellschaft and Gesamthavenbetriebsverein im Lande Bremen E.V in Bremen employed 5.000 people in the port around 1990, while they today engage only 180 employees for the cargo handling. This

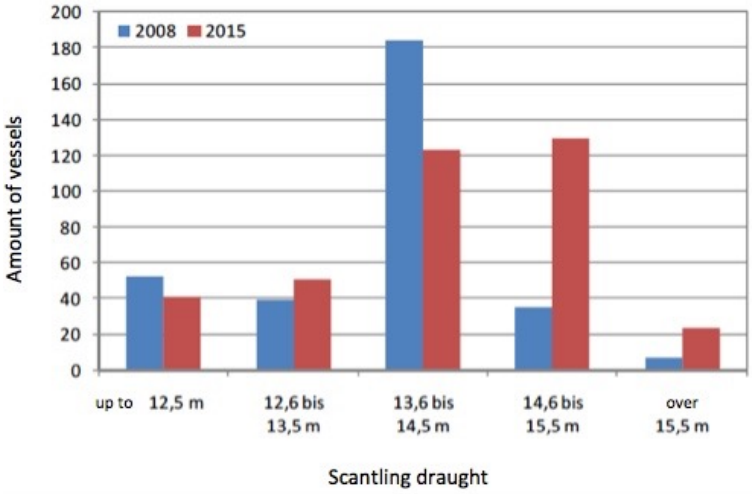
significant reduction is caused by the diminishing container turnover, the increase in efficiency as well as the shift of work to logistic centers. Bremerhaven, on the other hand, could increase the turnover dependent employment from 2000 in the year 2010 to 3.500 in 2014 (Gabriel/Salot/Ludwig 2015). As a consequence, the restrictive Weser fairway impeded the development of Bremen. Container vessels evaded the profit reducing underutilization and thus container turnover shifted to Bremerhaven and accordingly, all incremental trade emerges. Simultaneously, the dependent employment declines in Bremen, while it increases in Bremerhaven.

7 Qualitative consequences for the port Hamburg

In consideration of the development in Bremen, the same determinants should be analyzed and quantified for the case of Hamburg. How will container turnover and consequently employment progress, due to the insufficient fairway dimensions? Additionally, the subsequent effects on gross value added (GVA) and national income will be examined. As displayed, the restrictive fairway of the Elbe causes a critical delay for tidal dependent vessels and a cargo capacity deficit. Thus costs rise and revenues shrink for the respective ship owners. Moreover, the sharp timetable maintenance is jeopardized (Handwerk 2015). The important trade route between NR – EA is especially affected by these hindrances. This connection, accounting for about 50 % of Hamburg´s trade, deploys the largest available container ships. Referring to a forecast made in 2009, always assuming a complete capacity utilization, 90 % of the operating fleet needs to consider the tides of the Elbe. Seventy-five percent of these vessels cannot exit the port of Hamburg fully loaded and enter only with the use of the shortly available tidal wave. The draught of 42 % of these carriers is too large to enter at all. Graphic 8 presents the amount of vessels per draught class for 2008 and a forecast for 2015. It indicates a crucial growth in the draught category over 14.5 m (Lempert/Maatsch 2009). However, this forecast has proven conservative, given the current global fleet. The

number of ships with a draught exceeding 15.5 m already rose to 54, according to App. L. An allocation of less than 50 % to this route contradicts the facts. In consequence, the actual amount of vessels on this connection indicating a draught over 15,5 m is significantly higher (United Nations 2014).

Graphic 8 The operating fleet on the route North Europe – East Asia



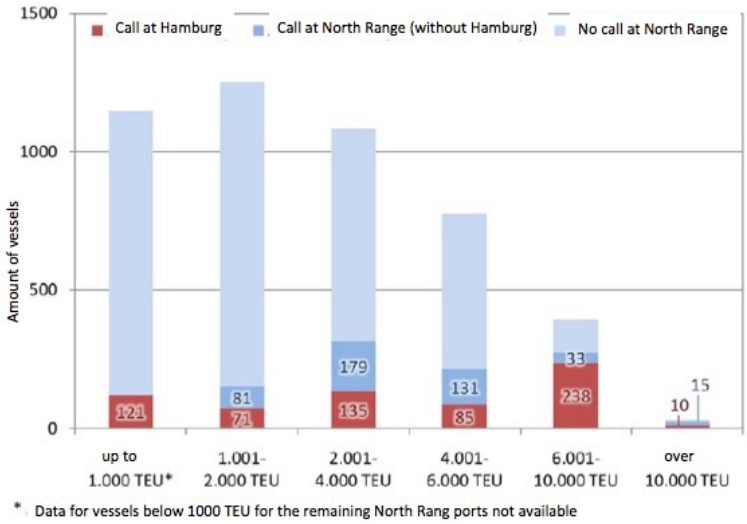
Source: Lempert/Maatsch 2009

As a result, the port of Hamburg already lost market share on this trade connection. Regarding the time frame between 2008 and 2013, the corresponding market share diminished by 6.1 % (Maatsch/Tasto 2015). Due to the shipping crisis, vessels did not run with the usual flotation depth. In contrast to 2008, where ships, accessing the port of Hamburg, used almost 88 % of their possible draught, the crisis resulted in an average utilization of only 81 %, as App. O presents (Lempert/Maatsch 2009). Referring to a 14,000 TEU carrier, this indicates a difference of almost 1,000 TEU. The crisis lasted longer than expected and forced ships to operate with a smaller usage of capacity. In the case of Hamburg, the annual container turnover just recently reached the amount of 2008 again. Collaterally with the growing container handlings, the vessels` overcapacities shrink and the draught increases (Port of Hamburg 2015).

Following the general expansion of container ships, an increasing amount of large vessels will neglect the port of Hamburg and use one of its competitor ports in the NR instead. Due to the

great TEU capacity of these ships, their absence is particularly influential. As presented, ships having a draught over 13.50 m were already responsible for 60 % of the total container handlings in 2012. Moreover, the development of absent container ships can even become a double-edged sword. Big cargo carriers, servicing EA, initiated Hamburg`s function as a hub and hence foster the feeder transshipments. As displayed, the port´s transshipment quote refers to 40 % of all handled containers (Oßenbrügge 2014). This implies, the reduction of Hamburg´s trade with EA will likewise decrease the trade with the North and East European countries (Bräuniger/Otto/Stiller 2010). The feeder ships will, according to the container ships, service other ports in the NR. Also supported from the shipping crisis, the low freight rates and fuel prices, new feeder ship connections already emerged as capable to compete. Additionally, big container ships partially supplied the Baltic ports directly. As a consequence, Hamburg's respective trade with North- and East Europe diminished by about 10 % each from 2008 to 2013 (Maatsch/Tasto 2015). A declining total container turnover decreases the competitive advantage among the NR ports, which is fundamental for the benefit of the economies of scale (Bräuniger/Otto/Stiller 2010). In the following, an examination of the expected losses in container turnover is conducted. The subsequent graphic 9 presents the world container fleet of the year 2009 allocated in TEU categories. Furthermore, it shows the share of ships calling on the port of Hamburg as well as the share calling at any other port of the NR, excluding Hamburg. The ratio of the ships servicing the NR to the total fleet significantly grows with the increasing TEU capacities. This can be explained by the fact that the NR ports primarily trade with long distance ports and especially EA. These connections engage the biggest ships of the fleet. This also affects the case of Hamburg. The TEU class of 6,000 to 10,000 represents the highest amount of calling ships in the port. Furthermore, it displays the greatest ratio of incoming ships in Hamburg to the world fleet, as well as of ships accessing Hamburg to vessels calling the NR (Lempert/Maatsch 2009).

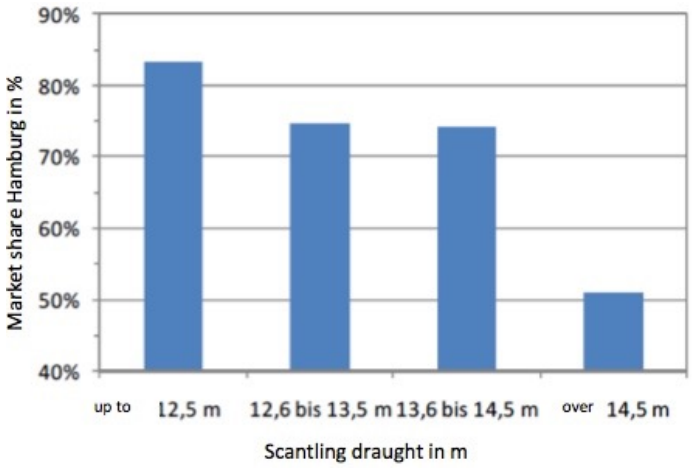
Graphic 9 TEU categories calling at the North Range and Hamburg



Source: Lempert/Maatsch 2009

Again, this demonstrates the great value of the EA traffic for the north German port, which at the same time possesses a crucial position in the total EA trade. Among the NR, Hamburg possessed in the year 2013 a market share of 33 % of the trade with EA. Even after the experienced market share loss, Hamburg therefore represents the leading port in the far-east connection (Maatsch/Tasto 2015). The following Graphic 10 allocates the port´s market share on the different vessel draught categories, regarding only the trade between the NR and EA. The respective shares represent the part of the total category that calls at the port of Hamburg. In contrast to prior analyses, the shares clearly decrease with the growing draught. In particular the increasing flotation depth classification over 14.5 m includes Hamburg with only 51 % of the fleet. The examinations therefore indicate, that Hamburg possesses a crucial market share on the NR – EA trade, which significantly diminishes with the draught exceeding the critical constraints of 12.5 and 14.5 m. These constrained depths are, respectively, the limit of the tidal independent movement and the possible maximum flotation depth, using the tide wave. The overall market share of incoming vessels amounts to 72 % (Lempert/Maatsch 2009).

Graphic 10 Market share of Hamburg per draught category



Source: Lempert/Maatsch 2009

8 Quantification of the consequences

This chapter examines the consequences in terms of container handlings, port dependent employment, GVA, income and tax income. The quantification is neither able nor aims to examine the exact results. It is based on several assumptions and prognostications, which clearly influence the outcome. Nonetheless, the calculated reference values provide a suitable forecast and indicate the effects. Moreover, the examination follows the principle of conservatism. It expresses the results as losses per analyzed year, referring to the prognosticated amount without the fairway hindrances. However, each result should be interpreted as an unrealized value.

8.1 Quantification of the anticipated cargo loss

For the following calculations, the above stated market shares are assumed to constantly apply. Furthermore, they are equated to Hamburg´s container trade with EA. Consequently, a percentage change in the first category will imply the same for the latter one. To estimate the market share variation, the future fleet servicing the referring trade route must be prognosticated. This estimation must be based on assumptions. The operating fleet is assumed to grow in proportion to the global fleet with the rate 8.95 % from 364 to 397 vessels by 2019,

as App. P implies on basis of App. K. The composition of the prognosticated fleet is based on the forecast for 2015, presented by Graphic 3. The forecasted groups of TEU capabilities are interpreted as a reference to the highest currently existing TEU capacities. This means, the range of vessels above 10,000 TEU represents the largest present capability and refers to this characteristic. The new prognostication therefore applies the cascade effect and upgrades these groups to the contemporary level of container vessels. The largest vessels force smaller out of the market. App. Q illustrates the method. Accordingly, it is assumed that 33 % of the operating fleet will consist of the largest current TEU category. The group`s range is set in correspondence to the prognosticated global fleet. 131 vessels will represent 33 % of the operating fleet. According to App. K.2, this is exactly the amount of ships globally existing above 14,000 TEU. The second category includes, as in the 2015 forecast, the subsequent range of 4,000 TEU. Thus it comprises, referring to 41 %, 163 vessels with a capability of handling between 10,000 and 14,000 TEU. The third category, including vessels from 8,000 to 10,000 TEU, is further suggested to drive all smaller vessels out of the market and will include 103 vessels, or 26 % of the operating fleet. This composition also considers prior indications that vessels below 8,000 TEU capacities are not able to competitively operate (Davidson 2014). In the following, the prognosticated operating fleet must be expressed in draught categories. Strict capacity and draught relations do not exist and can vary for each construction. The subsequent transfer in Graphic 11 is therefore conducted in respect to the fleet statistics and the average draft per capacity class, represented by App. R. Furthermore, Hamburg´s market shares per draught class are indicated. The draught class exceeding 15 m is technically included in the prior category of draughts above 14.5 m and hence also displays a market share of 51 %. This moderate approach is applied. Nonetheless, following the trend of a diminishing market share per rising draught would suggest calculating with a lower share.

Graphic 11 Forecasted composition of the operating fleet

Vessels	TEU	Draught m	Market share
103	8,000 - 10,000	13,5 - 14,5	74%
163	10,000 - 14,000	14,5 - 15	51%
131	> 14,000	15 - 16	51%

Source: Own calculation

Referring to this forecast, all employed vessels will need to respect the tides. Moreover, almost 75 %, considering the opportunity of the tidal wave usage, will not be able to call at the port without cargo deficits. Applying the analyzed market shares per draught category on the forecasted fleet allows for an estimation of the new market share. As a result, due to the increasing vessel sizes and the remaining hindrances, the respective market share of accessing ships will shrink from 72 % to only 57 %, a loss of 20.3 %. In order to transfer this reduction to the handled TEU volume, the future trade emergence between Hamburg and EA must similarly be prognosticated. According to an Institute of Shipping Economics and Logistics analysis, the trade for the NR will grow annually by 3.8 %, which is assumed to equally apply for the trade between EA and Hamburg (Maatsch/Tasto 2015). App. S charts the forecasted trade development. Consequently, the reduction of 20.3 % will cause a loss of 1,063,296.89 TEU in 2019. Additionally, as indicated, the East Asian container turnover effectuates a further transshipment of 40 %. Diminishing container turnover on the route to EA will therefore also decrease the transshipments by 425,853 TEU. In aggregate, turnover of about 1,500,000 TEU will not be realized. This calculation is further extended to the year 2030, based on the same operating fleet as prognosticated for 2019. As a result, the corresponding loss amounts to 2,240,000 TEU in total, as presented by App. T. The continuously developing fleet will even increase this volume. This reduction will further deteriorate the port´s competitiveness. Compared to other ports in the NR and the contrasting scenario, its economies of scale will significantly decrease.

8.2 Quantification of the forecasted loss in employment

Following the analysis of Jacobs, Ducruet and de Langen (2010), Hamburg represents one of

only ten world port cities defined by the coexistence of great cargo throughput and extensive advanced producer services. App. U displays the determinants and categories. In line with Hamburg´s strong correlation of turnover and service institutions, the port dependent employment takes a central role in the city's activity level. Applying the analyses of the research institution Planco, it can be distinguished between direct and indirect port dependent work. The first category combines activities related to turnover, storage or shipping as well as complementing sectors as banks, insurances or trading companies. Indirectly dependent employment arises, among others, through construction measures, legal services or consumer spending (Planco 2009). Considering the year 2013, the respective port dependent employment was estimated to sum up to 267,372 jobs. The metropolitan region of Hamburg included 153,319 of these positions. Solely the container transportation was responsible for 151,983 employees nationwide, of which 47,923 were directly dependent and exclusively based in Hamburg (Planco 2014). In order to prognosticate the effects on employment one needs to further distinguish between generally diminishing container turnover and shifting container turnover. While the prior one affects both direct and indirect employment, a shift in container turnover to other German ports is expected to leave indirect employment constant. A shift to European ports on the other hand, is also assumed to decrease the national indirect employment (Planco 2009). This examination therefore assumes an even allocation to national and international ports and consequently an effect on independent employment of 0.5. Planco calculated a relation of 50 directly dependent employees to a container turnover of 10.000 TEU (Planco 2009). Additionally, corresponding to the ratio of directly and indirectly dependent jobs, each directly dependent job induces 2.17 further indirect dependent jobs. Transferring this ratio and the additional leverage to the primarily prognosticated throughput reduction in Hamburg, results, as App. V proves, in a diminishing employment of 15,544 in 2019 and 23,427 in 2030. A further reduction due to the increasing productivity can be expected.

8.3 Quantification of the prognosticated gross value added reduction

The GVA represents, besides the employment effects, the most central determinant for the port´s economic impact. It distinctly displays the port´s created monetary value. Solely in Hamburg the respective GVA amounted to 11.7 billion € in 2013, which signifies 13.4 % of the city´s total creation. Considering that the regional port dependent employment only accounted for 10.8 % of Hamburg´s entire activity implies the port´s disproportional productivity. The container transport nationwide created a GVA of 11.5 billion €, which can be equated to the corresponding total container turnover (Planco 2014). Consequently the prognosticated trade growth rate of 3.8 % equally applies for the GVA, which is assumed to replicate the value of 2013 in 2015. As App. W proves, the forecasted reduction in container handlings will therefore cause a diminishing GVA of 1.85 billion € in 2019 and 2.8 billion € in 2030.

8.4 Quantification of the effects on income and tax payments

Simultaneously with the reduction in port dependent employment the national income will decrease, which will subsequently reduce tax payments. The total port dependent income in Germany equaled 14.6 billion € in 2013 (Planco 2014). The container trade contributed 8.2 billion €, which was achieved by the corresponding employment of 151,983. The forecasted employment loss of 15,544 in 2019 and 23,427 in 2030, represents a reduction of 9.12 % compared to the prognosticated potential employment associated with the fairway adjustment. This impact can be translated to the national income level, which is assumed to grow proportionally with employment resulting in increases of 12.11 % by 2019 and 68.97 % by 2030. Accordingly, referring to App. X, the lost container handlings and therefore the diminishing employment will cause an income reduction of 840 million € in 2019 and 1.27 billion € in 2030. Taking into account solely the average income tax rate of 24.95 % in 2014,

this reduces the states income tax revenues by 210,000,000 € in 2019 and 315,000,000 € in 2030 (BMF 2015).

9 Conclusion

Focusing on Hamburg´s primary means of transport, the container, and the central trade relation with EA, implies, under correspondence of the continuous vessel dimension increment, to prognosticate the prospectively operating fleet. This analysis displays that, by the year 2019, all corresponding vessel movements will depend on the tides and 75 % will have to employ capacity deficits, in order to pass the waterway. The subsequent delays will cause the large containerships, which are responsible for the major container throughput in Hamburg, to shift to other ports instead. Simultaneously, the absence of the cargo will diminish the subsequent feeder transports. The waterway obstacles are assumed to decrease Hamburg´s market share of accessing vessels on the route between EA and the NR by 2019 from 72 % to only 57 %. Considering the following 40 % of transshipments and the trade forecast for 2019 and 2030, this decline will reduce the handled TEU in the port respectively by an accumulated amount of approximately 1,500,000 TEU and 2,240,000 TEU. Since a high container turnover, in comparison to the competing North Range ports, is fundamental to achieve economies of scale, this loss will additionally deteriorate the port`s competitiveness. Furthermore, it will reduce the port dependent employment nationwide by about 15,500 jobs in 2019 and 23,400 in 2030. Simultaneously, the nation`s gross value added, income and tax payments will decrease. Therefore, in my opinion, the environmental organizations opposing the fairway adjustment, clearly object to a solution which is in the public`s greater interest, which is the compulsory prerequisite to legalize the adjustment. Nevertheless, the questioning and counteracting process benefits the environment and the society, because it forces the authorities to reduce the adverse impacts to the minimum possible extent. But at this desirable state, progress must courageously be allowed and supported on behalf of our future.

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