Measurement of the Trade Facilitation in Taiwan Semiconductor Export Regions

Cheyuan Liu, Tao He[(✉)], and Feng Xie

School of Economics and Management, Guangxi Normal University, Guilin, China
865155235@163.com

Abstract. In the context of the normalization of the Covid-19 and the marginalization of Taiwan in the Regional Economic Cooperation Organization, the improvement of trade facilitation level is a powerful way to reduce trade costs and increase trade flows in Taiwan. By selecting trade facilitation indicators from four aspects: customs clearance environment, port efficiency, transportation infrastructure and e-commerce. This paper measures the current level of trade facilitation in a broad sense in Taiwan's counties and cities where semiconductor export enterprises are located and analyses the trend of trade facilitation in Taiwan.

Keywords: trade facilitation · Taiwan · semiconductor export

1 Introduction

Since the COVID-19 pandemic in 2019, the slow reform of the old multilateral trading system has been unable to cope with the new economic globalization, and the entry into force of regional economic integration organizations such as the CPTPP and RCEP has gradually become a new driving force for rebuilding the international economic order. By concluding free trade agreements and joining regional economic integration organizations, economies have lowered trade barriers, innovated trade rules, and reconstructed the order of global industrial and supply chains. If Taiwan has long been isolated from the edge of the Asia-Pacific regional economy and is unable to participate in the supply chain reconstruction process of regional economic integration organizations, it will inevitably have a serious impact on its industrial development. How Taiwan can increase trade flows and reduce trade costs in the face of the prevalence of anti-globalization, the risk of potential supply chain disruptions, and the increase in global trade costs has become a question worth considering. Studies have shown that one of the central propositions of trade facilitation is how to simplify procedures and controls for cross-border economic activities in order to reduce transaction costs in international trade, particularly between firms and governments, and thereby maximize efficiency (Grainger, 2011) [7].

WTO members concluded negotiations at the 2013 Bali Ministerial Conference on the landmark Trade Facilitation Agreement (TFA), which entered into force on 22 February 2017 following its ratification by two-thirds of the WTO membership. Trade Facilitation Agreement (TFA) mainly focus on the cross-border efficiency. According

to the data of Trade Facilitation Agreement Database of World Trade Organization, it shows that Taiwan's commitment to Trade Facilitation Agreement (TFA) has reached 100%. It means Taiwan's trade facilitation level of cross-border efficiency has reached a high level.

In the future, in addition to the level of cross-border trade facilitation, more attention should be paid to the level of intra-boundary trade facilitation, and a broad level of trade facilitation should be built based on indicators that can reflect regional differences, such as the level of e-commerce at the county and city level and the construction of information infrastructure to promote the export growth of Taiwan enterprises.

Therefore, how to better measure and improve the level of trade facilitation has become one of the focuses of Taiwan's future attention. This paper attempts to make a marginal contribution in the following areas: (1) to measure the current level of trade facilitation in a broad sense in Taiwan's counties and cities where semiconductor export enterprises are located; (2) Analyzing the trend of trade facilitation in Taiwan.

2 Literature Review

2.1 Definition of Trade Facilitation

Wilson (2002) [23] pointed out that the definition given by WTO and UNCTAD refers to the simplification and coordination of international trade procedures, including activities, time, including collection, display, communication, and processing of information required for the movement of international trade goods. APEC(2002) [24] and other international organizations also pointed out a similar definition, trade facilitation generally refers to a simplified procedure.

With the development of time, the academic definition of trade facilitation continues to expand, trade facilitation on the definition of boundaries is also expanding. In addition to specific boundary elements, such as port efficiency, customs administration and abstract boundary internal elements, such as the environmental factors in which trade transactions occur, including the level of regional infrastructure construction, the use of e-commerce, etc. (Wilson et al., 2005) [22]. Mönch (2013) [13] further pointed out that trade facilitation is a policy and measure aimed at improving the efficiency of each stage of the international trade chain to reduce trade costs.

Although there are subtle differences, trade facilitation is generally recognized by academics as a set of institutional norms to reduce trade costs. Its purpose is to coordinate several norms between countries in order to improve efficiency, transparency and predictability on the basis of norms, standards and internationally recognized time.

2.2 Measurement Content of Trade Facilitation

According to the different definitions of trade facilitation, the academic community's measurement of trade facilitation is also different. At present, the academic community's analysis of trade facilitation is mainly divided into three categories. The analysis of trade facilitation from a narrow perspective usually adopts the method of case analysis, or the form of dummy variables to analyze and compare the corresponding customs documents

and customs clearance policies. For example, Porto (2015) [4] used the signing of AEO, SW and MRA as a dummy variable to analyze trade facilitation. Tavengerwei (2018) [20] analyzed how to use trade facilitation to better develop cross-border e-commerce through the case of small and medium-sized countries. The measurement of trade facilitation from a broad perspective can be divided into three categories according to the scope of the measured object.

(1) Level of Trade Facilitation from a Regional Perspective
The level of trade facilitation from a regional perspective is the most common type of mainstream analysis. It is usually based on the work of Wilson (2005) [22]. By using data from WEF, it is analyzed from infrastructure, customs environment, port efficiency, institutional environment and e-commerce as measurement indicators of trade facilitation. In the early days, due to the lack of data, most scholars chose countries as the basic unit of trade facilitation (Moïsé et al., 2011; Shepherd & Wilson, 2009; Wilson et al., 2002, 2005) [12, 18, 23, 22]. In recent years, there have been more and more studies on the measurement and analysis of trade facilitation levels in provinces within a region or counties within a region. More and more scholars have begun to study the level of trade facilitation at the provincial and municipal levels and analyze the impact of intra-regional trade facilitation on enterprises(Cheng Kai & Yang Fengmin, 2020; DUAN & JING, 2021; Li & Li, 2021) [2, 5, 8].

(2) Trade Facilitation Level from the Perspective of Sector
The analysis of trade facilitation level from the perspective of sector pays more attention to specific industries, the impact of trade facilitation level on specific sectors or the estimation of trade facilitation level of specific industries. As Mann(2008) [10] first proposed the analysis of the level of trade facilitation at the sector level, the level of trade facilitation at the national level is compared with the level of trade facilitation at the industrial supply chain level. Moïsé (2011) [12] analyzed the impact of trade facilitation on manufacturing, agriculture and other sectors. He pointed out that trade facilitation indicators are extra valuable for manufacturing, but due to the lack of particularity in indicator construction, the estimation of agricultural products is not good. Tang (2021) [19] analyzes the impact of trade facilitation on Japan's tourism industry.

(3) Trade Facilitation Level from the Perspective of Port
The level of trade facilitation from a macro perspective often focuses on the overall level of a country. It is difficult to analyze the specific trade facilitation measures that should be taken at the port level and evaluate the competitiveness of trade facilitation measures at each port. For example, RUDJANAKANOKNAD(2013) [15] compared the levels of trade facilitation at the port level in seven international ports from Thailand, and Cheng (2018) [3] compared the levels of trade facilitation at the port level in Shenzhen and Hong Kong, China.

To sum up, from the broad perspective of trade facilitation analysis, usually build a set of trade facilitation index system. Among them, Wilson(2005) [22]' s work is the most perfect, and most articles refer to this indicator for analysis. The system according to the port infrastructure, customs clearance environment, institutional environment, e-commerce level of these four angles to quantify the analysis. Through this measure,

the'inside the border' elements and'border elements' are combined to analyze the overall level of trade facilitation in a region. However, due to the limited statistical data, the indicators of a region are analyzed by a city in the region as a representative. Mann (2012) [11] pointed out that most of the data are only at the national level rather than the departmental or corporate level.

Although the level of trade facilitation in the narrow sense within the region remains stable, considering the heterogeneity of factors within the borders of various regions, there may be differences in border management. Therefore, it is likely that there are differences in trade facilitation within a country or in various regions within the economy. In the future, it is necessary to further analyze the level of trade facilitation at the meso-micro level.

2.3 Index Selection of Trade Facilitation Measurement

In the selection of trade facilitation indicators, some articles measure the implementation effect of specific trade facilitation measures in the form of dummy variables (de Sá Porto et al., 2015) [4], and most articles reflect the above-mentioned definition of trade facilitation.

When estimating trade facilitation in multiple countries, most of the literature uses indicators from the WEF's GCR to proxy measures, from the World Bank's business index, LPI logistics performance, and the CPI index from Transparency International as data sources.

However, global indicators can only make a more comprehensive and consistent estimate of trade facilitation policies at the national level, and there are defects in the study of the impact of trade facilitation policies on countries with many different hub ports (Cheng et al., 2018) [3]. In the estimation of trade facilitation in various regions of a country, due to the lack of research data sources, it needs to be enriched and expanded. The literature generally uses specific case analysis methods. Although some scholars have further divided the indicators of trade facilitation into more detailed 100 secondary indicators (Mönch et al., 2013) [13], in general, Wilson (2003, 2005) [21, 22] is the most perfect for the measurement of trade facilitation, and the academic community refers to the index system when calculating the index system of trade facilitation. The system according to the port infrastructure, customs clearance environment, institutional environment, e-commerce level of these four angles to quantify the analysis. The literature on measuring the level of micro-trade facilitation and analyzing its impact on enterprises, such as Li(2021) [8], Zhao(2022) [25], (DUAN & JING, 2021) [5], also refer to Wilson(2003, 2005) [21, 22]. The index system selects approximate proxy indicators for measurement analysis.

2.4 Measurement Method of Trade Facilitation

Scholars generally use principal component analysis (Ganbaatar et al., 2021; Sakyi et al., 2018) [6, 16], entropy weight method (Shan et al., 2020) [17], AHP analytic hierarchy process (Bhatti & Hanjra, 2019; RUDJANAKANOKNAD et al., 2013) [1, 15] weighted the selected trade facilitation indicators, or directly used the simple average

method (DUAN & JING, 2021; Mann, 2008; Wilson et al., 2005) [5, 10, 22] conducted a comprehensive calculation of indicators to obtain the final results.

In summary, most of the studies of the World Bank, WEF and the current academic circles are based on national or regional overall data, and there is no detailed analysis and discussion of trade facilitation in Taiwan's counties and cities. Different from the traditional literature which only selects the trade facilitation level of Taipei city in Taiwan as the analysis, this paper refers to the index system of scholars(Wilson et al., 2003, 2005) [21, 22] to measure the trade facilitation level of each county and city in Taiwan.

3 Indicator Construction and Analysis

Taiwan has completed the procedure and submitted the Trade Facilitation Agreement (TFA) acceptance letter to the WTO on August 17,2015, becoming the 13th member to complete the Trade Facilitation Agreement (TFA) approval procedure. The entry into force of Trade Facilitation Agreement (TFA) will help Taiwan manufacturers reduce trade costs and further expand international economic and trade space in the context of economic recession. Since February 22,2017, Taiwan's commitment to Trade Facilitation Agreement (TFA) has been 100% implemented. To a certain extent, this shows that the level of trade facilitation in the narrow sense of Taiwan has reached a good institutional norm. Therefore, the measurement of Taiwan in this paper will not be limited to border efficiency, but will consider the impact of factors inside the border. At the same time, because the customs policies of the same province are generally consistent, there will be no major differences in customs policies among counties and cities. Therefore, it is also necessary to consider more about the level of trade facilitation in the broad sense of each county and city outside the customs procedures and institutional norms.

Therefore, according to the data statistics of Taiwan, considering that the semiconductor enterprises in Taiwan are mainly distributed in the three major scientific parks(Hsinchu Science Park, Central Taiwan Science Park and Southern Taiwan Science Park), this paper collects the data of each region from the county and city level where the semiconductor enterprises are located and summarizes the trade facilitation index system of each county and city, and finally aggregates the trade facilitation score.

Based on the research results of Wilson(2003, 2005) [21, 22], this paper constructs trade facilitation indicators from four aspects: customs clearance environment, port efficiency, transportation infrastructure and e-commerce.

The customs clearance environment (regulatory environment) refers to the selection of regulatory environmental indicators in People's Daily Thinktank(2019) [14], the approximate indicator of the reliability of police services, and the criminal population rate published in Taiwan by selecting the data. The number of economic cases seized per 10,000 people is used as a proxy variable to measure local corruption and social stability. Since the counties and cities in Taiwan do not publish the statistical trade volume, similar port efficiency indicators are selected with reference to the practice in DUAN (2021) [5]. Port efficiency is measured and calculated by the ratio of trade volume to total trade value of the three major scientific parks (Hsinchu Science Park, Central Taiwan Science Park and Southern Taiwan Science Park) in Taiwan.

Table 1. Trade facilitation measurement index construction table (compiled by the author)

Variable	Detail	Source
Port efficiency	Ratio of port trade volume to total trade volume (data of top three industrial parks).	Taiwan Technical Committee for Scientific Affairs
Transport infrastructure	Road mileage intensity (km/km2) by counties and cities.	Taiwan Statistics Bureau for Eco-nomic Affairs
Customs environment	The average of these two indicators: Offender rate: (per-son/100,000 persons). Economic cases: (pcs).	Taiwan Statistics Bureau for Eco-nomic Affairs
E-commerce	The average of these three indicators: Internet usage rate. Balance held on deposit in financial institutions. Balance held on loan in financial institutions.	Taiwan Communications Commission Banking Bureau, Financial Supervisory Commission

With reference to LIU (2010) [9] and DUAN (2021) [5], road mileage density is used as a proxy variable to measure transportation infrastructure. This index is calculated by dividing the length of road miles (km) by the land area (sq. km) of each county or city in Taiwan. Referring to Mann(2008) [10] Considering the financial infrastructure, the important role of e-commerce in trade facilitation, the level of e-commerce is measured by network usage, the balance of deposits of financial institutions, and the balance of loans of financial institutions. The selected indicators and source data are shown in Table 1.

This paper first uses the scoring method and the form of proxy variables to measure the performance of the corresponding areas of trade facilitation. Considering that the statistical methods of each sub-index of trade facilitation are different, it is impossible to obtain the total trade facilitation score by direct summation. In this paper, the sub-indexes of trade facilitation are standardized according to the standardized scoring method in DUAN (2021) [5]. The value range of sub-indexes is 0–10. The greater the value, the higher the level of trade facilitation's corresponding aspect. Finally, refers to Wilson (2003, 2005) [21, 22] and DUAN (2021) [5], the simple average method is used to sum up each index for aggregate trade facilitation score. This paper summarizes the standardized data and calculates the average value to obtain the trade facilitation index of each region where the semiconductor enterprises in Taiwan are located. The trade facilitation score of each county or city is shown in Table 2.

Table 2. Trade facilitation composite score table (made by the author)

Region\Year	2013	2014	2015	2016	2017	2018	2019	2020
Kaohsiung	3.547	3.503	3.727	3.727	3.644	3.792	3.818	3.594
Miaoli County	3.059	3.224	3.455	3.675	3.673	3.970	4.197	3.938
Taipei	6.691	7.002	6.500	6.661	5.975	6.130	6.451	6.573
Tainan	3.857	3.745	3.568	3.425	3.364	3.327	3.310	3.016
Taichung	3.607	3.573	3.665	3.966	4.077	4.252	4.201	4.182
Taoyuan	4.678	4.834	4.843	5.325	5.381	5.635	5.648	5.566
New Taipei	4.062	4.575	4.522	4.785	4.889	5.232	5.322	5.231
Hsinchu	5.359	5.246	5.714	5.957	6.453	6.521	6.299	6.302
Hsinchu County	3.721	3.724	3.641	3.642	3.628	3.584	3.737	3.632
Yunlin County	2.760	2.698	2.873	3.113	3.252	3.234	2.740	2.269
Changhua	2.960	2.977	3.062	3.223	3.347	3.354	2.995	2.325

4 Conclusions

By calculating the comprehensive index of trade facilitation, it shows that the overall level of trade facilitation in the region where Taiwan semiconductor export enterprises are located is significantly higher in the north than in the south. Among them, Taipei City, Hsinchu City, Taoyuan City, and New Taipei City have a high level of trade facilitation in all counties and cities in Taiwan. The level of trade facilitation in Tainan City has a downward trend, and Kaohsiung City has generally remained stable. The level of trade facilitation in Miaoli County, Taichung City and New Taipei City increased rapidly from 2013 to 2020.Except for Hsinchu City and Taipei City, the level of trade facilitation in most counties and cities showed a downward trend from 2019 to 2020. The score of Taiwan's trade facilitation is shown in Fig. 1.

For further analysis in the future, this paper believes that it can further supplement data sources and improve the measurement of trade facilitation level in various regions of Taiwan. Li(2021) [8] measured the trade facilitation level of provinces in mainland China and analyzed its impact on the competitiveness of enterprises. Zhao(2022) [25] estimated the level of trade facilitation in 281 prefecture-level and above cities in mainland China, and examined the impact and mechanism of trade facilitation on domestic and international patent applications of Chinese mainland enterprises. In the future, we can empirically analyze the impact of trade facilitation in various regions of Taiwan on the trade volume of semiconductor companies and decompose the trade costs faced by Taiwan companies. We can also explore the impact of trade facilitation levels of Taiwan's counties and cities on the innovation ability and supply chain efficiency of semiconductor enterprises.
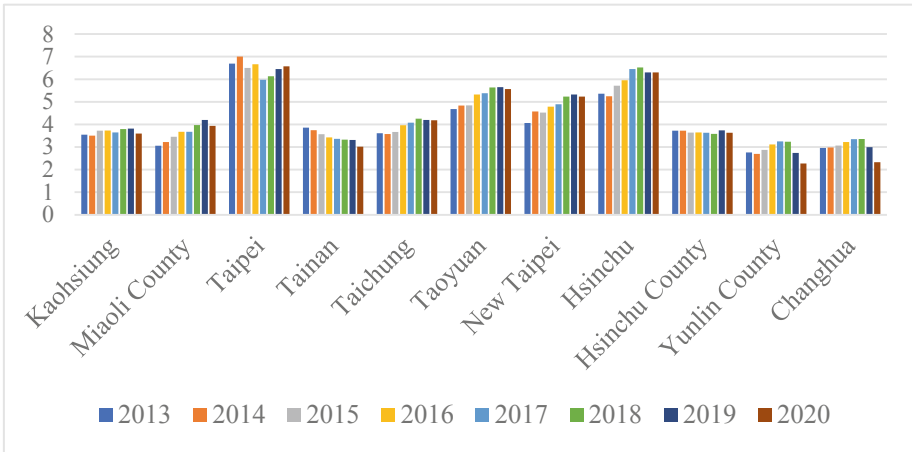
Fig. 1. Trade facilitation score chart (made by the author)

References

1. Bhatti, O. K., & Hanjra, A. R. (2019). Development prioritization through analytical hierarchy process (AHP)-decision making for port selection on the one belt one road. *Journal of Chinese Economic and Foreign Trade Studies*, *12*(3), 121–150.
2. Cheng Kai & Yang Fengmin. (2020). Trade Facilitation and Quality Upgrading of Chinese Enterprises' Imported Intermediate Products. *Economic Review*, *5*, 82–97. https://doi.org/10.19361/j.er.2020.03.12
3. Cheng, M. C., Wang, D., & Wang, J. J. (2018). A port-based evaluation framework of trade facilitation policies: Case of Shenzhen and Hong Kong. *Case Studies on Transport Policy*, *6*(2), 297–307.
4. de Sá Porto, P. C., Canuto, O., & Morini, C. (2015). *The Impacts of Trade Facilitation Measures on International Trade Flows*. The World Bank. https://doi.org/10.1596/1813-9450-7367
5. DUAN, W., & JING, G. (2021). Trade Facilitation, Global Value Chains Embedding and Efficiency of Enterprise Supply Chains-Based on the Perspective of Export Enterprise Inventory. *China Industrial Economics*, *02*, 117–135. https://doi.org/10.19581/j.cnki.ciejournal.2021.02.022
6. Ganbaatar, B., Huang, J., Shuai, C., Nawaz, A., & Ali, M. (2021). Empirical analysis of factors affecting the bilateral trade between Mongolia and China. *Sustainability*, *13*(7), 4051.
7. Grainger, A. (2011). Trade facilitation: A conceptual review. *Journal of World Trade*, *45*(1).
8. Li X., & Li N. (2021). The Impact of Trade Facilitation on Enterprise Competitiveness and Spatial Effect. *International Economics and Trade Research*, *37*(10), 22–37. https://doi.org/10.13687/j.cnki.gjjmts.2021.10.002
9. LIU, B., WU, P., & LIU, Y. (2010). Transportation Infrastructure and the Increase in TFP in China-Spatial Econometric Analysis on Provincial Panel Data. *China Industrial Economics*, *3*, 54–64. https://doi.org/10.19581/j.cnki.ciejournal.2010.03.005
10. Mann, C. L. (2008). Trade Facilitation Benchmarks and Priorities for Action: A Product-Specific and Supply-Chain Focused Tool. *Economics Department Working Paper, Brandeis University, Waltham, MA.*

11. Mann, C. L. (2012). Supply Chain Logistics, Trade Facilitation and International Trade: A Macroeconomic Policy View. *Journal of Supply Chain Management*, *48*(3), 7–14. https://doi.org/10.1111/j.1745-493X.2012.03270.x

12. Moïsé, E., Orliac, T., & Minor, P. (2011). *Trade facilitation indicators: The impact on trade costs*.

13. Mönch, L., Fowler, J. W., & Mason, S. J. (2013). *Production Planning and Control for Semiconductor Wafer Fabrication Facilities* (Vol. 52). Springer New York. https://doi.org/10.1007/978-1-4614-4472-5

14. People's Daily Thinktank. (2019). Evaluation Report on Trade Facilitation of the Six Economic Corridors under the Belt and Road Initiative. *Frontiers*, *19*, 64–91. https://doi.org/10.16619/j.cnki.rmltxsqy.2019.19.009

15. RUDJANAKANOKNAD, J., SUKSIRIVORABOOT, W., & SUKDANONT, S. (2013). Development of Trade Facilitation Indices to Compare International Ports in Thailand. *Journal of the Eastern Asia Society for Transportation Studies*, *10*, 66–80.

16. Sakyi, D., Bonuedi, I., & Opoku, E. E. O. (2018). Trade facilitation and social welfare in Africa. *Journal of African Trade*, *5*(1–2), 35–53.

17. Shan, F., Gu, Q., Qian, S., Ping, C., & Wang, R. (2020). Research on Trade Facilitation Performance Evaluation of China's Cross-Border E-Commerce Comprehensive Demonstration Cities Based on Entropy Right-Gray Correlation: From Research on Thirteen Cross-Border E-Commerce Cities. *International Conference on Education, Economics and Information Management (ICEEIM 2019)*, 208–213.

18. Shepherd, B., & Wilson, J. S. (2009). Trade facilitation in ASEAN member countries: Measuring progress and assessing priorities. *Journal of Asian Economics*, *20*(4), 367–383.

19. Tang, R. (2021). Does trade facilitation promote the efficiency of inbound tourism?—The empirical test based on Japan. *International Journal of Tourism Research*, *23*(1), 39–55. https://doi.org/10.1002/jtr.2390

20. Tavengerwei, R. (2018). Using trade facilitation to assist MSMEs in E-commerce in developing countries. *Journal of International Economic Law*, *21*(2), 349–378.

21. Wilson, J. S., Mann, C. L., & Otsuki, T. (2003). Trade Facilitation and Economic Development: A New Approach to Quantifying the Impact. *The World Bank Economic Review*, *17*(3), 367–389. https://doi.org/10.1093/wber/lhg027

22. Wilson, J. S., Mann, C. L., & Otsuki, T. (2005). Assessing the benefits of trade facilitation: A global perspective. *World Economy*, *28*(6), 841–871.

23. Wilson, J. S., Mann, C., Woo, Y. P., Assanie, N., & Choi, I. (2002). Trade facilitation: A development perspective in the Asia Pacific Region. *APEC Committee on Trade and Investment*.

24. Yamazawa, I., & Urata, S. (2003). Trade and investment liberalisation and facilitation. In *Asia Pacific Economic Cooperation (APEC)* (pp. 71–109). Routledge.

25. Zhao Z., & Li Z. (2022). Trade Facilitation and Chinese Enterprise Innovation: From Domestic R & D to Patenting Abroad. *Economic Review*, *3*, 3–21. https://doi.org/10.19361/j.er.2022.03.01