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開放兩岸貿易與直航對臺灣全球貨櫃吞吐量成長之影響

The Impact of Opening Trade and Direct Shipping across Taiwan Strait to the Growth of Taiwan's Global Container Throughput

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摘要

自臺灣與大陸開放貿易與直航後，臺灣海峽海運貨櫃運量呈現結構性的轉變，而本文探討 1990～2012 年間影響臺灣貨櫃運量的主要因素。研究結果顯示逐漸開放的兩岸貿易政策使得臺灣的進出口貨物比率逐漸提升，此的確有助於臺灣貨櫃運量成長；此外，兩岸間往來貿易的需求彈性及穩定的規模報酬率在 1990～2001 年間是顯著的，然而在 2002～2012 年間則為不顯著，且對臺灣而言其規模報酬是遞減的。在非兩岸因素的檢定上，產業 GDP 成長的變動 (2004～2012 年間) 對貨櫃運量而言，呈現出顯著的正向效果；而油價的變動則對貨櫃運量呈現出顯著負向效果。綜論之，兩岸間的貿易與航運開放政策，的確有助雙方全球貿易成長，惟對於 2002 年之後的直航與兩岸經濟合作協議的公平分配效益，仍需有再檢驗的必要。

關鍵字： 貿易政策、貨櫃運量、規模報酬、臺灣海峽

Abstract

There are significant structural shifts in container flows across the Taiwan

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Strait since the launch of direct shipping between Taiwan and Mainland China in the end of 2008. The purpose of this paper is aiming to identify the main driving forces for the growth of Taiwan's international container throughput via (1) the impact analysis of relaxing trade regulations between Taiwan and China since 1990 up to now, and (2) applying general theories to examine the impact of the establishment of cross-strait direct shipping link on the growth of Taiwan's container throughput from December 2008 up to now. This paper creates two time-related dummy variables to explore the impacts of "unilateral" import trade constraint and the relaxing "bilateral" cross-strait shipping regulations on the growth of Taiwan's container throughput in the past two decades. The result shows that (i) relaxing cross-strait trade regulations resulting in gradual rising import-export trade volume which has a positive impact on the growth of Taiwan's international container throughput, and (ii) the demand elasticity and constant return to scale of cross-strait trade (including export and import) to container throughput growth are found to be statistically significant only during 1990-2001, but no significant impact is found in the period of 2002-2012. We conclude that gradually relaxing cross-strait import regulations was a correct and fair policy for both Taiwan and China between 1990 and 2001. However, the impact of direct shipping link and cross-strait economic cooperation negotiations after 2002 should be further examined in the future. Finally, the growth of industrial GDP has positive impact and the fluctuating oil price has a negative impact on the growth of Taiwan's container throughput during 2004 to 2012.

Keywords: Trade policy, Container throughput, Return to scale, Taiwan Strait.

1. INTRODUCTION

Direct trade and civil interactions between Taiwan and Mainland China had been banned during 1949-1987 due to civil war and political conflicts between People's Republic of China (brief as China or Mainland China hereafter) and Republic of China in Taiwan. Taiwan began trade and foreign exchange reform on 1958 as the first step of trade liberalization. However Taiwan

did not open its trade with Mainland China until 1985.[4] Most of the indirect trade was conducted via a tariff-free regime via Hong Kong and Macao.

Taiwan Strait, next to the eastern China coast, have experienced significant economic activities due to the gradual opening of legal indirect trade in 1988, investment in 1993 and then direct shipping between Taiwan and China in 2001. China launched open door policy and set up four Economic Special Zones in two southern coastal provinces in 1980; then opened 14 coastal cities from South to North in 1984 and 3 river deltas in 1985 so as to attract foreign direct investment (FDI). Early in 1979, the Mainland China authority once suggested both sides could begin interactions on navigation, mail and trade (this was the so called '3 links'). During 1980-1981, China announced a tariff-free policy on Taiwan-made import goods. However, this policy soon ended due to non-Taiwan products masquerading to be Taiwanese and flowing into China markets. In 1982, imports of Taiwan products became more strictly regulated (Chiu Chen, 1992).

In order to respond to growing trade demand between Taiwan and Mainland China, indirect offshore shipping center was inaugurated and has operated from both sides of the Taiwan Strait since May 1995 up to now. This regulation allows transshipment cargos to be shipped directly between Fuzhou and Xiamen in China and Kaohsiung port in Taiwan. The circumvent trip via a third port (such as Hong Kong, Japan's Club Med port or Korea's Pusan port) is no more necessary. From then until 2009, stepwise cross-strait trade and navigation open measures between the two sides have assured peace and economic prosperity in the nearby region of Taiwan Straits. Such a close and direct shipping and trade relationship is beneficial on reducing transshipment costs (mainly on extra feeder costs and container lift charges) so as to boom the economic growth in Taiwan and China. This paper attempts to contribute to filling the gap by using data from 1990 to 2012 to estimate three regression models for exploring the relationship between cross-strait trade growth and Taiwan's container shipping market.

The paper is organized as follows. Section 2 reviews the cross-strait policy and discusses the impacts to the growth and operation of Taiwan's container throughput.

[4] It was called "non-interference principle of indirect exports to the mainland" at the time. Please refer to page 19 of Chiu Chen, 1992.

This is done in order to understand the background of gradual trade and shipping open policy in this political sensitive region. Section 3 reviews the progress of sea transport liberalization and the issue of direct shipping, especially the shipping trade statistics before and after the open of direct shipping, between Taiwan and Mainland China. The literatures on impact analysis of opening cross-strait economic relations and trade-derived demand of maritime transportation are reviewed in Section 4. The methodologies for the regression models are proposed in Section 5. Section 6 provides the empirical results. Conclusion and discussion are given in section 7.

2. THE GRADUAL OPEN OF TAIWAN STRAIT TRADE AND IT'S IMPACTS ON THE GROWTH AND OPERATION OF TAIWAN'S CONTAINER THROUGHPUT IN THE REGION

During the political hostility period between China and Taiwan, any trade or business activity with Mainland China was regarded as treason. This is illustrated by the "Regulations on Prohibition of Commercial Products from Bandit-controlled Areas" which were promulgated in 1977. In this regulation, only a few medicinal and necessary agricultural or industrial materials were allowed to be indirectly imported to Taiwan via Hong Kong.

Several months after lifting the ban on visiting relatives to Mainland China in November 1987, Ministry of Economic Affairs open 19 items of shoe-making semi-finished products to be imported on August 1988. Due to the obvious comparative advantage of low production cost in the Mainland, business leaders requested to open more and more items every half a year with temporary administration regulation of Bureau of Foreign Trade (see Table 1).

Cross-strait open policy was implemented under two important policy slogans "Root remains in Taiwan" and "production

Table 1 Gradual open of importing industrial components from Mainland China to Taiwan

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Open Items	50	42	57	46	240	1,219	400	1,004	2,275	295
Accumulated Items	50	92	149	195	435	1,654	1,694	2,698	4,973	5,370

Sources: Bureau of Foreign Trade, Ministry of Economic Affairs.

division of labor across the Strait" which put forth two separated "investment" and "trade" administrative management systems since 1992. The major criterion for permitting investment items was that open items should be no negative effect on national security or domestic industries.[5]

In brief, economic open policy across the Strait for Taiwan can be summarized as: (1) Trade Resumption period (1978-1986), (2) Investment Resumption and Legalization Period (1987-1996), open the manufacturing division of labor on labor-intensive products), (3) "No haste, be patient" period (1997-2001), (4) "Open actively, manage effectively" period (August 2001-2008, open the manufacturing division of labor on technology-intensive products) and (5) Direct voyage link and ECFA period (2008 up to now, encouraging the investment in tertiary industries).

The latest stage has not brought benefit to Taiwan economy so far. The annual GDP growth rates from 2008 up to 2012 have been lingering around 2% to 4%, the historical lowest period, due to impact of global economic depression. Most economic institutes[6] have forecasted a lower than 2% for 2013. Chen (2010) argued that before opening Taiwan's market for China investors, Taiwan did not negotiate two critical issues: (1) firmly asking for fair distribution of cross-strait route-assignment for Taiwan ship companies, and (2) how to organize effective logistic and supply chains so as to open China's domestic economy with enough commercial and service market potential. Lin et al. (2013) conducted ex ante impact analysis of the cross-strait Economic Cooperation Framework Agreement (ECFA) on Taiwan's labor demand and income distribution. The conclusions are: Overall, ECFA will benefit all levels of household income. However, the biggest beneficiaries of cross-strait trade liberalization are the highest income group families. The Geni's coefficient increases with the greater market openness, indicating that the trade liberalization will worsen the economic inequality problem in Taiwan.

The ex post impact analysis of such

[5] The investments managed system of 1993 classified approximately 8,000 items of HS coded 8-digit commodities into permitted items, prohibited items, or case-by-case evaluation items. There were four criteria for prohibited items: COCOM (Coordinating Committee for Multilateral Export Controls) limited products or technology, national defense related products, leading new products, or key components and products. There have been evolving versions of the management system since then to now.

[6] Institute of Economics, Academia Sinica, Chung-hua Institution for Economic Research, Directorate General of Budget, Accounting and Statistics, Taiwan Institute of Economic Research and some other research institutes belong to private banks in Taiwan.

"import constraints, no export constraints" cross-strait (from indirect to direct) trade policy to the competitiveness of container ships or feeders had proven to be enormous, especially for small–and medium–sized container companies or feeders. The freight of a full container from Taiwan to Hong Kong was US$ 420 in 1993. It reduced to US$ 80 to 90 in 2002. Originally normal price of a full container from Taiwan to Shanghai was US$ 200. For frequent Taiwanese manufacturer customers, the price could be negotiated down to US$100 in 2002. The management of cross-strait container throughput from time to time can be sacrificed for getting commodities for long-haul shipping destinations, such as Europe or the USA.[7] Therefore, the demand of direct voyage policy from Taiwan's four major commercial ports to Mainland China's major cities/ports where Taiwanese companies are conducting manufacturing division of labor and supply chain management across the Taiwan Strait is soaring significantly.

This paper specifies one meaningful index of "import/export ratio" across the Taiwan Strait (as shown in column (3) of Table 2) to continue the observation and conduct the impact analysis. Cross-strait import/export ratio has grown from 18% to 51% during 1990 to 2012. Such a significant growth proved that Taiwan gradually shifted to an import-oriented trade market and China has now become the major partner of Taiwan's exports (see Table 2). In terms of trade value, interaction between the two sides has progressively grown, except for year 2009 and 2012, in both cases a result of the global economic recession.

3. THE PROGRESS OF DIRECT SHIPPING ACROSS THE TAIWAN STRAIT

The two sides of the Taiwan Strait have performed mutually dependent economic activities since the 1990s in order to construct cross-strait manufacturing supply chains. After "Regulations for Establishment and Operation of Offshore Shipping Centers" was enacted by the Ministry of Transportation and Communication (MOTC) in Taiwan in 1995, the first direct shipping trade across the Taiwan Strait was begun from Xiamen port to Kaohsiung port in April 1997, under the principle of "no customs clearance and

[7] Refer to pages 198-208 of Wang et al. (2002).

Table 2 Export and import trade between Taiwan and China during 1990 to 2012 Unit: billion $US

Year	(1) Export (A)	(2) Import (B)	(3) I/X Ratio (=B/A)	(4) Total trade value (=A+B)	(5) Growth rate of total trade value
1990	4.4	0.8	18%	5.2	—
1995	19.4	3.1	16%	22.5	332.69%
2000	25.0	6.2	25%	31.2	20.93%
2001	25.6	5.9	23%	31.5	0.96%
2002	31.5	8.0	25%	39.5	25.40%
2003	38.3	11.0	29%	49.3	24.81%
2004	48.9	16.8	34%	65.7	33.27%
2005	56.3	20.1	36%	76.4	16.29%
2006	63.3	24.8	39%	88.1	15.31%
2007	74.2	28.0	38%	102.2	16.00%
2008	74.0	31.9	43%	105.9	3.62%
2009	62.1	24.5	39%	86.5	–18.32%
2010	84.8	36.0	42%	120.8	39.65%
2011	91.1	43.6	48%	134.7	11.51%
2012	80.7	40.9	51%	121.6	–9.73%

Source: Mainland Affair Council[8] http://www.mac.gov.tw/.

no entry to Taiwan". Next, in 2001, partial liberalization of direct trade was introduced. Taiwan promoted the so-called Mini-Three Links to allow direct shipping trade between the Matsu and Kinmen islands of Fujian Province of Taiwan authority and the Fuzhou and Xiamen port Cities of China. On 15 December, 2008, 63 ports (48 coastal ports and 15 inner ports) in China and 11 ports in Taiwan were opened for direct shipping transport across the Taiwan Straits. This was on the basis of The Shipping Agreement across Taiwan Strait signed between the Straits Exchange Foundation (SEF, Taiwan side) and the Association for Relations across the Taiwan Strait (ARATS, Mainland China side) on 4 November, 2008.[9] Direct shipping shortened the trade barriers across the Taiwan Strait and the primary benefit was the significant savings in transshipping time and costs. For example, the shipping trip of 700-800 TEU containership between Taiwan and

[8] Summary from Taiwan Customs Statistics, Hong Kong Customs Statistics and China Customs Statistics.
[9] Straits Exchange Foundation http://www.sef.org.tw/; Association for Relations Across the Taiwan Straits http://big5.chinataiwan.org/gate/big5/www.arats.com.cn/.

Xiamen was now reduced by 30% in terms of the shipping costs due to a circumvent trip via an extra third place no longer being required (Chen, 2010). Another significant phenomenon shown in Table 3 is that growth rate of cross-strait container throughput in Keelung had dropped to -10.4% from 2010 to 2011. This is mainly due to annexed geographic locations between Keelung port and Taipei port.

Despite the fluctuation in container throughput volumes among the four ports, the growth of share of direct-shipping throughput in Taiwan's container throughput has been growing stably. By quarterly comparison, the share of cross-strait to Taiwan's container throughput was 11.8% in Q1 of 2009. It has risen to 14.1% in Q1 of 2011 (see Table 4).

Table 3 Container throughput Statistics across the Taiwan Strait (by year /port). Unit: thousand TEU

Port / Year	2009		2010			2011		
	thousand TEU	%	thousand TEU	%	Growth rate %	thousand TEU	%	Growth rate %
Kaohsiung	976	62.8%	1,122	58.3%	15.0%	1,131	57.6%	0.8%
Taichung	250	16.1%	341	17.7%	36.4%	371	18.9%	8.8%
Keelung	328	21.1%	450	23.4%	37.2%	403	20.5%	–10.4%
Taipei	0.47	0.0%	11	0.6%	2,240.4%	60	3.1%	445.5%
Total	1,554	1	1,924	1	23.8%	1,965	1	2.1%

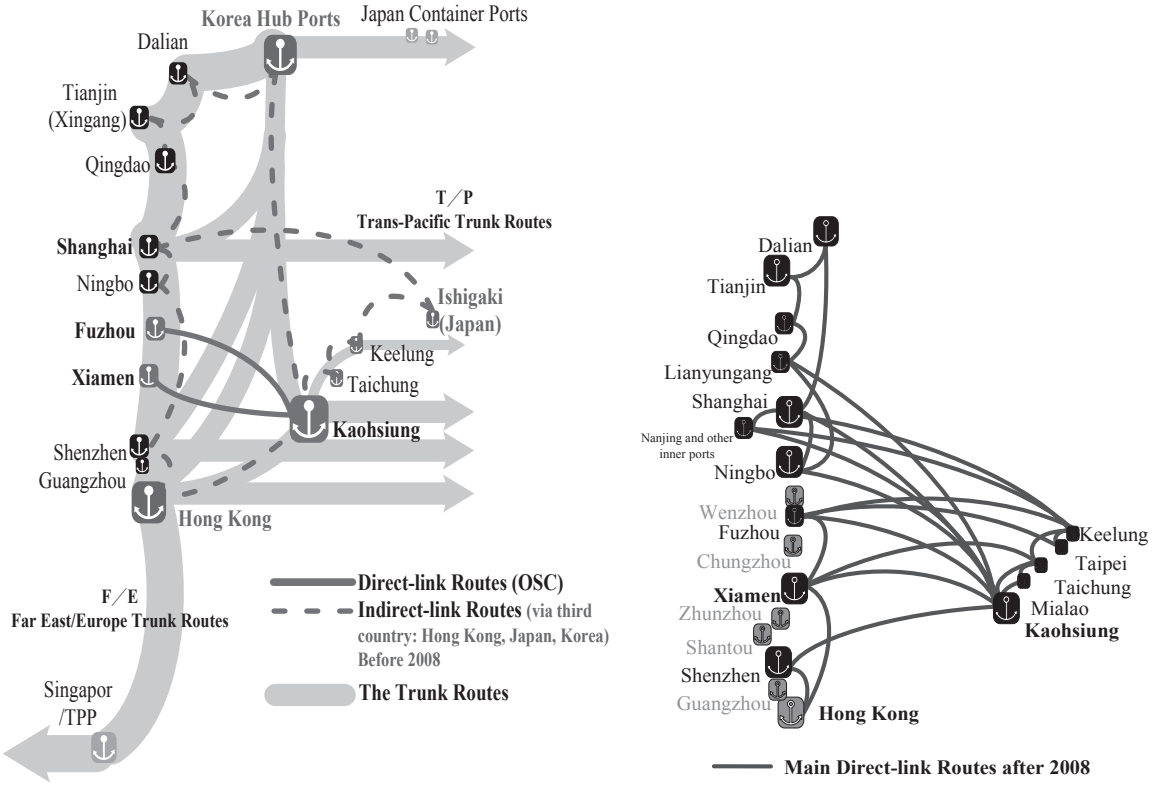
Source: Ministry of Transportation and Communication in Taiwan.
Note: Taipei port was operated in 2009.

Shipping links across the Taiwan Strait prolong study of routes-deployment changes (Tai, 2012). In Fig. 1-a, the direct-link routes in OSC increased more transshipment container only for Kaohsiung port. All of the trade cargo must transit via third country

Table 4 Share of cross-strait volume in Taiwan's container throughput. Unit: thousand TEU

Category	2009				2010				2011			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
A	2,532	2,954	3,075	3,148	2,979	3,303	3,176	3,279	3,144	3,475	3,360	3,444
B	300	405	404	441	413	495	483	533	443	510	508	503
% (B/A)	11.8%	13.7%	13.1%	14.0%	13.9%	15.0%	15.2%	16.3%	14.1%	14.7%	15.1%	14.6%

Notes: A: Taiwan's container throughput, B: All cross-strait direct shipping throughput.
Sources: Kaohsiung port authority http://www.khb.gov.tw/; Keelung port authority http://www.klhb.gov.tw/; Taipei port authority http://www.tchb.gov.tw/; Taichung port authority http://www.tpport.gov.tw/.



a. Indirect-links across Taiwan-strait during April 1997 to December 2008

b. Direct-links across Taiwan-strait after 2009

Fig. 1 The route-deployment structures between Taiwan and Mainland China.

ports to both sides, and until the end of 2008, the routes-deployment and cargo-flows were separated across the Straits. Yet, as Fig. 1-b shows, from the beginning of 2009, direct-links shortened the barriers and saved transit time and cost for carriers and shippers. However the restrictions of only both-side permitted carriers and ships, causing container throughput and routes centralization, are also deliberately excluding the engagement of foreign carriers and ships.

4. LITERATURE REVIEW

An economic-based peace development regime between one big country with abundance of labors and lands for production vs. one small country with much high labor and land costs need careful and regular evaluation from the smaller side. Without cautious open strategies, the sudden open of trade and investment flows may cause "fatal attraction" to business sector. With regard to

past studies, developing direct shipping across the Taiwan Strait has attracted great attention. In the beginning stage, most studies focused on policy analysis (e.g., Kung, 1997; Chang et al., 2006). After Taiwanese businesses have invested significant amount in China, the studies began to stress how to integrate the outward FDI with Taiwan's domestic economic goals: industrial upgrading and regional balanced development (Chen, 2014).

Regarding trade effect, Chen et al. (2009) found that trade liberalization across the Taiwan Straits has had significant and positive impacts on external trade, domestic investment and real GDP (Gross Domestic Production) for the economies of Mainland China and Taiwan.

In discussions of trade or maritime demand forecasting studies, several forecasting methods have been applied in past studies (Chen, 2008; Luo et al., 2009), such as regression (Seabrooke et al. 2003), error correction model (Hui et al. 2004), grey forecasting (Chen, 2008), and autoregressive integrated moving average (ARIMA). For example, Peng and Chu (2009) compared the performance of six methods (classical decomposition model, trigonometric regression model, regression model with seasonal dummy variables, the grey model, hybrid grey model, seasonal autoregressive integrated moving-average (SARIMA) model) for forecasting container throughput volumes in Taiwan's three major ports. They found that the classical decomposition model provided the most accurate prediction. Chou et al. (2008) proposed a modified regression model for forecasting the volume of Taiwan's import containers. The main predicting variable included population, industrial production index, GNP, GNP per capita, wholesale price, GDP, agricultural GDP, industrial GDP and service GDP.

In terms of the study of maritime demand drivers, Langen (2003) analyzed the determinants of maritime container demand for the period of 1980-1995 and identified seven variables: GDP, export quota of economies, the direction of trade, the value density of trade, the container stable share of transport flows, the containerization rate and the share of shipping in international trade. With regard to the macroeconomic impact study of Taiwan Strait direct voyage links, Chen et al. (2009) applied a computable general equilibrium model to investigate the potential economic effects of trade liberalization across the Taiwan Strait. Their results revealed that trade liberalization would have a positive impact on external trade, domestic investment and real GDP for the economies in this region. Despite the

significant contribution of maritime demand studies in the past studies, the literature on statistical analysis of container throughput across Taiwan Strait is scarce. In light of this, this paper adopts basic micro-economic theorem and regression models to construct our own impact analysis.

5. METHODOLOGIES

The data sources of this paper were collected from Ministry of Transportation and Communication,[10] Directorate-Generate of Budget[11] and Mainland Affairs Council[12] in Taiwan. In order to select the best model for this study, both OLS regression and the general to specific modeling approach were adopted. The latter involved starting from the most general model with all the variables included and allowing the data to determine which set of variables are the most significant.[13] The approach avoids the possible omitted variables bias problems that may arise otherwise (Spanos, 1986). Once the estimated regression model was formulated, prediction on container throughput was calculated with using ordinary economic assumptions between dependent and independent variables, such as freight or containers demand are derived from the economic or industrial activities. As to the policy impact assumptions are basing on historical data and original policy-setting expectation of how "unilateral" import constraint and "bilateral" direct shipping may influence new market development.

5.1 Impact analysis of "Cross-strait Import Constraint Policy" on Taiwan's trade growth

In this study, the dependent variables are Taiwan's global trade value or cross-strait trade value. The independent variable is import trade value. We define the model and variables in Table 5.

$$Y_i = \alpha + \beta(Cross\text{-}strait\ import\ trade) + \varepsilon_i \quad (1)$$

[10] http://www.motc.gov.tw/en/index.jsp.
[11] http://eng.dgbas.gov.tw/mp.asp?mp=2.
[12] http://www.mac.gov.tw/mp.asp?mp=3.
[13] For example, the independent and dependent variables are both set as following situations.
1) Independent variable in logarithm vs dependent variables in logarithm.
2) Independent variable vs dependent variables in logarithm.
3) Independent variable in logarithm vs dependent variables.

Table 5 Description of variables in Empirical Estimation

Variables	Definition	
Dependent variable	Taiwan's global trade value	Yearly Taiwan's global trade value over the time period 1990-2012 (in US$ billion)
	Cross-strait trade value	Yearly trade value between Taiwan and China over the period 1990-2012 (in US$ billion)
Independent variable	Cross-strait import trade value	Yearly bilateral import trade value between Taiwan and Mainland China over the time period 1990-2012 (in US$ billion)

Source: Directorate-Generate of Budget, Accounting and Statistics http://www.dgbas.gov.tw/mp.asp?mp=1 Mainland Affairs Council http://www.mac.gov.tw/mp.asp?mp=3

Where where Y_i is the container throughput for the ith observation and ε_i is the ith residual with $\mathrm{Var}(\varepsilon) = \sigma^2$, assuming all figures to be normally distributed. i = 1, 2 for Taiwan's global trade value and Taiwan's cross-strait trade value, respectively.

5.2 Demand elasticity and return to scale hypothesis of cross-strait trade and direct voyage link to Taiwan's global containers growth

It is well-established that sea freight demand is the derived demand of import and export activities. If Taiwan has unilaterally controlled the open of importing semi-finished products from Mainland China to Taiwan (as shown in Table 1), a fair consequence of cross-strait direct voyage link should lead to a constant return to scale of cross-strait trade growth to containers throughput growth. If our regression shows an increasing return to scale, Taiwan container shipping companies may have benefited from extra profits in this bilateral peace development via trade and sea link negotiation. Conversely, if a decreasing return to scale is shown, Taiwan's companies (including manufacturers, ship owners and all shipping logistic firms) may have sacrificed due to an imbalance in the negotiation powers between one big political entity (China) and one much smaller political entity (Taiwan).

To measure such impacts, we adopt Cobb-Douglas function to define the transportation derived demand function. The original form of the equation can be defined as $Y = A \cdot E^{\alpha} \cdot I^{\beta}$ Where Y denotes "Taiwan's total container throughput"; E denotes "cross-strait export trade value"; I denotes "cross-strait import trade value".

We then can calculate two demand elasticity, α and β, respectively cross-strait elasticity of cross-strait export and

import to container throughput. Following the hypothesis of constant return to scale, we can examine the sum up of two demand elasticity. If $\alpha + \beta = 1$, it means the equation holds constant return to scale; larger than 1, increasing return to scale; smaller than 1, decreasing return to scale.

For the convenience of regression estimation, we take the reduced form of above Cobb-Douglas function and get following empirical regression model:

$$\begin{aligned} lnY_i = {} & lnA + \\ & \alpha ln(Cross\text{-}strait\ export\ trade) + \\ & \beta ln(Cross\text{-}strait\ import\ trade) + \varepsilon_i \end{aligned} \quad (2)$$

Where Y_i is Taiwan's total container throughput for the ith observation and ε_i is the ith residual with $\mathrm{Var}(\varepsilon) = \sigma^2$, assuming all figures to be normally distributed.

5.3 Non-cross-strait factors on the growth of container throughput (from 2004 to 2012)

In order to identify potential influential factors that affect container throughput between Taiwan and Mainland China, quarterly data was used to collect dependent and independent variable. Based on the literature review, three explanatory variables were used: industrial outputs of GDP (namely Industrial GDP), GNP and variation in oil price.[14] Quarterly data associated with response variable of container throughput (including export and import container) and potential independent variables were collected from 2004 Q1 to 2012 Q4. Container throughput data of Taiwan[15] was obtained from the Ministry of Transportation and Communication, while the Directorate-General of the Budget and Statistics in Taiwan[16] provided data regarding industrial GDP, GNP and variation in oil price. The hypotheses of anticipated impact are:

- Industrial Gross Domestic Production (GDP): High industrial production would speed up the trade flow and signify high consumption demand (Langen, 2003; Chou et al., 2008; Chang and Chang, 2009).
- Gross National Product (GNP): Economic growth could foster international trade and lead to the expansion of cargo shipment

[14] Although several potential variables (e.g., population, industrial production index, GNP, GNP per capita, wholesale price, GDP, agricultural GDP, industrial GDP and service GDP) have been used to develop forecasting model in past studies (e.g. Chou et al., 2008; Langen, 2003), we selected the four key variables of Industrial GDP, GNP, variation in oil price and one dummy variable as they were related to our research topic.
[15] http://www.motc.gov.tw.
[16] http://www.dgbas.gov.tw/.

(Chang and Chang, 2009). The growth of GNP would reflect the increase of production and containers throughput between Taiwan and Mainland China.

- Variation in oil price: The fluctuation in oil prices would affect transportation costs for shipping carriers and have a negative impact on shipping trade (Notteboom and Vernimmen, 2009).
- QDummy variable. Direct shipping brings the benefits for shipping companies due to a reduction in transshipment costs (mainly extra feeder costs and container lift charges) and is expected to reshape the container shipping market. The opening of direct shipping in 2009 was set as a dummy variable in the research model.

These dependent and independent variables are summarized in Table 6.

Table 6 Variables Description in Empirical Estimation

Variables	Definition
Container throughput	Quarterly container throughput over the time period 2004 Q1-2012 Q4 (in TEU)
Industrial GDP	Quarterly industrial GDP in Taiwan over the time period 2004 Q1-2012 Q4 (in US$ million)
GNP	Quarterly GNP in Taiwan over the time period 2004 Q1-2012 Q4 (in US$ million)
Variation in oil price	Quarterly variation of oil price in Dubai over the time period 2004 Q1-2012 Q4 (in US$ per barrel).
QDummy	Variable value=0 for the period of 2004 Q1-2008 Q4; variable value=1 over the period of 2009 Q1-2012 Q4

Sources: Ministry of Transportation and Communication http://stat.motc.gov.tw/mocdb/stmain.jsp?sys=100.
Bureau of Energy, Department of Economic Affairs http://210.69.152.10/oil102/.
Directorate-Generate of Budget, Accounting and Statistics http://www.dgbas.gov.tw/mp.asp?mp=1.

The model was then estimated through OLS regression. All analyses were conducted with SPSS 16.0 for Windows. The container throughput regression model was specified as a function of industrial GDP, GNP, variation in oil price and one dummy variable.

$$Y_i = \beta_0 + \beta_1(Industrial\ GDP) + \beta_2(GNP) + \beta_3(Variation\ of\ Oil\ Price) + \beta_4(QDummy) + \varepsilon_i \quad (3)$$

where Y_i is the container throughput for the ith observation and ε_i is the ith residual with $\mathrm{Var}(\varepsilon) = \sigma^2$, assuming all figures to be normally distributed. The Durbin-Watson test and the variance inflation factor (VIF) were used in this paper to test whether the residual values of the regression model had autocorrelation and collinearity.

6. RESULTS

6.1 Relationship between cross-strait trade and Taiwan's global container throughput

The result of the regression analysis indicated that Taiwan's cross-strait import trade policy had significant influenced the cross-strait trade and the growth of Taiwan's global trade (see Table 7 and Table 8). Increase of one unit (US$ billion) of cross-strait import value contributes 0.985 and 0.994 times of Taiwan's global trade value and cross-strait trade value, respectively. Such a phenomenon reveals that import-constraint trade policy across the Strait did stimulate Taiwan's global trade growth in a stable pace. The result is shown as equation (2) and (3).

Taiwan's global trade value = 0.985 cross-strait import trade value (4)

Table 7 Result of Regression Analysis (Dep.= Taiwan's global trade value)

Variables	Coefficients	T value	*P* value
Import trade value	0.985	22.699	0.000*

Note: * Significant at 1% level; adjusted R^2 = 97.0%

Table 8 Result of Regression Analysis (Dep.= Cross-strait trade value)

Variables	Coefficients	T value	*P* value
Import trade value	0.994	40.597	0.000*

Note: * Significant at 1% level; adjusted R^2 = 98.7%

6.2 Demand Elasticity and Return to Scale of cross-strait trade to Taiwan's Global Containers Growth

As to the second set of regression for estimating demand elasticity and return to scale via the Cobb-Douglas derive demand function, we found that cross-strait import and export demand elasticity showed positive impact on Taiwan's global container throughput, the significant level for import achieved 99%. "Unilateral import trade control" policy during 1990s played a significant role in stimulating Taiwan's total container throughput. Nevertheless, such policy effect is no more effective during the second decade 2002-2012 (see Table 9).

As Table 9 shows, the demand elasticity of cross-strait import value to Taiwan's global container throughput was 0.78, as compared to 0.20 (although not passing t-statistics) of cross-strait export[17] during 1990-2001.

[17] This result meets Taiwan's "production division of labor" across the Taiwan Strait in the 1990s which encouraged some low price MIC (made in China) products should be assembled and exported directly from Mainland China's ports. Only designated semi-finished products can be imported to Taiwan, finished in the final step of assembly, and then exported to the global market as MIT (made in Taiwan) products.

Table 9 Result of Regression Analysis (Dep.= ln (Taiwan's global container throughput))

Time span	Variables	Coefficients	T value	*P* value
1990-2001	ln (Export trade value)	0.204	1.196	0.262
	ln (Import trade value)	0.787	4.618	0.001*
	Variables	**Coefficients**	**T value**	***P* value**
2002-2012	ln (Export trade value)	0.033	0.016	0.988
	ln (Import trade value)	0.683	0.323	0.755

Note: Time span: 1990-2001. * Significant at 1% level; adjusted $R^2 = 0.938$
Time span: 2002-2012. adjusted $R^2 = 0.39$

Although the regression results of 2002-2012 did not reach statistical significance, it is still notable that the derived demand elasticity of cross-strait import and exports dropped to 0.683 and 0.033 respectively.

Secondly, regarding the effect of return to scale, defined as the demand elasticity of cross-strait export (0.204) plus the import (0.787), during 1990-2001 was equal to 0.991- nearly equal to 1. This result shows Taiwan's cautious cross-strait trade open policy with Mainland China resulted in a fair constant return to scale to global throughput growth.

During 2002-2012, when Taiwan's shipping association began to negotiate the cross-strait voyage link with their mainland counterparts, various reasonable or non-reasonable conditions were requested by the PRC authority. The demand elasticity of cross-strait export (0.033) plus the import one (0.683) (despite being not statistically significant) was only 0.716, smaller than 1. This period of entering bilateral negotiation shows decreasing return to scale of cross-strait trade to Taiwan's global throughput growth.[18] After bilateral negotiation, Taiwan side is negatively impacted.

6.3 Non-cross-strait factors on the growth of container throughput

The growth of container throughput has its original theory (refer to section 4 literature review) in world marine studies. This section examines the non-cross-strait factors by following orthodox theory with available seasonal data from 2004 to 2012.

The correlation matrix of dependent (container throughput) and independent

[18] There are two major arguments on Taiwan's vulnerabilities on bilateral negotiation of cross-strait container shipping: (1) due to the vicious competition from China's counterpart ships or feeders which operate in much lower operation costs. (2) The strong opposition of China side for opening Taiwan's cross-strait container shipping to link the international lines.

variables (industrial GDP, GNP and variation in oil price) is presented in Table 10. It shows that there is a medium correlation between container throughput and industrial GDP (ρ = 0.776) and GNP (ρ = 0.764). With regard to the correlation between independent variables, in contrast, shows a high correlation between industrial GDP and GNP (ρ = 0.913). The least correlations are between industrial GDP and variation in oil price (ρ = 0.215), and correlation between GNP and variation in oil price (ρ = –0.062). Although industrial GDP has high relation with GNP, it is reserved in the correlation analysis due to its crucial role that affects the volume of containers in Taiwan (Chou et al., 2008). Therefore, three independent variables (industrial GDP, GNP and variation in oil price) are selected in the regression analysis.

In order to select the best model, the general to specific modeling approach was adopted until the set of variables were the most significant (see Appendix). The initial regression result of the container throughput reveals that variable GNP should be deleted from the analysis because of its non-significance (t = 0.053). Finally, variable industrial GDP and variation in oil price were selected for the model with a corresponding VIF of 2.143, which fitted the threshold value of (< 10) (O'Brien, 2007). After adjusting the standardized coefficients, the equation of the regression becomes:

Container Throughput = 0.190 ln(Industrial GDP) − 0.053 Variation in Oil Price + 0.855 QDummy (5)

Two independent variables (industrial GDP and variation in oil price) and one dummy variable were significant at the 5% level (Table 11).

The regression model is statistically significant at the p = 5% level (R^2 = 98.5%; adjusted R^2 = 98.3%, F value = 677.7) and indicates the model is acceptable empirically. The Durbin-Watson statistics of 1.674 show no evidence of serial correlation. The significance of independent variables is now described.

Table 10 Pearson's Correlation Matrix

	Industrial GDP	GNP	Variation in oil price	Container throughput
Industrial GDP	1.000	0.913	0.215	0.776
GNP		1.000	–0.062	0.764
Variation in oil price			1.000	–0.006
Container throughput				1.000

Table 11 Result of Regression Analysis (Dep.= Container Throughput)

Variables	Coefficients	T value	*P* value
ln (Industrial GDP)	0.190	5.940	0.000**
Variation in oil Price	–0.053	–2.243	0.032*
QDummy***	0.855	27.689	0.000**

Note: * Significant at 5% level
** Significant at 1% level
*** QDummy is quarter dummy variable Durbin-Watson = 1.674; adjusted R^2 = 98.3%

First, the dummy variable (open of direct shipping in 2009) with an estimated coefficient of 0.855 at 1% level plays the most significant role in container throughput. This reflects the assumption that direct shipping policy efficiently stimulated the increase of shipping trade after 2009 due to shorter shipping routes and lower operation costs (i.e. time and fuel costs). Second, the estimated coefficient of industrial GDP is 0.190, is statistically significant at 1% level. Economically, it means when Taiwan's industrial GDP grow one unit, the demand of global container throughput will increase 19.0%. Finally, the estimated coefficient of the variation in oil price is –0.053, which is significant at the 5% level. The negative sign indicates that the one unit of higher oil price (increased indirectly the freight rate) and thus results in 5.3% decrease of demand on container throughput.

In sum, the significance of explanatory variables in the regression confirms that trends in container throughput run parallel to the open policy of direct shipping and economy growth; however, the figures are negatively influenced by the fluctuation in the inter-national oil price.

7. CONCLUSION AND DISCUSSION

This paper examined the progress of cross-strait trade and direct shipping open policy and their impacts to the growth of container throughput. The whole process constructed three regression models (two of them using time dummy variable) to explain the impact of trade policy and cross-strait direct shipping policy on the growth of container throughput in different periods.

Taiwan has unilaterally controlled the open of importing semi-finished products from Mainland China to Taiwan. A fair consequence of cross-strait direct voyage link leads to a constant return to scale of cross-strait trade growth to Taiwan's global containers throughput growth during 1990-2001. However a decreasing return to scale is shown during 2002 to 2012 when bilateral negotiation on direct air and sea voyage links gradually began. Taiwan's companies (including manufacturers, ship owners and all

shipping logistic firms) may have sacrificed due to an imbalance in the negotiation powers between one big political entity (China) and one much smaller political entity (Taiwan).

This portion of study findings indicates that imbalanced political powers can damage the peace development between or among conflict political entities. A serious re-negotiation of equal benefit sharing on cross-strait direct voyage link and cross-strait production division of labor need be implemented soon so as to improve Taiwan's vulnerability.

Since Taiwan's container throughput are mainly serving the demand of global production division of labor and market demand, an over China market oriented cross-strait policy after 2002 may also the major reason in resulting decreasing return to scale of cross-strait trade policy to Taiwan's global container throughput. Taiwan also need examine global balancing trade and investment policies by itself.

The cross-strait open impact analysis approach innovated in this paper (time dummy OLS regression on the growth of cross-strait trade to Taiwan's global trade growth; demand elasticity and constant return to scale measurement) will become a universal criteria for evaluating fair peace development between two originally hostile political entities if China can also conduct a comparable research by using similar datasets and methodologies.

Last but not the least, the three statistically significant (at the 5% level) variables were identified: opening of direct shipping (positive effect), industrial GDP (positive effect), and variation in oil price (adverse effect). They are able to explain a substantial proportion of the variation in container throughput. Also, the regression model is acceptable although container data was limited due to the fact that data on container shipping trade policy across the Strait between Taiwan and Mainland China only exists after its relatively recent start, and then only for 9 years (2004-2012).

There are a number of potential avenues for further research. For example, in this paper, due to the non-availability of certain data, we omitted the impact of freight, this potential factor can be included in the demand forecasting in future studies. In addition, future studies could investigate short-term flexibility in demand and supply and consider the delayed response to the excessive demand or supply that result in price oscillation in the container shipping market.

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Appendix-Comparison of Regression Models

As shown below, model 4 is the best model after evaluating the coefficient sign and significance, and model adjusted R^2 indicator within four model comparisons.

Model 1

$Y_i = \beta_0 + \beta_1(Industrial\ GDP) + \beta_2(Variation\ of\ Oil\ Price) + \beta_3(QDummy) + \varepsilon_i$

Dep.= Container Throughput (Y_i)

Variables	Coefficients	T value	*P* value
Industrial GDP (β_1)	0.195	6.153	0.000**
Variation in oil Price (β_2)	–0.045	–2.001	0.054*
QDummy (β_3)***	0.848	27.460	0.000**

Note: * Significant at 5% level
** Significant at 1% level
*** QDummy is quarter dummy variable Durbin-Watson = 1.674; adjusted R^2 = 98.4%

Model 2

$lnY_i = \beta_0 + \beta_1(Industrial\ GDP) + \beta_2(Variation\ of\ Oil\ Price) + \beta_3(QDummy) + \varepsilon_i$

Dep.= Container Throughput (lnY_i)

Variables	Coefficients	T value	*P* value
Industrial GDP (β_1)	0.010	0.266	0.792
Variation in oil Price (β_2)	0.034	1.304	0.202
QDummy (β_3)**	0.983	27.613	0.000*

Note: * Significant at 1% level
** QDummy is quarter dummy variable Durbin-Watson = 0.608; adjusted R^2 = 97.8%

Model 3

$lnY_i = \beta_0 + \beta_1 ln(Industrial\ GDP) + \beta_2(Variation\ of\ Oil\ Price) + \beta_3(QDummy) + \varepsilon_i$

Dep.= Container Throughput (lnY_i)

Variables	Coefficients	T value	*P* value
Industrial GDP (β_1)	0.006	0.160	0.874
Variation in oil Price (β_2)	0.035	1.300	0.203
QDummy (β_3)**	0.986	28.197	0.000*

Note: * Significant at 1% level
** QDummy is quarter dummy variable Durbin-Watson = 0.608; adjusted R^2 = 97.8%

Model 4

$$Y_i = \beta_0 + ln\beta_1(Industrial\ GDP) + \beta_2(Variation\ of\ Oil\ Price) + \beta_3(QDummy) + \varepsilon_i$$

Dep.= Container Throughput

Variables	Coefficients	T value	*P* value
Industrial GDP (β_1)	0.190	5.940	0.000**
Variation in oil Price (β_2)	–0.053	–2.243	0.032*
QDummy (β_3)***	0.855	27.689	0.000**

Note: * Significant at 5% level
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