Empty container movements arising from cargo seasonality: Turkish terminals

Ahmet Selcuk Basarici
Piri Reis University, Istanbul, Turkey, and
Tanzer Satir
ITU Istanbul Technical University, Istanbul, Turkey

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Abstract

Purpose – The purpose of this study is to reveal the magnitude of empty container movements (ECM) arising from cargo seasonality by means of long-term datasets of Turkish terminals. Trade imbalance is one of the well-known major reasons of ECM. Cargo seasonality apart from some other operational drivers and market effect, i.e. commercial decisions of the ship operators, is the major operational driver in Turkish terminals effecting ECM. Furthermore, this study highlights the significance of market effect, leading to take measures for more effective empty container operations in terms of decision makers leading the ship operators.

Design/methodology/approach – Time series analysis of full container datasets was performed through X-13ARIMA-SEATS methodology, implementing seasonal adjustment.

Findings – The results indicate that 17 of 112 time series in hand, based on a terminal/hinterland, container type and "in and out" foreign trade, exhibit cargo seasonality. Roughly, the amount of ECM originating from cargo seasonality in Turkish terminals represents 10 per cent of total ECM except trade imbalance in those terminals where seasonality is present. This reveals that ECM arising from market effect should not be underestimated.

Research limitations/implications – Reefer container traffic could not be sorted from the datasets.

Originality/value – This paper focuses on one of the major reasons of ECM, cargo seasonality. It brings a novel point of view and interpretations which were not suggested previously about ECM, motivating to overcome inefficiency in container operations.

Keywords Time series analysis, Cargo seasonality, Empty container movement, JDemetra+, Maritime container transportation, Market effect

Paper type Research paper

Introduction

In container terminals, the reasons for ECM can be considered in three categories: trade imbalance, operational drivers, and market effect (Basarici and Satir, 2019). In case of having trade and/or container imbalance in a terminal, it is inevitable to face ECM. Here in this study, the amount of additional empty container movements (AECM) refers to the magnitude of ECM other than trade imbalance. The concept of AECM consists of operational drivers, and market effect. The reasons classified under market effect belong to operations resulting from voluntary commercial decisions of ship operators. The reasons for operational drivers occur under the limited control of ship operators or are entirely beyond their control. The operational drivers involve in seasonal demand, abundant container

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owners, container condition, uncertainties in demand/handling/shipment, and blind spots in supply chain (Boile *et al.*, 2004; Song and Carter, 2009; Basarici and Satir, 2019). During this study, firstly, one has calculated the magnitude of cargo seasonality (Seasonal AECM), which is the major element of operational drivers in Turkey, on the basis of TEU and then compared it with the magnitude of AECM of each container terminal located in Turkey. Second, the importance of market effect has been inquired.

The production and consumption amounts of some goods differ throughout the year. Harvest of fruits and vegetables, seasonal species of fish, religious days, holidays, festivals and so on causes increases or decreases in due course (Løfstedt *et al.*, 2010). There are fluctuations in the seasonal shipping demand of world trade for reasons related to social activities and seasons. Chinese new-year period is a good example for this. Another example is the vacation period of European automotive manufacturers lasting for about one month in summer season. The transportation traffic slows down during these periods; afterward it starts to get into motion again.

The purpose of seasonal adjustment is to remove seasonal fluctuations from a time series. For this purpose, the methods of seasonal adjustment decompose a time series dataset into its components to capture specific movements. The components of a time series are trend-cycle, seasonality and irregularity. Seasonality in container transportation mode can be detected by analysing change of full container movements in time. Time series analysis (TSA) is a technique examining sequential change in a dataset of any parameter. TSA is used when observations are made repeatedly over 50 or more time periods (Tabachnick and Fidell, 2001). It might aim at detecting patterns to set a model, viewing variation of observations, or detecting existence of seasonality and measuring its magnitude, or forecasting further time periods (Tabachnick and Fidell, 2001). The best solution so far is the model submitted by Box and Jenkins (1970), ARIMA. Dagum adapted X-11 method he had developed between 1975-1977 to the ARIMA model. X-11 method can be used for seasonal adjustment in addition to some other purposes (Dagum, 1978). The ARIMA part incorporated into the X-11 program plays a key role in the estimation of seasonal factor forecasts (Dagum, 1980). Other methods running alike X-11 are TRAMO (Time series Regression with ARIMA noise, Missing observations and Outliers) and SEATS (Signal Extraction in ARIMA Time Series). TRAMO intends a consistent modelling against presence of missing observations and outliers. On the other hand, SEATS intends to detect seasonal signals and to decompose them (Gomez and Maravall, 1997). Improvements on X-11 method resulted in X-12 and then X-13. They both were integrated with SEATS method.

In the literature, some studies aiming at various goals make use of TSA. It can be detected, for instance, whether the terminals in the same region compete each other or they collaborate (Yap and Lam, 2006; Da Silva and Rocha, 2012), thus investment plans in a region can be executed firmly. Another one is seasonal fluctuations. They strike not only the terminals but undoubtedly the ship operators, also. Service networks of ship operators suffer from cargo seasonality (Polat and Gunther, 2016). But the most popular execution area of TSA in the literature of container transportation is forecasting (Schulze and Prinz, 2009; Ee *et al.*, 2014; Rashed *et al.*, 2016; Gokkus *et al.*, 2017). Forecasting is highly important for terminal operators who plan investment on constructing new terminals or buying new terminal equipment and for ship operators who charter and/or purchase ships and containers and perform scheduling. However, sorting out seasonal effects from full container throughput has not drawn attention much so far in the literature, because probably its practical outcomes have been found meaningless. However, cargo seasonality in full container traffic is one of the major reasons of ECM and must be studied in this context as we have uniquely executed in this study.

The studies relevant to TSA and dynamics of ECM have been discussed in Section 2. Section 3 details the method of X-13ARIMA-SEATS benefited herein this study while analysing the datasets. Section 4 discusses a case study in Turkish terminals and the statistical datasets have been analysed in Section 5. Finally, the findings of the study, the implications, the limitation of the research, and the future research directions have been presented in Section 6.

Literature review

Most of the studies about empty container reposioning in the literature focus on optimising it to reduce operational cost and environmental depredation. The basic problem of equipment circulation in the literature generally has been taken shape on imports/exports imbalance in terms of cargo and container type. Several solutions have been suggested to minimise the amount of ECM. Song and Carter (2009), Vojdani *et al.* (2013) and Monios and Wang (2014) focussed on establishing a common container pool with the participation of numerous ship operators. Moon *et al.* (2010) and Varshavets *et al.* (2013) scrutinised the popularisation of container leasing among ship operators instead of inventory stock, motivating container sharing. Chang *et al.* (2008) thought over benefiting 20-foot and 40-foot containers in place of each other. The optimisation studies in the literature extended to locating depot facilities (Dang *et al.*, 2013; Olivo *et al.*, 2013) and container storage areas (Lei and Church, 2011; Mittal *et al.*, 2013) in addition to on board solutions of voyage planning (Christiansen *et al.*, 2013; Braekers *et al.*, 2013; Meng *et al.*, 2015) and empty container allocation (Cheung and Chen, 1998; Song and Dong, 2011; Long *et al.*, 2012). Furthermore, carrier based solutions such as flexible destinations during a voyage (Song and Dong, 2010) and street-turns (Jula *et al.*, 2006; Legros *et al.*, 2016) were discussed. Benefiting and popularising foldable containers (Moon *et al.*, 2012) and deployment of hybrid type of equipment (Malchow, 2016) are quite hot agenda items today. All these studies and more than these aspire to mitigate AECM.

On the other hand, these studies partly touch on the reasons of ECM. A great deal of studies underscored trade/container-type imbalances (Olivo *et al.*, 2005; Song and Dong, 2011). Chang *et al.* (2008) concluded that container-type imbalance in Los Angeles and Long Beach ports caused extra operational cost. Benefiting 20-foot container in case these ports lack 40-foot container or vice versa, a cost advantage of between 4 and 47 per cent might be obtained.

Some papers underscored seasonal demand explicitly, but some papers gave indication implicitly. Song and Carter (2009) discussed the critical factors affecting ECM. These factors are the regional trade imbalances and dynamic behaviour, demand, handling, and/or shipment uncertainties, container-type differences, blind spots in the transportation chain, and operational and strategic practices of ship operators. The term *dynamic behaviour* refers to seasonal shipping demand which means cargo seasonality. Song and Dong (2015) refer to *dynamic operations* as one of the key factors in ECM, too.

Diaz *et al.* (2011) underlined the undeniable impact of trade imbalance but revealed the fact that the high number of ECM cannot be explained solely by this impact but must be explained by some practices as Song and Carter (2009) attributed this to the operational and strategic practices of ship operators. This emphasis highlights another impact arising from voluntary commercial decisions of ship operators, called the market effect.

Basarici and Satir (2019) reviewed the literature and suggested a taxonomy indicating the reasons for ECM into three categories. The category *trade imbalance* consists of structural trade imbalance and region-based container-type imbalance. *Operational drivers* include seasonal shipping demand, abundant container owners, container condition, uncertainties in demand/handling/shipment, and blind spots in supply chain. The last category *market effect* points out the impact of commercial decisions of ship operators. The authors attribute ECM partly to the hub port strategy of ship operators, competition between them on a string basis and ship operator-based container imbalance.

Herein this study the impact of cargo seasonality has been investigated empirically by means of a wide range of datasets to discover its significance level in Turkish container terminals. This study is a complement of the efforts disclosing the dynamics of ECM detailed here in above. It focuses on a specific field i.e. seasonality in container transportation, revealing one of the prominent factors leading to ECM i.e. market effect. It tests the existence of cargo seasonality and its magnitude in one of the significant trade regions in the world then analyses and discusses further dynamics. Therefore, herein this section some papers relevant to maritime container transportation and benefiting TSA methods are examined. Most of below mentioned studies about TSA focus on forecasting of terminal throughput and support the significance of ARIMA model as compared with others. Only one paper benefiting DJemetra+ program hosting X-13ARIMA-SEATS could have been reviewed in this section due to very limited publishing benefiting this method.

Schulze and Prinz (2009) examine container transshipment at the German ports benefiting the Seasonal ARIMA (SARIMA) model and the Holt-Winters exponential smoothing approach. The model makes use of quarterly dataset and is designed especially to take account of the seasonal behaviour. The authors aim to forecast the values of next two years by a dataset between 1989 and 2006. According to forecasting error measures such as Mean Square Error and Theil's U, the SARIMA-approach yields slightly better values of modelling the container throughput than the exponential smoothing approach. The forecast results indicate strong growth for German container handling in total.

Xie *et al.* (2013) scrutinised and compared hybrid methods based on least squares support vector regression (LSSVR), intending container throughput forecast. The three hybrid approaches include SARIMA, seasonal decomposition (SD) and classical decomposition (CD). The proposed hybrid approaches, i.e. SARIMA–LSSVR, SD–LSSVR and CD–LSSVR, are based on the principle of divide and conquer to overcome the difficulty in container throughput forecasting. Experimental forecasts of container throughput at Shanghai port and Shenzhen port were made by using the experiment design and methodologies mentioned above. As per the results, SARIMA's forecasting performance is excellent among single forecasting methods, and better than LSSVR.

Ee *et al.* (2014) paper is about planning of container terminal equipment which has been uncertain due to seasonal and fluctuating throughput demand along with other factors. They scrutinised the issue by using two methods of TSA, SARIMA and Holt-Winters. Though both the forecasting models share close similarity in results, one can note the superiority of the SARIMA model for its flexibility of transforming and eliminating spikes in autocorrelation and partial autocorrelation functions.

Rashed *et al.* (2016) paper aims at short-term forecast of container throughput for the port of Antwerp. Two different approaches were applied: The ARIMA model combining seasonality with the intervention function to account for the effect of shocks and, the ARIMAX model with leading economic indicator. They compare the results to determine which model gives a better forecast. A monthly dataset of past 20 years up to 2015 respecting container throughput at the port was used during the research. The authors conclude that the benefit of the ARIMA-intervention model is not related to its forecasting power, but rather in identifying and quantifying the impact of shocks on the behaviour of the time series.

Literature review indicates that detection of seasonality in time series has been shaped on ARIMA modelling which considers serial effect. Today several institutions such as Eurostat and Statistics Canada use software programs based on ARIMA. In this context JDemetra+ procedure and program were chosen to detect seasonality in this study. No other study benefiting from JDemetra+ for TSA in container transportation was determined in the literature. One of the very rare studies using JDemetra+ was released by Edvinsson and Hegelund (2016). They studied GDP dataset of Sweden in the recent century. Their paper presents a time series back to 1913 on manufacturing and private consumption. As they both are indicators, the authors use standard methods for disaggregation from annual GDP data. Most of all, JDemetra+ procedure and software is applied on the dataset to estimate a deseasonalised time series. Thus, they find that the new series provides new information on the business cycle, confirming its irregular nature and detecting recessions that are not clearly indicated by a set of actual data. In terms of seasonality, they apply both methods embedded in the procedure i.e. X-13ARIMA-SEATS and TRAMO/SEATS. The results indicate that the difference between two methods is, in practice, quite small.

In container transportation, cargo seasonality is substantially referred as one of the reasons leading to ECM but no empirical study about this reason has been coincided in the literature. This study can assist to fill this research gap in this field. Furthermore, this study strengthens the phenomenon of market effect in the way of normal science.

Methodology

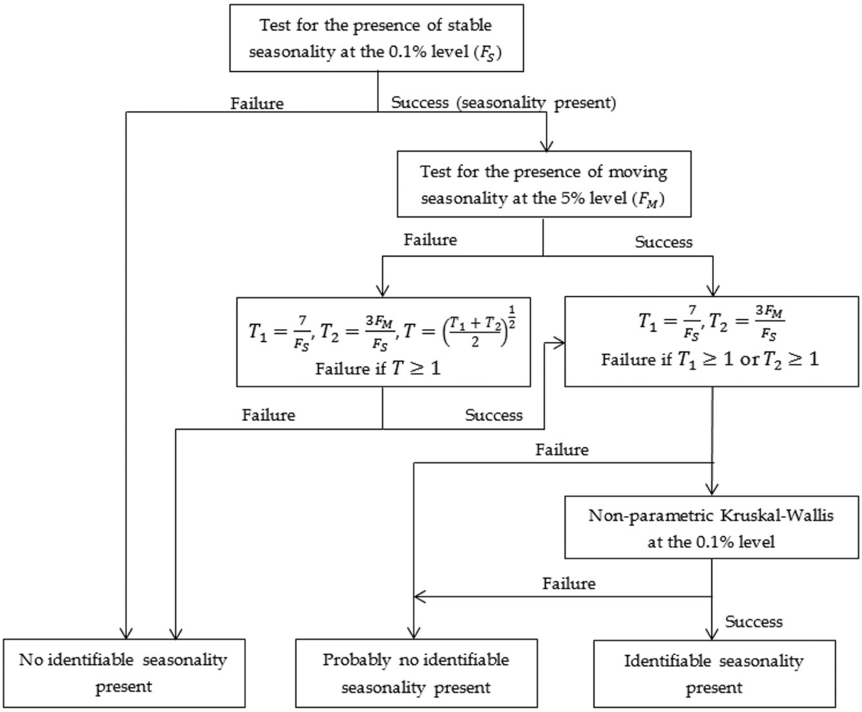
There are several techniques to implement seasonal adjustment. They can be divided into two groups: moving average based methods and model based methods. Moving average based methods use filters and do not rely on any explicit underlying model (Eurostat, 2015; Edvinsson and Hegelund, 2016).

> The moving average based method in JDemetra+ is X-13ARIMA-SEATS, while the model based method is TRAMO/SEATS. The first step in both methods removes deterministic effects applying a regression model. The difference between two models is in the second step. X-13ARIMA-SEATS is based on Henderson moving average of the seasonal components. Its advantage is its sensitivity to sudden changes in the seasonal component (Edvinsson and Hegelund, 2016).

Therefore, herein this study X-13ARIMA-SEATS was chosen to analyse the datasets of initial AECM. Recent releases of X-13ARIMA-SEATS and JDemetra+ program hosting it have led to a paradigm shift since both seasonal adjustment programs unify the non-parametric X-11 method and the parametric ARIMA model-based approach under one umbrella (Webel, 2016). In 2012, Eurostat released an upgraded version of the software called Demetra+, and in 2014, JDemetra+ consisting of X-13ARIMA-SEATS methodology in collaboration with National Bank of Belgium. Seasonal adjustment instructions of the European Statistical System advice that adjustment must be done only if there is seasonality in a time series. Therefore, during this study, adjustment process is implemented when seasonality has been detected in time series by combined seasonality test (CST).

Combined seasonality test

This test combines the Kruskal–Wallis test along with a test for presence of seasonality assuming stability, and evaluative seasonality test for detecting the presence of identifiable seasonality. The main purpose of the test is to check if the seasonality of the series is identifiable. CST includes four sub alternate tests (Figure 1) which are stable seasonality



Source: Grudkowska (2016)

Figure 1.
CST

test, moving seasonality test, a test for presence of identifiable seasonality and Kruskal–Wallis test. CST concludes that seasonality is present, or not present, or probably not present. JDemetra+ procedure and program include CST (Grudkowska, 2016).

Stable seasonality test (also called the Friedman test)
This test is a non-parametric method for testing that samples are drawn from the same population or from populations with equal medians. In the regression equation, the significance of the month effect is tested. Under the null hypothesis of no seasonality, all monthly periods can be treated equally. If the null hypothesis of no stable seasonality is rejected at the 1 per cent significance level, then the series is considered to be seasonal.

Moving seasonality test (also called evaluative seasonality test)
This seasonality test is based on a two-way analysis of variance model. The model uses the values from complete years only. The null hypothesis says that there is no change in seasonality over the years.

Test for presence of identifiable seasonality
This test combines the values of the F-statistic of the parametric test for stable seasonality and the values of the moving seasonality test. The test checks if the stable seasonality is not dominated by moving seasonality. In such a case, the seasonality is regarded as identifiable.

Kruskal–Wallis test

The Kruskal–Wallis test is a non-parametric test used for testing whether samples originate from the same distribution. The null hypothesis states that all months have the same mean. The rejection of the null hypothesis of the Kruskal–Wallis test implies that at least one sample stochastically dominates at least one other sample. Under the null hypothesis, the test statistic follows a chi-square distribution. When this hypothesis is rejected, it is assumed that the values of a time series differ significantly between periods.

X-13Arima-seats

The method of X-13ARIMA-SEATS especially focuses on detecting seasonal signals and decomposition (Gomez and Maravall, 1997) and furthermore it is quite sensitive to sudden seasonal changes (Edvinsson and Hegelund, 2016). X-13ARIMA-SEATS can adjust seasonality by means of two different ways (Grudkowska, 2016). First one is SEATS which is based on ARIMA. The other one is upgraded version of X-11 method. Whereas X-11 method processes on monthly or quarterly based, SEATS can be practised on a dataset including number of 2, 3, 4, 6 and 12 observation units in a year. SEATS is a method being used to estimate unobserved stochastic elements. Time series incur deterministic effects as much as they usually are under the effects of outliers and missing observations. Therefore, original series are modelled by ARIMA and linearized to get rid of such effects (Grudkowska, 2016). One of the fundamental assumptions made by SEATS is that the stochastic time series x_t follows the ARIMA model.

$$\Phi(B)\delta(B)x_t = \theta(B)a_t \tag{1}$$

where:

B = *backshift* operator;

$\delta(B)$ = a non-stationary autoregressive polynomial in B (unit roots);

$\theta(B)$ = an invertible moving average (MA) polynomial in B;

$\Phi(B)$ = a stationary autoregressive (AR) polynomial in B and stationary seasonal polynomial in B; and

a_t = a white-noise variable with the variance (Grudkowska, 2016).

$$x_t = \sum_{i=1}^{k} x_{it} \tag{2}$$

where:

i = trend, seasonal, transitory or irregular components; and

k = number of components.

The procedure consists in estimation of time series components by means of the Wiener-Kolmogorov filters as the minimum mean square estimators using unobserved component ARIMA model.

Seasonal adjustment procedure for a dataset

A raw dataset might handicap a healthy analysis due to presence of outliers, missing observation units and incomprehensible rise and fall in time series. Outliers in a raw dataset must be sorted out since they may affect results due to parametric test procedures. The JDemetra+ program can detect outliers and any weird change in time series. These are described as follows (Grudkowska, 2015)

- *Additive outlier (AO)* – abnormal value in isolated point of the series;
- *Transitory change (TC)* – a series of outliers with temporarily decreasing effects on the level of the time series;
- *Level shift (LS)* – a series of innovation outliers with a constant long-term effect on the level of the time series, where for innovation outlier is meant anomalous values in the innovation series.

A hinterland may include a few terminals. In this study, a genuine procedure suggested and detailed here below was used to discover presence of seasonality based on a terminal or a hinterland.

- A raw dataset is tested by CST. If seasonality is present, the process is ceased.
- If seasonality is not present, or probably not present as described in the program, a dataset is adjusted in terms of AO, TC and LS without spoiling its essence.
- An adjusted dataset is tested by CST to reveal if seasonality is present or not.

After deducting seasonality on a terminal/hinterland basis, further items determine if seasonality is to be held on a terminal or a hinterland basis.

- If there is no seasonality on the basis of a terminal in a hinterland, seasonality in a dataset might be accepted on a hinterland basis if it exists.
- If one or more number of terminals display seasonality, it is accepted that seasonality is on the basis of terminal regardless there is seasonality on the basis of a hinterland.

Case study for container terminals in Turkey

The analysis of cargo seasonality was performed by means of full container throughput. The statistical datasets were requested from the Communications Centre of Turkish Prime Ministry (BIMER) and acquired from relevant government office, the directorate of planning and information management. The methodology was applied on the eleven-year datasets of 20-foot and 40-foot containers based on imports and exports respectively between 2006 and 2016. The special type of equipment movements such as reefer containers could not be distinguished. The original datasets include monthly full and empty equipment movements on the basis of terminal. They include only the foreign trade in Turkey (i.e. the datasets of imports/exports and inbound/outbound ECM with respect to international trade) but excludes the data relevant to transit and cabotage liftings. Due to limited amount of lines, only the results between 2014 and 2016 could have been delivered herein this study.

Results and discussion

The datasets were scrutinised for 18 terminals and 10 hinterlands located in Turkey. In total 28 terminals/hinterlands have been reviewed for 20-foot and 40-foot containers and respectively for imports and imports. This reveals 112 datasets to analyse. In 33 datasets of total 112, seasonality effect was detected (Table I). A genuine procedure (see Methodology, Seasonal adjustment procedure for a dataset) to determine whether seasonality exists on a terminal or a hinterland basis has revealed that 17 terminals/hinterlands consist of cargo seasonality and a genuine interpretation helped to sort the seasonality effect out from AECM. One must take in consideration that a ship operator may call at different terminals concurrently. Therefore, seasonality might be detected on a hinterland basis though no seasonality is detected on a terminal basis located in this hinterland. In Ambarli Istanbul

	20'		40'	
	Imports	Exports	Imports	Exports
Kumport	Prob. Not Present	Prob. Not Present	Not Present	Not Present
Mardas	Not Present	Not Present	Prob. Not Present	Not Present
Marport	Prob. Not Present	Not Present	Prob. Not Present	Not Present
Ambarli hinterland	Prob. Not Present	PRESENT	PRESENT	Not Present
Haydarpasa	PRESENT	Not Present	PRESENT	Not Present
Istanbul hinterland	Present	Present	Present	Not Present
Evyap port	Not Present	Not Present	Prob. Not Present	Not Present
Yilport	Prob. Not Present	Not Present	Prob. Not Present	Not Present
Limas	Not Present	Not Present	Not Present	Not Present
Kocaeli hinterland	Not Present	Not Present	PRESENT	Not Present
Borusan	Prob. Not Present	PRESENT	Not Present	Not Present
Gemport	Prob. Not Present	Not Present	Prob. Not Present	Not Present
Rodaport	Not Present	PRESENT	Not Present	Prob. Not Present
Gemlik hinterland	Prob. Not Present	Present	Prob. Not Present	Prob. Not Present
Marmara hinterland	Present	Present	Present	Present
TCDD Izmir Alsancak	PRESENT	PRESENT	PRESENT	PRESENT
Ege Gubre	Prob. Not Present	Not Present	Prob. Not Present	Not Present
Nemport	Not Present	Prob. Not Present	Not Present	Not Present
Izmir – Aliaga hinter.	Present	Prob. Not Present	Present	Present
Assan	Not Present	Not Present	Prob. Not Present	Not Present
Limak	Not Present	Not Present	Not Present	Not Present
Iskenderun hinter	Not Present	Not Present	Not Present	Not Present
Mersin MIP	Prob. Not Present	PRESENT	Prob. Not Present	PRESENT
Mersin Iskenderun h.	Prob. Not Present	Present	PRESENT	Present
Antalya	Not Present	PRESENT	Prob. Not Present	Not Present
Samsun	PRESENT	Not Present	Not Present	PRESENT
Trabzon	Not Present	Not Present	Not Present	Not Present
Turkey Total	Present	Present	Present	Prob. Not Present

Note: Prob. = Probably. The word PRESENT with capital letters indicates that seasonality is on either a terminal or a hinterland basis

Table I. Seasonality presence on the basis of terminal and hinterland

hinterland, level shifts in datasets observed in January 2011 and in February 2016 are good examples for this. In 2011, Kumport Istanbul terminal had a growing trend whereas Marport Istanbul terminal in the same hinterland was facing downtrend. In 2016, on the contrary, Marport had a growing trend and Kumport was facing downtrend.

Since cargo seasonality is scrutinised merely the datasets consisting of full containers have been adjusted. Seasonality in a time series must be investigated in series for both imports and exports respectively. However, seasonality might be detected for both simultaneously. This brings up a further interpretation. Such a case was observed during the analysis of the datasets belonging to Izmir Alsancak terminal for both 20-foot and 40-foot full containers. This event leads to absorption of reciprocal ECM. Simultaneous analysis of datasets for imports and exports displays an amount of absorption, and the non-absorbed amount equals to AECM originating from seasonality. If the difference between actual and adjusted (SA) data in a month has the same direction for both inbound and outbound traffics (Figure 2), AECM originated from seasonality is absorbed. Any probable AECM is prevented accordingly. For instance, AECM for an amount of 100 TEU in inbound traffic absorbs AECM for an amount of 100 TEU in outbound traffic. Hence no AECM occurs. Otherwise, inbound and outbound datasets must be assessed independent of each other.

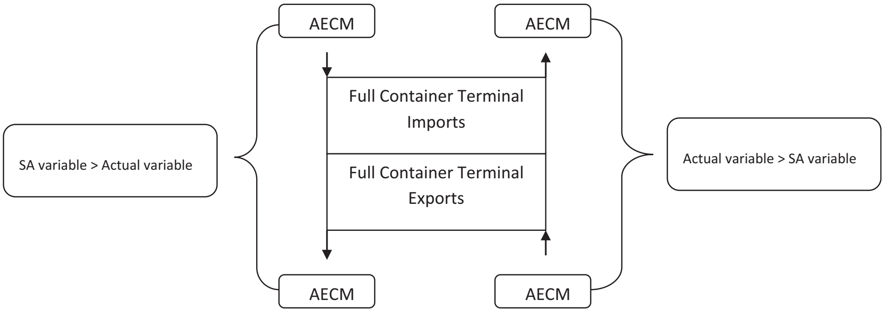


Figure 2.
Seasonal absorption

Our further genuine interpretation reveals that an adjusted dataset represents that "if there was no cargo seasonality, adjusted dataset would be valid". There is a difference between original and adjusted time series for each month. The sign of difference might be positive or negative for successive months (Tables II to IV). The crucial point is to interpret how ECM was affected by these monthly differences. For a dataset of imports, if an adjusted datum is greater than an actual datum of the same month, essentially an amount of containers which is equal to the difference between them had to be discharged as full container but this amount of full container was missing. This gap is closed by means of additional empty container discharge. Hence, this difference equals to AECM originating from cargo seasonality. If an actual datum is greater than an adjusted datum of a same month, one must understand that an amount of full container which equals to the difference was performed, but essentially, it did not have to be taken place. It triggers ECM for exports arising from seasonality. Since 20-foot and 40-foot containers practically are not interchangeable, seasonality of a container type is independent of each other. Therefore, this study does not include a research in this context.

Seasonal AECM in AECM were calculated accordingly (Tables V to VII). It differs between 1 per cent and 73 per cent. Ambarlı hinterland in Istanbul has the greatest amount of AECM for 20-foot (imports) between 2014 and 2016. Its seasonality ratio in AECM is 12-13 per cent. Regarding other major terminals/hinterlands the results are: Ambarli Istanbul for 40-foot (imports), 9-10 per cent; Mersin for 20-foot (exports), 25-35 per cent; and Mersin-Iskenderun hinterland (imports), 10-11 per cent. Country-wide, one can say that roughly, the amount of AECM originating from cargo seasonality represents 10 per cent of total AECM (around 100.000 units in 2016) in those major terminals/hinterlands where seasonality is present.

In general, the effect of cargo seasonality is relatively low, considering total ECM in Turkish terminals. AECM can be calculated by deducting ECM arising from trade imbalance from total ECM per container-type. Furthermore, after deducting seasonal AECM from AECM one can find out AECM arising from the rest of operational drivers except cargo seasonality and market effect (Basarici and Satir, 2019). Ambarli Istanbul has a huge container throughput if compared other local terminals. In 2016, ECM for both 20-foot and 40-foot equipment reached 366.191 units. Only an amount of 98.963 units were moved due to trade imbalance. The empty throughput arising from cargo seasonality reached only 27.738 units. It means 239.489 units moved due to operational drivers except cargo seasonality and market effect, equalling to 65 per cent of ECM to/from Ambarli Istanbul. The results of other terminals and hinterlands in Turkey support this determination more or less (Tables VIII and IX). Country-wide but limited to the datasets in hand, market effect together with

Table II.
Original series vs adjusted series (40-foot imports Ambarli Istanbul)

Date	Original series	Adjusted series	Difference
01.2014	31.308	30.000	1.308
02.2014	31.969	32.426	−457
03.2014	32.524	31.299	1.225
04.2014	29.864	29.808	56
05.2014	34.149	31.850	2.299
06.2014	32.562	30.988	1.574
07.2014	34.819	33.295	1.524
08.2014	33.417	32.504	913
09.2014	32.053	33.890	−1.837
10.2014	30.541	32.033	−1.492
11.2014	30.498	34.430	−3.932
12.2014	31.995	33.595	−1.600
01.2015	29.150	27.951	1.199
02.2015	29.889	30.428	−539
03.2015	34.973	33.617	1.356
04.2015	28.059	28.061	−2
05.2015	27.752	25.911	1.841
06.2015	28.560	27.121	1.439
07.2015	27.114	25.887	1.227
08.2015	27.207	26.648	559
09.2015	26.510	28.006	−1.496
10.2015	28.282	29.660	−1.378
11.2015	24.372	27.417	−3.045
12.2015	29.281	30.578	−1.297
01.2016	27.639	26.492	1.147
02.2016	25.586	26.116	−530
03.2016	29.032	27.902	1.130
04.2016	28.691	28.737	−46
05.2016	28.761	26.994	1.767
06.2016	30.434	28.837	1.597
07.2016	33.809	32.154	1.655
08.2016	27.718	27.321	397
09.2016	26.271	27.680	−1.409
10.2016	26.926	28.193	−1.267
11.2016	25.659	28.817	−3.158
12.2016	25.879	26.945	−1.066

operational drivers except cargo seasonality is responsible of around 750.000 units of empty movements of around 1.550.000 units in total.

Conclusions and recommendations

Trade and container imbalances are the major and the most highlighted reasons of ECM. The concept of AECM refers to the magnitude of ECM other than trade imbalance and container imbalance. AECM consists of operational drivers and market effect. Market effect describes ECM resulting from voluntary commercial decisions of the ship operators. On the other hand, the reasons for operational drivers occur under the limited control of ship operators or are entirely beyond their control. One of them is seasonal demand. Seasonal demand is the major operational driver in Turkish terminals, effecting ECM. Herein this study containerised cargo seasonality was detected and long-term time series of full containers in Turkish container terminals were adjusted to discover the magnitude of cargo seasonality leading to conceive the importance of market effect.

Date	Original series	Adjusted series	Difference
01.2014	8.365	9.103	−738
02.2014	9.513	9.866	−353
03.2014	11.129	10.233	896
04.2014	12.019	11.435	584
05.2014	11.492	10.694	798
06.2014	11.277	10.768	509
07.2014	11.344	10.740	604
08.2014	11.403	11.683	−280
09.2014	10.221	10.675	−454
10.2014	10.453	10.721	−268
11.2014	11.340	11.768	−428
12.2014	9.653	10.541	−888
01.2015	10.127	10.918	−791
02.2015	10.562	10.915	−353
03.2015	12.741	11.796	945
04.2015	11.917	11.254	663
05.2015	11.872	11.051	821
06.2015	12.250	11.731	519
07.2015	11.574	11.056	518
08.2015	10.709	11.032	−323
09.2015	11.700	12.144	−444
10.2015	11.253	11.509	−256
11.2015	11.207	11.597	−390
12.2015	10.708	11.611	−903
01.2016	11.073	11.944	−871
02.2016	12.561	12.918	−357
03.2016	13.962	12.958	1.004
04.2016	13.913	13.165	748
05.2016	14.449	13.638	811
06.2016	12.427	11.889	538
07.2016	13.237	12.803	434
08.2016	12.598	12.952	−354
09.2016	13.322	13.747	−425
10.2016	14.414	14.657	−243
11.2016	14.137	14.487	−350
12.2016	13.488	14.421	−933

Table III. Original series vs adjusted series (40-foot imports Kocaeli)

This study consists of eleven-year datasets of full container movements in Turkish terminals on a monthly basis between 2006 and 2016 and reveals the presence and magnitude of seasonality, and was executed in two-stage. During the first stage, one should detect if cargo seasonality is present in time series on the basis of terminal and/or hinterland, and assess its magnitude by means of JDemetra+ program benefiting CST and X-13ARIMA-SEATS procedure. The difference on a monthly basis between original and adjusted time series of full container throughputs represents the amount of AECM originating from seasonality. In the second stage, the amount of seasonal AECM is compared AECM. This comparison requires a genuine interpretation as we executed in this study (Section 5). Another genuine part of the study is a rapprochement of hinterland-based assessment of container movements apart from terminal based one. In a hinterland, if ship operators change the ports of call, this might prevent to detect seasonality on the basis of terminal. Therefore, seasonality on the basis of hinterland hosting more than a terminal was investigated as well. In terms of originality, a novel concept of absorption in point of

Date	Original series	Adjusted series	Difference
01.2014	16.645	17.111	−466
02.2014	14.110	16.520	−2.410
03.2014	15.343	16.816	−1.473
04.2014	14.810	16.115	−1.305
05.2014	17.813	16.422	1.391
06.2014	17.348	15.932	1.416
07.2014	16.376	15.799	577
08.2014	14.412	14.586	−174
09.2014	15.251	14.914	337
10.2014	12.766	13.601	−835
11.2014	14.814	13.961	853
12.2014	17.433	15.514	1.919
01.2015	13.480	14.280	−800
02.2015	12.175	14.186	−2.011
03.2015	14.441	15.814	−1.373
04.2015	13.113	14.119	−1.006
05.2015	16.047	14.678	1.369
06.2015	16.726	15.117	1.609
07.2015	14.505	14.566	−61
08.2015	15.348	15.418	−70
09.2015	15.805	15.638	167
10.2015	15.962	16.276	−314
11.2015	16.992	16.283	709
12.2015	17.410	15.868	1,542
01.2016	13.073	14.221	−1.148
02.2016	15.119	16.566	−1.447
03.2016	14.382	15.786	−1.404
04.2016	16.790	17.432	−642
05.2016	18.070	16.747	1.323
06.2016	18.539	16.878	1.661
07.2016	13.939	14.514	−575
08.2016	17.142	17.069	73
09.2016	16.864	16.861	3
10.2016	19.134	18.937	197
11.2016	17.891	17.342	549
12.2016	18.819	17.584	1.235

Table IV.
Original series vs adjusted series (20-foot exports Mersin MIP)

simultaneous seasonal AECM of imports and exports must be underlined, too (Section 5). Nonetheless, one has to emphasise the limitation of this research study. Some Turkish terminals have a significant amount of reefer container traffic. Due to undetailed breakdown, this type of container traffic could not be sorted from the datasets. The datasets include them, as they are standard equipment.

The results indicate that 17 of 112 time series based on terminal or hinterland exhibit cargo seasonality. This study displays the significant magnitude of seasonality throughout the country. Cargo seasonality occurs almost in every district of Turkey along with having various rates in AECM between 1 per cent and 73 per cent. Furthermore, the total amount of seasonal AECM in Turkey represents almost 10 per cent of AECM in those terminals/hinterlands where seasonality is present. However when examining ECM arising from other than trade imbalance and cargo seasonality, one can see that a huge amount of empty container traffic realises due to majorly market effect and partly operational drivers except cargo seasonality.

Terminal/Hinterland	Cont. Type	Trade	AECM	AECMs	Ratio
Ambarli Istanbul	20'	Exports	98.466	12.479	0,13
Ambarli Istanbul	40'	Imports	207.362	18.217	0,09
Haydarpasa Istanbul	20'	Imports	9.396	1.011	0,11
Haydarpasa Istanbul	40'	Imports	3.098	1.544	0,50
Kocaeli hinterland	40'	Imports	44.790	6.800	0,15
Borusan Gemlik	20'	Exports	6.911	2.831	0,41
Rodaport Gemlik	20'	Exports	2.276	923	0,41
Mersin MIP	20'	Exports	37.246	13.155	0,35
Mersin MIP	40'	Exports	86.734	15.197	0,18
Mersin - Iskenderun	40'	Imports	97.676	10.645	0,11
Antalya	20'	Exports	20.717	13.477	0,65
Samsun	20'	Imports	15.992	131	0,01
Samsun	40'	Exports	2.091	1.535	0,73
TCDD Alsancak Izmir	20'	Imports-Exports	23.233	5.360	0,23
TCDD Alsancak Izmir	40'	Imports-Exports	21.596	7.833	0,36

Table V. Seasonal AECM (AECMs) in 2014

Terminal/Hinterland	Cont. Type	Trade	AECM	AECMs	Ratio
Ambarli Istanbul	20'	Exports	88.538	11.555	0,13
Ambarli Istanbul	40'	Imports	174.172	15.378	0,09
Haydarpasa Istanbul	20'	Imports	7.053	819	0,12
Haydarpasa Istanbul	40'	Imports	3.107	1.332	0,43
Kocaeli hinterland	40'	Imports	57.749	6.927	0,12
Borusan Gemlik	20'	Exports	7.590	2.830	0,37
Rodaport Gemlik	20'	Exports	2.539	965	0,38
Mersin MIP	20'	Exports	38.596	11.032	0,29
Mersin MIP	40'	Exports	91.368	15.759	0,17
Mersin - Iskenderun	40'	Imports	105.324	10.834	0,10
Antalya	20'	Exports	23.893	11.291	0,47
Samsun	20'	Imports	10.298	143	0,01
Samsun	40'	Exports	2.539	1.535	0,60
TCDD Alsancak Izmir	20'	Imports-Exports	18.446	5.037	0,27
TCDD Alsancak Izmir	40'	Imports-Exports	40.352	6.799	0,17

Table VI. Seasonal AECM (AECMs) in 2015

Terminal/Hinterland	Cont. Type	Trade	AECM	AECMs	Ratio
Ambarli Istanbul	20'	Exports	109.108	12.569	0,12
Ambarli Istanbul	40'	Imports	158.120	15.169	0,10
Haydarpasa Istanbul	20'	Imports	5.727	687	0,12
Haydarpasa Istanbul	40'	Imports	3.081	1.187	0,39
Kocaeli hinterland	40'	Imports	60.987	7.068	0,12
Borusan Gemlik	20'	Exports	7.448	2.831	0,38
Rodaport Gemlik	20'	Exports	2.896	1.041	0,36
Mersin MIP	20'	Exports	41.652	10.260	0,25
Mersin MIP	40'	Exports	84.880	17.267	0,20
Mersin - Iskenderun	40'	Imports	109.816	11.087	0,10
Antalya	20'	Exports	39.357	8.175	0,21
Samsun	20'	Imports	9.920	150	0,02
Samsun	40'	Exports	2.724	1.536	0,56
TCDD Alsancak Izmir	20'	Imports-Exports	10.672	4.669	0,44
TCDD Alsancak Izmir	40'	Imports-Exports	35.944	7.352	0,20

Table VII. Seasonal AECM (AECMs) in 2016

Terminal/Hinterland	ECM	ECMti	AECM	AECMs	AECM-AECMs	Ratio
Ambarli Istanbul	147.012	37.904	109.108	12.569	96.539	0,66
Haydarpasa Istanbul	10.564	4.837	5.727	687	5.040	0,48
Gemport Gemlik	37.949	24.141	13.808	0	13.808	0,36
Borusan Gemlik	24.355	16.907	7.448	2.831	4.617	0,19
Roda Gemlik	4.920	2.024	2.896	1.041	1.855	0,38
Kocaeli hinterland	65.558	32.833	32.725	0	32.725	0,50
Egegubre Aliaga	44.404	31.440	12.964	0	12.964	0,29
Nemport Aliaga	38.088	28.343	9.745	0	9.745	0,26
TCDD Alsancak Izmir	98.724	88.052	10.672	4.669	6.003	0,06
Mersin MIP	104.011	62.359	41.652	10.260	31.392	0,30
Mersin - Iskenderun	122.002	75.314	46.688	0	46.688	0,38
Antalya	79.570	40.213	39.357	8.175	31.182	0,39
Samsun	12.881	2.961	9.920	150	9.770	0,76

Notes: ECM = Empty Container Movement; ECMti = ECM arising from trade imbalance; AECM = Additional ECM; AECMs = AECM arising from cargo seasonality; Ratio = (AECM-AECMs)/ECM; (AECM-AECMs) = ECM arising from market effect and operational drivers except cargo seasonality

Table VIII.
20-Foot ECM in Turkey (2016)

Terminal/Hinterland	ECM	ECMti	AECM	AECMs	AECM-AECMs	Ratio
Ambarli Istanbul	219.179	61.059	158.120	15.169	14.2951	0,65
Haydarpasa Istanbul	13.024	9.943	3.081	1.187	1.894	0,15
Gemport Gemlik	37.218	22.983	14.235	0	14.235	0,38
Borusan Gemlik	18.996	12.133	6.863	0	6.863	0,36
Roda Gemlik	8.217	2.927	5.290	0	5.290	0,64
Kocaeli hinterland	68.468	7.481	60.987	7.068	53.919	0,79
Egegubre Aliaga	43.666	25.786	17.880	0	17.880	0,41
Nemport Aliaga	40.232	30.341	9.891	0	9.891	0,25
TCDD Alsancak Izmir	58.448	22.504	35.944	7.352	28.592	0,49
Mersin MIP	107.418	22.538	84.880	17.267	67.613	0,63
Mersin - Iskenderun	140.655	30.839	109.816	11.087	98.729	0,70
Antalya	5.481	4.043	1.438	0	1.438	0,26
Samsun	2.763	39	2.724	1.536	1.188	0,43

Notes: ECM = Empty Container Movement; ECMti = ECM arising from trade imbalance; AECM = Additional ECM; AECMs = AECM arising from cargo seasonality; Ratio = (AECM-AECMs)/ECM; (AECM-AECMs) = ECM arising from market effect and operational drivers except cargo seasonality

Table IX.
40-Foot ECM in Turkey (2016)

Especially in Turkey, one can allege that the difference between AECM and seasonal AECM substantially reflect the amount of ECM arising from market effect (Basarici and Satir, 2019). In case AECM arising from market effect can be decreased, less cost for supermarkets and less environmental depredations might be obtained. ECM can be reduced through information and equipment sharing, freight pooling and cooperation of transport service providers (UNCTAD, 2015). Likewise, Lee and Song (2017) allege that empty container positioning can be mitigated by container exchange. In this respect, substantial magnitude of ECM arising from market effect points out a solution area. This fruitlessness, first of all, must motivate the ship operators or the governments for a good cooperation in point of container exchange. Information sharing and freight pooling can be evaluated in common particularly for spot cargo market.

Here in this study, we found out how to reach the magnitude of seasonal AECM. The rest of operational drivers, abundant container owners, container condition, uncertainties in demand/handling/shipment and blind spots in supply chain, can be investigated in future studies to conceive the magnitude of market effect further.

References

Basarici, A.S. and Satir, T. (2019), "Empty container movements beyond the effect of trade imbalance: Turkish terminals", *International Journal of Logistics Systems and Management*, Vol. 33, No. 2, pp. 141-166.

Braekers, K., Janssens, G.K. and Caris, A. (2013), "Integrated planning of loaded and empty container movements", *Or Spectrum*, Vol. 35 No. 2, pp. 457-478.

Boile, M., Theofanis, S. and Mittal, N. (2004), ""Empty intermodal containers a global issue", *Annual Forum of the Transportation Research Forum Northwestern University, Transportation Center, Evanston, IL*, 21-24 March.

Box, G.E.P. and Jenkins, G.M. (1970), *Time Series Analysis Forecasting and Control*, Holden-Day, San Francisco.

Chang, H., Jula, H., Chassiakos, A. and Ioannou, P. (2008), "A heuristic solution for the empty container substitution problem", *Transportation Research Part E*, Vol. 44 No. 2, pp. 203-216.

Cheung, R.K. and Chen, C.Y. (1998), "A two-stage stochastic network model and solution methods for the dynamic empty container allocation problem", *Transportation Science*, Vol. 32 No. 2, pp. 142-162.

Christiansen, M., Fagerholt, K., Nygreen, B. and Ronen, D. (2013), "Ship routing and scheduling in the new millennium", *European Journal of Operational Research*, Vol. 228 No. 3, pp. 467-483.

Dagum, E.B. (1978), "Modelling, forecasting and seasonality adjusting economic time series with the X-11 ARIMA method", *Journal of the Royal Statistical Society, Series D*, Vol. 27 Nos 3/4, pp. 203-216.

Dagum, E.B. (1980), *The X-II-ARIMA Seasonal Adjustment Method*, Statistics Canada, Ottowa.

Dang, Q.V., Nielsen, I.E. and Yun, W.Y. (2013), "Replenishment policies for empty containers in an inland multi-depot system", *Maritime Economics and Logistics*, Vol. 15 No. 1, pp. 120-149.

Da Silva, F.G.F. and Rocha, C.H. (2012), "A demand impact study of Southern and southeastern ports in Brazil: an indication of port competition", *Maritime Economics and Logistics*, Vol. 14 No. 2, pp. 204-219.

Diaz, R., Talley, W. and Tulpule, M. (2011), "Forecasting empty container volumes", *The Asian Journal of Shipping and Logistics*, Vol. 27 No. 2, pp. 217-236.

Edvinsson, R. and Hegelund, E. (2016), "The business cycle in historical perspective: Reconstructing quarterly data on Swedish GDP 1913-2014", Stockholm Papers in Economic History, No: 18, available at: www.historia.se/SPEH18.pdf (accessed 22 October 2017).

Ee, J.Y.C., Kader, A.S.A., Ahmad, Z. and Beng, L.K. (2014), "Univariate throughput forecasting models on container terminal equipment planning", *Jurnal Teknologi (Sciences and Engineering)*, Vol. 69 No. 7, pp. 163-171.

Eurostat (2015), "ESS guidelines on seasonal adjustment", Manuals and guidelines, available at http://ec.europa.eu/eurostat/documents/3859598/6830795/KS-GQ-15-001-EN-N.pdf (accessed 5 May 2018)

Gokkus, U., Yildirim, M.S. and Aydin, M.M. (2017), "Estimation of container traffic at seaports by using several soft computing methods: a case of Turkish seaports", *Discrete Dynamics in Nature and Society*, Vol. 2017, available at: https://doi.org/10.1155/2017/2984853 (accessed 20 July 2018).

Gomez, V. and Maravall, A. (1997), "Programs TRAMO (time series regression with ARIMA noise, missing observations and outliers) and SEATS (signal extractions ARIMA time series)", *Gobierno de Espana, Ministerio de Hacienda Y Funcion Publica*, available at www.sepg.pap.minhafp.gob.es/sitios/sepg/esES/Presupuestos/Documentacion/Documents/DOCUMENTOS%20DE%20TRABAJO/SGAPE97001.pdf (accessed 18 May 2016).

Grudkowska, S. (2015), *JDemetra+ User Guide*, Narodowy Bank Polski, Warszawa.

Grudkowska, S. (2016), *JDemetra+ Reference Manuel*, Narodowy Bank Polski, Warszawa.

Jula, H., Chassiakos, A. and Ioannou, P. (2006), "Port dynamic empty container reuse", *Transportation Research Part E: Logistics and Transportation Review*, Vol. 42 No. 1, pp. 43-60.

Lee, C.Y. and Song, D.P. (2017), "Ocean container transport in global supply chains: Overview and research opportunities", *Transportation Research Part B*, Vol. 95, pp. 442-474.

Legros, B. Bouchery, Y. and Fransoo, J.C. (2016), "The role of consignees in empty container management", BETA publicatie: working papers, Vol. 517, Technische Universiteit Eindhoven, Eindhoven, available at: https://pure.tue.nl/ws/files/44571395/wp_517.pdf (accessed 15 August 2017)

Lei, T.L. and Church, R.L. (2011), "Locating short-term empty-container storage facilities to support port operations: a user optimal approach", *Transportation Research Part E*, Vol. 47 No. 5, pp. 738-754.

Løfstedt, B., Alvarez, J.F., Plum, C.E.M. P.D. and Sigurd, M.M. (2010), "An integer programming model and benchmark suite for liner shipping network design", Working paper, Report no. 19, Technical University of Denmark: DTU Management Engineering, Lyngby.

Long, Y., Lee, L.H. and Chew, E.P. (2012), "The sample average approximation method for empty container repositioning with uncertainties", *European Journal of Operational Research*, Vol. 222 No. 1, pp. 65-75.

Malchow, U. (2016), "Tworty box to improve the equipment logistics of container lines", *Transnav the International Journal on Marine Navigation and Safety of Sea Transportation*, Vol. 10 No. 2.

Meng, Q., Wang, T. and Wang, S. (2015), "Multi-period liner ship fleet planning with dependent uncertain container shipment demand", *Maritime Policy and Management*, Vol. 42 No. 1, pp. 43-67.

Mittal, N., Boile, M., Baveja, A. and Theofanis, S. (2013), "Determining optimal inland-empty-container depot locations under stochastic demand", *Research in Transportation Economics*, Vol. 42 No. 1, pp. 50-60.

Monios, J. and Wang, Y. (2014), "Regional stakeholder solutions to empty container repositioning costs in peripheral regions", *Transport Research Institute, STAR (Scottish Transport Applications and Research) Conference*, Edinburgh Napier University, available at: www.starconference.org.uk/star/2014/MoniosWang.pdf (accessed 18 August 2017).

Moon, I.K., Ngoc, A.D.D. and Hur, Y.S. (2010), "Positioning empty containers among multiple ports with leasing and purchasing considerations", *Or Spectrum*, Vol. 32 No. 3, pp. 765-786.

Moon, I.K., Ngoc, A.D.D. and Konings, R. (2012), "Foldable and standard containers in empty container repositioning", *Transportation Research Part E*, Vol. 49 No. 1, pp. 107-124.

Olivo, A., Di Francesco, M. and Zuddas, P. (2013), "An optimization model for the inland repositioning of empty containers", *Maritime Economics and Logistics*, Vol. 15, pp. 309-331.

Olivo, A., Zuddas, P., Di Francesco, M. and Manca, A. (2005), "An operational model for empty container management", *Maritime Economics and Logistics*, Vol. 7 No. 3, pp. 199-222.

Polat, O. and Gunther, H.O. (2016), "The impact of seasonal demand fluctuations on service network design of container feeder lines", *Journal of Transportation and Logistics*, Vol. 1 No. 1, pp. 39-58.

Rashed, Y., Meersman, H., Van de Voorde, E. and Vanelslander, T. (2016), "Short-term forecast of container throughout: an ARIMA-intervention model for the port of antwerp", *Maritime Economics and Logistics*, Vol. 19 No. 4, pp. 749-764.

Schulze, P.M. and Prinz, A. (2009), "Forecasting container transshipment in Germany", *Applied Economics*, Vol. 41 No. 22, pp. 2809-2815.

Song, D.P. and Carter, J. (2009), "Empty container repositioning in shipping industry", *Maritime Policy and Management*, Vol. 36 No. 4, pp. 291-307.

Song, D.P. and Dong, J.X. (2010), "Effectiveness of an empty container repositioning policy with flexible destination ports", *Transport Policy*, Vol. 18 No. 1, pp. 92-101.

Song, D.P. and Dong, J.X. (2011), "Flow balancing-based empty container repositioning in typical shipping service routes", *Maritime Economics and Logistics*, Vol. 13, pp. 61-77.

Song, D.P. and Dong, J.X. (2015), "Empty container repositioning", *Handbook of Ocean Container Transport Logistics*, Springer International Publishing, New York, NY, pp. 163-208.

Tabachnick, B.G. and Fidell, L.S. (2001), *Using Multivariate Statistics*, Allyn and Bacon, Needham, MA.

United Nations Conference on Trade and Development (UNCTAD) (2015). "Review of Maritime transport", pp. 39, 52, available at http://unctad.org/en/PublicationsLibrary/rmt2015_en.pdf (accessed 10 December 2016).

Varshavets, A., Voß, S. and Pawellek, G. (2013), "Empty container repositioning and short term leasing option in global container management", available at: www.isci.cl/tristan/data/Maritime%20Transport/TRISTAN8_paper_116.pdf (accessed 5 September 2015).

Vojdani, N., Lootz, F. and Rosner, R. (2013), "Optimizing empty container logistics based on a collaborative network approach", *Maritime Economics and Logistics*, Vol. 15 No. 4, pp. 467-493.

Webel, K. (2016), "A data-driven selection of an appropriate seasonal adjustment approach", working paper, No. 07, Deutsche Bundesbank.

Xie, G., Wang, S., Zhao, Y. and Lai, K.K. (2013), "Hybrid approaches based on LSSVR model for container throughput forecasting: a comparative study", *Applied Soft Computing*, Vol. 13 No. 5, pp. 2232-2241.

Yap, W.Y. and Lam, J.S.L. (2006), "Competition dynamics between container ports in East Asia", *Transportation Research: Part A*, Vol. 40 No. 1, pp. 35-51.

Corresponding author
Ahmet Selcuk Basarici can be contacted at: ahmetselcuk01@gmail.com