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The Impact of the Financial Tsunami on Hong Kong Port

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Contents

Abstract

We apply intervention analysis to examine the impact of the financial tsunami on container throughputs for Hong Kong port quantitatively. Evidences from ARIMA-intervention model show that the real impact of the financial tsunami on Hong Kong port happened earlier than the observable fall in the throughput data, namely significant impact started around May 2008, while the forecasting model with considering financial tsunami from Sept. 2008 to Oct. 2009 is superior. VAR-intervention analysis is employed to compare the Hong Kong and Shenzhen ports. Our findings suggest that Shenzhen port is more sensitive to the financial tsunami than Hong Kong port, showing an earlier and deeper impact. Their relationship also changed after the financial tsunami, namely Hong Kong and Shenzhen ports become less dependent on each other. These findings remind us that, when considering the impact of the financial tsunami on port, one should not casually choose a starting time point based on the visual observation from the data because there is a time delay between the real impact on container throughput and its manifestation in the throughput data series.

Key words : Financial Tsunami, Container throughput, Hong Kong Port, Intervention Analysis

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I. Introduction

The subprime crisis in the United States erupted in July 2007, and then triggered a sharp fall on the global economy. China is an export driven economy, hence almost all the related industries suffered a deep recession by this worldwide financial tsunami. Shipping industry especially experienced a hard time. The container throughputs for all the ports in China underwent dramatic reductions. Hong Kong is no exception.

The port of Hong Kong is an important center for the international finance and trade. The trading and logistics industry generated 24.1% of GDP and 22.6% of employment in Hong Kong in 2009.[1)] Since 1980s, Hong Kong port has been one of the busiest and most efficient international container ports in the world. It handled 21 million TEUs of containers in 2009.

The container throughput for Hong Kong port was locked in cold times during the financial tsunami. As Figure 1 shows, its year-on-year throughput growth rate decreased suddenly when the worldwide financial tsunami arrived in China around Oct. 2008. By examining the growth rate of container throughput for Hong Kong port, it is no doubt that the financial tsunami has a negative impact on Hong Kong port from Nov. 2008 to Oct. 2009 because the growth rate in this period exhibits a continuous negative development. In other words, from the data series, we can only observe this impact started from Nov. 2008. In fact, after the breakout of subprime crisis in 2007, it swiftly spread to the whole world including China. With the bankruptcy of Lehman Brothers and the takeover of Merrill Lynch, the Chinese central bank cut the interest rate on Sept. 2008 to prevent its economy from the downturn. After Sept. 2008, a deep recession overspread to all sectors in China including the port and shipping industry. Therefore, it seems exist a time delay between the real downturn of container throughput and the reflection of this recession on the throughput data series. This time lag is reasonable because, at the early stage after the eruption of the financial tsunami, shipping companies may still hold some orders for transportation in hand. Due to this time delay, one may wonder: does the impact happen before the observable decrease from

1) Refer to <The Situation of the Four Key Industries in the Hong Kong Economy in 2009>.

the throughput data for Hong Kong port? When is the real starting time the financial tsunami impacted on Hong Kong port and what is the degree of its impact? Moreover, since the financial tsunami is not an instantaneous event but lasted for nearly two years, its impact on container throughput should also exhibit a continuous process. Then, what are the scale and the scope of this process?

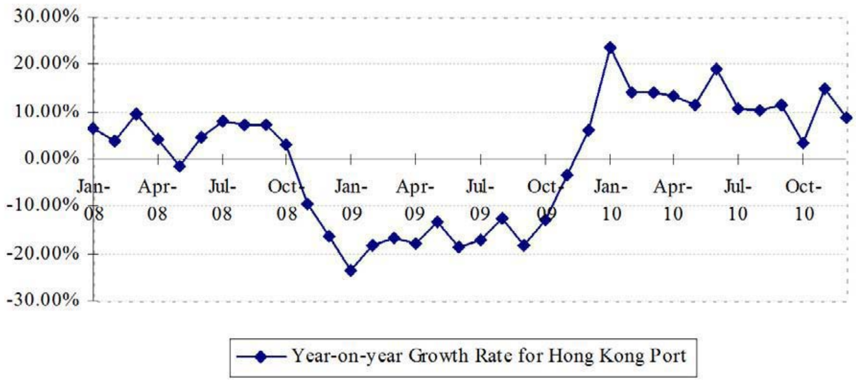
The financial tsunami not only impacted Hong Kong port but also the ports around it. Hong Kong port has been losing its market share in recently years, especially under the pressure of the fast development of Shenzhen port. Shenzhen and Hong Kong ports share a common demand source, the Pearl River Delta (PRD) area. Shenzhen port is export-oriented. With the movement of majority manufacturing industries to mainland China, transportation through Shenzhen port is more convenient and less costly. On the other hand, since majority of port calls of Shenzhen port also call at Hong Kong port, re-exports of goods from mainland China accounts for a large percentage of Hong Kong port's business. Because of the difference in the underlying economic structures, the impact of the financial tsunami may display different scales for Hong Kong and Shenzhen ports. Moreover, the financial tsunami caused the export demand decrease substantially which may in turn affect the interactions between Hong Kong and Shenzhen ports. Hence, in order to reveal their relationships, we also study the impact of financial tsunami on Hong Kong port by comparing with the impact on Shenzhen port. From Hong Kong port's point of view, a better understanding of the relationship with Shenzhen port can help Hong Kong to think about new strategies for keeping its world-class container port status.

Majority past works on the impact of the financial tsunami on port and shipping applied qualitative analysis.[2)] The quantitative works have only been carried out in the sectors other than the port and shipping. For example, Zhu and Wang studied the influence of the financial tsunami on the international trade in China.[3)] Chung et al. modeled the impact of financial crisis on the manufacturing industry in China.[4)] There still a lack of quantitative works

2) For example: Slack(2010) ; Ng and Liu(2010) ; Pallis and De Langen(2010).
3) Zhu and Wang(2010).
4) Chung et al.(2009).

on the scale of impact from the financial tsunami on the port and shipping industry. Particularly, the existing quantitative literature usually established the impact of the financial tsunami started from a particular time point, e.g. Sept. 2008.5) As mentioned, the real starting time of this impact may be earlier than what we can observe directly from the data. Thus, this issue should be examined over a longer time period.

<Figure 1> Year-on-year growth rate of container throughput for Hong Kong port



In summary, this paper makes a first attempt to analyze the impact of the financial tsunami on the container throughput for Hong Kong port quantitatively. We first examine the Hong Kong port separately to establish an initial month in which the impact of the financial tsunami on Hong Kong port starts. In this step, we also formulate a model to forecast the throughput for Hong Kong port more accurately. We then compare the impact of the financial tsunami on Hong Kong and Shenzhen ports to reveal their mutual relations and their different reactions to the financial tsunami.

The paper proceeds as follows. The next section gives our research methodology, Section 3 presents the empirical results and Section 4 concludes.

5) Zhu and Wang(2010), p.40.

II. Methodology

1. The ARIMA model

The Autoregressive Integrated Moving Average (ARIMA) model was developed to forecast a time series.[6] It can be represented as ARIMA(p,d,q) if a stochastic process y_t is stationary after d times differenced. ARIMA(p,d,q) combines p order Autoregressive term AR(p) and q order moving average term MA(q). Therefore, y_t satisfied ARIMA(p,d,q) process indicates that y_t depends linearly on its own previous values and a combination of current and past values of a white noise error term. In this paper, we apply this model to examine the container throughput for Hong Kong port. If we denote this variable as *HKP*, a non-seasonal ARIMA(p,d,q) for *HKP* can be written as

$$\Delta^d HKP_t = \phi_1 HKP_{t-1} + \phi_2 HKP_{t-2} + \cdots + \phi_p HKP_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \cdots - \theta_q \varepsilon_{t-q} \,, \quad (1)$$

where p and q are the number of autoregressive and moving average terms; d is the order of integration; Δ^d represents a dth differenced series; ε_t stands for the white noise random error.

In order to identify p, d and q, we should use the unit root test to determine d first. In this paper, we apply the Augmented Dickey-Fuller (ADF)[7] test to examine this order. p and q are determined by looking at the autocorrelation (AC) function and partial autocorrelation (PAC) plots of the d times differenced series.

The seasonal autoregressive (SAR) and seasonal moving average (SMA) terms can be included in the ARIMA model if the time series has seasonal patterns.[8]

2. The VAR model

A Vector Autoregressive (VAR) model can be used to analyze the relationships among a number of variables. The mathematical presentation of

6) Box and Jenkins(1976).
7) Dickey and Fuller(1981).
8) Box and Jenkins(1976).

the basic p-lag VAR(p) is as follows:

$$Y_t = c + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \cdots + \Pi_p Y_{t-p} + \varepsilon_t \,, \tag{2}$$

where Y_t is a k-dimensional vector of time series variables, Π_i are matrices of coefficients to be estimated, c is the intercept, p is the lag length and ε_t is an unobservable zero-mean white noise vector process.

In this study, we consider a bivariate VAR model with the growth rate of container throughputs for Hong Kong and Shenzhen ports. Equation (2) then becomes

$$\begin{aligned} GHK_t &= c_1 + \sum_{j=1}^{p} \alpha_{1j} GHK_{t-j} + \sum_{i=1}^{p} \beta_{1i} GSZ_{t-i} + \varepsilon_{1t} \\ GSZ_t &= c_2 + \sum_{j=1}^{p} \alpha_{2j} GHK_{t-j} + \sum_{i=1}^{p} \beta_{2i} GSZ_{t-i} + \varepsilon_{2t} \end{aligned} \,, \tag{3}$$

where GHK_t and GSZ_t denote growth rate of container throughputs for Hong Kong and Shenzhen ports, respectively.

3. Intervention analysis

Intervention analysis is used to estimate whether a certain event has an impact on a time series or on the relationships among a number of series. We apply ARIMA-intervention analysis to analyze the impact of financial tsunami on Hong Kong port separately, while VAR-intervention analysis will be performed to check whether the relationship between Hong Kong and Shenzhen ports has changed after the financial tsunami.

1) ARIMA-intervention analysis

As discussed above, ARIMA-intervention analysis is used to analyze Hong Kong port throughputs. Before conducting this analysis, we first need to build an ARIMA model. After establishing the original ARIMA model, the intervention term can be added to this model directly. We define the intervention term I_t as

$$I_t = \begin{cases} 1 & t = T \\ 0 & t \neq T \end{cases},$$

where T is the time when the event occurs.

2) VAR-intervention analysis

VAR-intervention analysis is used to examine the influence of the financial tsunami on the relationship between Hong Kong and Shenzhen ports. Similar to ARIMA-intervention analysis, we also need to build a VAR model first, and then add the intervention term to the original VAR model. For the bivariate VAR model with the growth rate for Hong Kong and Shenzhen ports, VAR-intervention model can be written as

$$\begin{aligned} GHK_t &= c_1 + \delta_1 I_t + \sum_{j=1}^{p} \alpha_{1j} GHK_{t-j} + \sum_{i=1}^{p} \beta_{1i} GSZ_{t-i} + \varepsilon_{1t} \\ GSZ_t &= c_2 + \delta_2 I_t + \sum_{j=1}^{p} \alpha_{2j} GHK_{t-j} + \sum_{i=1}^{p} \beta_{2i} GSZ_{t-i} + \varepsilon_{2t} \end{aligned}, \qquad (4)$$

where term I_t is above.

The null hypothesis of the Granger causality test in VAR framework is to examine whether $\beta_{1i} = 0$ or $\alpha_{2j} = 0$ for all i and j (i, j=1, 2… q) in both Equation (3) and (4). When $\beta_{1i} = 0$, the null hypothesis is that "*GSZ* does not Granger cause *GHK*" in the first regression in Equation (3) and (4). The rejection of this hypothesis suggests that *GSZ* can be used to forecast *GHK*. Likewise, when $\alpha_{2j} = 0$, the null hypothesis is that "*GHK* does not Granger cause *GSZ*" in the second regression in Equation (3) and (4).

3) Intervention starting time point

Intervention analysis requires specifying a starting time point or a period for an event. Clearly, in this study, we should choose a time period as the happening period for the financial tsunami. We first choose the end time point of this period. By examining the data series, Oct. 2009 was chosen as this time point because the container throughputs showed recovery or a positive growth for both Hong Kong and Shenzhen ports. We then choose the starting time point. As mentioned earlier, the subprime crisis in the Unite States happened on Jul. 2007, and then spread to other countries including China. In Sept. 2008, China cut interest rates to control the recession of the economy. Thus, any time point between Jul. 2007 and Sep. 2008 could be the starting time point for this issue because we do not know when the financial tsunami impacted the container throughput exactly. As a result, if we denote the time period of the financial tsunami by t_D, it should be examined in the period from a starting time point D to Oct. 2009, where $D = Jul.2007, Aug.2007, \cdots Sep.2008$. We use the following equation to represent this intervention term

$$I_{t_D} = \begin{cases} 1 & D \le t_D \le Oct.2009 \\ 0 & Others \end{cases} \qquad D = Jul.2007, Aug.2007, \cdots Sep.2008$$

where I_{t_D} represents the intervention term/event; D is the starting point of the financial tsunami considered in the analysis, dating from Jul. 2007 to Sep. 2008; t_D stands for the time period of the financial tsunami.

III. Empirical Results

1. Data

We collected monthly container throughputs for Hong Kong and Shenzhen ports from Census and Statistics Department (C&SD) of Hong Kong Government[9] and CEIC China database. For convenience, we use *HKP* and *SZP* to denote the container throughputs for Hong Kong and Shenzhen ports, respectively. *HKP* and *SZP* cover the period from Jan. 1999 to Dec. 2010 and are quoted in 1000 TEUs.

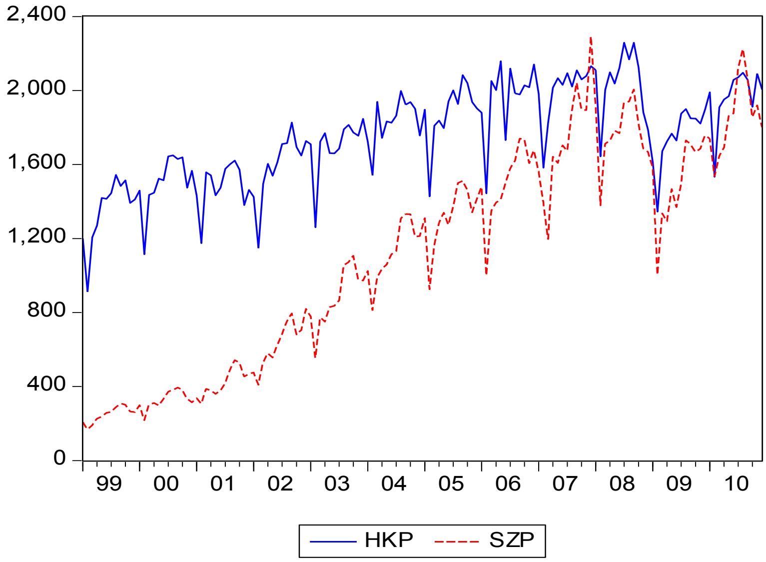
We first plot *HKP* and *SZP* to obtain a first indication of the data series in Figure 2. We can clearly observe that the container throughputs for Hong Kong and Shenzhen ports have no constant mean values, which imply that

9) Source, http://sc.info.gov.hk

they are more likely to satisfy a non-stationary process. In addition, each of the series exhibits the seasonal pattern. Hence, we calculate the year-on-year growth rates of the original data series which are denoted as *GHK* and *GSZ* accordingly, covered the period from Jan. 2000 to Dec. 2010.

Our tests will first consider the container throughputs for Hong Kong port separately, which requires the original data series of *HKP*. We will then compare Hong Kong port with Shenzhen port, using the transformed data series of *GHK* and *GSZ*.

<Figure 2> Container throughputs for Hong Kong and Shenzhen ports



We first apply the ADF test to check the order of these time series. The null hypothesis for this test is that the original series satisfied $I(d)$ process. For example, if $d=0$, the null hypothesis is that the original data series satisfies $I(0)$ process, namely it is a stationary data series. Rejection of this hypothesis indicates the series is non-stationary and its integrated order need to be further determined.

<Table 1> ADF test results

Variables	Time Periods	ADF Test	Type	Critical value (5%)	Prob.
HKP	1999M01~2010M12	-1.571	(C,0)	-2.876	0.4957
Δ *HKP*	1999M02~2010M12	-4.120	(C,0)	-2.876	0.0011**
GHK	2000M01~2010M12	-3.531	(C,0)	-2.883	0.0086**
	2001M01~2010M12	-3.330	(C,0)	-2.886	0.0156*
	2002M01~2010M12	-3.189	(C,0)	-2.888	0.0233*
	2003M01~2010M12	-3.163	(C,0)	-2.892	0.0254*
GSZ	2000M01~2010M12	-2.572	(C,0)	-2.884	0.1014
	2001M01~2010M12	-2.398	(C,0)	-2.886	0.1445
	2002M01~2010M12	-2.341	(C,0)	-2.888	0.1613
	2003M01~2010M12	-3.041	(C,0)	-2.892	0.0347*

Notes:
1. *HKP* represents the container throughputs for Hong Kong port while *GHK*, *GSZ* and *GGZ* stand for the year-on-year growth rates for Hong Kong, Shenzhen and Guangzhou ports, respectively.
2. Δ stands for the first difference value.
3. (*,*) represents (constant, trend)
4. *(**) denotes rejection of null hypothesis at 5% (1%) significant level.

Results in Table 1 summarized the ADF test results. It shows that *HKP* is non-stationary in levels but is stationary in their first difference values, i.e. *HKP* satisfied $I(1)$ process. For *GHK* and *GSZ*, results from ADF are inconsistent with different time periods. Specifically, *GHK* and *GSZ* are both stationary only in the period from Jan. 2003 to Dec. 2010. To fit the VAR model, we will apply *GHK* and *GSZ* in the period of Jan. 2003 to Dec. 2010 to examine the relationship between Hong Kong and Shenzhen ports.

2. The ARIMA model for *HKP*

We first consider the container throughput for Hong Kong port. To build an ARIMA(p,d,q) model, the order of integration d is determined first. ADF test results in Table 1 show that d equals to 1. By examining the AC and PAC plots of the first differenced *HKP*, we choose ARIMA(0,1,1) with SAR(12) and SMA(12) terms as our original model for *HKP*. This original model is named as Model 1 and the estimation results are given in Table 2.

<Table 2> ARIMA model for HKP

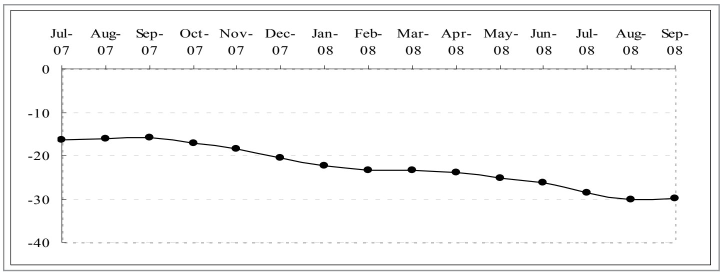
Model 1			
	MA(1)	SAR(12)	SMA(12)
Coefficients	-0.505202**	0.998783**	-0.908127**
R^2	0.769493		
AIC	11.80766		

Notes:
1. MA(1) represents one order moving average term. SAR and SMA stand for seasonal autoregressive and seasonal moving average terms, respectively.
2. ** denotes rejection of null hypothesis at 1% significant level.

The ARIMA model with intervention term I_{t_D} will be estimated next. In order to analyze the impact of the financial tsunami over time, the starting time point *D* will be tested with one month increment from Jul. 2007 to Sep. 2008. Table 3 gives the estimation results from all ARIMA-intervention models.

The coefficient of I_{t_D} describes the scale of the financial tsunami's impact on Hong Kong port. As shown in Table 3, the coefficients of I_{t_D} become more and more significant. It indicates that, with the spreading of financial tsunami, its impact on the container throughputs for Hong Kong port becomes greater. From Nov. 2007 to Apr. 2008, this impact is significant at 5% level, while it is significant at 1% level from May to Sept. 2008. Results here demonstrate that the actual impact of the financial tsunami on Hong Kong port happens earlier than the observable falls from the throughput data because significant impact started from May 2008. We plot the values of coefficients of I_{t_D} in Figure 3. It can be clearly seen that the financial tsunami exhibited a continuous negative impact on the container throughput for Hong Kong port, and this impact turned to be greater and greater over the period from Jul. 2007 to Sept. 2008. Until around Aug. 2008 or Sept. 2008, this impact reached to its deepest level.

<Figure 3> Coefficients of I_{t_D} from ARIMA-intervention model for Hong Kong port



<Table 3> Estimation results of the ARIMA-intervention models

ARIMA-intervention models						
Period of t_D	MA(1)	SAR(12)	SMA(12)	I_{t_D}	R^2	AIC
$Jul.2007 < t_D < Oct.2009$	-0.505202** (0.0000)	0.998783** (0.0000)	-0.908127** (0.0000)	-16.26919 (0.0574)	0.0.7750	11.7973
$Aug.2007 < t_D < Oct.2009$	-0.541222** (0.0000)	0.999697** (0.0000)	-0.908777** (0.0000)	-16.04245 (0.0638)	0.0.7747	11.7987
$Sep.2007 < t_D < Oct.2009$	-0.543604** (0.0000)	0.999562** (0.0000)	-0.908878** (0.0000)	-15.87929 (0.0695)	0.0.7744	11.7999
$Oct.2007 < t_D < Oct.2009$	-0.546256** (0.0000)	0.999681** (0.0000)	-0.908974** (0.0000)	-17.04969 (0.0534)	0.0.7751	11.7971
$Nov.2007 < t_D < Oct.2009$	-0.550615** (0.0000)	0.999944** (0.0000)	-0.909019** (0.0000)	-18.47820* (0.0377)	0.0.7759	11.7935
$Dec.2007 < t_D < Oct.2009$	-0.554839** (0.0000)	1.000352** (0.0000)	-0.908679** (0.0000)	-20.56364* (0.0219)	0.0.7772	11.7874
$Jan.2008 < t_D < Oct.2009$	-0.558960** (0.0000)	1.000865** (0.0000)	-0.908435** (0.0000)	-22.39492* (0.0136)	0.0.7784	11.7821
$Feb.2008 < t_D < Oct.2009$	-0.563044** (0.0000)	1.001398** (0.0000)	-0.908122** (0.0000)	-23.39872* (0.0110)	0.0.7789	11.7801
$Mar.2008 < t_D < Oct.2009$	-0.567738** (0.0000)	1.001854** (0.0000)	-0.908191** (0.0000)	-23.30648* (0.0127)	0.0.7783	11.7827
$Apr.2008 < t_D < Oct.2009$	-0.570698** (0.0000)	1.001229** (0.0000)	-0.908309** (0.0000)	-23.79508* (0.0124)	0.0.7782	11.7829
$May.2008 < t_D < Oct.2009$	-0.572219** (0.0000)	1.000870** (0.0000)	-0.908347** (0.0000)	-25.20650** (0.0095)	0.0.7789	11.7798
$Jun.2008 < t_D < Oct.2009$	-0.574477** (0.0000)	1.000483** (0.0000)	-0.908426** (0.0000)	-26.15483** (0.0085)	0.0.7792	11.7787
$Jul.2008 < t_D < Oct.2009$	-0.572114** (0.0000)	1.000404** (0.0000)	-0.908099** (0.0000)	-28.46755** (0.0055)	0.0.7805	11.7727
$Aug.2008 < t_D < Oct.2009$	-0.566871** (0.0000)	1.000087** (0.0000)	-0.908152** (0.0000)	-30.15664** (0.0048)	0.0.7811	11.7697
$Sep.2007 < t_D < Oct.2009$	-0.559609** (0.0000)	0.999834** (0.0000)	-0.908224** (0.0000)	-29.96108** (0.0078)	0.0.7801	11.7745

Notes:
1. MA(1) represents one order moving average term. SAR and SMA stand for seasonal autoregressive and seasonal moving average terms, respectively. I_{t_D} represents the intervention term; t_D denotes the happening period of financial tsunami.
2. The value in the bracket is *p*-value.
3. *(**) denotes rejection of null hypothesis at 5%(1%) significant level.

In the next step, we perform the forecasting of the container throughput for Hong Kong port. We choose Jan. 2010 to Dec. 2010 as the forecasting period to compare with the actual *HKP* values. The one-step ahead static forecast is applied since it is more accurate than the dynamic forecast method. Results above in Table 3 show that I_{t_D} is significant at 1% level when *D=May.2008, Jun.2008,⋯, Sep.2008*. Hence, we compare the forecasting ability of ARIMA-intervention models with *D=May.2008, Jun.2008,⋯, Sep.2008* to choose a superior model to forecast the container throughput for Hong Kong port.

Table 4 gives the Mean Absolute Error (MAE) and Mean Absolute Percent Error (MAPE) from the ARIMA-intervention models with $D = May.2008, Jun.2008, \cdots, Sep.2008$ and the original ARIMA(0,1,1) model without the intervention term. As it shows, ARIMA-intervention models are better than the original ARIMA model for predicting the Hong Kong port container throughput. Results in Table 3 show that, when $D = Aug.2008$, the ARIMA-intervention model is superior to the others by comparing its R^2 and AIC, whereas the model with $D = Sep.2008$ performs better forecasting ability than the others by comparing the values of MAE and MAPE. In order to examine which of the two models has a better forecasting ability, we denote the model with *D*=Aug. 2008 as Model 2, and the model with *D*=Sep. 2008 as Model 3. We compare the forecasting results drawn from Model 1, Model 2 and Model 3 with the actual values of *HKP* in Figure 4. The solid line with black color represents actual *HKP*, while the dashed lines with green, blue and red color represent the forecasting results from Model 1, Model 2 and Model 3, respectively. Clearly, results from Model 3 are much closer to the actual values of *HKP*. To conclude, the ARIMA-intervention model with intervention term from Sep. 2008 to Oct. 2009 is a superior model to forecast the future *HKP*.

<Table 4> MAE and MAPE from the forecasting model for HKP

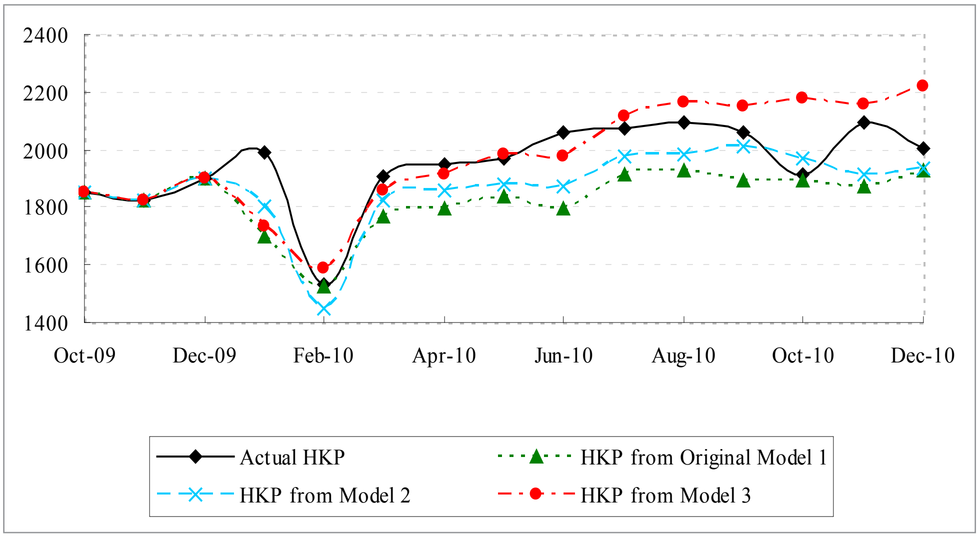
Model 1		Model with I_{t_D} ($May.2008 < t_D < Oct.2009$)		Model with I_{t_D} ($Jun.2008 < t_D < Oct.2009$)	
MAE	MAPE	MAE	MAPE	MAE	MAPE
60.7574	3.03141	60.74811	3.024713	61.03019	3.039275
Model with I_{t_D} ($Jul.2008 < t_D < Oct.2009$)		Model with I_{t_D} ($Aug.2008 < t_D < Oct.2009$)		Model with I_{t_D} ($Sep.2008 < t_D < Oct.2009$)	
MAE	MAPE	MAE	MAPE	MAE	MAPE
61.13785	3.043339	60.50647	3.009155	59.7700	2.968772

Notes:

1. I_{t_D} represents the intervention term; t_D denotes the happening period of financial tsunami.

2. MAE is mean absolute error and MAPE is mean absolute percent error.

<Figure 4> Comparison of forecasting results with different models of HKP



3. The impact of the financial tsunami on Hong Kong and Shenzhen ports

In this section, we compare the impact of the financial tsunami on Hong Kong and Shenzhen ports. We considered the year-on-year growth rate of container throughputs for these two ports to eliminate the non-stationary problem of the original data. Results in Table 1 show that *GSZ* and *GHK* are stationary only in the period from Jan. 2003 to Dec. 2010. Thus, we will build an original VAR model without intervention term, namely the VAR(*GHK*,*GSZ*) in the sample period from Jan. 2003 to Dec. 2010. The estimation results of VAR(*GHK*,*GSZ*) are showed in Table 5.

We then include the intervention terms in the original VAR(*GHK*,*GSZ*) model. Estimation results are summarized in Table 6. The coefficients of I_{t_D} show that the degree of the impact of financial tsunami and the Granger causality test results suggest the relationships between the ports.

From Table 6, we can observe that the influence of the financial tsunami displayed on Shenzhen port earlier than Hong Kong port because the coefficient of I_{t_D} is significant at 1% level even from Jan. 2008 in *GSZ* equation. For the Hong Kong port, the significant impact started from Mar. 2008 which is largely in line with the results from the ARIMA-intervention model.

<Table 5> Original VAR model for Hong Kong and Shenzhen ports

VAR(*GHK*,*GSZ*)					
	C	GHK_{t-1}	GHK_{t-2}	GSZ_{t-1}	GSZ_{t-2}
GHK_t	-0.011	0.258*	0.217	0.101	0.057
GSZ_t	0.033	0.101	0.172	0.327**	0.373**
Granger Causality Test Result					
H_0	$GSZ \nrightarrow GHK$		$GHK \nrightarrow GSZ$		
p-value	0.0457*		0.4487		

Notes:
1. *GHK* and *GSZ* represent the year-on-year growth rates of container throughputs for Hong Kong and Shenzhen ports, respectively.
2. " $\nrightarrow$ " means "does not Granger cause".
3. *(**) denotes rejection of null hypothesis at 5%(1%) significant level.

The findings here indicate that the impact of the financial tsunami on Hong Kong port should be considered earlier around Apr. 2008.

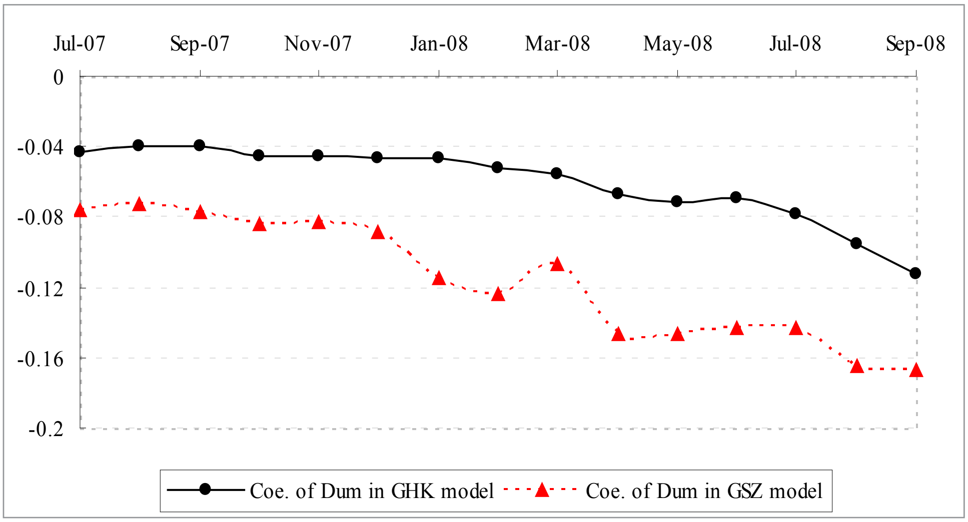
Figure 5 plots the coefficients of I_{t_D} drawn from VAR-intervention models to compare the impact scales on two ports. As it shows, the financial tsunami has a negative influence on either Hong Kong or Shenzhen port. Around Mar. 2008, when the financial tsunami arrived in China, its influence became greater and greater on the port and shipping industry. Deepest impact level also appeared around Aug. and Sept. 2008 for Shenzhen port. Generally speaking, Shenzhen port suffered a harder time than Hong Kong port by the financial tsunami, especially in the year 2008. Our results indicate that, by the influence of the financial tsunami, the shutting down of enterprises eliminated the export demand for the Shenzhen port. Since more than 50% of the international container liner routes are to America and Europe, Shenzhen port is more sensitive to this worldwide financial tsunami, showing the deeper impact in Figure 5.

Comparing the Granger causality test results in Table 5 and Table 6, we find that if we do not take the influence of financial tsunami into account, *GSZ* Granger causes *GHK*. This direction of Granger causality result is the same as the result in Liu et al. without considering the demand effect, namely the container throughput for Shenzhen port has a positive impact on Hong Kong port.[10] We have mentioned that Shenzhen and Hong Kong ports shared a

10) Liu et al. (2010)

common demand source. Majority of port calls of Shenzhen port also call at Hong Kong port. Thus, re-export plays an important role for Hong Kong port, while for the prospects in Shenzhen port, exports accounts for a high percentage. However, the Granger causality results from VAR-intervention (*GHK*, *GSZ*) show that no Granger causality can be found between Shenzhen and Hong Kong ports. It shows that these two ports became more independent after the financial tsunami. The changes of Granger causality between Hong Kong and Shenzhen ports indicate that the financial tsunami decreased the demands of the international trade, which in turn influenced the relationship between Hong Kong and Shenzhen ports. This finding further demonstrates that demand is the key factor influenced the dynamic relationship between Hong Kong and Shenzhen ports in Liu et al.

<Figure 5> Comparison of impact of financial tsunami on Hong Kong and Shenzhen ports



<Table 6> Estimation results from VAR(GHK, GSZ)-intervention model

Period of t_D		C	GHK_{t-1}	GHK_{t-2}	GSZ_{t-1}	GSZ_{t-2}	I_{t_D}	Granger Causality Test Results	
$Jul.2007 < t_D < Oct.2009$	GHK_t	-0.011	0.258*	0.217	0.101	0.057	-0.043*	$GSZ \nrightarrow GHK$	0.3038
	GSZ_t	0.033	0.101	0.172	0.327**	0.373**	-0.076*	$GHK \nrightarrow GSZ$	0.4808
$Aug.2007 < t_D < Oct.2009$	GHK_t	0.010	0.230*	0.227*	0.074	0.035	-0.040*	$GSZ \nrightarrow GHK$	0.2598
	GSZ_t	0.070	0.049	0.190	0.279**	0.333**	-0.073*	$GHK \nrightarrow GSZ$	0.4761
$Sep.2007 < t_D < Oct.2009$	GHK_t	0.008	0.236*	0.212	0.076	0.038	-0.039	$GSZ \nrightarrow GHK$	0.2200
	GSZ_t	0.070	0.056	0.162	0.280**	0.336**	-0.077*	$GHK \nrightarrow GSZ$	0.5577
$Oct.2007 < t_D < Oct.2009$	GHK_t	0.010	0.232*	0.213	0.071	0.038	-0.045*	$GSZ \nrightarrow GHK$	0.2555
	GSZ_t	0.073	0.051	0.164	0.271**	0.337**	-0.085*	$GHK \nrightarrow GSZ$	0.5568
$Nov.2007 < t_D < Oct.2009$	GHK_t	0.010	0.228*	0.215*	0.071	0.038	-0.045*	$GSZ \nrightarrow GHK$	0.2548
	GSZ_t	0.071	0.046	0.168	0.274**	0.338**	-0.082*	$GHK \nrightarrow GSZ$	0.5531
$Dec.2007 < t_D < Oct.2009$	GHK_t	0.010	0.228*	0.211	0.072	0.036	-0.047*	$GSZ \nrightarrow GHK$	0.2508
	GSZ_t	0.072	0.044	0.160	0.274**	0.334**	-0.089*	$GHK \nrightarrow GSZ$	0.5845
$Jan.2008 < t_D < Oct.2009$	GHK_t	0.009	0.228*	0.210	0.071	0.039	-0.046*	$GSZ \nrightarrow GHK$	0.2487
	GSZ_t	0.082	0.026	0.156	0.254*	0.329**	-0.115**	$GHK \nrightarrow GSZ$	0.6130
$Feb.2008 < t_D < Oct.2009$	GHK_t	0.012	0.234*	0.210	0.059	0.040	-0.052*	$GSZ \nrightarrow GHK$	0.3439
	GSZ_t	0.086	0.043	0.156	0.229*	0.332**	-0.124**	$GHK \nrightarrow GSZ$	0.5835
$Mar.2008 < t_D < Oct.2009$	GHK_t	0.014	0.230*	0.222*	0.058	0.031	-0.056*	$GSZ \nrightarrow GHK$	0.4272
	GSZ_t	0.079	0.046	0.181	0.246*	0.323**	-0.107**	$GHK \nrightarrow GSZ$	0.5006
$Apr.2008 < t_D < Oct.2009$	GHK_t	0.017	0.219*	0.219*	0.060	0.020	-0.067*	$GSZ \nrightarrow GHK$	0.4618
	GSZ_t	0.094	0.014	0.177	0.238*	0.293**	-0.147**	$GHK \nrightarrow GSZ$	0.5386
$May.2008 < t_D < Oct.2009$	GHK_t	0.018	0.215*	0.216*	0.042	0.034	-0.071**	$GSZ \nrightarrow GHK$	0.5397
	GSZ_t	0.092	0.011	0.169	0.207*	0.326**	-0.146**	$GHK \nrightarrow GSZ$	0.5771
$Jun.2008 < t_D < Oct.2009$	GHK_t	0.018	0.215*	0.215*	0.056	0.021	-0.069**	$GSZ \nrightarrow GHK$	0.5078
	GSZ_t	0.092	0.011	0.169	0.235*	0.300**	-0.143**	$GHK \nrightarrow GSZ$	0.5863
$Jul.2008 < t_D < Oct.2009$	GHK_t	0.019	0.214*	0.206	0.049	0.022	-0.079**	$GSZ \nrightarrow GHK$	0.5754
	GSZ_t	0.087	0.020	0.151	0.232*	0.310**	-0.144**	$GHK \nrightarrow GSZ$	0.6400
$Aug.2008 < t_D < Oct.2009$	GHK_t	0.024	0.192	0.210*	0.044	0.013	-0.096**	$GSZ \nrightarrow GHK$	0.6690
	GSZ_t	0.093	-0.013	0.160	0.230*	0.297**	-0.165**	$GHK \nrightarrow GSZ$	0.6354
$Sep.2008 < t_D < Oct.2009$	GHK_t	0.028	0.167	0.200	0.033	0.016	-0.113**	$GSZ \nrightarrow GHK$	0.7465
	GSZ_t	0.090	-0.034	0.147	0.227*	0.313**	-0.167**	$GHK \nrightarrow GSZ$	0.6931

Notes:

1. I_{t_D} represents the intervention term; t_D denotes the happening period of financial tsunami. *GHK* and *GSZ* represent the year-on-year growth rates of container throughputs for Hong Kong and Shenzhen ports.
2. " $\nrightarrow$ " means "does not Granger cause".
3. *(**) denotes rejection of null hypothesis at 5%(1%) significant level.

IV. Conclusions

The global recession in 2008 has a significant impact on the port and shipping industry. We employ the intervention analysis to study the impact of the worldwide financial tsunami on the container throughput for Hong Kong port quantitatively. Empirical works are carried out in two aspects. First, ARIMA-intervention analysis is applied to examine Hong Kong port separately. Evidences from this part reveal that the actual impact of the financial tsunami on Hong Kong port was significant around Apr. to May 2008, which is much earlier than the observable decrease from the throughput data series. ARIMA-intervention model shows a better forecasting ability than the ARIMA model without the intervention term. Second, VAR-intervention model is employed to examine the relationship between Hong Kong and Shenzhen ports. The findings from this part further demonstrate our conclusion from ARIMA-intervention model, namely the actual impact of the financial tsunami happens earlier than we can observe since the impact display on Shenzhen port from Jan. 2008. These findings remind the researchers that, when considering the impact of financial tsunami, one should not casually choose a research period based on the visual observation from the data. By comparing the impact on Hong Kong and Shenzhen ports, we found that Shenzhen port was more sensitive to this financial tsunami because of its export-driven economy. The relationship between Hong Kong and Shenzhen ports also changed after the financial tsunami. They became less dependent of each other. It implies that demand is a key factor influenced the relationship between Hong Kong and Shenzhen ports.

Quantitative analysis on a financial crisis is relatively limited in the literature. In some cases, this kind of random event has a worldwide influence and is hard to identify the exact time when it happened, as is the case of the financial tsunami in 2008. Past studies usually define this period in advance. Our work applied a new method to address this issue and the evidences from our work suggest that this period should be chosen carefully.

We focused on the impact of financial tsunami on Hong Kong port since Hong Kong port's competition ability fades gradually in these years. The fast development of the nearby ports, such as Shenzhen and Guangzhou ports, put Hong Kong port under a tremendous pressure. How to cope with the threats and how to face the competition by the other ports in PRD are important issues requiring further analyze urgently.*

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References

BOX, G. E. and JENKINS, G. M. (1976), *Time series analysis: Forecasting and control*: Holden-Day.

CHUNG, R.C.P., IP, W.H. and CHAN, S.L. (2009), "An ARIMA-intervention analysis model for the financial crisis in China's manufacturing industry," *International Journal of Engineering Business Management*, Vol.1, No. 1, pp.15-18.

DICKEY, D. and FULLER, W. (1981), "Likelihood ratio statistics for autoregressive time series with a unit root," *Econometrica*, Vol. 49, No. 4, pp.1057-1072.

LIU, L., TIAN, X. and WANG, S (2011). "Empirical evidences of the evolving competition between Hong Kong and Shenzhen Ports," working paper, Department of Logistics and Maritime Studies.

NG, A.K.Y. and LIU, J. J. (2010), "The port and maritime industries in the post-2008 world: Challenges and opportunities," *Research in Transportation Economics*, Vol. 27, No. 1, pp.1-3.

PALLIS, A.A. and DE LANGEN, P.W. (2010), "Seaports and the structural implications of the economic crisis," *Research in Transportation Economics*, Vol. 27, No. 1, pp.10-18.

SLACK, B. (2010), "Battening down the hatches: How should the maritime industries weather the financial tsunami?" *Research in Transportation Economics*, Vol. 27, No. 1, pp.4-9.

ZHU, Z. and WANG, Q. (2010), "The intervention analysis of impact on foreign trade throughput resulting from financial crisis," *Mathematics in Practice and Theory*, Vol. 40, No. 7, pp.36-42.