

Assessing the economic effects of Hainan's free trade port policy using the HCW method

Haochuan Yu

Public Service and Public Policy, Hainan University/ Arizona State University, 570228 Haikou, China

Abstract. Hainan's Free Trade Port (FTP) policy is a major initiative to promote the opening up and development of China's southernmost province. The policy aims to create a world-class business environment and a high-level market system by 2035. However, the economic effects of this policy are not well understood. This paper applies the HCW method, a panel data approach for program evaluation, to assess the impact of Hainan's FTP policy on four key indicators: trade, investment, talent and tax burden. The paper constructs optimal control groups for each indicator using the HCW and compares the actual outcomes of Hainan with the counterfactual outcomes that would have occurred in the absence of the policy intervention. The paper finds that Hainan's FTP policy has increased its foreign trade and foreign direct investment significantly, but has not achieved noticeable improvements in attracting high-quality talent. The paper also conducts placebo tests to check the robustness and significance of the results and discusses some policy implications and future research directions based on the findings.

1 Introduction

Hainan's Free Trade Port (FTP) is China's newest, largest, and highest-level Free Trade Zone (FTZ), and its construction is very important for promoting China's reform, opening up, and internationalisation: China is striving to develop Hainan Island into one of the world's leading FTPs [1]. With greater autonomy to encourage more open markets, Hainan's FTP will compete with world-class free trade centres such as Singapore and Hong Kong. With its attractive tax policies and regulations that promote business, many companies are looking to Hainan with wonder and expectation. However, Hainan is currently in the preparatory stage of customs clearance; there are few quantitative studies on the effects of Hainan's FTZ policy, and this paper attempts to make an effort by evaluating the growth effect of Hainan's FTZ policy on foreign investment and foreign trade using the HCW methodology.

The content of this HCW method study is structured

as follows: the first part of content is the introduction of FTZ, which illustrate the FTZ background and purpose of the study; the second part is the literature review of FTZ research, which reviews the relevant theoretical and empirical studies and points out the innovation of this paper; the third part is the theoretical analysis, which describes the possible mechanisms and paths of the growth effect of Hainan's FTZ policy on foreign investment and foreign trade; the fourth part is the research methodology, which introduces the principle and steps of the HCW method, and explains the data sources and variable selection; the fifth part is the empirical analysis, which applies the HCW method to quantitatively assess the effects of Hainan's FTZ policy and conducts robustness tests; the sixth part is conclusion part, which summarises main findings and revelations of the study, and also define the drawback and provide future research directions.

2 Literature review

For the research on the economic effect of recent FTZ policy in China, there are mainly the following methods: first, difference-in-difference (DID) method, which estimates the policy effect by comparing the changes of chose experimental group and chose control group after and before the implementation of a fixed policy. Research following this method includes Deng Juan and Wang Jin [2, 3]; second, synthetic control methods (SCM), a quasi-natural experiment synthetic control method. research following this method include Liang Shuanglu et al. and Jiang Yufan et al. [4, 5]. HCW estimates counterfactual outputs by exploiting cross-sectional individual dependence characteristics, and this method is less frequently used, e.g., Rao Janni et al. and Cai Jun et al. [6, 7]. The HCW method is not only more flexible in the selection of samples, but also can better control for unobservable confounding factors. In terms of research objects, the earlier established FTZs such as Shanghai FTZ are the most important research objects, and part of the literature is unified for the newer FTZs according to time or geography. There is little literature on the quantitative study of the effect of single newer FTZs, especially the lack of research on Hainan FTZs. In summary, this paper attempts to quantitatively assess the growth effect of Hainan's free trade port policy on FTZs by using the HCW method to fill the unresearched topic, enrich the research methodology, and improve the research quality.

3 Theoretical analysis

The research questions of this paper are: what are the impacts of Hainan's FTZ policy on trade, investment, talent and tax burden in Hainan? Are these impacts positive or negative? How big are these impacts? In order to answer this question, this paper divides the growth indicators of foreign investment and trade into two main categories: investment and trade are the indicators of direct statistics, which measure the growth benefits of Hainan's FTZ policy on foreign investment and trade; talent and tax are the indicators of the business environment, which measure the basis that Hainan's FTZ policy has provided for the development of foreign investment and trade. According to the findings of other

research, this study forecast the possible impact of the Hainan FTZ [2, 5, 6, 8]. This paper, assumes that Hainan's FTZ policy has a positive impact on Hainan's foreign investment and foreign trade. Therefore, trade, investment and talent in Hainan are positively affected and tax burden is negatively affected.

This paper chooses the 'International Trade in Goods by Region' by location of importers/exporters as an indicator to measure the effect of trade growth, because it can directly reflect the improvement of the degree of openness and facilitation of trade in goods and services by the Hainan FTZ policy. According to Hainan's FTZ policy, Hainan will implement measures such as zero tariffs and relaxation of access in order to promote trade between Hainan and the international market. This paper expects that these measures will reduce transaction costs and barriers between Hainan and external markets, thereby increasing the volume of Hainan's import and export trade.

This paper chooses 'Registration Status of Foreign Invested Enterprises by Region at Year-end' by total investment as an indicator to measure the effect of investment growth because it can directly reflect the facilitation and incentivisation of foreign businessmen's access to and operation in the Hainan market under the Hainan FTZ policy. According to the Hainan FTZ policy, Hainan will implement a ban-or-go market access mechanism, including education, telecoms, advanced manufacturing, mining and business services industries that can be invested by foreign investors. It will also implement minimal approval and separation of permits and licences to reduce the resistance to foreign investment. This paper expects that these measures will create an open, transparent and predictable investment environment, which will enhance foreign investors' willingness to invest.

This paper sums the statistics number of college students, undergraduates and postgraduates together in 'Population Aged 6 and Over by Gender, Educational Attainment and Region' as a measure of the talent growth effect because it can reflect the attraction and retention power of Hainan's FTZ policy on highly skilled talents. According to the Hainan FTZ policy, Hainan will attract more talents to come to Hainan to look for work opportunities through the talent introduction policy. This will provide sufficient high-quality labor for foreign

capital to move in and build Hainan's talent advantage. Therefore, this paper expects the policy will have some effect of achieving talent introduced.

This paper chooses the 'Gross Regional Product' to divide 'General Public Budget Revenue by Region' by tax revenue as a measure of the tax burden effect, as it can reflect the extent to which Hainan's FTZ policy reduces the tax pressure on enterprises and individuals. According to the Hainan FTZ policy, Hainan will simplify the tax system with the introduction of various tariff preferences. Both corporate income tax and personal income tax will be reduced to lower the overall tax burden and attract more enterprises and talents. Therefore, this paper expects the policy to have a negative effect on tax burden.

4 Method

The policy evaluation method used in this paper, the HCW method, is a panel data approach to program evaluation, also known as the regression control method (RCM method) [9]. The method is to predict the counterfactual state of the experimental group in the absence of policy intervention by constructing an optimal control group. The policy effect is then estimated by comparing the difference between the actual and counterfactual states of the experimental group after the policy is implemented.

The advantages of this method are that there is no need to identify or measure common influences in the system, only the values of specific variables; there is no need to satisfy assumptions such as random assignment or parallel trends, only that the control group and the experimental group have the same development trend before the policy is implemented; and there is no need to use a complex model or methodology, but only a simple linear regression or least squares method.

This paper argues that the HCW method is suitable for the research question and data of this paper, because the research question of this paper is to assess the growth effect of Hainan's FTZ policy on foreign investment and foreign trade, rather than to explore its intrinsic causal mechanism or influence path; the data of this paper is panel data, which contains the economic indicators of Hainan and other provinces and regions in different years, which can be used to construct the optimal control group and to predict the counterfactual state.

Suppose this paper wants to assess the Hainan's FTZ

policy on the four variables. According to the principle that "the selected control group areas and the experimental group areas should not have the same events occurring during the examination period", Hainan is taken as the experimental group [10]. Excluding sixteen newly established FTZs in 2017 or 2019, such as Hubei and Shandong, the remaining fourteen Chinese mainland provinces or municipalities served as the control group. Since Hainan established the policy in October 2018, this paper assumes that the policy starts to be implemented in 2019, so 2011-2018 is the pre-policy impact period and 2019-2021 is the post-policy impact period. The data for all the above variables are obtained from China Statistical Yearbook and Regional Statistical Yearbook.

This paper uses y to denote the value of the variable and i and j to denote the experimental and control group areas, respectively. Time is by t . T_0 represents the time of policy implementation, $t=1, \dots, T_0, T_0+1, \dots, T$. $t \in (1, \dots, T_0)$ is pre-treatment period in this research. $t \in (T_0+1, \dots, T)$ is post-treatment period in this research. For the development of a region's economic indicator z , it can be expressed in the following equation.

$$y_{izt}=a_{iz}+b_i*f_{zt}+\varepsilon, i=1, \dots, n; t=1, \dots, T \quad (1)$$

Where a_{iz} represents the fixed effect of the z -indicator for region i at time t , f_{zt} represents the vector of time-varying common factors, b_i represents the k -dimensional vector of region-varying coefficients, and ε is the random perturbation term. Since both region i in the experimental group and region j in the non-established experimental group are affected by the macroeconomic common factor, there is commonality in f_{zt} . So when measuring the economic indicators of the experimental group, it is not necessary to determine the specific value of f_{zt} . Instead, predictions can be made by assessing the variables of the control group. From this, this paper can establish the hypothesis to speculate the y_{izt}' of the indicator in region z when no policy is implemented in region i at $t \geq T_0+1$ if the policy has never been implemented. Δy is the treatment effect of the policy.

$$\Delta y=y_{izt}-y_{izt}' \quad (2)$$

The key to accurately assessing the effect of the establishment of the FTZ lies in scientifically selecting an appropriate control group to predict it. In this paper, the

HCW method is implemented based on the Stata module proposed by Yan et al. [11].

Rcm 'variable z', trunit ('experimental group') trperiod (2019) ctrlunit ('control group') postperiod (2019/2021) method(lasso) criterion(cv) fold (7).

'Variable z', 'experimental group', and 'control group' are all labels, representing indicator z, region i, and region j. 2018 is used as the time of policy implementation T_0 . The suboptimal model is generated through the more accurate Lasso method, the optimal model is generated through cross-validation (instead of the information criterion, e.g. AICC or AIC), and specifies cross-validation with 7 folds. This module allows us to obtain the combination and weights of the optimal control group, as well as estimates of the policy effect and the treatment effect.

5 Empirical analysis

In this paper, regression analyses are conducted on four indicators of the Hainan FTZ. In order to clearly explore the time-varying trend of the policy effects of policy shocks on each economic indicator, this paper shows the fluctuation trends of the actual and predicted counterfactual values of economic indicators in the post-shock time period in Figures 1-4. The location of the vertical line represents the year 2018, when the FTZ was established, and the distance between the "actual" line and the "predicted" line on the left side of the vertical line reflects the degree of fit of the optimal control group series to the experimental group. The smaller the distance, the better the fit. The distance between the "actual" line and the "predicted" line on the right side of the vertical line reflects the policy effect of the FTZ. The size of the policy effect in each period is the distance between the actual value and the predicted value of the corresponding period in the vertical direction on the horizontal coordinate scale axis. The larger the distance between the two, the larger the policy effect is likely to be in the experimental group.

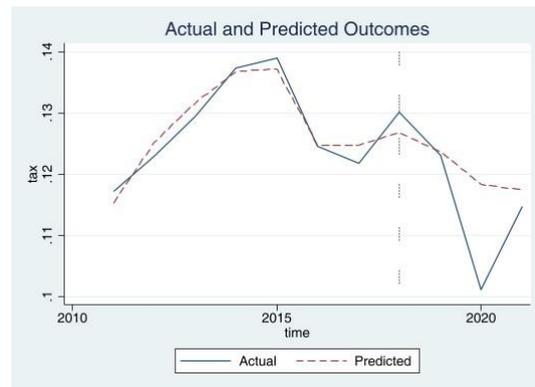


Fig. 1. Counterfactual and actual tax burden.

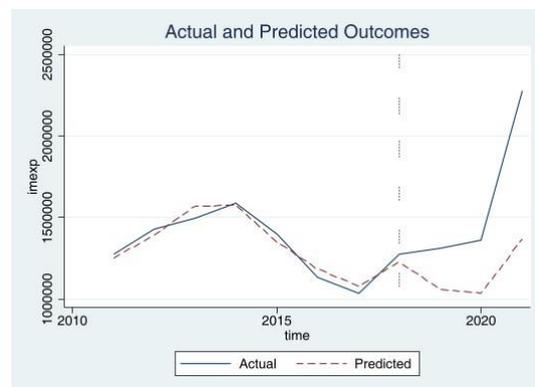


Fig. 2. Counterfactual and actual international trade.

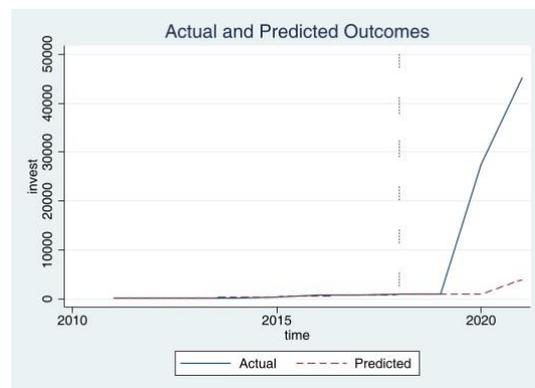


Fig. 3. Counterfactual and actual total foreign investment.

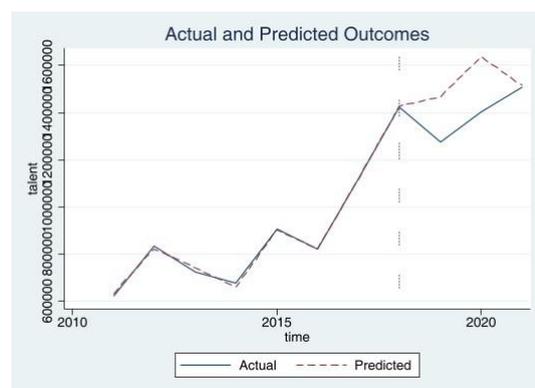


Fig. 4. Counterfactual and actual highly educated talent.

Table 1 shows the optimal control groups series and corresponding weights for the four selected economic indicators for Hainan. The optimal control groups for the national income burden rate are 9, 13, and 14, with an R^2 of 0.91017; the optimal control groups for the import and export trade volume are 2, 8, 13, and 18, with an R^2 of 0.93258; the optimal control group for the total amount of foreign investment is 18, with an R^2 of 0.92173; and the optimal control groups for the number of talents are 1, 4, 8, 13, 19, and 20, with an R^2 of 0.99794.

Table 1. Optimal control groups and treatment effect for each variable.

	tax	imexp	invest	talent
1Fujian				-0.0409
2Gansu		0.42		
4Guizhou				-0.246
8Jilin		0.1196		-0.048
9Jiangxi	0.7449			
13Qinghai	0.1986	0.9931		1.8531
14Shanxi	0.2315			
18Tianjin		0.0647	0.4116	
19Xizang				2.2052
20Xinjiang				0.1509
R^2	0.91017	0.93258	0.92173	0.99794
Mean predicted	0.1198	1154687	1975.035	1539895
Mean treatment	-0.0068	494965.2	22614.02	-144745
E	-5.68%	42.87%	1144.99%	-9.40%

After the establishment of the FTZ, the actual value of the national income burden rate is always less than or equal to the counterfactual value. This proves that the Hainan FTZ policy has reduced the tax burden of Hainan enterprises and individuals, and the average policy effect (E-statistic value) is -5.68%, which is in line with the expectation. The actual value of total international trade has been greater than its counterfactual value, which indicates that Hainan's FTZ policy has continued to promote the growth of foreign investment at the current stage, with an average policy effect of 42.87%, which is in line with expectations. The actual value of total foreign investment is much larger than its counterfactual value, with an average policy effect of 1144.99%, much higher than expected. The actual value of the number of highly educated talents is smaller than its counterfactual value, and the average policy effect is -9.40%, which is lower than expected.

The above four R^2 indicate that the combination of optimal control groups chosen in this paper is a good approximation of the changes in the economic indicators of the experimental group. Considering that there may be some chance factors that make the results of each period inaccurate when analysing it specifically. Therefore, in this paper, the percentage ratio of the average treatment effect to the average counterfactual value is used as the E to judge the percentage of the FTZ's benefit on the economic variables.

Based on the Stata module to implement HCW method proposed by Yan et al [11], the authors conducted a P-value test and tested it by changing the time of the policy (assuming that the policy was implemented in 2018) and fictitious treatment group (assuming the randomised control group to be the experimental group), respectively. This tests the significance of the experimental results against the endogeneity of region and time:

Rcm 'variable z', trunit ('experimental group') tperiod (2019) ctrlunit ('control group') postperiod (2019/2021) method(lasso) criterion(cv) fold (7) placebo (unit period (2018)).

By calculating the P-value, the authors found that for the two variables of tax and talent, the P-value of the two-sided test is close to 1; for the two variables of imexp and invest, the P-value of the one-sided test is 1. This suggests that if the Hainan FTZ policy is implemented in other regions, the policy effects are likely to be different: the

effects on the tax and talent variables will randomly increase or decrease; the effects on the imexp and invest variables will decrease. This suggests that Hainan's FTZ policy was tailored to the local context, and that the FTZ policy played a greater role in stimulating the endogeneity in Hainan, resulting in much greater benefits for tax and invest.

Assuming the year of policy implementation as 2018-2021 through a time placebo, the authors find that the counterfactual value of talent produces a large change, while the size and trend of the counterfactual values of the remaining three variables are not significantly different. This suggests that there is a strong influence on the talent variable in the year 2018, making it different from the rest of the years. Since the policies were not implemented at the same time, the "One Million Talents Entering Hainan" programme has been in effect since May 2018, which resulted in Hainan achieving a large number of talent introductions in 2018. Due to data availability, it is not possible to use quarterly data for statistical purposes. Therefore, it is not possible to accurately calculate the impact of the policy in Q3, Q4 2018. Meanwhile, the Yearbook uses a sampling method to count the number of talents with different academic qualifications. Depending on the sampling method in different regions and years, the statistical results may vary.

6 Conclusion

The main objective of this study is to use the HCW methodology to assess the economic effects of the Hainan FTZ policy on trade, investment, talent and tax revenues during the preparatory phase of island-wide closure. The results show that the policy has had a positive impact on trade and investment. First, the policy creates more opportunities and incentives for foreign trade and investment in Hainan by reducing tariffs, simplifying the tax system, lowering tax rates and improving the legal framework. These measures have lowered the costs and thresholds for foreign enterprises and investors to enter the Hainan market, enhancing Hainan's competitiveness and attractiveness as a global free trade hub. Secondly, the policy opens up key areas of focus for foreign investment, such as advanced manufacturing, business services, education, and value-added telecommunications, through a ban-or-go market access mechanism, giving foreign

investors the opportunity to enter key areas of focus. These measures have broken down the existing industry monopolies and protection barriers, and stimulated the vitality and innovation of Hainan's market.

However, the effect of the FTZ policy on Hainan's talent growth has not been significant or has even declined. This may be related to Hainan's lack of educational resources, infrastructure and social welfare, which makes it difficult to retain or attract more talented people. Therefore, Hainan needs to strengthen its investment in education, enhance its infrastructure, and improve its social security system in order to increase talent satisfaction and loyalty. Second, the tax burden effect of the policy is also unsatisfactory or even increased. This may be related to the fact that COVID-19 has led to increased public expenditure and reduced tax revenues; or it may be related to the fact that Hainan's FTZ policy has not reduced the tax pressure on enterprises and individuals to a sufficient degree. Therefore, Hainan needs to balance the relationship between tax incentives and fiscal sustainability in order to ensure the stability of economic and the decline of tax burden.

This study also has some limitations. First, cross-sectional design is used in this study, which may limit ability to infer causality or directionality of impacts. Longitudinal or experimental studies are needed to determine the temporal sequence and causal mechanism of the relationship between policies and economic outcomes. Second, the study only relies on data from the China Statistical Yearbook and regional statistical yearbooks, which may contain some inconsistencies or inaccuracies, and lacks quarterly and monthly data. Comprehensive data sources are needed to validate and supplement the findings. Third, the study used 14 provinces and districts as control units for the convenience sample and assumed that the policy started in 2019. Some of variables and were not able to effectively fit the development of the variables and all passed the test of 1% significance. Future studies should use larger sample sizes with more post-treatment periods to address data availability issues.

These findings have important implications for both researchers, policy makers and entrepreneurs. For researchers, this study contributes to the growing literature on the quantitative assessment of China's FTZ

policies and provides some evidence of the applicability and validity of the HCW methodology for causal inference in time-series cross-sectional data. For policy makers or entrepreneurs, this study focuses on some of the policy impacts in Hainan during the preparatory phase of island closure and customs clearance. Research at this stage has revealed that Hainan's FTZ policy has both benefits and costs for Hainan's economic development. There is a need to focus more on how to achieve trade-offs between economy and culture, efficiency and equity, and short-term gains and long-term goals in the future construction of the FTZ.

Reference

1. China Daily.
<http://www.chinadaily.com.cn/china/2018lookathnzone/index.html>.
2. J. Deng, *Huazhong Uni Sci Tech*, (2018)
3. J. Wang, *J Development Eco* **101**, 1 (2013)
4. S. Liang, L. Liu, Q. Cui, *Contemp Eco Manag* **42**, 8 (2020)
5. Y. Jiang, H. Wang, Z. Liu, *Energy Poli* **148**, (2021)
6. J. Rao, *Huazhong Uni Sci Tech*, (2020)
7. J. Cai, K. Xin, Y. Zhou, *J Manag Sci Engin* **6**, 3 (2021)
8. T. Bao, Y. Dai, Y. Feng, S. Liu, & R. Wang, *World Eco* **46**, 5 (2023)
9. C. Hsiao, H. Ching, S. Wan, *J Appl Eco* **27**, 5 (2012)
10. A. Abadie, A. Diamond, J. Hainmueller, *JASA* **105**, 490 (2010)
11. G. Yan, Q. Chen, *Stata J* **22**, (2022)