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RESEARCH ARTICLE

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REVIEW

Front Manage Bus, 2022, 4(1): 252-262
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RESEARCH ARTICLE

Black carbon and other pollutants from brickfields country-wise: Impact assessment and policy guidance under welfare analysis

Akim M. Rahman[1,2]

[1] Ahsanullah University of Science and Technology, Dhaka, Bangladesh
[2] Social & Economic Research Institute (SERI), The Ohio State University, Columbus, Ohio, USA

Correspondence to: Akim M. Rahman, Ahsanullah University of Science and Technology, Dhaka, Bangladesh; E-mail: rahman.19@osu.edu;

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Abstract: The brick industry in developing world is a vast, coal burning and polluting industry. Nearly 1,500 billion bricks are produced globally each year where 87% are from Asia. China dominates the world in producing bricks using coal combustion and woods as fuels where Australia placed the last. Bangladesh placed the 5th in the world, and it mostly uses woods as fuels. These industries are owned privately. It is a type of industry that is mostly driven with business mentality without emphasizing the hygiene and health aspects where government laws are barely active in practices where rapid urbanization has been increasing demand of bricks. But, in most cases, this industry uses inefficient and dirty technology that causes environmental externalities. Brick-kilns inject huge volume of effluent gases. It causes depletion of atmospheric O_2 level. Addressing the issue for policy guidance, this study first analyzes the consequences of these externalities in terms of marginal damage (MD) under neoclassical partial equilibrium demand & supply theory. It further analyzes the reasons of disparity between social-cost and private-cost by conventional marginal damage analysis. Findings show that due to gases emission from brickfields, the marginal social-costs are higher than marginal private-cost. In this economic *dilemma*, brick-kilns are benefiting with the expense of human-society country-wise. As it has been going on, the rises of brick-prices have been causing upward trends of welfare losses where producer surplus is dominating the total surplus. This consequential economic situation has been causing higher deadweight loss year after year. The reason is that the bricks-customers distribute this expenditure away from now more expensive bricks. Now there is an urgency for national policy actions for ensuring cleaner & sustainable brick production. On this aspect, reforestation efforts can be achieved in multi-faucets including brickfields' charity and govt. policies on planting trees and for motivational efforts inspiring citizens of this country. These motivational efforts can be in multi-faucets: (a) inspiring "birthday celebration by planting trees", (b) forcing to use green Tech in brick kilns and (c) conducting research in both phases of govt. and academicians where financial supports can be inspirational.

Keywords: brick kilns, effluent gases emission, social costs, government policies

1 Introduction

The brick industry in developing world is a vast, coal burning and polluting industry. It is almost entirely lacking automation. Nearly 1,500 billion bricks are produced globally each year where almost 1,300 billion bricks (or 87%) are from Asia [1]. Here rapid growth of urbanization with an average rate of 6 percent has been driving the increasing demand for brick where solid and fired clay bricks are among the most widely used building materials [1]. In this progression, brick-usages are widespread practices in South Asian Countries. It requires a large scale of brick production meeting the demand in this part of the world. Bangladesh, a Southeast Asian country, is the second highest brick producer after India. It has been contributing over one percent of the country's GDP [2] and generating employment for about two million people even though vast majority of these kilns that use outdated technologies.

The labor-intensive exercise of hand molding clay into bricks (Hand-made bricks), is the predominant way of shaping green bricks in developing countries. In contrast, bricks in the developed world are machine-made, fired in highly automated electricity-dependent tunnel kilns using a skilled labor force, which causes low level of pollution. The brick sector in developing countries is generally labor intensive and non-mechanized. This traditional brick-making process in countries such as Bangladesh causes high-level of pollution, and it injects gases into atmosphere. Particularly, the process of burning wood & coal in brick-kilns produces elevated level of SO_2, NO_x, CO_2, CO and CH_4 gases. Thus, brickfields emit them into atmosphere, which depletes atmospheric level of O_2. In last past 10 years, the percentage of CO_2 emission level from brickfields was 82.784 [3].

Addressing the issue for policy guidance, this study first analyzes the impact of effluent gases emitted from brickfields in terms of marginal damage (MD) under the neoclassical partial equilibrium demand & supply theory [4–7]. Besides this, it analyzes the reasons of the disparity between social-cost and private-cost using conventional marginal damage analysis [5, 8, 9]. So, this study expects that the findings serve as a guidance for effective policy-design in Bangladesh and beyond addressing the issue.

1.1 Problem statement based on the reality

Among other gases, CO_2 is a sizable part of effluent gases injected into atmosphere from the brickfields. It is one of a major contributors of greenhouse gas (GHG) emission into atmosphere. Studies found that CO_2 emission plays a critical role in accelerating global warming trends [10]. Furthermore, the Model of Global Warming suggests that an increase in emission level leads to an increasing oceanic vaporization, which results a warming cycle [10]. (see Figure 1)

Source: Daily Sun, 20/01/19 and Rahman, 2022e

Figure 1 Brickfields at a glance.

Here in Bangladesh, the major source of effluent gases emission is wood and coal combustion that are used in multi-faucets [11] in peoples' daily lifestyle. The current study has chosen only brickfield as a source of affluent gases emissions in Bangladesh.

This traditional brick making is held to manage a host of accompanying perils. There is no doubt that besides affecting the environment, the process used in brick making is one that adversely affects the ecosystem in Bangladesh. It also damages more, which leaves a harmful impact on livelihood and in cultivation process in the globe. This is particularly so when it comes traditional brick making practices here. Bangladesh stands as the fourth largest brick producer in the world. Brick-kiln industry accounts for approximately 1% of the country's GDP. Bangladesh currently has a population of 160 million and at current growth rate, Bangladesh will require constructing approximate four million new houses annually to meet the demands of the growing population. It will lead the growth for the brick sector as years ahead. Table 1 supplies a snapshot of brick sector as of May 2020 in country-wise [1].

Table 1 Brick production in world

Country	Production %	Billion
China	66.67	1000
India	13.33	200
Pakistan	3.0	45
Vietnam	1.67	25
Bangladesh	1.13	17
Nepal	0.40	6
Rest of Asia	0.47	7
Total Asia	86.67	1300
USA	0.53	8
UK	0.37	4
Australia	0.13	2
Rest of world	12.40	186
Total rest of world includes Latin America	13.33	200
Global Prod.	100	1500

Source: Hablakilns.com, 2020

Table 1 shows that China dominates the world in producing bricks using coal combustion and woods as fuels where Australia placed the last [1]. When it comes brick production Bangladesh placed the 5^{th} in the world and it mostly uses woods and coal as fuels. Since there are many unregistered brick-kilns mainly located in rural areas [9], these kilns are out of regulation. It

mostly uses wood as fuel, which causes huge effluent gases including SO_2, NO_x, CO_2, CO and CH_4 gases and produced black smoke. This study uses Bangladesh *scenario* as a case study for impact assessment and policy guidance.

As Department of Environment (DoE), Government of Bangladesh reported, in year 2020, there were total 7000 kilns in Bangladesh, which had produced 23 billion of bricks annually where the value of the output was $ 2.53 billion and total coal consumption was 5.7 million tons. These brickfields injected 16 million tons of CO_2 into atmosphere [9]. Because the brick-industry has been using inefficient, dirty technology and informal seasonal employment methods for extended period, it has created a huge environmental problem [2, 6]. This ongoing dilemma has been affecting on human health, agricultural yields, and causing global warming. To undermine the level of emission, authorities concerned put the blame on brick-field-owners for being unable to efficiently prevent the kilns from emitting black smoke.

It is obvious that because of the existence laws, which is weak in practice, little over 12,000 brickfields across the country are running in conventional methods [2]. All these brick kilns are using wood and coal to burn bricks, damaging arable land by cutting earth and polluting the air by emission, while other brickfields have been running just without approval of Dept of Environment (DoE) under the Ministry of Environment and Forest, Bangladesh.

However, the DoE headquarters do not have specific data on the number of brickfields currently running in the country and the extent of pollution – the volume of emitted smoke and impact of its contents on human, and crops, vegetation, and land. But a World Bank study released last year found that in the North Dhaka cluster, brick kilns are the city's main source of fine particulate pollution, accounting for approximately 50 percent of total emissions during the 5-month operating period. The environmental regulator says the harmful brick-kilns running around Dhaka city and other places across the country had been set up after securing approvals through muscle power.

Global survey conducted recently shows that Bangladesh ranked 131st among 132 countries in controlling air pollution about its effect on human health. India holds the very last position (Financial Express, October 18 of 2020).

1.2 Environmental compliance and enforcement in Bangladesh

The Environment Conservation Act, 1995 (ECA 1995) of Bangladesh and Environment Conservation Rules, 1997 (ECR 1997) guide the Environmental Regulatory Regime to set up environmental administration in Bangladesh. It gives DOE a mandate for their enforcement. The DoE officials are often engaged in different activities to enforce the provisions of laws and rules as provided in the ECA, 1995 and ECR, 1997.

In practice, the DoE routinely conducts compliance monitoring of industries and development projects to ensure that they have been set up or undertaken after having Environmental Clearance Certificates (ECC) from the DoE as mandated by ECA 1995. The DoE also enforces environmental quality standards and management of those industrial-units and project as stipulated in the Environment Conservation Rules, 1997 and the conditions set out in the ECC.

Underpinning Section 7 of the Bangladesh Environment Conservation Act 1995, compensation is collected for the environmental damage caused by brick-kilns. Based on this regulatory provision, from June 2016 to June 2017 the DoE conducted enforcement drive against thirty-eight brickfields in which a total of Taka 120 million was assessed as compensation in which Taka 8.5 million was realized.

Besides this, enforcement activities are conducted against illegal brick-kilns under the Mobile Court Act, 2009 under which penalty is imposed instantly by taking cognizance of the offences. In last year, the mobile court fined a total of twenty-seven brick fields Taka 8.7 million for running the kilns without having ECC and Brick Manufacturing Licenses. While this effort was going on, a total of twenty-nine brick kilns set up without environmental clearance certificates were knocked down by the DoE. But several newspaper medias have reported that a considerable number of brick kilns are not registered (Financial Express, Dec 07, 2019; The Daily Star, Jan 04, 2020).

1.3 Objectives of the study

(1) To tip-off on how to bring the brickfield effluent gases issues to policymakers' attentions.

(2) To communicate on guidance for policy-design using Welfare Analysis in Bangladesh perspective.

2 Methodology

Methodologies that are used in this study are Marginal Damage Analysis and the Standard Partial Equilibrium Models. This study assumes as follows:

(1) Effluent gases emission is external and the effluent gases, *especially*, CO_2 concentrated environment or environment quality is priced like a regular public good;

(2) There are "n" number competitive markets for the emission free environment;

(3) For simplifying the analysis, both export and import of this good (bricks) are small or nonexistent;

(4) There exists rivalry among consumer preferences for having better environment;

(5) Exclusivity exists;

(6) The changes in emission level caused by changing the input level (wood or coal) and productivity and the change in demand for improved environmental quality (less pollution) by increasing income, population and lifestyle or preference over time are ignored. As empirically reported, the increases of population, income and lifestyle preferences increased the supply and demand for having better quality of environment.

These assumptions ensure that the aggregate demand for improved environment can be viewed as a negatively sloped schedule of the demand for improved environment at various prices holding income and taste level are being constant. It further ensures that the aggregate supply curve could be drawn as a positive sloped function, holding other prices, cost, and technology unchanged. Given the assumptions, the 'n' demand functions of Bangladeshis for improved environment, are the function of n prices which are completely decided. Saying another way, Bangladesh can be considered as a single market for quality of the environment.

Consumer surplus (CS) concept is used to capture consumer welfare changes resulting from a price change in bricks. Here the Marshallian demand curve is used to approximate change although the Hicksian demand curve would be theoretically better. But the difference between Marshallian measurement and Hicksian measurement is not important if the following three conditions are satisfied [12, 13]:

(1) There is identical consumer when it comes clean air facilitation being a part of the society;

(2) In this one market, there is only one price change;

(3) Because the bricks are products of manufacturing, the income effect is small. If all these conditions are met, then the observed demand behavior can be used to construct a measure of welfare change.

In this study, the assumption of "n" identical consumers approximates Bangladeshis where the "traditional match up behavior" makes consumption patterns homogeneous [12, 13].

Thus, for a single price change, the percentage of *error* resulting from using CS in the order of CY/2M which is likely to be small (CY = consumer income, M= consumer's constant income.). So, in the static partial equilibrium model, the size of inefficiency of the efforts modernizing brick-kilns for the improved environment purchase and supply system can be measured by the deadweight loss [7].

3 Results

3.1 The problem of emission from brickfields

Reflecting the emission problem in Bangladesh from brickfields into our framework, the Fig 1 is drawn in such way that is problem. It is assumed that brickfield "A" produces Q_1 number bricks. The production of bricks generates input costs, which are costs for both producer and society. Furthermore, there is a set of costs attributable to pollution generated by this brickfield industry, which is borne by Bangladeshis and not by brickfield "A". This situation creates a divergence between private-cost and social-cost that are also shown in Figure 2.

In this assessment, the social cost includes added costs consisting of the damages generated by effluent gases emitted by the brickfield "A" while producing bricks. In Fig 1, Q_1 number of bricks is total production corresponding to condition of MPC = MPB where MPC = marginal private cost and MPB = marginal private benefit. This Q_1 is greater than socially optimal level of output Q^* corresponding to the MSC = MSB.

In this case, the excess cost (EC) = $(Q_1 - Q^*) * (P_2 - P_1)$ is the cost to Bangladeshis for having this higher level of output than optimal level. Considering all brickfields in Bangladesh, the total excess cost is EC_{BD} = n * $(Q_1 - Q^*) * (P_2 - P_1)$. This represents as the total damages, which is caused by pollution generated from n number of brickfields by degrading the environment in Bangladesh. In Figure 3, the area "e" is total damages in Bangladesh by the brickfields.

The total resource costs are examined in Figure 4. Here resource cost associated with Q_1 is the area OBQ_1. The area OP_1BQ_1 is the benefit gained by Bangladeshi society from having the resources used in 'n' brickfields in Bangladesh. The area OQ_1B is opportunity cost. Here, net value = area OBE, PS = P_1OB and CS = EP_1B. Considering Figure 2, Q^* pieces of bricks production guarantees Bangladeshis a pollution free environment but they will have to spend as a whole n * $(P_2 - P_1)$. The welfare loss for this higher cost is shown in Figure 5.

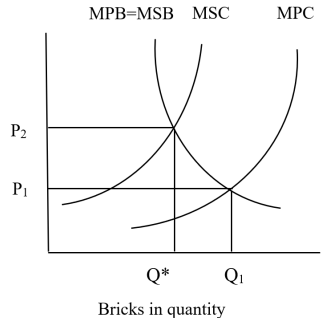

Figure 2 Market failure when Brickfields are not regulated in Bangladesh. MSC: Marginal social costs; MPC: Marginal private costs; MPB: Marginal private benefits; MSB: Marginal social benefits; Q^*: Bricks production with no emission; Q1: Bricks production and causing emission.

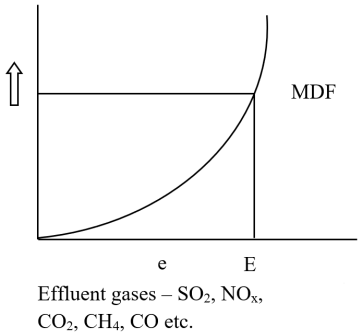

Figure 3 Effluent gases injected from brickfield in Bangladesh. MDF: Marginal damage function.

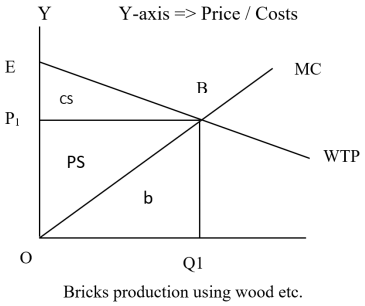

Figure 4 Resource cost for producing bricks. MCP: Marginal cost for the brick-kiln; WTP: Willingness to pay; CS: Consumer surplus; PS: Producer surplus; B: Resource cost or Opportunity cost.

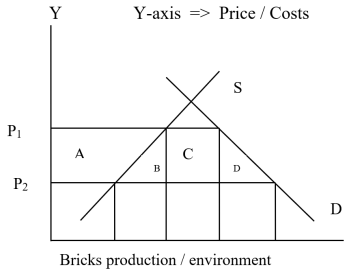

Figure 5 Welfare aspects of producing bricks with effluent gases emission. BS: Brick supply; BD: Brick demand.

In this *scenario*, the changes in price cause changes in CS. Price changes from P_1 to P_2 causes CS drops equal to the area (A+B+C+D). On the other hand, PS increases by the area A which directly goes to brickfields' owners. The area B is variable input cost. The area (C + D) is "deadweight" losses because consumers distribute this expenditure away from now more expensive Q_1 number of bricks usages. It can also be represented as Bangladeshi's real income loss for having a pollution free environment. It is noted here that the relative size of (C + D)

depends on the magnitudes of the induced price changes and the price elasticity of supply and demand.

3.2 Feasible options undermining emission-level from brickfields

The goal of this section is to look for probable options abating effluent gases namely CO_2, CO, NO_x, SO_2 and CH_4 emission from brickfields in Bangladesh. The emission of CO_2significantly dominates the Global Warming issues.

3.2.1 Reforestation or replantation

Replantation is an act of restoring indigenous forests to lands originally covered by forest. Studies found that replantation is one of the important options in reducing the level of CO_2 in the atmosphere because it significantly mitigates level of CO_2 emissions [14]. Planting trees can be used to control or sequester level of CO_2 in the atmosphere.

Hence, increasing the number of trees or plants and thus increasing the rate of photosynthesis may increase biological fixation of CO_2 level and other effluent gases emit from brickfields. Applying this reforestation idea into welfare analysis, which is shown in Figure 6, let us assume brick-kiln companies or government makes the tree planting decision setting MPC = MPB.

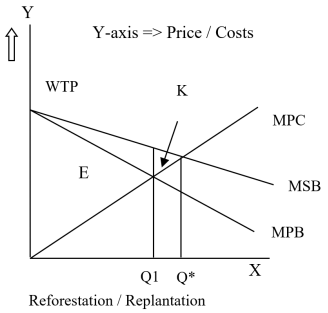

Figure 6 Welfare / Benefit from replantation

The corresponding market level of replantation is $Q_{1,}$ and optimal level is Q^* (for Bangladeshis) that are generated by reducing soil erosion, higher degree of better environment. The area "K" is Net Social Gains that are generated by planting trees. The following approaches can be recommended underpinning the findings of this study.

(1) If the industry takes part in planting, then it can pay the planting cost as a charity to the society where DoE will monitor the actuality in practice. Also, DoE can issue a Report Card and congratulate the industry issue a Certificate.

(2) If government takes part in planting, then government will collect these costs or taxes from the brickfield companies that manage emitting effluent gases in Bangladesh. In this case environmental clean- up or pollution prevention is a task for the government like any other public infrastructure (road, telecommunications etc.). This dual approach ratifies sharing the cost among Bangladeshis for ensuring a better environment, which can ensure a win-win results for all parties involved.

(3) Government can encourage people in different ages to celebrate individual birthday by planting a tree beside roads & highways and near train-lines with the approval of local assigned officer(s) under DoE. In this process, DoE can issue Celebration Certificate, which can be a win-win to all parties involved. This message can be communicated *via* schools, colleges, and universities for ensuring effective and continuous outcome. It can ensure a greater return for the efforts it may need for implementing the theme.

(4) Delivering motivational message should be strengthened that a forestation is a social and moral obligation for every citizen. It should begin with introducing the message in institutional education system. Also, it should be promoted on TV and Radio medias.

(5) Research on finding fast-growing species of trees, having better fuel and timber values should be strengthened keeping local climate and social condition in view. Also, research on discovering techniques for use the waste-product of sugarcane should be conducted. Besides the contribution of curtailing the magnitudes of emission level, it can be a win-win for the parties involved.

Government subsidies or company's charity as shown in Figure 7, the area (A+B+C+D+E) is consumer surplus where company pays area (A+E) as charity. Government subsidies are area (E+B+C+D+F), which is collected from Bangladeshis as taxes. Net loss to Bangladeshis is equal to area (E+F). Area E reflects a net loss of producer surplus, which is evolved from underutilized resources, subsidies, or charity. The area F is deadweight loss that is just lost, which cannot be recovered.

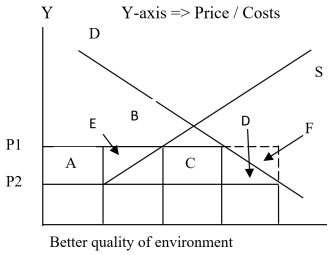

Figure 7 Welfare or benefit from better quality environment via Govt. subsidies & company charity

3.2.2 Taxation for ensuring better environment

The taxation policy is a great tool for controlling economic-growth activity. This is because the imposition of a tax can acts as a catalyst to create incentives for investment in curtailing levels of emissions including CO_2emission (Denver and Nixon, 1989). In practice, the basis of taxation may differ. Thus, addressing emission from brickfield including CO_2 emission reduction in Bangladesh, new taxes can be based on the rate of emission, not taxes on number of bricks produced. Despites the fact that taxes on bricks can necessarily cause a reduction of gases including $CO_2$from the brickfields, this study examines only the option "taxes on emission" The term "taxes on emission" can also be represented as an abatement-cost.

Under taxation policy, emission abatement level can be decided by setting MD = MAC where MAC represents marginal abatement cost as it is shown in Figure 8. Here, emission level is set to E_1, and it is curtail-able *via* gases including CO_2 sinks in the atmosphere. Brickfield "A" abates E1 / "n' units *via* government relevant regulations.

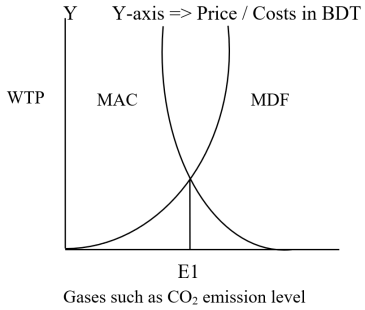

Figure 8 CO_2 after regulations. MAC: Marginal abatement costs; MDF: Marginal damages function; E1: Optimal level of emission, which is consistent.

Assumptions include the followings:

(1) Government regularly checks each brick-kiln's level of emission for gases such as CO_2;

(2) Government is not aware about brickfield's marginal cost (MC), and it is ambiguous measuring in currency (Taka) of both marginal damages caused for gases emitted and marginal abatement cost needed for abating these emissions. The idea of optimal level of emission need not be static. This is because it may adjust over time, and it aids to overcome this constraint;

(3) Government sets the target at "a" in Figure 9 but brick industry suppose "A"s emission level is at E_2. As $E_2 > E_1$, thus, industry "A" pays taxes for $(E_2 - E_1)$ in a certain fashion.

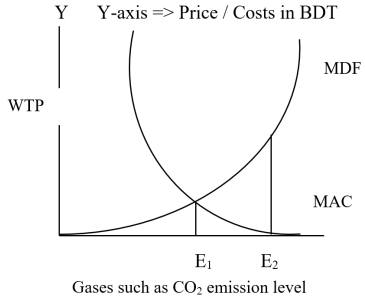

Figure 9 CO_2 emission under command & control. E1: Emission level under regulation; E2: Emission level produced by Brickfields.

The taxation-policy reduces PS by (A+B+C+D) in Figure 10. Variable inputs in this illustration move into other competitive technology or inputs in aim to improve plant's performance

and energy efficiency to minimize losses of PS. Now the question is: how does the PS-loss spread throughout the economy of Bangladesh?

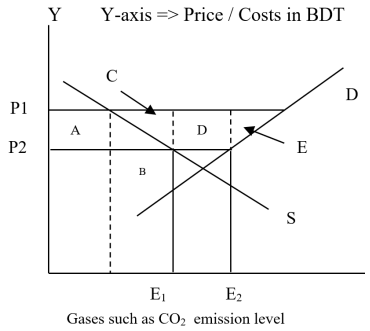

Figure 10 Welfare analysis under command & control. E1: Emission under regulation; E2: Brick-kiln industry produces.

The value (A + B) becomes an increased part in CS which interprets the improvement of environment comparing other environment where "command and control" is not in practice. The value "D" is picked up as tax-revenue, which is equivalent to the volume of ($E_2 - E_1$). This leaves triangles C and E to be accounted for. Here C is losing to the society, and it will be equal to *zero* by adjusting the target level over time. Area E is deadweight loss that cannot be picked up. It is just gone.

3.2.3 CO_2 emission control technology

The Clean Air and Sustainable Environment (CASE) project supports an entire range of activities including introduction of energy-efficient brick making technologies and is proving the viability of alternative building materials.

Technologies such as Improved Fixed Chimney Kiln (IFCK), Improved Zigzag Kiln (Zigzag), the Vertical Shaft Brick Kiln (VSBK), and the Hybrid Hoffmann Kiln (HHK) etc. are cleaner, consuming less energy and emit lower levels of pollutants and greenhouse gases (US Dept of Energy, 1993). In most of the methods, other than in HHK, coal is used as fuel to burn the bricks. The DoE officials showed that they would decide soon, which method is supposed to be in place. The regulator also suggests that the production of hollow block bricks needs to be prescribed, even though it is costlier, as the method contributes nothing harmful to the environment. Bricks are made with silt, cement, and stone crush, and later are dried in the sun. These bricks are soundproof and earthquake friendly.

3.2.4 Fuel switching and reappearing power plants

Gases including CO_2 emission can also be reduced by fuel-switching brickfields (Driver and Nixon, 1989). However, the question of cost effectiveness is a concern in this policy-option. In general, it is expensive to "scrub" carbon from combustion waste gases [15].

3.2.5 Clean coal technology

Clean coal technology shows using new & advanced coal use technologies. They are more efficient; thus, it can result a low-cost. They are more environmentalism sounds comparing to traditional coal burning exposure. The use of quality raw materials may also ease better kiln firing process overall. Development of green belt around the brick kiln industries may be an effective mitigation mechanism. Also, with clay, usages of sugarcane bagasse ash have been recommended as brick materials in literature [16]. It can be an instrumental curtailing the magnitudes of emission from brickfields in Bangladesh.

3.2.6 Monitoring number of brick kilns and conducts mobile court drive

National Strategy for Sustainable Brick Production in Bangladesh [17], Government Report shows that there is total seven thousand brick-kilns in Bangladesh. But report on total number of brick-kilns varies from government information to classified information. However, a newspaper, Financial Express reported that there are more than 11000 brick-kilns that are currently in operation in Bangladesh. In this total number a considerable number is not registered with the government (Financial express, Dec 03, 2019)

To overcome this *dilemma* in aim to curtail the magnitudes of emission level from brickfields, government should play active roles conducting Mobile Court Derives. This policy and effective efforts will be a win-win-win for the society. This is because it can ensure generating adequate revenues. On the same token, it can curtail magnitudes of emission, which can be appreciated

by many organizations such as UNO. So, the UNO would not be hesitated to grant monetary support underpinning Kyoto Protocol Agreement.

3.3 How to motivate policymakers for designing & adopting policies relate to brickfield?

In Bangladesh, the income level is rising, which has resulted rapid urbanization, which has resulted an increasing demand for residential, commercial, industrial, public buildings and other infrastructures. This development has resulted dramatic rise of brick manufacturing industry in Bangladesh. But this industry alone injects enormous volume of effluent gases. This is because they are using inefficient & dirty technology.

On the issue for national strategies and policy actions for cleaner and sustainable brick production, Bangladesh Government, introduced guidelines on national strategy for sustainable brick production in year 2017 [17]. The goal of this effort was to prepare a 'National Strategy Paper' and recommend policy actions for sustainable brick manufacturing industry.

With this progressive effort of government, it would not be unreasonable to ask: can policymakers of a nation, like Bangladesh, play role for better-ness of its modern-human-society in aim to meet environmental challenges in multi-faucets?

The answer to the question posed is, YES, where efforts of relevant industries or news-media can play significant roles in spreading message, which can be inspirational to policymakers sooner than further delays. Besides these traditional organizations, roles of academic institutions are crucial for conducting Academic Conferences or International Research Conferences on agenda(s) such as:

(1) Needs for rapid growth of use green tech in brick industry sooner than further negligence in actions;

(2) Raising awareness and engaging the public, officials, and policy makers in support of policy-designs underpinning slogan "we can do better for the society as a whole" which can promote use of green tech than before in Bangladesh;

(3) Inspiring brick-kilns in Bangladesh or brick industries globally for encouraging or for hosting conferences on the proposal where roles of United Nations Organization (UNO) can be crucial in practice in case of global efforts.

3.4 Who should finance or sponsor the proposed conferences?

Agenda-setting is a crucial element of the strategies that political actors pursue [18]. Agenda-setting is an important part for politicians, officials, and interest groups for policymaking. This is because getting an issue to be considered is a precondition for decision-making, which requires gaining attention of the issue.

On the same token, publication or proposal in literature does not guarantee its application or agenda setting in practice unless policymakers are engaged for designing relevant policies addressing the issue in general. The process of setting agenda for policymakers' attentions in any country goes through various challenges [19]. However, there are two distinct challenges. They are as follows:

(1) Gaining attention for the issue;

(2) Building sufficient credibility for the nation to deal with the issue for society-interest.

Gaining attention is a crucial element in all agenda-setting processes. Here mobilization of interest is what agenda-setting is about. Since this effort is *parallel* to the theme of global movement – Kyoto Protocol, UNO and brick industries in a country or countries would contribute directly for development of policy communities by subsidizing interest groups. These groups will push for the issue at the national level. It has become a widespread practice in countries globally when it comes public interest issues [20].

Furthermore, academicians' efforts can be used hosting conferences. Their efforts on relevant publication can play significant roles spreading messages, which can be inspirational to policymakers sooner than further delays. But it must require delivering the message directly to policymakers individually.

In addition, both the brick-kiln sector and interest groups themselves actively will try to develop networks of experts and stakeholders within its nation for relevant policy-design. . The brick industry sector can do so by meeting groups on having use of green tech in practice meeting the demands of 21^{st} Century technology-driven world where academicians in the field can be tapping into presenting the proposal to policy-practitioners.

3.5 Future research

Studies can be conducted in multi-faucets examining the possibility of use of green tech in brick manufacturing industry using opinion-survey of management & employees of the

brick-kilns in Bangladesh. However, research grants can be inspirational for investing research-efforts soon. Factor Analysis, hypothesis development & testing etc. can be conducted. Thus, the expected findings can be educational enhancing the growth of using green tech meeting the challenges. *Lastly*, welfare analysis can be conducted for individually clean-bricks-users, brick-kilns and for the society.

3.6 Conclusion

The brick industry in developing world is a vast, coal burning and polluting industry. Nearly 1,500 billion bricks are produced globally each year where 87% are from Asia. China dominates the world in producing bricks using coal combustion and woods as fuels where Australia placed the last and Bangladesh placed the 5^{th} in the world. Since the beginning of advancement, bricks have been playing important roles for construction of houses and other infrastructure in Asian countries where Bangladesh is no exception. Bricks are effort-able building material in urban areas of Bangladesh. In recent years, because of rural-to-urban migration, a rapid urbanization has created an increasing demand for bricks. As a result, the number of brickfields has risen dramatically. But this industry uses inefficient, dirty technology. As a result, it emits huge volume of effluent gases such as CO_2. More specifically, burning wood and coal in brick-kilns produces elevated level of SO_2, NO_x, CO_2, CO and CH_4. Thus, brickfields inject them into atmosphere and deplete atmospheric O_2. For impact assessment and then policy-guidance on the issue, this study analyzes the basic issues of gases emit from brickfields in terms of marginal damage (MD) analysis and the neoclassical partial equilibrium demand & supply theory. It analyzes the reasons of disparity between social-cost and private-cost by conventional marginal damage analysis technique. Findings show that because of gases emission from brickfields, the marginal social costs are higher than marginal private costs. Here brick-kilns are benefiting with the expense of Bangladeshi society. Continuation of increasing number of brick production under traditional fuels results higher welfare loss incurred from higher social costs. Also, because of high rise demand of bricks, the prices of bricks are becoming upward trends. It has been increasing PS. By using inefficient fuels in brick manufacturing industry, producers continue generating higher revenues and consumers face higher prices, which creates higher deadweight loss year after year. This unplanned development of the brick industry in Bangladesh is unsustainable. Thus, there is an urgency for national strategies and for policy actions for cleaner & sustainable brick production. Reforestation efforts can be achieved in multi-faucets including brickfields' charity, govt. policies on planting trees, govt.'s policies on motivational efforts inspiring citizens of this country. These motivational can be in multi-faucets: inspiring "birthday celebration of everyone by planting trees, forcing to use green tech in brick kilns. An inspiration for conducting research in both phases including govt. and academic arena are needed.

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RESEARCH ARTICLE

Do doctors work for patients in today's business-mentality world: Looking through consumer choice theory lens?

Akim M. Rahman[1,2]

[1] Department of Arts and Social Sciences, Ahsanullah University of Science and Technology, Dhaka, Bangladesh
[2] Social & Economic Research Institute (SERI), The Ohio State University, Columbus, Ohio, USA

Correspondence to: Akim M. Rahman, Department of Arts and Social Sciences, Ahsanullah University of Science and Technology, Dhaka, Bangladesh;
E-mail: rahman.19@osu.edu;

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Abstract: In the 21st century world, people mostly behave with business-mentality without considering moral obligations in society. In this behavioral change, service-market, particularly Medical-care service-market is appeared to be vulnerable. Because of supplying medical-care services, the doctor or hospital receives capitation payments, fees-for-services, risk pool settlements, incentive payments or other fees. However, today it is probably the most criticized profession in world-economy country-wise such as Bangladesh. Sometimes doctors here are blamed for requiring unnecessary tests of patients for doctor's own monetary gains. In some cases, doctors' efforts are assumed to be connecting with pharmaceutical-products promotion by writing lengthy prescriptions. Some group claims that today doctors spend less time for each patient. All these interactions justify claiming that a patient works for a doctor when the patient visits a doctor for medical-care services. Here the existence of "asymmetric information" dominates the medical-care market where doctor takes advantages in multi-faucets. It causes market inefficiency that creates negative economic externalities – *deadweight loss*. Improving medical education with special emphasis on ethical aspects and soft skills in communication are considered important in aim to reduce the magnitudes of today's dilemma of medical-care service-market. Also, strict enforcements of medical-care provisions and ethical code of conduct among all health works can be instrumental. Finally, the answer to the question "Do doctors work for patients or something else, depends on who are asked. But the reflections of today's medical-care-market in economy of Bangladesh are no deniable, which deserves to be studied further curtailing the magnitudes of the problem.

Keywords: medical-care service-market, Hippocratic oath, misuse of services, economic externalities, deadweight loss

1 Introduction

Today's human-society lives in world of business-mentality where most people try taking advantages without considering moral & ethical obligations in its society and beyond [1]. In this behavioral changes, service-market, particularly Medical-care service-market is appeared to be vulnerable particularly under the pluralistic setup of community-level and facility-based services. These services are delivered by the government, NGOs, and private for-profit providers in economy country-wise such as Bangladesh [2, 3].

Thus, it requires policymakers' attentions country-wise where the roles of the World Health Organization (WHO) can be instrumental. Here my preferred subject is medical-care services, not the healthcare services. This is because the causal factors of healthcare are many. However, the provision of medical care is what is necessary for a person's health and well-being by a doctor, nurse, or other medical care professionals [2]. For further clarity, medical-care-service means diagnosis, writing prescription, treatment, or prevention of disease. Here services and supplies are applied for the purpose of affecting any structure or function of the body [2]. In this setup, a private physician or a company or government entity delivers or handles delivering to patients through physicians, professional medical corporations, ancillary service providers (Lawinsider.com). Because of supplying these services, the entity is entitled to receive capitation payments, fees-for-services, risk pool settlements, incentive payments or other fees.

These medical-care services fulfill the vital features of a market in today's world where prior to graduation, under oath - the *Hippocratic oath* revitalizes physician's pledges to prescribe only beneficial treatments to his / her abilities & judgment. Also, in profession, she/he refrains from causing harm and to live an exemplary professional life. However, today medical-care service-market has been blamed to be polluted country-wise. This is because this profession relates to life and death of human-beings. However, today it is probably the most criticized

profession in world-economy country-wise such as Bangladesh [2,3]. Sometimes doctors here are blamed for requiring patients' unnecessary tests for doctor's own monetary gains [4]. In some cases, doctors' efforts are assumed to be connecting with promotional of pharmaceutical products' by writing lengthy prescriptions. Some group claims that doctors now-a-days make more money by spending less time for each patient. Other group claims that in some cases when a doctor is employed by government, on duty s/he is not hesitant advising patients to visit doctor's other chamber, which means his/her second employment, with assurance of having available better instruments for accurate tests.

This *dilemma* raises question: what others say in summary about it in research community?

Answering the question posed, it is recognized that outcomes of medical-care -services depend on accurate diagnosis & making prescription for the disease a patient come with for treatment. It requires taking or collecting proper history and physical examination of the patient [5]. On the same token, a doctor can gather a patient's detailed history, if s/he is cordial and trustworthy enough to the patient [6]. So, a doctor might need to be communicating with the patient on humanistic manner for supplying satisfactory treatment. So, both ways cooperations & compliances by patient and the physician in treatment-process are crucial for quality medical-care [7,8]. No misuse in these efforts from both sides can ensure fruitful outcome of medical treatments and its efficacy in medical-care services. This is because patient's values and preferences along with medical facts diagnosed by the doctor are essential for clinical decisions [9,10]. So, outcomes of any treatment depend on the quality of the doctor-patient relationship. Moreover, a trustworthy relationship between doctor and patient can lead to better medical outcomes. In contrast, mistrust can produce sub-optimal medical outcomes. Thus, a doctor-patient relationship is an integral part of medical-care delivery.

With these concerns and prospects in hand, at the present doctor-patient relationship is a major issue in medical-care industry, which is mostly debated country-wise no matter where we live. On this critical issue, Bangladesh is no exception. So, the current effort is for detecting doctor-patient relationship in market system of today's medical-care services in economy country-wise such as Bangladesh. So that the scientific findings or quality information can be spread to research community throughout the universe.

1.1 Doctor-patient relationship: A reality check of medical-care service-market in BD

In profession, increasing specialization over-dependence on technology and commercialization etc. associated with escalating costs of healthcare are thought to be the underlying causes for this problem. Also, in today's medical-care practices of defensive medicine are affecting the quality of care as well as the relationship between the doctor and the patient.

Another area of deterioration in the doctor–patient relationship is the nexus between doctors and pharmaceutical companies, which kindles a suspicion in the mind of the patient that s/he is paying more than s/he needs to. Also, sometime on-spot doctor performs prescribed injection to patient in doctor's chamber where the prescribed injection is managed or bought by doctor's assistant from nearby of doctor's chamber. However, in this *scenario*, the patient has no knowledge about the name brand of it. So, while the patient suffers next time with the same health problem, s/he needs to go back to the same doctor for having the same brand for its immediate cure. It is no overstated that sometime doctors may intentionally do not disclose prescribed medicine particularly injection brand-name to the patients with an expectation that patient will need to visit the same doctor again. This is because this self-setting-up effort can generate extra visiting-fees or income from the said patient.

1.1.1 Problems in medical-care services sector-wise: A reality check

(1) Problem in private sector

Since 1980s, Bangladesh has been following market-oriented liberalizing policy reforms and have prioritized private sector-led growth. Furthermore, overcoming public hospital's limitations in multi-faucets, besides investing in medical education & training, government allows physicians to practice privately. However, this private healthcare services are facing a severity of crisis [11]. As TIB reported (TIB, 2022), these hospitals & diagnosis centers have turned in to be profit-driven entity or organization in Bangladesh-economy. However, these money-driven services contradict with the basic principles that govern medical-care services since the beginning of human society. As reported [11], today's medical-care services under private sector in Bangladesh-economy run based on somewhat "commission-based marketing mechanism". Under referrals provision, some parties do exchange for commission for the referees. In this mechanism, generally, doctors, owners of private medical facility and middlemen are . benefited [12]. Like the Savar Prime Hospital, most of the private hospitals, clinics, and diagnostic centers in Savar upazila of Dhaka

are dependent on such middlemen [12]. Also, there are many private hospitals and diagnostic centers are illegal, according to the Private Hospital Owners Association of Savar [12].

These all have limited the benefits for the improvement of peoples' health where government aggressive approaches are partially missing the issues in private sector of medical-care services in Bangladesh. It clearly suggests that doctors dominate medical-care service-market where a patient is forced to pay as the doctor wishes it. The growth of this sector has limited benefits for the improvement of people's health. The government should take a comprehensive approach and engage its political will to make changes in management and in governance and bring in stewardship to revitalize the public sector.

(2) Problems in public sector

Public sector hospitals in Bangladesh face problems in multi-faucets. The main problems of these hospitals are a) limited number of hospital-beds and personnel in hospital b) poor utilization c) poor perception & quality of services d) doctors give extremely limited time to patients in consultation & diagnosis e) most lab-tests are needed to be completed thru private entities, which is expensive f) inadequate connections between public and private sectors etc.

These problems in the public sector have caused customers i.e., patients to use the private sector, thus, it has promoted the growth-trend of private sector. Outpatient consultation is the major mode of service provision in the public sector. However, while the population of Bangladesh increases annually by nearly two percent, the number of people seeking medical care from public sector hospitals over the longer term has been decreasing. For example, there was a 30 percent decrease in attendance between 1993 and 1996 (DGHS 1998: 69). Reasons for this trend include the non-availability of doctors and drugs, over-crowding, increased waiting & travelling times and poor communication between doctors and patients [1]. Consumer dissatisfaction with this sector has led to an increase in attendance numbers at private facilities.

(3) Problems in non-profit organization sector

Currently, there is not enough evidence available within Bangladesh. However, the general feeling here is that, due to a variety of reasons, the doctor–patient relationship is under strain. Today's doctor-patient relationship appears to be somewhat business-mentality rather having ethical & medical etiquette perspective behaviors in general.

1.1.2 Medical-care service-market: Compliance and enforcement in Bangladesh

In Bangladesh, Medical Practices, Private Clinics and Laboratories Regulation, *Ordinance NO. IV OF 1982*, authorizes maximum charges & fees that may be demanded in a private clinic or private laboratory for surgical operations and other medical examinations or services. But these charges must be specified in Schedule in advance. This law further requires every registered medical practitioner carrying on private medical practice and every private clinic and private laboratory shall prominently display in the chamber, clinic, or laboratory a list of charges and fees that may be demanded by him or it. On top of this, Bangladesh has a comprehensive set of policies for Universal Healthcare Coverage (UHC), *e.g.*, a health-financing strategy and staged recommendations for pooling of funds to create a national health insurance scheme and expand financial protection for health.

However, despites the Ministry of Health and Family Welfare serve as watchdogs of healthcare laws & policies and overall healthcare system in Bangladesh, other organizations have been considerably influencing on decision-making process and on outcome. Also, the inequitable access to and financing mechanism in healthcare system between urban and rural are significant. These factors have been hindering the achievement of UHC since its beginning in Bangladesh.

1.2 Problem statement based on the reality check: Medical-care services in Bangladesh

Like any government country-wise, Bangladesh government values the significance of medical care towards building a healthy and productive population. Over time, the country has made great progress in improving life expectancy, reducing infectious disease, infant and maternal mortality. The government is encouraging further development of the sector through favorable incentives. However, in recent years, medical-care service-market has been blamed to be polluted where it is claimed that patients are ripped off in multi-faucets in Bangladesh [2, 3].

On this aspect a recent study [2] was conducted based on analysis of survey-data in Bangladesh, which serves as a *scenario* with minor variations in today's medical-care services in economy country-wise.

1.2.1 Bangladesh medical-care-service system: An overview

The medical-care services in Bangladesh are described as pluralistic in that community-level and facility-based services are delivered by the government, non-governmental organizations

(NGOs), and private for-profit providers [13, 14]. This pluralism is thought to have contributed to Bangladesh's successes in improving health outcomes. However, Bangladesh is still lagging in medical care services for the poor. Healthcare system here has undergone number of reforms. The Medical Practices and Private Clinics and Laboratories (Regulation) Ordinance, 1982, eased this approach [15]. It is now highly decentralized. As a result, it is regulated and controlled by for-profit companies, NGOs, the national government, and international welfare organizations. Now it presents an extensive medical-care industry in tri-faucets. They are a) public b) nonprofit and c) private sectors.

But healthcare system in Bangladesh is still a long way from achieving universal health coverage. Despites statutory healthcare system in place covering all citizens in principle, many sick people are left untreated every year in practices. Also, there are discriminations in supplying medical-care services to patients. For example, government funded hospital such as Combined Military Hospital (CMH) supplies services to members of armed forces and to their parents only. This CMH is a chain where branches are situated in all cantonments of Bangladesh and fully funded by taxpayers' money. Rather questioning the medical-care services to current as well as to retirees of armed forces with taxpayers' money, people here are debating on the justification of spending taxpayers' money for medical-care services to relatives of armed forces. Sometimes people see it to be feeding the neighbors with taxpayers' money for keeping life the monarchy in political arena. On the other side, private sector of health-care services is becoming too expensive for many no matter where they live [12].

1.2.2 How do patients and attendants of patients feel about medical-care services in Bangladesh?

A recent study [2] where data statistics were collected from attendants of the patients, the patients, and the doctors in Bangladesh, shows in Table-1 that nearly 79% attendants show negative perceptions on doctor's cordiality towards patients. Nearly 78% shows negative perceptions on trusting doctors in Bangladesh. The estimated overall weighted mean is 2 (two), which also confirms the current doctor-patient relationship to be poor in Bangladesh. On overall perception that nearly 90% people believe that "*patients-work-for-doctors*" in healthcare market.

In contrast, 52% patients, which is smaller than attendant percentage, show negative perceptions on doctors' cordiality issue. On trust issue, 69% patients show negative perception on trusting doctors in Bangladesh. In this case the estimated overall mean is 2.9 (nearly three), which confirms a poor doctor-relationship in Bangladesh. On overall perception - Felt like "*doctors-work-for-patients*" in healthcare market, nearly 65% patients expressed negative perceptions. In other words, nearly 65% people believe that "*patients-work-for-doctors*" in today's medical care market in Bangladesh. (see Table 1)

Table 1 Attendant perception and patient perception toward the doctors in Bangladesh

Respondents = 100 where Public = 60, Private = 30 nonprofit = 10	Attendant Perception			Patient Perception		
Indicators	(+) in %	(-) in %	Mean	(+) in %	(-) in %	Mean
Delivered treatment cordially	20.0	78.9	2.2	48.2	51.8	3.21
Delivered treatment with responsibility	30.0	70.0	1.9	22.9	77.1	2.51
Invested adequate time	24.5	75.5	2.2	26.8	73.2	2.77
Supplied mental support	30.0	70.0	2.1	49.0	51.0	3.18
Listened to the patient attentively	20.5	79.5	2.3	33.2	66.8	3.2
Patient was satisfied with the medical care services	33.0	67.0	1.9	34.6	65.4	2.9
Described the disease / health issue	30.0	79.0	2.1	27.2	72.8	2.8
Explained the prescriptions clearly	33.0	67.0	2.0	23.0	77.0	2.9
Felt like influenced by a pharma/ commission agent	75.2	24.8	2.1	46.0	54.0	3.0
No discrimination was found in services	10.0	90.0	2.0	33.0	67.0	2.9
Having trust on the doctor as service provider	22.8	77.2	1.9	31.0	69.0	3.1
Overall perception: Felt like "doctor*s-work-for-patients*" in healthcare market	15	84.6	2	35.0	65.0	2.9

Source: Rahman (2022). (Health)

In "doctor's perception" survey, because of time limitation, 30 doctors where 15 from three public, 10 from 2 private and 5 from one nonprofit hospital located in Dhaka City were interviewed. Since the socio-demographic background was intentionally ignored, here doctors' responses cannot be judged based experience, qualification etc. but all doctors. Here over 90% doctor's perception was positive towards doctor's freedom of choosing treatment-protocol. Over 72% respondents agreed that patient did not counter his/her decision or did not raise unnecessary questions to him/her. Over 72% respondents acknowledged about their 2^{nd} jobs with private / nonprofit. On third-party linkage-perceptions, exactly 70% respondents showed negative. Here the estimated overall mean is 3.2 which confirms a doctor-relationship better in Bangladesh. On overall perception - Felt like "*doctors-work-for-patients*" in healthcare market, over 57%

doctors expressed positive perceptions. In other words, nearly 43% of the respondents believe that "*patients-work-for-doctors*" in today's medical care market in Bangladesh. (see Table 2)

Doctors' perceptions

Table 2 Doctor perception toward patient in Bangladesh

Respondents= 30 where Public= 15, Private = 10, Nonprofit= 5	Doctor Perception		
Indicators	(+) in %	(-) in %	Mean
I am engaged in second job (private / nonprofit sector)	72.5	27.5	3.8
I can play vital role for choosing treatment protocol	90.2	9.8	4.0
Patients/attendants respect me properly	56.0	44.0	3.5
Patients / attendants are highly cooperative	30.2	69.8	2.9
Patients listen to me carefully	65.0	35.0	3.5
Patients follow my instructions carefully	48.2	51.8	3.3
Patients are well behaved	30.0	70.0	3.5
Prescription was influenced by third party linkage	30.0	70.0	2.5
Third party influenced test requirements	56.0	44.0	3.0
I do not face unnecessary questions from patients	72.5	27.5	3.1
I have proper safety if any unexpected incident occurs	40.1	59.9	2.5
Overall perceptions: Felt like "*doctors work-for-patients*" in healthcare market	57.2	42.8	3.2

Source: Rahman (2022).

1.3 Factors that undermine effectiveness of medical-care services in Bangladesh

To undermine the magnitudes of the debate or incidents, sometime these service-providers take shelter under the banner "Gross Negligence" relates to professional duties to the patients. So, the relevant authority(s) may regard the incident to be a misconduct. Once this step takes place, this progression is used as sufficient to justify the suspension or removal of the medical-practitioner or service-provider from the registrar. And then the offender(s) is entitled to be prosecuted [2]. However, in today's business-mentality-world, it may not be executed in most cases, unless the incident had taken place in public-eyes. Otherwise, in the self-interest politics-driven-world, sometime this progression is used paying compensation to the victim so that the matter can be taken off from the table with parties' agreement. Alternatively, sometime the victim is warned and asked for backing off unless the victim wants facing retaliation where the mood or magnitudes of the retaliation depends on who is backing the offender.

The recent incident "Bashundhara Managing Director" and its later steps towards covering up for good justifies the analogy made above. In practice, despites knowing the fact that victim was denied issuing a medical report, Justice System has concluded dropping out the case based on agency's report without questioning its validity [4, 11], in the country of Bangladesh. As Barbara Kruger (2020) [16] said "money talks, ……, it determines what food we eat, whether we are cured or die". Based on observation of incidents during COVID-19 & the aftermath and scientific studies by the current author [2, 17, 18], I say "money can make people to dance with or without cloth".

There is no doubt that the pandemic crisis has ignited the practices of unethical further without boundaries [17]. There is a vivid example of this reality of issuing falsehood COVID-19 Certificates in Bangladesh, which is known as Sabrina-ism in literature [18]. This Sabrina-sim reminds us how large the negative impacts in multi-faucets can be on the people in the country. In this episode, Sabrina was a money-sucking machine at the frontline of the tunnel [19]. It was noticed globally and criticized in multi-faucets [19].

These all practices & concerns of human-society raise question on today's doctor-patient relationship. This study takes on the challenges answering the question posed.

1.4 Objectives of the current study

(1) To interpret doctor-patient relationship in medical-care service-market country-wise such as Bangladesh using Theory of Consumer Choices & Behaviors;

(2) Do the current practices cause externality in today's medical-care service-market country-wise such as Bangladesh?

(3) To estimate the consequences of market-inefficiency in medical-care services;

(4) To tip-off on how to marginalize the problem in today's medical-care service-market;

2 Methodology

In aim to understand the relationship between doctors and patients in today's medical-care service-market country-wise economy, on suitability basis, Bangladesh medical-care service

market has been chosen. First this study uses the data statistics, which are available in literature on the similar topic [2]. The referred study [2] captured how patients, patients' attendants and doctors feel about medical-care service market in Bangladesh.

This study uses effective statistical techniques to capture the period "first confirmation and then spread" for better understanding in aim to set up the theoretical arguments. Secondly, this study uses the Consumer Choice Theory capturing doctors and patients' relationships country-wise. It then captures the economics of externalities, particularly deadweight loss or economic inefficiency that occurs because of an occurrence within a market that distorts the equilibrium set by the free market. It reexamines the presence of "asymmetric information" in such way so that it can be helpful understanding inefficiency issues of medical-care service-market country-wise.

3 Results

3.1 Economics of medical-care service-market: Patient *vs.* doctor

In Market Economics, most often economists use the terms supply and demand. The concept of a market is a way in which an economic activity is organized between a buyer and a seller through their choices and interactions with another. It is not always necessary to have a medium of exchange or currency in any market system if both buyer and seller or parties are involved and agree to exchange their product or services without reservation. Thus, exchange of goods or services, with or without money, is a transaction [20, 21]. It can also be said that demand in market is determined by many factors [22]. Thus, when there is a change in demand of a product due to one or more than one factors, other than price or cost, results lead the shift of demand curve. On this aspect, think about the epidemic of a particular disease, which raises the demand for medical-care services. So, medical care consumers, i.e., patients face at higher price or cost. However, in case of medical-care service-market, it lacks a vital feature of a market. And that is, the existence of "asymmetric information" in market system. More specifically, doctors are professionals, but patients are not. This asymmetric information refers to service-provider's knowledge of his /her object of sale and to which the service-receiver does not have access.

This is because here patient's choice for medical-care-service is provided by doctor, nurse, or other medical care professionals [23] if they are available and willing to invest their efforts for supplying services. Here their effective efforts on diagnosis, treatment, or prevention of patient's disease can inspire the patient coming back to the same service-provider or the patient may look for better option. Here services and supplies are applied for the purpose of affecting any structure or function of the body [23] where physicians, once agreed delivering service, are obligated through quality control and ethical codes of conduct. In this market the service-provider has information however, the patient does not. Thus, this asymmetric information between the service-provider and the patient causes externalities in medical-care-service usage or consumption. Thus, externality as a basis, the quality control & ethical codes are in place in most medical-care services country-wise such as Bangladesh.

Besides this, as reported [11], today's medical-care services under private sector in Bangladesh-economy run based on somewhat "commission-based marketing mechanism". In this mechanism, generally, doctors, owners of private medical facility and middlemen are benefited [12]. Like the Savar Prime Hospital, most of the private hospitals, clinics, and diagnostic centers in Savar Upazila of Dhaka are dependent on such middlemen [12]. So, patient's cost for middleman is part of the patient's total cost for medical-care services, particularly in Dhaka [12].

However, few characteristics particularly payment method in the market vary country-wise. This is because some countries have universal health coverage provisions in place such as the USA. Some other countries have government subsidized public healthcare services along with progression of private healthcare services such as Bangladesh. For further clarity, medical-care service-market of Bangladesh is under the pluralistic setup of community-level and facility-based services that are delivered by the government, NGOs, and private for-profit providers in economy.

With this reality in hand, despites medical-care service-market has buyers (patients) and suppliers (doctors etc.), various features of medical care market complicate the analysis. Particularly they are a) third parties such as government, insurers, and unwritten bystanders etc. are involved where they have interests in healthcare outcomes b) in general, patients do not know what they need and cannot evaluate the treatment they are receiving c) in case of insurance option, service providers are paid not by patients but insurance companies, which causes allocation of resources in the medical-care service-market to be highly inefficient.

With these features & characteristics in today's business-mentality world country-wise, asymmetric information in medical-care service-market can lead to different behaviors of the service-providers as well as of consumers. In this process service-providers may intend for higher profit, which may result bypassing the quality control & ethical codes of conduct unless they get caught

in practice. Moreover, physicians may prescribe unnecessary medicine for securing benefits, even though it is contradictory to his/her oath – *The Hippocratic Oath*.

Speaking about oath, it is a major step in becoming a doctor, medical students must take the *Hippocratic Oath* which is attributed to the ancient Greek physician Hippocrates. And one of the promises within that oath is "first, do no harm". While some medical schools ask their graduates to abide by the *Hippocratic Oath*, others use a different pledge – or none.

Doctors in Bangladesh, on qualification, sign up to a Bangladesh version of the 1948 World Medical Association's "Declaration of Geneva." This is a modern version of what is known as the Hippocratic Oath, which is the promise that doctors make to keep to the principles of the medical profession [4]. In summary the *Hippocratic Oath* is "*I will follow that system of regimen which, according to my ability and judgment, I consider for the benefit of my patients, and abstain from whatever is deleterious and mischievous.*"

However, today we live in business mentality era of human-society where opportunity makes people to be gainer or richer no matter s/he is under oath or not.

3.1.1 Medium of exchange for medical-care services in market

In market economics, medium of exchange is an intermediatory instrument or system, which facilitates sales, purchase, or trade of goods & services between parties. It ensures efficiency in trading products & services and then exchanging it. It acts as a stabilizing factor in economy. If money or insurance-coverage, as represented by a currency, is no longer viable as a medium of exchange, consumers lose their ability to plan budgets and there is no longer a way to gauge supply and demand accurately.

These phenomena are no different in case of medical-care service-market. Besides currency transaction, health insurance here plays role just like currency if it covers the cost of the services provided by a physician. In general, patient, who has health insurance coverage, can be considered as advantageous-patient-group. On the same token, patient who use currency to pay for medical-care services, can be considered as adverse-patient-group.

The number of private exchanges set up by benefit companies and health insurance carriers have grown in recent years. Besides this, government subsidized medical-care services are also available where some cases very nominal fees or there are no fees for medical care services. These are common practices in medical-care service-market where services are available through private hospitals, non-profit organized hospitals, government subsidized-hospitals and individual physician services in medical-care service-market. These hospitals or physician, who chooses private practices, are ran based on government rules & regulations country-wise. For example, these entities and private physician needed to display doctor fees and cost for other medical-care services.

So, medical-care service-market is like fixed-price service-market, however, what medical-care services are needed only the physicians know about it. With this limitation, it can be said that money does not enable the patient who possesses it to participate as an equal player in medical-care service-market. Thus, a patient cannot effectively make a bid in response to the asking (display fee or fees for services) price. This limitation creates disorder and unpredictability on the cost of services in medical-care service-market. Here service providers know what to prescribe and how much to charge. So, patients cannot reliably plan their budgets around predictable and stable pricing / costing models when patients go for medical-care services in market. In case of having health-insurance coverage, patients do not need to be worried about the cost as long it covers all costs. At the same time service-providers are not worried about payment and later they bill / charge insurance company based on the rate they jointly established earlier where service type or number of services are no questionable.

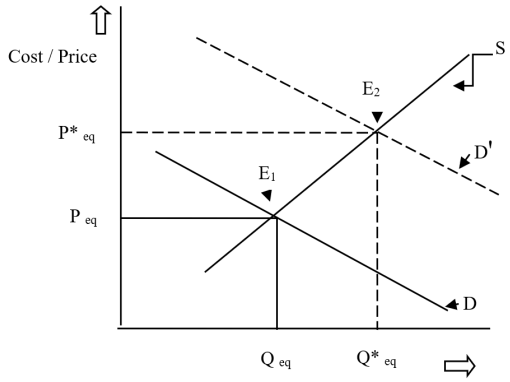
This dilemma raises question do doctors work for patients or patients work for doctors in today's business-mentality era of human-society country-wise? Answer to the question posed depends on who is asked.

3.1.2 Do doctors work for patients in reality?

Underpinning differences country-wise, economics activities in medical-care service-market are organized between a seller i.e., service-provider such as a doctor and a buyer i.e., service-receivers such as a patient through their choices and interactions with one another. In human-society, when an individual becomes physically in critical condition or just ill, individual may look for service(s) from a doctor. This doctor can be self-employed (private entity) or employed either by the government or nonprofit organization. In this setup, in case doctor's fee is high, a patient may visit another doctor with patient's expectation of similar services. Alternatively, a patient may decide not to visit a doctor because of the patient's budget constraints and strength of his or her perceived risk-factor. These are the common *scenarios* of patients & doctors' behaviors in today's medical-care service-market.

In private medical-care service-provider and service-receiver, which is like a perfectly competitive market in terms of market-economy. Since other two faucets government and nonprofit healthcare services are subsidized in operations, the patient just pays nominal registration fees. There is no fee for the doctor. However, patients who need it most based on their affordability here sometimes find it to be difficult getting into for services because of its limitations of resources in multi-faucets of medical-care services. In some cases, the patient may reach out middleman for getting services [12]. These are common *scenarios* in government hospitals where service-providers are employed and get paid, and patients pay nominal fees for admission or registration. For treatment in government hospitals, in most cases, general patients may face difficulties getting access to services there.

In this setup, in case doctor's fee is high, a patient may visit another doctor who charges lower-fee or does not visit a doctor because of patient's budget constraint. These are the common *scenarios* of private medical-care service-provider (doctor) and service-receiver (patient), which is like a perfectly competitive market in terms of market-economy. Since other two faucets government and nonprofit regulated healthcare services are regulated in operations, patients sometimes find it to be difficult getting into for services unless general are in life threat. This *scenario* is something like government rationing system for some essential foods when market prices are too high. (see Figure 1)



Note: D = Demand for medical-care services when it is needed most; D' = New demand line for medical-care services during epidemic disease. (Note: here demand line shifts outward which raises higher demand that raises prices or cost for the services; P = Prices / cost for the services; Q = No. of times visiting doctor; Q_{eq} = equilibrium no. of times vising doctor; Q^*_{eq} = number of times vising doctor due to epidemic; E_1 & E_2àIntersection of D-S & D′- S

Figure 1 Medical-care service-market

Based on observation in recent years in Bangladesh, it is well recognized now that doctors do more than one jobs, and it has been approved by the government. Besides working as a full-timer, a doctor can do more services meeting market demand. During any epidemic disease, medical-care service-demand-curve shifts outward and customers face higher prices. Conversely, demand curve shifts inward from its original demand curve indicating that consumers face lower price for medical-care services [21].

3.1.3 Looking thru consumer choice theory lens

The Consumer Choice Theory interprets how a consumer or patient decides to spend money based on patient's severity and budget constraints. Foremost, it serves on making decision whether the patient will go to government subsidized hospitals or to a private hospital for medical-care services. As a branch of microeconomics, consumer theory shows how individuals make choices, subject to factors such as: how much income they have available to spend, that means budget, the costs for the services and the necessity of the services. However, in case of medical-care services, once the patient reaches to physician for services, being an expert, the physician takes over authority of decision and make prescription as the physician feels it to be right. The prescription might include requirements of tests, medicines etc. that are needed to be done or purchased where the patient bears total costs in case of private hospital services or in case of private physician services. Here the service provider i.e., the physician has the information but the buyer i.e., patient does not.

This asymmetric information refers to service-provider's private knowledge of his/her object of sale services / products and to which the patient does not have access, it is called "adverse selection". It may cause misusing the market system, in this case, the medical-care service-market system where the doctor is the *Commander-in-Chief* and patient has right to decide whether *leave it or take it.* Obviously, this privilege a patient has prior to get admission into a hospital

for treatment. Once got into for treatment, the patient is bound to follow Commander-in-Chief's command.

Even exploitation and abuse of patients are forbidden by code of medical ethics, physicians are in a power while writing prescription or in other type of medical-care services, and this power can be misused. These abusive behaviors include doctors functioning as agents of control, exploiting physician's prerogatives - generating monetary benefits from pharmaceutical companies by writing unnecessary medicine , acting out personal problems in the medical setting, allowing subversion of their judgment, deliberately delivering suboptimal care, dehumanizing care etc.

3.2 Economics of Externalities: Deadweight loss in Today's Medical-care Services

Once an individual gets sick, s/he may decide going to a private physician, government hospital, nonprofit hospital or to a private hospital for treatment. In case of government hospital, the patient is required to minimum registration fees or in some cases it is a place for free services where in most cases, patient's admission to hospital is avoided because space limitation. If the required tests or services are not available there, doctors may advice the patient to get it done outside. However, in private hospital cases, once patient arrives there, s/he fills-out Information Form that has patient's information as well as cost payment info etc. After completion the Form, patient is assigned to meet with on-duty out-door physician with the coordination of the staff-members there. Based on doctor's assessment, patient is required for admission there for continuation further treatment. This is the beginning of economic transaction between a doctor and a patient in medical-care service-market in economy.

One of the problems that modern economic theory studies regard to economic transactions is that of adverse selection, which occurs when the seller or service provider has more information about the object being transacted or about service-provider's preferences or technologies that the customer or patient does not have. For example, in case of doctor-patient service-market, this phenomenon occurred. This is because when a patient comes to a doctor for treatment, the patient or the attendant of the patient describes the problem the patient currently faces relate to his/her health. After taking notes on patient's side, the doctor decides whether further medical test(s) is needed prior to prescribe medicine. In this *scenario*, the doctor has the expertise & information, but the patient does not. This inequality of information including expertise of the service-provider in medical-care services, economists call "asymmetric information" When asymmetric information refers to the service-provider i.e., doctor's private knowledge of his object of sale and to which the buyer i.e., the patient does not have access, it is called "adverse selection".

In medical-care service-market, the real effect of adverse selection is to dominate the services in multi-faucets. When a patient comes to doctor for medical-care services, doctor takes advantages of this opportunity and spontaneously suppresses the market for generating additional income. Even though it is contradictory to the oath the doctor took prior to graduation for profession.

This is because the medical-care service-provider typically has more knowledge of the service being supplied than the patient who is the consumer. The patient's lack of expertise means he or she is ill-equipped to judge the quality of health care. To make matters worse, quality of medical-care is notoriously difficult to measure and opinions amongst medical-care practitioners themselves may vary about what the best quality of medical-care service is. To overcome this dilemma, there are strict regulations of medical-care practitioners to ensure that they consistently supply good medical-care services. However, regulation does not always necessarily require a high degree of public sector intervention.

With these limitations & misuses, in English colloquialism sense, it would not be overstated that the medical-care service in today's business-mentality-world is becoming "out to be a pig in a poke" or "buying a pig in a poke". It means that something is sold or bought without the buyer knowing its requirement, nature, or worthiness, especially when buying without inspecting or consulting with another expert (physician) the item beforehand. To overcome this dilemma, in today's business-mentality world, sometime the patient checks with another doctor. However, this practice is rare because of its monetary cost involvement that further costs the patient.

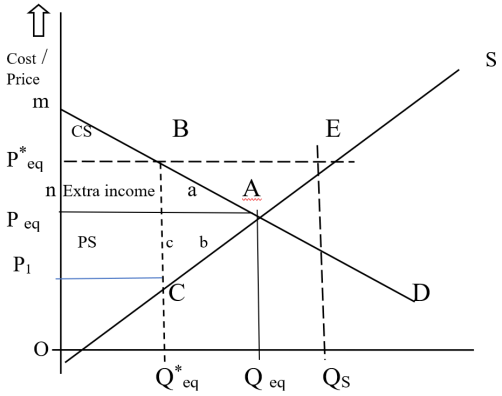
On social-cost aspect, first, doctor's services create positive externality. This is because, if the doctor would not supply medical-care services, the disease could have been spread among human-society, which would create negative social-cost. A positive externality presents itself when the influence is beneficial. This positive externality exists from others receiving health care services. Additional positive externalities include health affects wealth, technology, and vaccinations.

However, in today's medical-care service-market, a doctor's suppression creates a negative externality, which impacts the adverse, in this case the patient. This impact can be represented as

the deadweight loss, which is an outcome of inefficiency in medical-care service-market where doctor receives the benefits and patient bears the burden. It is an economic inefficiency that occurs because of a policy or an occurrence within a market, which distorts the equilibrium set by the free market.

This economic inefficiency refers to a situation where the services are being supplied and the price / cost that it is being exchanged for is not equal to the equilibrium set by the supply and demand components of that market. And on this reality in today's business-mentality era, sometimes physicians' these suppressing activities are questioned on whether there are unnecessary tests & lengthy medicine prescription. In case of Govt subsidized hospital, sometime some medicines are distributed free of cost. Here sometime doctor advice patients to visit his or her second workplace with a claim that it has better health-instruments that can be helpful for better diagnosis.

This negative externality is connected to an adverse – the patient's loss. So, the medical-care service-market witnesses deadweight loss. This is because here this added cost is a financial cost to individual patient, which creates deadweight loss where doctor, pharmaceutical companies receive the benefits. (see Figure 2)



Note: D = Demand for medical-care services; S = Doctor supplies services; P = Cost or Price for doctor's services; Q = Medical-care services; Q_{eq} = equilibrium level of services; Q^*_{eq} = services are supplied based on doctor's misuses (monopoly nature); P_{eq} = price corresponding equilibrium; Deadweight loss = Δ ABC = ½ x b x h = $\{(P^*_{eq} - p1) \times (Q_{eq} - Q^*_{eq})\} \div 2$; Where b = base x height; This deadweight loss refers to the total monetary amount of efficiency being lost, within medical-care service-mkt, because of doctors' misuse or other equilibrium distorting occurrences. In this case patient just lost it. As consequences now patient goes to doctor, if s/he is seriously ill. Whether the occurrence or policy that is causing the deadweight loss is good or bad, is subjective.

Figure 2 Graphical presentation of deadweight loss

In Figure 2, the area mnA was the initial consumer surplus (CS) where there was no misuse in medical-care service-market and then the producer surplus (PS) was area nAo. However, because of today's misuses in medical-care services, the consumer surplus reduces and the current CS = area mP^*_{eq} where $\Delta\ mP^*_{eq} < \Delta$mnA. That means patients are affected severely.

In case of service-providers, the new PS = $P^*_{eq}BCP_1$ where $\Delta\ P^*_{eq}BCP_1 > \Delta$nAo , which means services-providers or doctor are gaining, not losing in today's medical-care service-market.

For further clarity, the following can be helpful for better understanding the situation corresponding to the graph.

Before extra income CS = ΔmnA;

Before extra income PS = ΔnAo;

After doctor's extra income CS = ΔmP^*_{eq} where $\Delta mP^*_{eq} < \Delta$mnA;

After doctor's extra income PS = $\Delta P^*_{eq}BCP_1$ where $\Delta P^*_{eq}BCP_1 > \Delta$nAo;

In case of measure CS, PS and deadweight loss in numbers, the following techniques [1] can be used:

$D(x_1)\ \Delta x + D(x_2)\ \Delta x + - - - + D\ (x_n)\ \Delta x \rightarrow \int_0^{qe} D\,(q)\,dq \rightarrow$ sum gets closer and closer $\int_0^{qe} D\,(q)\,dq$ as n get larger. Thus, total amount paid at maximum prices $\int_0^{qe} D\,(q)\,dq$;

Thus CS = $\int_0^{qe} D\,(q)\,dq$ - $p_e q_e$ = $\int_0^{qe} [D\,(q)$ - $p_e]$dq

Since producer gain by trading at the equilibrium prices,

PS = $p_e\ q_e - \int_0^{qe} D\,(q)\,dq = \int_0^{qe} [pe - s(q)]dg$,

Total social gain = CS + PS = $\int_0^{qe} [D\,(q) - pe]dq + \int_0^{qe} [pe - s\,(q)]\,dq$.

If calculated total social gain values become negative, then it would be considered as social lost [1].

Here deadweight loss = ΔABC = ½ base x height. It is a triangle in which each of the angles is acute and measure is less than 90^o.So, in this case Horon's formula can be used for calculating the area of triangle. The Horon formula is $S = \frac{a+b+c}{2} \rightarrow$ Half the perimeter.

Area of triangle ABC = $\sqrt{s\ (s-a)\,(s-b)\,(s-c)}$ where s = $\frac{a+b+c}{2}$ → Half the perimeter. Here a, b and c are length of each line of the ΔABC.

Based on above calculation techniques, values of all components including CS, PS, extra income, losses to patient and deadweight losses can be calculated. Thus, in summary it can be said that here everyone loses. The service-provider, the Doctor of Medical-care services now see smaller number of patients. This is because there is higher medical-care cost, fewer individuals are coming for treatment. But monetarily they make it up with adding extra income. The patient loses since s/he cannot afford medical-care services and thus they rarely visit doctors unless the situation is life threating. And once they visit; they are required to spend more than before. This deadweight loss is visually represented by the triangle ABC, which is just gone because of medical-care service-market inefficiency, which causes externalities – *deadweight loss*.

3.3 Marginalizing the problem in today's medical-care service-market

Improving medical education with special emphasis on ethical aspects and soft skills in communication are considered important in aim to reduce the magnitudes of today's medical-care service-market dilemma. It raises question: how to strengthen the doctor–patient relationship?

It is suggested that several approaches should be followed to improve the doctor–patient relationship. It should be considered as an essential element for strengthening the medical-care services-market system. The following can be suggested:

(1) Continue teaching of ethics and medical etiquette in the medical curricula;

(2) Enforcing an ethical code of conduct amongst all health workers;

(3) Enforcing medical-care provisions strictly;

(4) Introduce online or media-based patient-education & improvement;

(5) Some systems should also be changed or introduced for shorter waiting time to see doctor;

(6) Introducing effective referral system to enable doctors to spend some more time with the patients and supplying information and help to the patients;

(7) For doctor–patient relationship improvement, all possible efforts should be harmonized. These include medical councils, medical associations, and professional bodies;

(8) Patients always have expectations to consult a doctor. They expect easy access to the doctor, quality up-do-date treatment, transparency, nondiscrimination, and a certain amount of information. These expectations should be met;

(9) Every effort should be made to promote a dialogue between doctors and patients and special platforms should be created to enable this to happen.

On healthcare insurance, medical insurance like other types of insurance has inherent problems of adverse selection and moral hazard. Moral hazard occurs with insurance where the insured take greater risks than they would do without it because they know they are protected. The idea behind adverse selection is that those who will insure are those who are the most likely to benefit from insurance. To counter the adverse selection, setting higher health insurance rates for people who are habituated to things that causes health problem.

On negative externality issues, besides other options including heavy regulations in place, there should have procedures in practice so medical-care practitioners tend to be self-regulated as it is in members' interests keeping standards high to maintain their reputation. For example, the British Medical Association in practice ensures that doctors have reached certain standards before they join the association. The association further strikes members off from the association if their performance jeopardizes patients' health.

Besides these, medical-care industry country-wise such as Bangladesh should invest for hosting conferences on the proposal where roles of World Health Organization (WHO) [24] can be crucial in practice in case of global efforts.

3.4 Who should finance or sponsor the proposed conferences?

Agenda-setting is a crucial element of the strategies that political actors pursue [18]. Agenda-setting is an important part for politicians, officials, and interest groups for policymaking. This is because getting an issue to be considered is a precondition for decision-making, which requires gaining attention of the issue.

On the same token, publication or proposal in literature does not guarantee its application or agenda setting in practice unless policymakers are engaged for designing relevant policies addressing the issue in general. The process of setting agenda for policymakers' attentions in any country goes through various challenges [19]. However, there are two distinct challenges. They are as follows:

(1) Gaining attention for the issue;

(2) Building sufficient credibility for the nation to deal with the issue for society-interest;

(3) Gaining attention is a crucial element in all agenda-setting processes.

Here mobilization of interest is what agenda-setting is about. Since this effort is parallel the theme of WHO, the WHO, Doctors Association country-wise, Pharmaceutical Company Association country-wise would contribute directly for development of policy communities by subsidizing interest groups. These groups will push for the issue at the national level. It has become a widespread practice in countries globally when it comes public interest issues [20].

Furthermore, academicians' efforts can be used hosting conferences. Their efforts on relevant publication can play significant roles spreading messages, which can be inspirational to policymakers sooner than further delays. But it must require delivering the message directly to policymakers individually. In addition, both the Doctors Association and interest groups themselves actively will try to develop networks of experts and stakeholders within its nation for relevant policy-design.

3.5 Future research

Studies can be conducted in multi-faucets examining the possibility and affects to advantageous group in medical-care service-market in cases where health insurance is in practice. However, research grants can be inspirational for investing research-efforts soon. Factor Analysis, hypothesis development & testing etc. can be conducted relates to the topic: Do doctors work for patient? Thus, the expected findings can be educational for curtailing the magnitudes to today's dilemma in today's medical-care service-market country-wise such as Bangladesh.

4 Conclusion

In today's world, people mostly behave with business-mentality where they try taking advantages without considering moral obligations in its society. In this behavioral changes, service-market, particularly Medical-care service-market is appeared to be vulnerable particularly under the pluralistic setup of community-level and facility-based services. These services are delivered by either doctors in own chamber(s) or by doctors employed by government, NGOs, and private for-profit hospitals. Because of supplying these services, the private-doctor and entity receive capitation payments, fees-for-services, risk pool settlements, incentive payments or other fees. However, today it is probably the most criticized profession in world-economy country-wise such as Bangladesh. Sometimes doctors here are blamed for requiring patients' unnecessary tests for doctor's own monetary gains. In some cases, doctors' efforts are assumed to be connecting with promotional of pharmaceutical products' by writing lengthy prescriptions. Some group claims that today doctors spend less time for each patient where they are not hesitant advising patients to visit doctor's other chamber with assurance of having available better instruments for accurate tests. And accordingly try to make more money from the same patient. All these interactions justify to claiming that a patient works for a doctor when a patient visits a doctor for medical-care services. Here service-providers i.e., doctors are professionals, but patients are not. As a result, the medical-care market lacks a vital feature - *information equally available to both buyer and seller*. Thus, the existence of "asymmetric information" dominates the medical-care market where doctor takes advantages in multi-faucets. This asymmetric information refers to service-provider's knowledge of his /her object of sale and to which the service-receiver does not have access. Because of the existence of "asymmetric information", the patients face higher prices or costs once they visit a doctor for medical-care services. It causes market inefficiency that creates negative economic externalities – *deadweight loss*. Because of these consequences, consumer (patient) surplus reduces but producer (doctor's surplus increases in medical-care service-market.

Improving medical education with special emphasis on ethical aspects and soft skills in communication are considered important in aim to reduce the magnitudes of today's medical-care service-market dilemma in Bangladesh. Furthermore, strict enforcements of medical-care provisions and ethical code of conduct among all health works can be instrumental. Finally, the answer to the question "Do doctors work for patients or patients work for doctors in today's medical-care service-market in economy country-wise such as Bangladesh?" depends on who are asked. But the reflections of today's medical-care markets *scenarios* in economy of Bangladesh are no deniable, which deserves to be studied further. Here practices in today's medical-care industry have made the doctor-patient relationship to be questionable. The expected findings can be an instrumental in multi-faucets.

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REVIEW

Recent advances in internal control: Soft control overcoming the limits of hard control

Peter Yao Lartey[1*] **Isaac Gumah Akolgo**[2] **Santosh Rupa Jaladi**[3] **Selorm Ayeduvor**[4] **Stephen Owusu Afriyie**[5]

[1] Niagara Community Observatory (NCO), Brock University, ON, Canada
[2] Simon Diedong Dombo University of Business and Integrated Development Studies, Wa, Ghana
[3] Prin. L.N Welingkar Institute of Management Development & Research, Bangalore 560100, India
[4] CSIR, Science and Technology Policy Research Institute, Cantonment, Accra, Ghana
[5] IT Business, Ghana Communication Technology University, PMB 100, Accra North, Ghana

Correspondence to: Peter Yao Lartey, Niagara Community Observatory (NCO), Brock University, ON, Canada; E-mail: vf_plartey@brocku.ca;

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Abstract: Uncertainties and risks continue to pose a threat to governance and internal control, impeding public sector modernization and essential service delivery. Attempts to develop alternative strategies to meet desired results in highly bureaucratic institutional environments such as the public sector are intensifying because ideas and principles matter. This study advances informal "soft control" as a substitute for formal "hard control" in four dimensions: (a) creates a clear difference between "soft" and "hard" control; (b) designs key determinants of informal "soft" control; (c) limitations of formal "hard" control; and (d) a conceptual framework and propositions to support future empirical research and "operationalization" of the proposed constructs. Critical observations imply that the increasing cases of corporate malpractice and consequential non-alignments with best practises in recent times are sufficient evidence to suggest that formal control is incapable of mitigating financial crimes, irregularities, and preventing complex accounting scandals classified as white-collar fraud. The causes of these control failures are attributed to overreliance on "hard control" which primarily works with sanctions and the neglect of informal control mechanisms "soft controls". This condition has limited the ability of auditors to uncover systematic failures of controls that are process-specific, resulting in a partial and incomplete evaluation of internal controls. The study assumed a theoretical approach due to the lack of existing empirical research on "soft control". However, this observations form a solid theoretical foundation for further discussions. We argue that "tone at the top," informal social control, organisational culture, ethical values, empowerment, and employee competence are effective substitutes for and complements to formal "hard" controls in preventing another Enron.

Keywords: soft control, hard control, public administration, "tone at the top"

1 Introduction

Public auditors are less likely to independently evaluate and report potential weakness of formal control when it is obvious that process-based control deficiencies remain unresolved due to management and audit committees' involvement in internal audit programs [1]. This topic is attracting growing debate as recent advances in public administration is permanently shifting towards a post-bureaucratic era, but attempts to digest the argument rather point to more controversies due to wide-ranging opinions [2]. From a public sector perspective, this study highlight key elements for unlocking extreme bureaucracy in public organizations, pointing out those measures that advance informal control, as alternative strategies for downscaling the limitations of internal control, mostly caused by coercive control which applies ; (a) control activities; (b) monitoring; (c) risk assessment; (d) control environment (e) information and communication [3].

Customarily, these tools are initiated to supervise and maintain alignment with best practices and organizational standards [4]. These principles belong to two major classifications namely; formal and informal controls, alternatively called tangible and intangible controls [5]. Examples of formal controls (bureaucratic, hard control) are; organizational structure, approval and review, audit, and segregation of duties [6]. Informal and intangible controls include "tone at the top," ethical climate, core values, organizational culture, trusting relationships, and competency. However, in this study, we argue that public organizations place too much emphasis on formal controls while devoting little or no attention to the benefits of informal controls. This stance is based on the fact that key audit programs are traditionally meant to highlight compliance

objectives thus; verifying public income expenditure statements, reconciliations of financial records and review of authorization procedures, monitoring assets acquisition, and the general idea of promoting value for money [7]. These are mostly the key factors captured in audit findings, and the results remained silent over the control environment which embodies; the organizational culture, management philosophy, core values, and competency which are equally important. We find contradiction to COSO's underlying principle, which stipulates that internal control may cease to provide full advantage if the five main components are used independently of one another. To that end, it is justified to use this research to reassess the weaknesses and limitations of formal controls and highlight the advantages of informal controls. Failure to accomplish this research objective would leave internal control being partially assessed, and it is a constraint to accomplishing organisational goals.

2 Literature review

2.1 Formal – hard controls

The definition of "formal control" (hard control) is ambiguous [8]. Earlier researchers outlined two dimensions. First, they defined the meaning of internal control and separately highlighted what makes it formal. Quite similar to Commission definition [9], formal control is documented and written standards of procedures designed to guide individuals toward a collective objective [10]. The term describes how people's behavior is influenced to achieve organizational goals along with tools to detect errors, correct mistakes, and determine punishment for wrongdoing such as fraud. According to, Ouchi [11] such control measures are explicitly visible, taught, and passed on to members of the organization. From the perspective of public organizations, formal control can be constitutional provisions and legislative instruments such as public administrative acts and laws [5]. These features characterize formal controls as bureaucratic tools in public service, similar to those applicable to industry. The universally accepted definition of internal control is the one enshrined in COSO's framework [9]. The framework consists of mechanisms that support organizations to navigate risks and advance the effectiveness, and efficiency of operations, guarantee financial reliability and promote compliance with applicable ethical standards and laws with a systematic application of its five principles [12]. To fulfill the entity's objectives, the control system must encompass; control environments, control activities, risk assessment, monitoring, and information and communication. Jensen [13], observation that "making the control systems operate effectively is a major challenge confronting the management profession" has resurfaced in management research after decades. We may interpret internal control as any available means by which management can achieve its goals, however it is widely acknowledged that internal control have frequently proven incapable and inefficient, so creating a conducive environment for managerial greed, poor governance, and fraud, such as the highly publicized global financial scandals that led to the collapse of well-known, reputable firms [14]. Experts undoubtedly anticipated more corporate scandals after what the world witnessed in; Enron, WorldCom, the Lehman brothers, Siemens, Cadbury, Kodak, and Compaq [15], if attempts to promote informal control fails to materialize.

In public administration, formal controls refer to constitutional mandates implemented by heads of public entities, through the board and executives directors to direct and strictly control people and public expenditure [5]. They are visible, written, documented, and published and circulated among members of the public and known to all civil servants. In public service, control systems mainly guard against financial irregularities, and payroll fraud, and regulate public procurement, accountability, and sound governance [16]. Some authorities argue that formal control may not be explicit, known and taught to public workers, as most civil servants only learn about misappropriation when annual audit reports detailing financial irregularity is published [17]. Nonetheless, what distinguishes formal control is the desire to collectively force compliance with specified norms, which are harshly penalized when violated.

From industry perspective, formal control have been used to achieve specific targets, thus sales targets, consumption limits, revenue, and budgeted expenditure targets, which is planned and backed by relevant authority and supervision for the accomplishment of tasks [18]. Experts suggest that the cost of installing effective control may outweigh the benefits. Audit fees, Forensic auditors, audit committees, board members' remuneration, automated controls, and other physical controls are a few examples of what makes formal control a costly program [19]. On many occasions, failure to meet high financial expectations such as revenue targets often necessitates corrective actions like pay cuts, bonus reductions, or even demotion. Controls are relevant for maintaining consistency of performance, minimizing organizational risks, and overcoming threats of fraud, misappropriation, and bad governance [20]. However, hard controls are not always effective because organizational risks are evolving and changing rapidly,

and systems of controls need to change in equal proportion to minimize the impact of those risks (Kong et al., 2018). Substantial literature implies that formal control may not guarantee absolute compliance as the global financial landscape is getting more complicated than ever [19]. According to Commission [14] the internal control framework is recommended but not mandatory. However, appraisal, evaluation, and use of controls are entirely based on judgment, context of organization and peculiar opinion of policymakers. The board's most important task is to maintain reasonable independence from management, executive directors, and other actors involved in the entity's oversight responsibility [21]. Boards and senior management executives are complicit in major corporate scandals making internal control the most vulnerable. Experts argue that an organization's survival and continuity depend on the control system. Therefore, when control mechanisms fail, the entire organization fails due to unresolved limitations of formal control [4]. Moving forward, the effectiveness of internal control requires a periodic appraisal and benchmarking with well-established international norms and frameworks, most preferably adopting cost-effective alternatives

2.2 Limitations of formal controls

There is little doubt that polarization and politicization occur in public administration due to excessive bureaucratic procedures [22]. Management accounting literature rarely emphasizes the inadequacy of formal control and how it fails to mitigate all types of corporate wrongdoing; the conversation is focused on continual evaluation to eliminate risks and propose new solutions to all categories of deficiencies [2]. Despite the set-up of internal control, an organization and its people may be vulnerable to excesses. According to Kumar and Mohan [23] control effectiveness is not permanent, thus require regular review; management procedures are critical for identifying a long-term solution to accounting and corporate scandals caused by internal control breakdowns. Today, forensic auditors are concerned and devoted to designing stiffer standards to strengthen integrity and thwart fraudulent schemes [24], however, this comes at a cost to the public budget, and yet public organizations continue to record significant accounting irregularities yearly, implying the limited strength of formal control. According to one study, stringent controls are insufficient to stop new dimensions of fraud and corporate scandals; therefore, managers must decide whether the organization's control mechanisms are too misleading or simply a formality [25]. Assessing various aspects of internal controls and determining their effectiveness and the root causes of malfunctioning components satisfies the conditions of effective controls.

Experts argue that limitations of formal control can be viewed from various angles, each of which is unique to each organizational structure. Consideration of people as a "business resource," indicates that the organization analyses employee conduct in the same way it would when acquiring new assets or managing physical resources for ultimate profit [26].

These organizations are concerned with determining what resources are required, how to obtain them, how much they will cost, and then how to use them profitably to achieve desired goals (much like fixed assets, stock, and so on) [27]. As a result, the primary aim will be to squeeze the most value and efficiency out of them (workers), most likely by squeezing their employment resources to minimize business costs. In a formal control environment, management's first job is to ascertain the organization's labor requirements, recruit for them, and manage them appropriately (hiring, relocating, and terminating) [28]. Hard control is primarily concerned with efficiency and production, not with investing in people's intangible assets. In a typical formal control environment, the organization may hire frequently and fire frequently. In an ideal scenario, the entity would oppress employees because its primary focus is on financial compensation for its members, which is linked to individual performance [29]. Another drawback of hard control is the presence of a complex hierarchical system that provides very little employee empowerment, responsibility, and authority. The absence of delegation of authority, according to Fukuyama [30] is a common occurrence.

Overreliance on formal control tools such as; monitoring, approval, segregation of duties, review, reconciliation, and internal audit, for economic results (profits), may uncontrollably turn into a system of indoctrination of people [2]. Extreme rigidity, bureaucracy of control brings frustration upon employees when poorly executed [31]. Likewise auditors turn to overlook potential red flags when overly relied on formal controls. Experts recommend automated control environment with continuous audit program to adequately handle the increasing demand for rapid fraud detection and risk assessment [20]. However, new findings show that, despite the use of advanced internal audit techniques, organizations are still unable to achieve full compliance due to time, resource, and budget constraints [24]. Internal control deficiencies have a significant impact on external auditors' reports since their judgements and opinions are significantly impacted by internal audit methods.

In practice, formal controls may have been ineffective and wilfully ignore serious errors

and misappropriations, particularly in the case of most public organizations. According to Tumwebaze, Mukyala [21] management unduly rely on formal control, allowing it to ease supervisory duties and consistency and subsequently exposing the organization to risks such as accounting fraud, errors, and avoidable liabilities. Instead prioritising "tone at the top", an ethical climate, culture, integrity, trust, and competency are commendable [26].

Evidence of collusion between employees or management, directors, and CFOs, with tendencies to undermine or bypass procedures to commit misleading reporting, is a major cause of the alarming financial irregularities in public organizations [17]. Formal control is degraded, and it demands prioritising informal control to nurture good conduct and build a culture of ethical compliance.

Few authorities argue that formal control serve as cover-up for management. It lowers their degree of responsiveness and ultimately misleading management on quality standards. To make matters worse, the installation of technology control methods renders the system open to cyber-attacks and system hacking [32]. Recent research has shown that excessive control limits individual creativity, organizational learning, and knowledge sharing. This issue not only lowers the value of human capital, but it has a detrimental impact on overall performance [33]. Excessive control restricts interaction between senior workers and inexperienced staff and ultimately limits the rapid dissemination of technical knowledge. Studies have concluded that corporate scandals are strongly influenced by management overriding well-designed control mechanisms. In some cases formal control is vulnerable when employee loyalty is divided. There is a higher probability that at a given opportunity, employees may rebel against oppressive hard controls. Interesting findings by Jarah, Zaqeeba [34] establish that misapplication of relevant controls are the causes of ineffective risk management. Finally, the most detrimental limitation of formal control occurs when two or more circumvent the purpose of controls [14], usually for motivated by greed, mistrust and lack of integrity.

2.3 Informal "soft controls"

The environment of control is a component of the COSO framework whose embedded values are under research; its main function is to establish a positive tone [2]. However, the component's significance is frequently clouded by misconceptions [35]. Soft control comprised of elements found in the control environment, described as invisible standards derived from company culture and virtues instilled in employees during induction via policy orientations [28]. The control environment serves as the foundation for the whole control program, often manifest in the governance and leadership approach and imbedded in the minds of individuals. Controlling the environment entails "operationalizing" the organizational culture and core values, emphasizing employee competence, empowerment, and satisfaction instead of financial rewards [36]. Unconsciously shared and transferable old philosophical ideas and norms among employees maintains consistency with the corporate vision and it's a typical example of soft controls that work [37]. Earlier empirical researchers categorized organizational culture, information sharing, social networks, motivation, delegation, and trust as strong determinants of individual behavior [8]. Prior study by Falkenberg and Herremans [38] observed that "coordinating individuals with disparate traits, abilities, and talents from diverse cultural backgrounds can only be accomplished through informal controls, thereby stimulating people's behavior in a way that aligns interpersonal skills among employees, in a social environment devoid of barriers to group learning and mentoring." Although informal control is not as visible as formal controls, its assessment and observation require a strong sense of judgment based on their soft components, which include management's ability to promote organizational learning, ethical values, and positive tone; commitment to ethics, empathy, and integrity; internal communication; collectiveness; and social trust [39]. As a result, businesses are turning to self-development to achieve employee satisfaction and loyalty rather than defining particular performance requirements with monetary benefits. According to experts, informal control is preferred when assessing factors influencing the attitudes of people in crucial positions in organisations through unwritten culture, as opposed to formal control, which uses explicit benchmarks to develop control systems [38]. Well-known study discovered that interpersonal connections, employee social networks, group behavior, expectations, and peer review all have a significant impact on the effectiveness of informal [40]. Similar variables featured in a knowledge management research where the researchers discovered that when employees are connected through social networks, technology tools, and organizational learning, they influence organizational knowledge [33]. Its, justifiable to imply that informal control is best described as the application of collective values guiding a group of people based on their shared beliefs, custom, and morals that are universally acceptable by members of the group or organization and it members [41]. The issue of informal control first emerged in literature but lacked maximum consideration, consensus and thorough evaluation since [42] were published. Attempts to fill

the research gap generated disagreement and full elevation, thereby being dominated by the conversation surrounding formal control [43]. Subsequent reintroduction of informal control can be traced to the environment of control.

Operationalizing control systems is based on essential elements of the entity environment, such as culture, philosophy, training, recruitment ideals, and ethics, and what instills organizational discipline [36]. Other theories argue that informal control is preferable since it is drawn from institutional culture, is intuitively integrated into employees' daily work, and encourages them to achieve the organization's purpose without being imposed or threatened with a punishment [43].

The assumptions supporting the use of formal and informal control can be categorized into economic goals—maximizing profit and opportunistic tendencies; core values—hierarchy and structure of authority; Social values define trusting relationships along the hierarchical levels, which all drive individual respect towards the institutional vision [38]. Individuals become conscious of their work culture and morals and they resort to self-control in compromising situations [2]. People act according to their ideologies and principles, which are in alignment with those of their charismatic leaders. The working environment and the social circles and personal involvement turn to influence the individual's attitudes toward the ethical values of the organization [44]. Employees are guided by internal values, which have long been utilized as an informal control.

In their research entitled "Building Your Company Vision" presence of moral values and internal beliefs encourages people work independently and decide what is beneficial for the company rather than taking orders from superiors [45]. An empirical finding concluded that corporate ethical environment, staff training have a significant relationship with quality internal control. The study further stressed that ethics is deep rooted and that promotes a positive work attitude [46]. Few years' earlier a study concluded that informal control can successfully replace formal controls based on three assumptions; there should be no condition where employees would be oppressed by actions of other employees and that management must always create a healthy working atmosphere [47]. Several notable studies concluded that behavior orientation is an essential foundation for developing the mindset of adhering to quality control processes [48,49]. Recent advances in internal control research require solid empirical evidence to establish consensus on informal controls and validate how ethical culture, voluntary moral judgment, and corporate values may eliminate bureaucratic systems in public administration.

2.4 Propositions for future empirical research

Following the global financial crisis and several high-profile corporate scandals, academics and business leaders began reviews of governance, leadership, control, and transparency policies [50]. As a result, many laws and provisions emerged aimed at preventing bad corporate behavior through stricter and more stringent regulation. However, increasing cases of financial malpractices and white-collar crimes point to the conclusion that these financial decrees have proven incapable of eliminating corporate fraud, unethical behaviour, and restoring sanity in public administration, thus introducing more research gaps to be addressed [19]. This study is aiming to formulate the key elements of informal/soft control to lay the foundation for future empirical research. The implications of developing these hypotheses are to encourage responsible accountability based on organisational cultural norms and to reduce reliance on formal control and outdated regulatory instruments that have little impact on ethical financial behaviour [15]. These hypotheses are useful tools for empirical researchers interested in investigating the impact of "soft control" but lack reasonable justification for selecting the key variables [51].

2.4.1 Proposed conceptual framework

The conceptual framework (see Figure 1) is a deliberate effort to direct researchers' attention toward a quantitative methodology technique to facilitate the advancement of empirical research and simplify the process of variable identification for this topic. These variables are drawn from a vast literature attempting to explain the significance of informal "soft control" such as hypotheses; (H1-H3) depicting ; tone at the top, ethical values and organisational culture [46]. The conceptual framework also captured "hard control" factors for consideration and re-evaluation in future study to provide new evidence.

Adopting this conceptual framework necessitates three criteria: establishing a clear purpose, consider effective and unsuccessful historical control policies. Other assumptions include industry type, external forces, institutional context, and relevant regulations.

The institutional context relates to top management's exemplary behavior, as indicated by "tone at the top," which emphasizes on managers who demonstrate commitment to alignment with best practices without resorting to sanctions. As this condition may vary across organizations, it

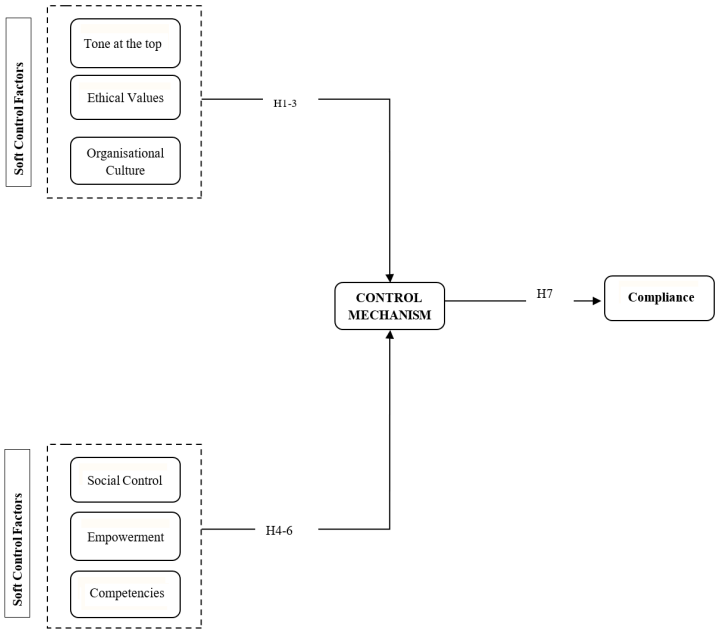

Figure 1 Conceptual framework (Source: by authors)

requires critical judgment. A broad category of variables emerged in literature and have been associated with "soft control" informal control thus; commitment to integrity, loyalty, an ethical culture, personal ideals, innovation, employee competency, information sharing, moral climates, and collective thought [52]. Hard controls, as seen in Figure 1, are fairly explicit in their goal to regulate behaviour through the framework of procedures, regulations, and standards, as well as many means of directing and influencing people's behaviours in a specific manner that requires them to adopt certain laws.

(a) Tone at the top

"Tone at the top" represent board and top managerial commitment to integrity, setting the right alignment with existing controls [14]. The public sector exists to provide essential services based on a constitutional obligation directing all public agencies headed by the boards to report to stakeholders on how public funds is spent and whether they follow specific guidelines that will ensure value for money [53]. The purpose of introducing this variable is to use quantitative methodologies to assess how management tone can represent soft control and improve ethical compliance. This variable is hypothesized as follows:

***Propositions (1)**: "tone at the top" positively enhances compliance*

The tone is established by the control environment that exists in every entity, and it is the board's obligation, as prescribed by law, to direct and correct wrongs of public institutions in accordance with key public administrative regulations [16]. The key elements embedded in to tone include prioritizing accountability, quality reporting and adherence compliance

(b) Ethical values

This hypothesis measures the extent management uses minimal rigidity and limited supervision and reflects on deep internal communication, beliefs, diversity, and social behavior that indirectly impacts productivity, creativity, and high performance [37]. Core values belong to the category of control policies that connects people by their shared morals and uses less visible measures of control. Empirical evidence is needed to validate this claim. The following hypothesis is formulated to examine the impact of ethical values on internal controls:

***Proposition (2):** ethical values positively affects compliance*

Values influence behaviour, which may be studied at both the individual and collective level. A strong balance of individual and institutional values is referred to as "person-organizational fit," also known as "congruence" [54]. The goal of this hypothesis is to demonstrate empirically how ethical beliefs encourage people to deliberately obey best practises without being coerced by rules, regulations, or prescribed penalties. Based to one study, organisations with high internally consistent values are more likely to resolve ethical conflicts. Subsequently, it was argued that ethical principles promote ethical decisions at all levels of an organisation.

(c) Organisational culture

A survey of vast literature reveal no single universal definition of organizational culture, as in

the case of leadership, except those given in contexts. According to one study, the actual benefit of utilizing organisational culture is based on the environment and ideas, as well as a conscious appraisal of the organization's culture and behaviour [26]. A very popular definition of culture is credited to Collins and Porras since 1996. Organizational culture defines the organizational behavior, philosophy, and moral standards observed by the people, including management, employees, and the board, in a manner that influences the conduct of individuals to pursue the objectives of the enterprise. Considering the wide spread of fraud and accounting scandals, with the existence of legal regulatory frameworks, "soft controls" have become essential alternative for curbing corporate malpractice. The following proposition is introduced to test the above variables:

Proposition (3): *organisational culture has a positive impact on compliance*

(d) Informal social control

According to the social disorganisation theory, social control is vital in regulating criminal behaviour and reducing crime [55]. Various definitions of social control is documented in criminology literature, while some related sources imply that social informal control reduces unethical behaviour in people and institutional contexts [56]. This hypothesis is aimed at testing how intention to voluntarily act ethically in the absence of formal controls. Informal social control uses actions such as "gossips", "peer scolding" , "group disapproval" and peer discussion all with the intention of preventing unwanted behavior [57]. Other factors affecting social control include: seeking help from neighbours to solve a problem; surveillance; and rapid contact with law enforcement and local authorities. Prior studies suggest that established social ties, shared expectations, and collective objectives are the pillars of sustaining informal social control [58]. It implies that the organisation encourage friendship ties its employees. Other factors include contributory relations with peers as it motivates intention to act [55]. As implied by the collective efficacy theory, shared expectations are a key indicator of collective norm and are likely to influence behavior. This hypothesis seeks to gain conceptual clarity about using informal control to achieve quality internal control compliance. This model has been previously examined in community regulation to maintain social order [57]. In the opinion of this study, it is important to explore whether social ties and shared expectations of employees are strong determinants of informal control ("soft control"). The "operationalization" of this variable may minimise white-collar crime in public administration.

Proposition (4): *informal social control positively impacts compliance*

(e) Empowerment

Employee empowerment originates from organisational practices that provides subordinates with the authority to take critical decisions affecting their daily functions [59]. This level of authority is sometimes derived from existing structural conditions that permit employee initiatives at every level of the organisation and not necessarily the individual traits or impact of socialization [60]. Positive indicators of empowerment include perception of working conditions, while existing knowledge classifies accessibility to growth opportunity for employees, delegation of critical functions, access to relevant information and participating in decision-making. The implication is that people are more likely to work towards the organisational objectives and willingly comply with applicable guidelines without necessarily being forced when they perceive better chances for growth and personal development, creativity and knowledge associated with the condition of the tasks [61]. Access to opportunity may arise from leadership mentoring programs, succession plans and knowledge sharing tools that advances organisational learning [33]. This process prepares employees for bigger responsibilities as they rise through the ranks. Employees also get empowered when organisations prioritize in service training such as higher education opportunities for employees to upskill periodically [62]. According to Randolph [63] employees are more likely feel empowered with timely access to vital information that provides clear guidance about the goals , policy changes and the strategic direction of the organisation. Empowered employees turn to offer maximum contribution to the goals and are able to measure their individual input with the collective achievement. The study proposes the hypothesis to investigate the association between empowerment and informal control.

Proposition (5): *employee empowerment positively enhances compliance*

(f) Competence

Sufficient evidence from empirical findings suggests that employee competence is strongly associated with organisational performance and output [64, 65], but little is documented about the relationship between competence and internal control compliance, which explains why the effectiveness of internal control deteriorates over time from weak to vulnerable. Commission's [14] elaboration adds clarity by stating that operational efficiency is reliant on the type of control measures designed and taught to employees. Studies have attempted to investigate how

employee competence affects the degree of alignment with applicable laws, best practices, and sound ethical governance and became the foundation stone for further studies [66]. Subsequent studies suggest that employee competence limits the occurrence of risks and weaknesses in the control mechanism of the entity [35]. However, further examination is necessary to determine how organisations can incorporate competency as a soft control mechanism with the following proposition;

Proposition (6): *employee competence has a positive impact on compliance*

Competence is a criterion-referenced measurement used to predict an individual's job performance [67]. The definition of competence is mostly taken in context; for example [68], define competence as knowledge accumulated from performing a cross-functional functions overtime. Miville and Duan [69] associate competence with performance success. Key features of competence include; ability to perform a task with minimum supervision and produce results with minimum errors. Competent employees often possess prerequisite capabilities, positive attributes and expertise necessary to meet organisational goals. By implication employees also understand the laws and all relevant rules and regulations guiding the entity's business.

(f) Compliance

Compliance is the result of effective internal control [5]. The theory of internal control imply that a well-designed system of control guarantees judicious utilization of assets and resources only for the purposes of the entity's activities. More specifically, compliance involves series activities that compel members of an entity to be conscious and not violate relevant laws, norms and applicable guidelines [7]. The concept of control stipulates the gravity of liability if violated. The board of directors design the governance and risk management frameworks to embody internal control when discharging their oversight duties to guard against unethical practices [24]. Historical literature emphasised that internal control compliance has always been successful with the use of sanctions associated as a disincentive or deter unwanted and unethical corporate behavior. Preventive controls mostly spell sanctions to discourage individuals from engaging in wrongdoings or taking actions that are nonaligned with the accounting and other organisational standards [5]. Internal control compliance is defined as a system where an entity maintains conformity with its strategic objectives by enforcing operational efficiency and reliable financial reporting as prescribed in relevant accounting and governance standards. Internal auditors and the audit committee of the board are directly responsible for conducting internal assessment to measure alignment and detect reasonable deviations [21]. The board's responsibility include review of control policies and tightening internal control requirements periodically. Given that existing literature has overemphasised on sanctions, which originated from the – General Deterrence Theory (GDT) that is traditionally a disciplinary measure to intimidate people from acting against a collective objective [70]. Sanctions have contributed significantly to financial discipline however, past and present corporate scandals have cast doubt on the effectiveness of sanctions which are also referred to as formal controls. Despite the significant impact of sanctions on internal control compliance, this study examines a new dimension using informal control to predict compliance. The outcome of this study will offer recommendations against the numerous findings that found a strong relationship between severity of sanctions and compliance. In this study formal control elements are replaced with informal control factors such as; empowerment, competence, ethical values, organisational culture and tone at the top among others. This is in consonance with Boss and Kirsch [71] who opined that a good reward system is a strong determinant of internal control compliance.

2.5 Advancing informal "soft control" in public administration

Table 1 emphasize key control processes and policies that regard employees as the most valuable resource and, typically, will obtain a significant competitive advantage from a human capital standpoint [28]. Table 1 implies that when top management builds contributing relationships among employees, strengthens social links, and implements a culture of shared expectations at all levels, employees are more inclined to conform to internal control. Then, among people of the same rank, peer criticism may be used to discourage unethical behavior. Furthermore, to ensure that the ethical culture is widely taught and observed by all, peer discussion may be used.

In contrast to the formal control "hard approach," soft control focuses on getting the most out of people and how they can assist the organization overcome challenges [80]. Most likely, the decision concerns policies that gets the right recruits and then developing their potential, keeping them motivated and well-organized enough to drive the organization with passion and collective thinking. This study also infer that public sector will possibly set a good tone when management exhibit ethical conduct, design a two-way communication and being conscious of their reputation when they remain consistent in their conduct. Furthermore, exemplary leadership born out of their commitment to integrity is key to achieving internal control compliance without resorting

to rigid laws and bureaucratic principles [49]. However, reward and compensation are linked to employee empowerment in this context. It implies that delegation of authority, organizational learning/upskill and promoting participative decision making are key determinants of informal control. The study also observed that, giving employees leadership roles, autonomy with consistent appraisal systems will create mutual trust. When management treat feedback and recommendation from employees as valuable, it's a positive sign of collectivity. This way employees may not rise against decisions they are part of.

Table 1 Key Variable definition and proposed measurement

Variable/Factor	Actionable tools	Literature Domain	Sources
Informal Social Control	Friendship/Social ties Contributory relations Shared expectations Peer disapproval Peer discussion	Criminology /Organisational Behavior	[55–58]
"Tone at the top"	Good conduct Two-way communication Credibility Consistency Ethical foundation Collaboration Positive Reputation Exemplary Leadership	Corporate Governance /Management /Accounting /Leadership	[14–16, 45, 46, 52, 53]
Organisational Culture	Moral framework Interest alignment Shared assumptions Free-flowing opinions Organisational learning Social Network Unified purpose Recognition & Appreciation Openness & Creativity Leadership foundation Diversity	Organisational behavior /Knowledge management /Ethics /social responsibility	[22, 26, 33, 36, 40, 47, 49, 54, 72]
Ethical Values	Trustworthiness Core morals Fairness Confidentiality Privacy Autonomy Veracity Beneficence Justice Veracity Respect & responsibility Share norms	Management /Medical Health /Ethics /Business	[37, 43, 48, 54, 73, 74]
Employee Empowerment	Delegation of authority Responsibility Leadership/Mentorship roles Organisational Learning/upskill Participative decision/criticisms Feedback/recommendations Employee autonomy Mutual trust Reward & Incentive systems Fair appraisal systems	Leadership /Governance /Strategic management / HR	[65, 75, 76]
Competence	Change management Knowledge management Succession planning Retain tacit knowledge Reward outstanding contributions Innovation Mental health programs Personality alignment Technology tools	Leadership /Governance /Strategic management /HR /Innovation /Mental Health	[33, 72, 77–79]

Source: by authors

It can be inferred that "Soft control" uses non-financial methods of rewards and motivation such as job satisfaction, working environment, culture, organizational learning, and transfer of knowledge between senior and junior employees in an apprenticeship relationship [37]. The idea of "Soft control" primarily stands for all forms of empowerments that identifies and develop employee potential towards creativity and new knowledge. With this approach, an organization turn to have flatter structures where the leadership style protects rights of employees.

3 Emerging issues and theoretical implication

Managing people in a public organization can be similar to managing bureaucracy. Public expenditure forms a substantial proportion of a country's economic growth. This makes the behavior of those in charge of executing various public spending programs a major concern in the face of transparency, governance, leadership, and controls. The method of control depends on a combination of the leadership approach and the posture of those in charge of authority. According to Weber [81] "Economy of Society", bureaucracy is the best method of maintaining law and order in a large organization, such as the public sector. It further implied that the structure of bureaucracy enhances consistency in processes when managing human institutions. This statement defines some characteristics of public control with multiple layers of legislative procedures, hierarchical powers, and excessive protocols, which are often referred to as the "iron cage of control." Emerging studies are shaping the style of management control, but major concerns remain with the public sector where most of the characteristics of bureaucracy are largely evident, such as the division of labor according to clearly defined objectives and specific goals, explicitly written formal rules, and procedures with structured guidelines and ambiguous expectations [82]. There are challenges of a long chain of command in the public sector with the decision-making authority allocated to only top executives who conduct performance measurements based on strictly on years of service without considering other motivating factors such as competencies and empowerment [38]. These approaches are not only discouraging, but oppressive, as they kill innovation and trust.

A new approach to management control is focusing on informal control "soft control" such as directors performing oversight responsibilities over management but in broad consultation, embracing diverse views and reflecting on the concerns of various interest groups both within and outside the organization, and ensuring that it maintains a fair balance between the expectations of leadership and employee development [83]. Hard controls have failed to address the increasing scale of corruption, financial irregularities, and unprofessional conduct of public sector [84]. Opined that formal control does not guarantee effective control because the influence is not permanent. However, the culture, ethical values, and social network of individuals supported by internal communication are more likely to shape the behavior of people permanently. If culture and ethical values replace excessive bureaucracy, internal control weaknesses such as management overriding and setting aside a well-designed control system in pursuit of their interests will be addressed. Furthermore, conflicts of interest, involving employees having their loyalty divided between bad management policies and their well-being, which often compel them to work against the formal control, also termed as "collision" can be eliminated. Finally, an inclusive approach where management and employees participate in change decisions, treat every opinion equally important, address differences, and offer equal growth opportunities would promote compliance with controls.

4 Conclusion

It has emerged that the few recent publications on "soft control" seem to highlight more the limitations and excessive use of hard control in organizational behavior. By utilizing culture and ethics, competence, employee and management social networks, trusting relationships between leader and team members, internal communication mechanisms, and organizational structure, this study provides an alternative practical guide for public organizations on how to incorporate soft controls into management and leadership frameworks to align people's behavior with internal control's principal objectives. The outcomes of the study highlight the need for management and the board of directors to incorporate appropriate soft controls into their internal control structures. Soft controls are an important part of the board's corporate governance, and they must always be incorporated into the tone, posture, and leadership philosophy. The entire organization will become aware of the repercussions of fraud, risk, and other corporate misdeeds if the board is committed to openness and transparency.

If the board is dedicated to developing social networks between itself and the rest of the organization, it will encourage greater collaboration and a diversity of viewpoints and opinions rather than rigid regulations that must be followed to meet deadlines [25]. The culture and

ethical principles of an organization form its identity, ensuring that all segments are aware of the values rather than defying them. Furthermore, the researchers suggest that individuals in a soft-control organization are more likely to guide one another, share experience, solve problems on the job, and generate new knowledge than they should be in a strict-control organization [85]. Hard controls, which rely on external auditors, laws, policies, supervisory procedures, standards, and management's high expectations, are significantly more expensive to implement than soft controls, which rely on effective communication with clarity, and commitment to employees' competence.

Conclusively, the study suggests that auditors reporting on the effectiveness of internal controls must attach minimum value to hard controls, which consist solely of strict standards such as organizational structure, protocols, authority and approval, and bureaucratic layers of rules, which are insufficient and ineffective in accounting for people's behavior. They can instead concentrate on organizational culture, competence, socialization, and better workforce communication. If the impact of people's conduct, which forms part of the "so-called" norms and procedures, is overlooked, audit results may be inaccurate and unscientific.

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RESEARCH ARTICLE

Research on the export competitiveness of aquatic products and its influencing factors: A case study of Guangdong Province in China

Li Huang[1] **Chengxiu Pi**[1] **Youdong Chen**[1*]

[1] Business School, Foshan University, Foshan 528000, Guangdong, China

Correspondence to: Youdong Chen, Business School, Foshan University, Foshan 528000, Guangdong, China; E-mail: 945504861@qq.com;

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Abstract: Guangdong Province is a major producer of aquatic products in China, but its export has been lack of competitiveness. Based on data of aquatic products in Guangdong Province from 2009 to 2020, this paper analyzes the export competitiveness and influencing factors of aquatic products in Guangdong Province using an extended gravitational model and result show that production factor input and high-quality production management are the core factors to enhance the export competitiveness of aquatic products. The geographical distance of importing countries and GDP per capita have a significant positive impact; The impact of the fisheries industry and construction industry is significantly positive; Whether the exporting country is an APEC has a significant negative impact, indicating that the previous trade agreements have no effect on the improvement of the export competitiveness of aquatic products in Guangdong Province over time. It has no significant impact on fish breeding area, the number of processing enterprises above designated size and the openness of foreign trade. Reducing the density of aquaculture, increasing innovation, strengthening the supervision of aquatic products and improving the supporting facilities of related industries are important measures to improve the export competitiveness of aquatic products in Guangdong Province.

Keywords: aquatic products, export competitiveness, influencing factors, Gravitational model

1 Introduction

Aquatic products are an important source of food for human beings. In the face of the current Global COVID-19 epidemic and the risk of international trade uncertainty, China's food security problems are becoming increasingly prominent, so aquatic products, as one of the main categories of agricultural products, can not be ignored in China's food security. With the rapid development of the world economy, the scale and quality of people's consumption of aquatic products are also rising, which also promotes the development of trade between aquatic products among countries. Since its accession to the WTO, China has successively ranked first in the world in terms of aquatic products producing and exporting countries, ranking first in the world in terms of production and export scale, and its exports have increased significantly. As of 2020, China's total aquatic product exports reached US$19.041 billion, an average annual increase of 11.24% compared with US$6.07 billion in 2001.

Guangdong Province is rich with water resources and has a long history of aquaculture. In 2020, the total aquatic product value of Guangdong Province reached 160.879 billion yuan, accounting for about 11.90% of the total aquatic product value of the country, ranking second in the country, and the total output scale was also close to 8.76 million tons[data source 2021 China Fishery Statistics Yearbook], and ranked first in the country, it can be said that aquatic products in Guangdong Province occupy an important position in the production of aquatic products in various provinces in China. In addition, Guangdong Province is also the largest province in China's foreign trade, ranking first in the country in terms of total foreign trade over the years. However, in the face of such strong production advantages and geographical advantages, Guangdong aquatic products have not shown corresponding export competitive advantages. In 2020, Guangdong's foreign exports of aquatic products were only 538,000 tons, far less than Shandong (944,300 tons), Fujian (826,100 tons) and Liaoning (709,200 tons) in the same period, and the export value was the same. In addition, in recent years, the export of aquatic products in Guangdong Province has continued to be affected by Sino-US trade frictions. In 2018, the United States publicly imposed a 10% import tariff on tilapia and shrimp imported from China, of which tilapia and shrimp are the top three main varieties of aquatic products production and export in Guangdong Province, and the United States is also the main target market for aquatic products exports in Guangdong Province, thus causing a strong impact on aquaculture and export enterprises in Guangdong Province, coupled with the outbreak of the new crown

epidemic in 2020, the export volume of aquatic products in Guangdong Province continues to decrease, and the export competitiveness of aquatic products in Guangdong Province needs to be improved.

By constructing the panel data of aquatic product exports and their influencing factors in Guangdong Province from 2009 to 2020, this paper uses an extended gravitational model to explore the influence of five major factors in the diamond model, including production factors, demand, corporate strategy and competition, related and supporting industries, government policies and opportunities, on the direction and size of Guangdong Province's aquatic product export competitiveness, and puts forward the specific path of aquatic product export competitiveness improvement.

2 Literature review and research hypotheses

2.1 Research on the influencing factors of the export competitiveness of aquatic products

There are many studies on the influencing factors of aquatic product export competitiveness, including qualitative or quantitative analysis from the aspect of multi-factor influence, as well as detailed research on a specific influencing factor, and from the perspective of various influencing factors, this paper divides the influencing factors of aquatic product export competitiveness into external factors and internal factors.

From the perspective of external factors, Ligeon et al. (1996) [1] analyzed the impact of catfish exported by the United States on the domestic industry from the perspective of the domestic pangasius industry, and found that the impact was not significant. Fontagné et al. (2005) [2] pointed out that the technical trade barriers of importing countries have an important impact on the export trade and international competitiveness of a country's products. Zhang et al. (2018) [3] studied the influencing factors of the "Belt and Road" of aquatic products exports in Shandong Province by constructing a trade gravity model, and concluded that the GDP, per capita consumption expenditure, and whether or not an APEC member of the "Belt and Road" importing member countries had a significant positive impact on the export of aquatic products in Shandong Province, while the factors of import and export logistics time and distance with partner countries were significantly negative, indicating that logistics efficiency and distance cost had a serious inhibitory effect on aquatic product exports. Yang et al. (2021) [4] used the constant market share model to analyze the influencing factors of the export of cephalopod aquatic products, and found that the change in international market demand has an important impact on China's export of cephalopod aquatic products. In addition, international trade frictions, especially the Sino-US trade dispute arising during the Trump administration, have also had a certain negative impact on the export competitiveness of China's aquatic products [5].

From the perspective of internal factors, Wang et al. (2016) [6] analyzed the influencing factors of China's aquatic product export competitiveness from the aspects of aquatic product production, demand, development of related industries, business strategy and competitive pressure, opportunities and government role of aquatic products according to the five elements of the diamond model, and found that the production technology level of fishery, the domestic demand for aquatic product quality, the safety production and cost of fish feed, the degree of brand cultivation of enterprises, Intra-industry competition and some accidental events have a great impact on the export competitiveness of China's aquatic products. There are also many scholars who have studied related and supporting industries based on diamond model theory: for example, the higher the level of deep processing of a product, the higher the added value of its aquatic products, which also has a significant role in promoting the competitiveness of product exports [7]. In addition, Zhang Mei (2008) [8] analyzed the impact of aquatic product processing industry, and found that the improvement of the development scale of aquatic products processing industry can significantly promote the improvement of aquatic product export competitiveness, and the degree of influence is the first, followed by technical education, aquatic product safety testing and industrial agglomeration. In addition, the performance of the logistics sector, the level of brand and processing technology are also key factors affecting the competitiveness of aquatic products exports [9, 10]. In addition, the improvement of labor productivity and the use of agricultural biotechnology are also important factors in improving the competitiveness of product exports [11, 12]. A small number of scholars have proposed the influence of price and quality factors: regarding price factors, the higher the export price of aquatic products, the higher its economic added value and competitiveness can be improved [13]; Regarding quality factors, Wang et al. (2015) [14] found that a series of quality and safety events such as drug residues and heavy metal excesses in aquatic products in China are important factors affecting the export competitiveness of aquatic products.

2.2 Research on strategies for improving the competitiveness of aquatic products

Most of the research on export competitiveness improvement strategies are based on the "diamond" model as the theoretical framework, which is specifically manifested in terms of production factors, demand, corporate strategy and competition, related and supporting industries, government, and opportunities.

2.2.1 Factors of production

Production factors mainly include the natural environment such as geography and climatic conditions required for the production of products, as well as capital, human capital, and production infrastructure. Olin's factor endowment theory points out that when a country produces its products with resource endowment advantages, its production costs are often low, and its products can obtain price competitive advantages in the international market. The richness of resource factors often has an important impact on the competitiveness of products, such as Cai et al. (2018) [15] in the analysis of the influencing factors of China's aquatic products international competitiveness found that abundant labor force and the advantages of output scale can play a significant positive role in the competitiveness of China's aquatic products. In recent years, the impact of production factors on product competitiveness has also attracted much attention from academic circles. Xu et al. (2020) [16] also pointed out when analyzing the export situation of aquatic products in China, which has seriously squeezed the living space of aquatic products due to the decrease in the area of aquatic products year by year, resulting in a serious lack of competitiveness in the development of aquatic industry. In addition, the technical level of aquaculture, the cost of agricultural inputs, and the management aspects also have an important impact on the improvement of aquatic export competitiveness [17]. Teng et al. (2021) [17] believe that technological innovation should drive the development of the aquaculture industry to high quality, so as to increase the technical content of products and maintain competitive advantage. In addition, Shao et al. (2020) [18] also emphasized that improving aquatic infrastructure and improving the quality and technical level of managers are conducive to the improvement of aquatic product competitiveness, based on this, this paper puts forward a research hypothesis 1.

Hypothesis 1: When other conditions remain unchanged, increasing the input of production factors has a positive impact on the export competitiveness of aquatic products.

2.2.2 Demand side

The diamond model points out that demand factors mainly involve two aspects: domestic and foreign. The consumer demand in domestic and foreign markets will stimulate aquatic enterprises to continuously carry out technological innovation and change production methods, thereby improving the competitiveness level of aquatic products in the international market. Jiang et al. (2016) [19] believe that if the overall quality of the product is higher than the average quality of such products in the world, and the quality premium is achieved, it can indicate that the products of the country or region have export competitiveness, so it can improve the quality of domestic aquatic product demand, and then stimulate domestic aquatic production enterprises to improve product quality and improve export competitiveness through technological innovation. In addition, aquatic export enterprises should also get rid of the defect of simplification of export markets, and actively explore foreign markets and expand foreign demand by taking advantage of product diversification, informatization and sales channel diversification [20]. Generally speaking, the higher the level of economic development of a country's domestic and foreign importing countries, the stronger the consumption power of products, which is conducive to the improvement of product export competitiveness [21]. Regarding the impact of consumer demand in the domestic market, some scholars believe that the domestic consumers' demand for product quality will stimulate domestic production enterprises to actively improve product quality, and then promote the improvement of the export competitiveness of their products [22]. In contrast, the quality and safety standards of aquatic products in the international market, especially in developed regions, are often higher than those in China, so its higher quality standards will also affect the export of aquatic products in China and the competitiveness level in the market [23]. Based on this, this paper proposes a research hypothesis 2.

Hypothesis 2: When other conditions remain equal, the expansion of domestic and foreign consumer demand has a positive impact on the improvement of the competitiveness of aquatic exports.

2.2.3 Related and supporting industries

The export trade of aquatic products involves a series of industrial processes, and a perfect industrial chain will not only greatly reduce production costs, but also improve the quality of

aquatic products, thereby enhancing its export competitiveness. For example, fishery insurance and financial services related to aquatic product production will also profoundly affect their export competitive advantage [6]. Some scholars pointed out that the development level of international logistics also has a significant positive impact on the export of aquatic products, and the higher the level of logistics development, the lower the transportation cost, which is more conducive to the improvement of the price competitive advantage of aquatic products in the international market [3]. Based on Han (2014) [24], which believes that vigorous efforts should be made to develop the aquatic product processing industry, improve the level and efficiency of export logistics services, and improve the construction of logistics infrastructure, this paper puts forward a research hypothesis 3.

Hypothesis 3: When other conditions remain unchanged, the improvement of the development level of related and supported industries has a positive effect on the export competitiveness of aquatic products.

2.2.4 Corporate strategy and competition

Porter pointed out that the competition and business strategy of enterprises are important factors affecting the competitiveness of enterprises' products. Regarding corporate strategy, such as the brand strategy of enterprises often plays an important role in the improvement of product export competitiveness, enterprises with brand advantages often give priority to consumers in the international market, may also cause consumer loyalty, so as to have more competitive advantages than other products. Sun (2005) [22] shows that cultivate competitive key aquatic product export enterprises, increase business entities, improve the level of intra-industry competition, and force aquatic products enterprises to increase investment research on production factors, so as to continuously improve the competitiveness level of products. In addition, the competitive pressure from the same industry will continue to motivate enterprises to improve product quality, reduce costs, and thus have greater price competitive advantages in the international market [20], but this is in the long run, in the short term, the greater the competitive pressure of general enterprises, it may weaken the export competition of enterprises. Based on this, this paper proposes a research hypothesis 4.

Hypothesis 4: When other conditions remain unchanged, the competitive pressure of enterprises has a negative effect on the improvement of aquatic product export competitiveness.

2.2.5 Opportunities and government support

According to the theory of competitive advantage, in addition to the above four main factors, the competitive advantage of products is also affected by two auxiliary factors: government and opportunity. Cooperation and exchanges between countries, the signing of trade agreements, and the reduction of tariffs and non-tariff barriers may become competitive factors for the export of products from a country or region [25], including the role of the government. The government is mainly reflected in the policy support, legal protection and information platform construction of production enterprises, which is to assist the external development of enterprises, which is also a major competitive advantage for export enterprises in the international market [26]. The government should increase policy guidance and financial support for aquatic enterprises, cultivate professional aquatic technical personnel, assist enterprises to introduce advanced production and aquaculture technologies, and encourage private financing [26]. At the same time, Chen et al. (2018) [27] pointed out that the government should strengthen the quality supervision of aquatic products, including comprehensive quality control of the production, processing and transportation of aquatic products, and promote the quality of China's aquatic products to meet the testing standards of importing countries, so as to enhance the export competitiveness of aquatic products. Zhang et al. (2020) [13] believe that China's aquatic enterprises should fully seize the opportunity and actively expand exports to countries that have established free trade agreements with China, so as to obtain the competitive advantage of export products. Based on this, this paper proposes a research hypothesis 5.

Hypothesis 5: When other conditions remain equal, enterprises' grasp of opportunities and government support have a positive impact on the improvement of aquatic product export competitiveness.

3 Methodology

3.1 Model construction

The trade gravitational model is derived from the law of universal gravitation in physics, which was proposed by foreign economists Tingbergen and Poyhonen when studying international trade. Subsequently, after a large number of scholars expanded and applied it, and new variables were continuously introduced, the expanded gravitational model was formed, and the

analysis was more comprehensive and detailed, and the accuracy was constantly improving. The dependent variable of the trade gravity model is the total amount of exports, and the export amount can reflect the market share of a country's export of a commodity, which in turn can represent the level of export competitiveness of a country's products. In addition, the export of aquatic products is also greatly related to the export distance and the level of economic development abroad, so it is more appropriate to use the gravitational model. Therefore, this paper draws on Guo (2019) [28] research on the influencing factors of international competitiveness, introduces other factors affecting the export competitiveness of aquatic products on the basis of the gravitational model, and constructs an extended version of the gravitational model to analyze the influencing factors of aquatic product export competitiveness in Guangdong Province. The specific model equation is as follows:

$$\begin{aligned}\mathrm{LnEXP_{ijt}} = \beta_0 + \beta_1 \mathrm{LnSqua_{it}} + \beta_2 \mathrm{LnPri_{jt}} + \beta_3 \mathrm{LnPergdp_{jt}} + \beta_4 \mathrm{LnDis_{jt}} + \\ \beta_5 \mathrm{LnSecon_{it}} + \beta_6 \mathrm{LnNum_{it}} + \beta_7 \mathrm{t} \times \mathrm{APE} + \beta_8 \mathrm{LnOpen_{jt}} + \epsilon_{ij}\end{aligned}$$

Among them, EXPijt represents the total export of aquatic products from Guangdong Province to the export area, i represents Guangdong Province, j represents the export area, t represents the year, and $\beta 0 \sim \beta 8$ is the coefficient of each variable. Squait represents the aquaculture area in Guangdong Province; Priijt indicates the average export price of aquatic products exported by Guangdong Province in the J region; Pergdpjt represents GDP per capita in the T Year j region; Disjt indicates the distance between Guangdong Province and J region; Seconit indicates the output value of the fishery industry and construction industry in Guangdong Province; Numit indicated the number of aquatic product processing enterprises above designated size in Guangdong Province in t; APE indicates whether the exporting country is a member of the Asia-Pacific Economic Cooperation (APEC), and t*APE indicates the interaction of time trends with APE; Openjt indicates the openness of the export region J, and uij is the residual term. Regarding the selection of gravitational model indicators, it should be noted that: according to the research content of this paper, because the trade side is fixed as Guangdong Province, for other regions of export, the GDP value of Guangdong Province is fixed and therefore omitted. By taking the corresponding logarithm of each variable, the data can be smoothed and the situation of large difference in the magnitude of each variable can be eliminated, except for t×APE.

3.2 Sample selection

Based on the completeness and availability of sample data, this paper selects the data of Guangdong Province and its aquatic products exports from 20 major regions from 2009 to 2020, including the United States, Kenya, Canada, Indonesia, Australia, Italy, Mexico, Hong Kong, New Zealand, Japan, Macao, Malaysia,Republic of Côte d'Ivoire,Singapore, Thailand, Russia, Taiwan, Zambia, the Philippines and Chile. The total amount of aquatic products exports in Guangdong Province accounts for more than 85% of the total aquatic products exports of Guangdong Province over the years, and the data of these 20 countries are relatively complete and the sample representation is good.

3.3 Selection of indicators for variable measurement

The indicators of the variables in this paper are selected with reference to the five major influence levels in diamond model theory and the gravitational model. Based on the availability and completeness of the data, the explanatory variable in the empirical model in this paper is the export value of Guangdong Province to various countries, reflecting the size of export competitiveness [29]. A total of eight indicators of the selected influencing factor explanatory variables are shown in Table 1.

3.3.1 Measurement of production factors

In this paper, the aquaculture area (Squa) and the average export price of aquatic products (Pri) in Guangdong Province are selected. First of all, according to the special instructions of the "Central Document No. 1" in 2022: "To stabilize the aquaculture area and improve the quality of fishery development", it can be seen that the increase in aquaculture area will inevitably play a role in stabilizing the production and export of aquatic products, so its export competitiveness tends to be stronger. It is expected that the impact on the competitiveness of aquatic exports will be significantly positive. In addition, the average export price of aquatic products can reflect the technical content and added value of aquatic product production, and the higher the average export price, the higher the added value and better quality of the exported product, and therefore the higher the competitiveness level of the export product [30], and the expected impact is positive.

Table 1 Meaning and expected symbols of explanatory variables

Influencing factors	Indicator selection	Meaning	Theoretical description	Expected impact
Factor of production	$Squa_{it}$	t annual aquaculture area in Guangdong Province	The larger the aquaculture area, the more aquatic products can be exported and the stronger the export competitiveness	+
	Pri_{ijt}	Average price of aquatic products exported in j region of Guangdong Province	The higher the export price of aquatic products, the higher the product quality and the stronger the export competitiveness	+
Demand elements	$Pergdp_{jt}$	Export region j in t annual GDP per capita	The higher the per capita GDP of the exporting area, the better the economic development and the greater the demand for aquatic products	+
	Dis_{ijt}	The distance of Guangdong Province from each export area in t year	The closer the distance, the lower the cost, the more conducive to the export of aquatic products	–
Related and supporting industries	$Secon_{it}$	The output value of fishery industry and construction industry in Guangdong Province t year	The higher the development level of related industries, the more conducive it is to the development of the aquaculture industry and the enhancement of its competitive advantages	+
Competitive pressures on businesses	Num_{it}	The number of aquatic product processing enterprises above designated size in Guangdong Province	The greater the number of enterprises above designated size, the greater the competitive pressure of enterprises, which may improve competitiveness in the long run, but restrict exports in the short term	–

3.3.2 Demand element measurement

In this paper, the per capita GDP (Pergdp) and geographical distance (Dis) of the exporting countries of Guangdong Province reflect the influence of international demand, and these two factors are also the influencing factors included in the gravitational model. The per capita GDP of the exporting country can reflect the consumption capacity and level of the aquatic product exporting country, the higher the economic development level of the exporting country, the stronger the demand for aquatic products, so for the country with the higher the per capita GDP, the greater the competitive advantage of aquatic products export in Guangdong Province. The expected impact is positive. In addition, for the distance factor (Dis), this paper draws on the practice of Jiang et al. (2011) [31], uses the geographical distance between Guangzhou, the capital of Guangdong Province, and the capital of various countries (regions), and adjusts the weight of international crude oil prices. For countries closer to Guangdong Province, the transportation cost and preservation cost of aquatic products are low, so the higher the foreign demand, the stronger the export competitive advantage. The expected impact is negative.

3.3.3 Relevant and supporting industry measurement

This paper selects the Gross Domestic Product of Fishery Industry and Construction Industry (Secon) of Guangdong Province to reflect the development of related industries of the fishery industry, the higher the development level of the fishery industry and the construction industry, the more conducive it is to the production and development of the aquaculture industry, which in turn can enhance the export capacity of products and improve their export competitiveness. The expected impact is positive.

3.3.4 Intra-industry competition measurement

Since the influencing factors at the strategic level of enterprises are difficult to quantify, and based on the principle of data availability, this paper selects the number of processing enterprises above designated size (Num) of aquatic products enterprises in Guangdong Province as the index of enterprise competitive pressure, the main body of aquatic industry mainly includes production and processing industry, the more the number of aquatic product processing enterprises above designated size, the greater the competitive pressure in the same industry, and enterprises will be forced to improve the competitiveness level of products under competitive pressure. It is expected that the impact on the export competitiveness of aquatic products in Guangdong Province will be positive.

3.3.5 Measurement of opportunities and government support

Select whether it is the interaction item of APEC with time trend (t×APE) and the openness (Open) index of aquatic exporting countries. Drawing on the selection criteria of Dong et al. (2002) [31] and Jiang et al. (2011) [32], the product of the selection of APEC members and the time trend reflects the time when the exporting country becomes an APEC member, the longer the time, the closer the trade relationship, the more conducive to the export of products, so for the region that has been a member of the Asia-Pacific Economic Cooperation for a longer time,

Guangdong Province has a higher export competitiveness of aquatic products to the region. The expected impact is positive. In addition, the degree of openness of the importing country also has a greater impact on the export of products, which is equal to the proportion of total imports and exports to GDP. The higher the degree of openness of aquatic product importing countries, the more conducive it is to foreign trade, and the stronger the competitive advantage of products in this country [25]. It is expected that the impact on the export competitiveness of aquatic products in Guangdong Province will be significantly positive.

3.4 Data sources

The data of aquatic product exports, average export prices, per capita GDP of exporting countries, openness of exporting countries, international crude oil prices and whether it is a member of the Asia-Pacific Economic Cooperation in Guangdong Province from 2009 to 2020 are all from the national research network, and the aquaculture area, the number of aquatic product processing enterprises above designated size, fishery industry and construction industry in Guangdong Province over the years are all from the 2009-2020 China Fishery Statistics Yearbook. The geographical distance is calculated based on the distance calculator on the TimeandDate website.

4 Empirical analysis and discussion

4.1 Descriptive statistics, correlation analysis and multicollinearity testing of variables

4.1.1 Descriptive statistics of variables

Table 2 shows the statistical descriptions of the related variables.

Table 2 Statistical descriptions of variables

Variable	Number of Samples	Mean Value	Standard Deviation	Minimum	Maximum
Lnexp	240	17.476	1.937	7.631	20.639
LnSqua	240	13.189	0.082	13.068	13.262
LnPri	240	-0.556	0.725	-5.233	2.480
LnPergdp	240	9.552	1.325	6.879	11.449
LnDis	240	12.463	1.472	8.391	14.534
LnSecon	240	15.091	0.131	14.863	15.295
LnNum	240	4.988	0.082	4.852	5.182
t*APE	240	17.200	11.728	0.000	56.000
LnOpen	240	-0.556	0.724	-1.694	1.435

4.1.2 Correlation analysis

The correlation test of each variable data in this paper (see Table 3) by stata 15.1 shows that the dependent variable has a strong correlation with the selected 8 independent variables, which indicates that the regression in this paper has certain significance and can be further explained by regression.

Table 3 Correlation analysis of variables

Variable	LnExp	LnSqua	LnPri	LnPergdp	LnDis	LnSecon	LnNum	t*APE	LnOpen
LnExp	1.000								
LnSqua	-0.192 ***	1.000							
	0.003								
LnPri	0.378 ***	-0.032	1.000						
	0.000	0.618							
LnPergdp	0.419 ***	-0.033	0.490 ***	1.000					
	0.000	0.608	0.000						
LnDis	-0.285 ***	0.120	-0.026	-0.248***	1.000				
	0.000	0.064	0.685	0.000					
LnSecon	0.248 ***	-0.646 ***	0.202 ***	0.055	-0.075	1.000			
	0.000	0.000	0.002	0.399	0.246				
LnNum	0.200 ***	-0.897 ***	0.039	0.026	-0.152**	0.666 ***	1.000		
	0.002	0.000	0.544	0.686	0.018	0.000			
t*APE	0.493 ***	-0.172 ***	0.464 ***	0.371***	-0.114	0.183***	0.178*	1.000	
	0.000	0.007	0.000	0.000	0.077	0.005	0.086		
Variable	LnExp	LnSqua	LnPri	LnPergdp	LnDis	LnSecon	LnNum	t*APE	LnOpen
LnOpen	0.138 **	0.513	0.023	0.016	-0.334***	-0.032	-0.057	0.246 ***	1.000
	0.033	0.429	0.723	0.805	0.000	0.624	0.377	0.000	

Note: *, **, *** represent significance test levels of 10%, 5% and 1%, respectively

4.1.3 Multicollinearity test

As shown in Table 4, the multicollinearity test results show that the mean variance inflation factor for all independent variables is 2.51, which is much less than 10. Therefore, there is no serious collinearity problem between the independent variables of this model, and further regression analysis can be performed.

Table 4 Multicollinearity test results

Variable	VIF	1/VIF
LnSqua	5.29	0.19
LnNum	5.63	0.18
LnPri	1.62	0.62
LnSecon	1.96	0.51
t*APE	1.50	0.67
LnPergdp	1.51	0.66
LnOpen	1.26	0.79
LnDis	1.28	0.78
Mean VIF	2.51	–

4.2 Analysis of empirical results

The extended gravitational model was tested for F, LM and hausman tests using Stata 15.1 software. For the panel data model, the first is the mixed effects test, and the results show that the model has individual effects, that is, the rejection of mixed regression, and the second step is the individual random effects and mixed regression selection of the model, and the P value is 0.000, which also significantly rejects mixed regression. Further is the random-effects test for individual effects, where the P-value is still 0.000, indicating that the model strongly rejects random effects and should choose fixed effects. Therefore, a fixed effect was selected for final regression of the model, and the results are shown in Table 5.

Table 5 Fixed-effect regression results

Variable	Coefficient	Standard deviation	t-value	P-value
LnSqua	-1.313	1.734	0.760	0.450
LnPri	0.221*	0.128	1.730	0.085
LnPergdp	2.792***	0.657	4.250	0.000
LnDis	-0.939***	0.316	-2.970	0.003
LnSecon	3.264***	0.810	4.030	0.000
LnNum	1.533	1.704	0.900	0.369
t*APE	-0.205***	0.038	-5.470	0.000
LnOpen	0.762	0.753	1.010	0.313

Note: *, **, *** indicate significance test levels of 10%, 5% and 1%, respectively

Based on the above regression results, it can be further explained as follows:

First, the impact of aquaculture area on its export competitiveness is negative and insignificant, which is not in line with theoretical expectations. However, the average export price of aquatic products has a significant positive impact on the export competitiveness of Guangdong Province, and has passed the significance test level of 10%, which is in line with expectations. The possible reason is that the increase in aquaculture area has not changed the production mode of aquatic enterprises in Guangdong Province, and it still maintains an extensive traditional production mode, lacking technology and quality improvement, so its export competitiveness cannot be improved. Specifically: on the one hand, Guangdong Province is also a large consumption province of aquatic products, with a large population, a high demand for aquatic products, and domestic food safety supervision is far less stringent than that exported abroad, so most of the aquatic products produced by local aquatic enterprises tend to be sold to the province or other parts of the country. Due to the low food safety testing standards of aquatic products in the province, the high export costs, insufficient profits, and even the risk of being returned by customs, many aquatic products enterprises in the province are reluctant to export abroad, resulting in the export of aquatic products in Guangdong Province has not made substantial progress. However, for every 1% increase in the average export price of aquatic products, the export value of aquatic products from Guangdong Province also increased by 0.22%. This shows that the higher the export price of aquatic products, the added value and quality of export products can be improved, and then it can occupy more overseas markets, and the export competitive advantage can also be enhanced. At present, Guangdong Province's aquatic products are still dominated by primary production factors, mainly frozen fish and frozen fish fillets with low added value and low price, and the export competitiveness of aquatic products is

gradually decreasing, so Guangdong Province should continuously improve its export added value and cultivate high-level production factors, so as to increase the price of export products and win competitive advantage. Hypothesis 1 is partially validated.

Second, the per capita GDP of the exporting country has a significant positive relationship with the export competitiveness of aquatic products in Guangdong Province, and the geographical distance of the exporting country has a significant inverse relationship with the export competitiveness of aquatic products in Guangdong Province, which is in line with theoretical expectations. Every 1% increase in the per capita GDP value of Guangdong aquatic product exporting countries can increase the export value of aquatic products in Guangdong Province by 2.79%. The higher the economic development level of the aquatic products importing countries in Guangdong Province, the stronger the desire for consumer demand for aquatic products, which will also expand the import value of aquatic products. With the continuous development of the economy, the demand for aquatic products in the international market will be increasing, but at the same time, the quality standards for aquatic products demand are getting higher and higher, therefore, Guangdong Province should actively expand the aquatic products market of overseas developed countries, and at the same time enhance the concept of innovative development and continuously improve product quality, so as to continue to maintain a competitive advantage in the international market. The geographical distance of the exporting country has a significant inverse relationship with the export competitiveness of aquatic products in Guangdong Province, and it has passed the significance test level of 5%. For every 1% increase in geographical distance between Guangdong Province and exporting countries, the level of competitiveness of aquatic products exports decreased by 0.94%. The longer the trade transportation distance means the higher the cost of transportation of the product, the longer the time, and for aquatic products such perishable, deteriorated products, especially the export of aquatic products in Guangdong Province is mostly fresh fish, shrimp-based, the processing industry is underdeveloped, in the long-distance transportation, the higher the requirements for preservation technology, so for countries that are far away, the export competitiveness of aquatic products in Guangdong Province is often low. Hypothesis 2 is validated.

Third, the output value of fishery industry and construction industry has a significant positive impact on the export competitiveness of aquatic products in Guangdong Province, and has passed the significance test level of 1%. The empirical results show that for every 1% increase in the output value of the fishery industry and construction, the export value of Guangdong Province increased by 3.26%. This shows that the development level of fishery-related industries plays an important role in improving the competitiveness of aquatic exports. In addition, Guangdong's fishery industry and construction industry are still far behind other large fishing provinces. Although Guangdong Province ranked first in fishery production in 2020, the output value of its fishery industry and construction industry was only 43.915 billion yuan. Far less than Shandong (140.667 billion yuan) and Fujian (112.787 billion yuan), which shows that the low level of development of relevant industries in Guangdong Province is also an important aspect that restricts its export competition, so Guangdong Province should pay full attention to this factor to improve the development level of its fishery industry and construction industry, so that the export competitiveness of its fishery industry can be improved. Hypothesis 3 is validated.

Fourth, the number of aquatic product processing enterprises above designated size has a positive impact on the export competitiveness of aquatic products in Guangdong Province, but the results are not significant, which may be because the number of aquatic product processing enterprises in Guangdong Province is still small, and the traditional extensive processing mode is still maintained, although there is a slight increase in scale, but it is still unable to enhance the export competitiveness of aquatic products in Guangdong Province as a whole. Specifically, as shown in Table 6, from 2016 to 2020, the average number of aquatic product processing enterprises above designated size in Guangdong Province was only 178, far less than other major fishery provinces in China, although the number of aquatic scale enterprises in Guangdong Province in the past five years has maintained an overall upward trend, but the increase is small, and the average annual increase of only 3 aquatic product scale enterprises, so the improvement of the competitiveness of aquatic products export in Guangdong Province is not significant. Therefore, although the output and output value of aquatic products in Guangdong Province are relatively high, the number of large-scale processing enterprises that can really support their export in the international market is small, and the competitive pressure between the overall enterprises is naturally small, which makes it difficult for Guangdong Province's aquatic products to have strong competitiveness in the international market. Hypothesis 4 is not validated.

Fifth, whether it is a member of the Asia-Pacific Economic Cooperation (APEC) has a significant negative impact on the export competitiveness of aquatic products in Guangdong Province and has passed the significance test of 1%, which is contrary to theoretical expectations.

Table 6 Number of aquatic product processing enterprises above designated size in Guangdong Province and major coastal provinces (units)

Region	2016	2017	2018	2019	2020	Average value
Guangdong	145	163	156	166	178	162
Shandong	657	575	547	548	520	569
Fujian	406	400	401	403	387	399
Zhejiang	281	276	261	247	288	271
Liaoning	375	369	320	335	316	343

Source: China Fishery Statistics Yearbook 2017-2021

The coefficient of whether it is a member of APEC is significantly negative, which means that the role of APEC in promoting bilateral trade will gradually decline over time. The possible reason for this is that regional economic cooperation can indeed achieve trade facilitation and liberalization to a certain extent, but at the same time, with the accumulation of time, the trade potential of the two sides is gradually tapped, so that the space for improvement in aquatic product trade is gradually reduced, and the export competitiveness is gradually weakened. Therefore, Guangdong Province should strengthen its grasp of the latest trade agreement opportunities and proactively adjust its target export markets, so as to play its role in promoting the competitiveness of aquatic products exports. The openness of exporting countries has no significant impact on the export competitiveness of aquatic products in Guangdong Province, which is inconsistent with theoretical expectations. The degree of openness reflects a country's trade policy, the higher the trade volume, the higher its degree of openness, the theoretical more conducive to the export of aquatic products in Guangdong Province, but the empirical results are not consistent, the reason may be that with the rapid development of the world economy, although the degree of openness of the world to the outside world has gradually increased, and aquatic products as a large category of agricultural products, play an important role in their own food security, so countries will also formulate corresponding trade protection measures according to the development of their own aquatic enterprises, etc. Therefore, the more open the country, the stronger the import demand for imported aquatic products. Hypothesis 5 is not validated.

5 Conclusions and recommendations

This study uses the relevant data of aquatic products in Guangdong Province from 2009 to 2020, and uses the extended gravity model to conduct an empirical study on the export competitiveness of aquatic products in Guangdong Province and its influencing factors. The research results show that, first, the average aquaculture area and export. The regression results of prices comprehensively show that the input of modern advanced production factors and high-quality aquatic product production are the core elements to enhance the competitiveness of aquatic product exports in Guangdong Province; second, the geographical distance of importing countries and the regression results of per capita GDP are significant, It shows that countries with closer distances and higher levels of economic development have greater import demand for aquatic products in Guangdong Province. Therefore, the distance and economic level of importing countries are also important factors for the export competitiveness of aquatic products in Guangdong Province; third, fishery industry and The impact of the construction industry is significantly positive, reflecting that the higher the degree of fishery support industry development, the stronger the promotion effect on the competitiveness of aquatic product exports; fourth, the number of processing enterprises above designated size is not significant in the regression results, which may be due to the fact that Guangdong Province has There are few aquatic product processing enterprises with a certain scale in the past, which is not enough to promote the improvement of aquatic product export competitiveness; fifth, the impact of whether the exporting country is Asia-Pacific Economic Cooperation is significantly negative, indicating that over time, previous trade agreements have a negative impact on The improvement of Guangdong's aquatic product export competitiveness has no effect; sixth, the trade openness of importing countries has no significant impact on the improvement of Guangdong's aquatic product export competitiveness. Based on the above research conclusions, this paper puts forward the following countermeasures and suggestions.

First, reduce the breeding density, increase innovation and improve the quality of aquatic products. The empirical results show that the traditional primary production factors are no longer enough to support the further improvement of the export competitiveness of aquatic products in Guangdong Province. Only by producing high-quality products can the core competitiveness of aquatic product exports be re-established. Over the years, the export of aquatic products in Guangdong Province is still mainly based on the production of primary factors. Although the

production and export scale advantages are large, the quality of exported aquatic products is low and insufficient, which leads to its low level of competitiveness in the international market. Therefore, aquatic products enterprises in Guangdong Province should optimize the input of production factors, reduce the density of aquaculture, and increase the development space of aquatic products.

Second, strengthen the safety supervision of aquatic products and enhance consumers' food safety awareness. Improving the production quality of aquatic products is inseparable from the guidance and supervision of the government and relevant departments. Due to the current domestic food safety testing standards for aquatic products are generally low, and consumers do not pay enough attention to the consumption safety of aquatic products, resulting in irregular farming in most aquatic enterprises in Guangdong Province, and fishery drugs often exceed the standard. In contrast, foreign countries, especially the developed regions where Guangdong's aquatic products are mainly exported, have extremely strict safety testing standards for aquatic products, which also makes it difficult for most aquatic products in Guangdong to pass customs and cause losses. Therefore, the Guangdong provincial government should increase the safety supervision of the entire aquatic industry, actively call on consumers to enhance their awareness of aquatic product safety consumption, and improve the demand quality of aquatic products in the province. its market competitiveness.

Third, improve related industrial facilities and promote the upgrading of the aquatic industry chain. The empirical analysis shows that the improvement of the development level of related industries in the aquatic industry has a significant role in promoting the export competitiveness of aquatic products in Guangdong Province. Through the improvement of supporting industries related to aquatic products, the upgrading of the entire upstream, midstream and downstream industrial chains of the entire aquatic industry will be promoted, which will play an important role in promoting the production, export and competitiveness of aquatic products. First, innovate fishery insurance related to aquatic products. As an important supporting industry for aquatic product production, fishery insurance also plays an important role in improving its export competitiveness, such as climate index insurance, cost index insurance and fish feed price index insurance for aquatic products. In particular, fishery feed price index insurance, whose feed ingredients mainly include corn and soybean meal, has a relatively high risk for its frequent price fluctuations, and fishery insurance can effectively reduce production risks. Secondly, vigorously develop the aquatic product processing industry and support leading processing enterprises to become bigger and stronger. Guangdong Province should increase investment in research and development, actively explore deep processing technologies, and increase the long-term transportation and preservation period and added value of aquatic products, thereby enhancing its export competitiveness. At the same time, the government should actively help aquatic enterprises to expand financing channels, guide various types of capital to invest in the fishery industry, and adopt favorable policies to lower interest rates for enterprises and loans, so as to promote enterprises to expand their operations, gradually get rid of government financial subsidies and policy dependence, and then promote the export of aquatic products high-quality development. Finally, actively promote the construction of fishery industry and construction industry. Based on the analysis of empirical results, it can be seen that the development level of fishery industry and construction industry in Guangdong Province is low, and it has a significant positive impact on the competitiveness of aquatic product exports. Therefore, Guangdong Province should increase investment in fishery industry and construction industry, including The investment in fishing equipment, fishery medicine and fishery feed will comprehensively improve its industrial development level, which in turn is conducive to the improvement of Guangdong's fishery competitiveness.

Fourth, actively integrate into regional free trade zones and expand market space. Although the empirical results show that opening to the outside world and joining the OECD did not improve the export competitiveness of Guangdong's aquatic products, but with the full implementation of RCEP, it will greatly promote the trade of countries in the region. Guangdong Province must actively take advantage of its endowment advantages of a large aquatic province and rich water resources, actively expand the regional market to continuously improve the competitiveness of aquatic products.

Author contributions

Conceptualization: Li Huang and Youdong Chen;
Methodology: Youdong Chen;
Software: Youdong Chen;
Validation: Youdong Chen;
Formal analysis: Chengxiu Pi;

Investigation: Chengxiu Pi;
Resources: Youdong Chen;
Data curation: Youdong Chen;
Writing–original draft preparation: Youdong Chen;
Writing—review and editing: Li Huang;
Visualization: Youdong Chen;
Supervision: Chengxiu Pi;
Project administration: Li Huang;
Funding acquisition: Li Huang.
All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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Data availability statement

The data used by this study are publicly available at https://www.drcnet.com.cn/www/int were accessed and downloaded in December 2021.

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RESEARCH ARTICLE

How does industrial agglomeration affect firm performance of Chinese high and new technology industry?

Qianfei Shu

College of Foreign Studies, Kansai Gaidai University, Osaka, Japan

Correspondence to: Qianfei Shu, College of Foreign Studies, Kansai Gaidai University, Osaka, Japan;
E-mail: sqianfei@kansaigaidai.ac.jp;

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Abstract: Many researches have discussed the relationship between industrial agglomeration and firm performance. However, the relationship between policy-directed industrial agglomeration in the context of Chinese high and new technology (HNT) industry remains unclear. This study aims to investigate the correlation between industrial agglomeration and China's HNT firm performance by using the two-stage least squares (2SLS) and the system generalized methods of moments (GMM) approaches on account of the panel data of HNT industries in China during 2004-2015. The estimation results revealed that industrial agglomeration has a positive impact on HNT firm performance, including productivity and sales growth. To be specific, by taking advantage of agglomeration effect, foreign-owned firms have demonstrated excellent performance in both labor productivity and sales growth. In contrast, private-owned firms have not performed well in terms of productivity, but have shown sound performance in term of sales growth. Unfortunately, state-owned firms do not benefit from the industrial agglomeration. Moreover, large firms perform better in respect of labor productivity, while small firms experience higher sales growth.

Keywords: high and new technology industry, labor productivity, sales growth, China

1 Introduction

The study of industrial agglomeration has been the subject of debate among economists for more than one hundred years [1–6].

Marshall (1920) [5] first explained the reasons why firms spontaneously agglomerate in spatial concentrations from the perspective of external economies, which was confirmed by subsequent researchers [7–9]. The first reason is that industrial agglomeration leads to savings on transport expenses and the time spent commuting between suppliers and customers. This reason laid the foundation for the crucial hypothesis that was proposed in the later model of 'New Economic Geography' [4]. The second reason is that the concentration of firms generates economies of scale with a stronger labor force. The third reason centers on the easy flow of technology and ideas that result from geographic proximity. Krugman (1991b) [4] proposed that these three advantages of industrial location can be summarized using modern economic terms: backward and forward linkages, thick local labor market, and information spillover effect. There are many successful examples of industrial agglomeration worldwide: Silicon Valley in the U.S.; Carlton in Canada; Baden-Wurttemberg in German, *etc.* These forms of industrial agglomeration are characterized by a market orientation.

However, different from western developed countries, industrial agglomeration in China is directed by government policy, which is particularly noticeable in capital- and technology-intensive industries. Since China's economic reform and opening of borders in 1978, the Chinese government identified specific areas, termed Special Economic Zones (SEZs), and implemented a series of policies (*e.g.* attracting foreign direct investment (FDI), advanced technology, management and production systems), to stimulate regional economic development. In 1980, four SEZs were set up in Shenzhen, Zhuhai, Shantou, and Xiamen. The government encouraged the firms to target the international market and increase exports. The SEZs were first established in coastal regions (i.e., the Pearl River Delta and Yangtze River Delta regions). Over the 20 years that followed, SEZs were upgraded to define different types of zones with heterogeneous features throughout the country. Specifically, the following four types of SEZs were identified: High and New Technology Industrial Development Zone (HNTIDZ); Economic and Technology Development Zone (ETDZ); Export Processing Zone (EPZ); Free Trade Zone (FTZ). The establishment of these zones promoted Chinese economy in terms of GDP growth, total factor productivity (TFP), wage, employment, and foreign direct investment (FDI) [10–13].

An increasing number of firms entered into these zones over the course of the process of agglomeration development [14].

In essence, Chinese industrial agglomeration in the form of SEZs is distinct from market-oriented industrial agglomeration in western developed countries. Rather, it derives from the guidance of government policy, which motivates this current study: Does policy-directed industrial agglomeration, as the form of SEZs, affect firm performance? This study tries to investigate the effect of policy-directed industrial agglomeration on firm performance in China.

Furthermore, in this study, I pay attention to high and new technology (HNT, According to the definition of high and new technology industries provided by the Ministry of Science and Technology and the National Bureau of Statistics, the high and new technology industry comprises of six 'four-digit' industries i.e., the manufacturing of electronic chemicals (2665), manufacturing of medicines (2710–2770), manufacturing of medical equipment and measuring instruments (3681–3689, 4110–4119, 4121–4129, 4141, 4190), manufacturing of electronic and communication equipment (4011–4019, 4020, 4021, 4031–4039, 4051–4059, 4061, 4062, 4071, 4072, 4090), manufacturing of computer and office equipment(4041–4043, 4154, 4155), and the manufacturing of aircraft and spacecraft (3761–3769). In this study, 'HNT' is an abbreviation of 'high and new technology'.) industry, rather than all manufacturing industries. Over the last three decades, China has emerged as an important contributor in global manufacturing and exports. However, the competitive edge of low-cost labor that China enjoyed was disappearing because of advancements in manufacturing technology by Southeast Asian nations, such as Vietnam and Bangladesh, particularly after the 2008 financial crisis. Therefore, the upgrade of industrial structure from low-tech and medium-low-tech to high-tech industries has become increasingly crucial. The HNT industry is identified by intensive knowledge and technology [15], which can effectively mitigate risks in an unpredictable economic environment due to its high value-added products. In a result, HNT industry is widely recognized as a key driver of industrialization in transitional economies. The HNT industry in China is still in its infancy, beset by many difficulties such as financing constraints, talent shortage, imperfect innovation environment, *etc.* If SEZ, as a place-based policy by Chinese government, can promote the development of HNT firms, it may help China to move beyond the status of a "middle-income trap" in the future.

Figure 1 illustrates the conceptual diagram of this study. The remainder of this article is organized as follows. Section 2 analyzes the relationship between industrial agglomeration and firm performance, followed by a literature review on the effect of agglomeration on firm performance. Section 3 describes the data and explains the industrial agglomeration indicator used in this study. Section 4 presents the baseline specification and methodology, and Section 5 shows estimated results. Section 6 concludes and discusses the policy implications.

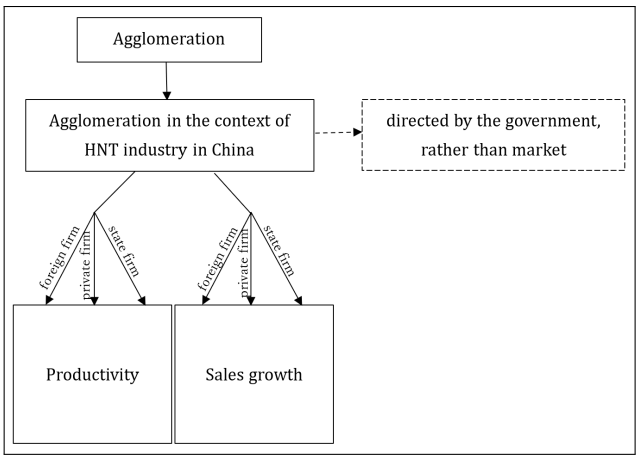

Figure 1 Conceptual diagram of the study

2 Related literatures: Industrial agglomeration and firm performance

I aim to explore the impact of industrial agglomeration on firm performance from the angle of institutional externality of agglomeration. As discussed before, theoretically, industrial agglomeration generates three positive externalities: dense local labor market; backward and forward linkages; information and knowledge spillover effect [4]. These positive externalities elicited by industrial agglomeration play a significant role in firm performance including productivity, profit, export and innovation activity.

Focusing on developing countries, numerous studies found that there exists a positive relationship between geographic agglomeration and firm performance. For example, using a firm-level panel dataset from 2000 to 2007, Hu et al. (2015) [16] examined the influence of industrial agglomeration on productivity growth in China by evaluating a comprehensive range of industries and extending the analysis to upstream industries. The study found that industrial agglomeration led to a 14% increase in productivity growth. They also found that private firms benefit the most from the effects of agglomeration. Due to the knowledge spillover that results from agglomeration, Ito et al. (2015) [17] suggested that the initial costs of exporting can be reduced, thus promoting Chinese firms' entry to export markets. Using Chinese firm-level data for the period 1998–2007, Zhang (2015) [18] found that agglomeration economies play a significant role in facilitating product innovation. The researches outlined above evaluated a large dataset of manufacturing firms in China and demonstrated that industrial agglomeration fosters a firm's performance.

In addition, some research investigated the contributions of SEZ policy in China. Alder et al. (2016) [19] used a panel dataset of 270 Chinese cities for the period 1988–2010 to investigate the influence of SEZs on a city's GDP growth. The study suggested that the establishment of state-level zones generates an increase of approximately 12% in GDP. Wang (2013) [11] argued that the place-based SEZ program achieves agglomeration economies and increases the total factor productivity (TFP) growth. Zheng et al. (2017) [20] found that spillover effects occur not only within SEZs but also in the surrounding districts. More recently, by using DID (Difference-in-Difference) approach, Tian and Xu (2022) [21] found that national high-tech zones promote local innovation and entrepreneurial activities.

This article is closely related to two studies by Lu et al. (2019) [14] and Wei et al. (2020) [22]. However, despite some similarities in the research subject on the effect of industrial agglomeration, this study is distinct from these two studies in several aspects, including research angle and object. While Lu et al. (2019) [14] focused on exploring the impact of place-based policy, SEZ, on productivity, this study aims to provide a more comprehensive and in-depth understanding of industrial agglomeration and its role in promoting productivity in the context of China's HNT industry, taking into account both policy-directed and market-oriented agglomeration effect. This study emphasizes that the agglomeration of China's HNT industry is a combination of policy guidance and market orientation, not just government intervention, which differs from the research focusing on SEZ policy as the object of study. Although SEZ policy is also a manifestation of agglomeration economies, its purpose is not to investigate the impact of agglomeration effect on productivity, but rather to stimulate local economy through specific policy measures. Therefore, I employ EG (Ellison and Glaeser) index to measure the degree of agglomeration, which can more specifically reflect the agglomeration situation of HNT industry, rather than just focusing on the government's policy guidance. Furthermore, while Wei et al. (2020) [22] explored the differential effects of agglomeration across regions and industries, this study examines the heterogeneous agglomeration effects of different ownership structures in the context of HNT industry, and analyzes the possible reasons for their differences. In China's HNT industry, firms with different ownership structures face different issues such as historical background, technological gaps, financing channels, and government subsidies, which may have an impact on their agglomeration effects. Therefore, it is necessary to consider the influence of these factors when analyzing agglomeration effects. The findings of this study may be useful in improving the implementation of policies. Taking into account all the aforementioned research gaps, this article contributes to previous studies by investigating the impact of industrial agglomeration in the field of HNT industry, which plays a pivotal role in stimulating economic development and technological advancement in China.

3 Data and measurement of industrial agglomeration

3.1 Date source

A firm-level dataset of Chinese manufacturing firms drawn from the National Bureau of Statistics of China was used, covering the period of 2004-2015. This database stores the basic information of all manufacturing firms with annual sales above 5 million RMB. (above 20 million RMB since 2011).

In this study, I focus on the high and new technology (HNT) industry. The Ministry of Science and Technology and the National Bureau of Statistics define the high and new technology industry to comprise six 4-digit industries: manufacturers of electronic chemicals (2665), manufacturers of medicines (2710-2770), manufacturers of medical equipment and measuring instruments (3681-3689, 4110-4119, 4121-4129, 4141, 4190), manufacturers of electronic and communication equipment (4011-4019, 4020, 4021, 4031-4039, 4051-4059, 4061, 4062, 4071, 4072, 4090), manufacturers of computer and office equipment (4041-4043, 4154, 4155), and

manufacturers of aircraft and spacecraft (3761-3769). Moreover, firms with less than three successive years of data are excluded since it is a common practice for system GMM estimation.

Initially, I obtain the unbalanced panel consisted of 47,176 firms with 235,413 firm-year observations. Table 1 summarizes the selected variables for the whole firm panel.

Table 1 Descriptive Statistics[1]

Variables	Mean	Std. Dev.	Obs. No.
Dependent Variables			
Labor productivity[2]	3.228	4.472	235,413
Sales growth[3]	0.132	0.813	235,413
Independent Variables			
Agglomeration Variable			
EG index[4]	0.048	0.012	6,084
Control Variables			
Firm age	8.326	11.224	235,413
Firm size[5]	11.137	1.762	235,413
Current assets/total assets	0.045	0.426	235,413
City R&D[6]	23.613	53.275	6,084
Foreign owned share[7]	0.362	2.145	235,413
Private owned share[8]	0.317	0.963	235,413

[1] Source: National Bureau of Statistics of China for the period 2004 to 2015.
[2] Labor productivity is calculated as the natural logarithm of value added/labor.
[3] Sales growth is measured by ($sales_t$-$sales_{t-1}$)/$sales_{t-1}$.
[4] The calculation of the EG index is based on the city level.
[5] Firm size is calculated as the natural logarithm of firm's employment.
[6] City R&D is calculated as the natural logarithm of city's R&D expenditure.
[7] Foreign owned share is the percentage ratio of total shares held by foreign, Hong Kong, Marco, and Taiwan investors.
[8] Private owned share is the percentage ratio of total shares held by individual investors.

3.2 Measurement of industrial agglomeration

How could industrial agglomeration be measured? As discussed before, HNT industrial agglomeration is directed by Chinese government as the form of special economic zones. Does the policy-directed industrial agglomeration achieve the substantial agglomeration effect? To explore this issue, I quantize the degree of industrial agglomeration by adopting "EG index" developed by Ellison and Glaeser (1997) [1]. The EG index, as the most standard and widely employed agglomeration index in previous studies [23–25], captures the degree of agglomeration within an industry and co-agglomeration across industries. The ratio of an industry's size within a certain region, the ratio of the aggregated size of manufacturing sectors within a certain region, and the market concentration of an industry are considered simultaneously in the EG index. Specifically, the EG index (r_j) is expressed as follows:

$$r_j \equiv \frac{G_j - \left(1 - \sum_c X_c^2\right) H_j}{\left(1 - \sum_c X_c^2\right)\left(1 - H_j\right)} \tag{1}$$

With the following formulas representing $G_j$and :H_j

$$G_j \equiv \sum_c \left(X_c - S_{jc}\right)^2 \tag{2}$$

$$H_j \equiv \sum_i Z_{ij}^2 \tag{3}$$

where j, c, and i represent industry, city, and firm, respectively. G_j expresses the spatial Gini coefficient, representing geographical concentration. The term X_c denotes the ratio of total employment within all HNT industries in city c. S_{jc} denotes the ratio of employment within the HNT industry of j in city c. The term H_j expresses the Herfindahl index of industry j, measuring industrial concentration. The term Z_{ij} denotes the ratio of firm i's sales in the HNT industry of j. In this study, EG index is calculated based on the city level.

In accordance with Ellison and Glaeser's (1997) [1] research, industries with $r_j > 0.05$, $0.02 \leq r_j \leq 0.05$, and an $r_j < 0.02$ are defined 'very concentrated', 'somewhat concentrated', and 'not very concentrated', respectively. Table 2 shows that the EG index experienced slow but consistent growth from 2008 to 2015, despite small fluctuations. Note that the term 'somewhat concentrated' can be applied to all HNT industries since 2008, except for the manufacture of medical equipment and communication equipment, which has been defined as 'very concentrated' since 2013. This result suggests that at some extent, the policy of establishing SEZs has contributed to HNT industrial agglomeration effect and remarkably increasing the level of industrial agglomeration of HNT firms.

Table 2 EG index based on the 4-digit HNT industries at city level for 2008-2015[1]

Industry	2008	2009	2010	2011	2012	2013	2014	2015
Manufacture of Electronic Chemicals	0.041	0.039	0.044	0.048	0.051	0.054	0.061	0.067
Manufacture of Medicines	0.045	0.048	0.056	0.061	0.064	0.066	0.062	0.069
Manufacture of Medical Equipment and Communication Equipment	0.026	0.024	0.028	0.033	0.035	0.038	0.043	0.042
Manufacture of Electronic Equipment and Communication Equipment	0.032	0.036	0.039	0.041	0.048	0.052	0.053	0.055
Manufacture of Computer and Office Equipment	0.039	0.043	0.046	0.053	0.058	0.062	0.061	0.064

Note: [1] According to China's administrative division, city level denotes 4 municipalities (Beijing, Tianjin, Shanghai and Chongqing) and 334 prefecture cities.

4 Research model

4.1 Firm performance model

To analyze the causality between industrial agglomeration and firm performance, the following empirical model is utilized:

$$\mathrm{Performance}_{\mathrm{ijct}} = \alpha_0 + \alpha_1 \mathrm{Agglomeration}_{\mathrm{jct}} + \alpha_2 \mathrm{X}_{\mathrm{ijct}} + \mu_{\mathrm{i}} + \mu_{\mathrm{j}} + \mu_{\mathrm{c}} + \mu_{\mathrm{t}} + \epsilon_{\mathrm{ijct}} \quad (4)$$

where i, j, c, and t indicate the firm, industry, city, and time, respectively. The dependent variable ($\mathrm{Performance}_{\mathrm{ijct}}$) denotes a firm's labor productivity and sales growth. Labor productivity is measured by the natural logarithm of value added/labor. I also use a firm's sales growth rate, measured by $(\mathrm{sales}_{\mathrm{t}} - \mathrm{sales}_{\mathrm{t-1}})/\mathrm{sales}_{\mathrm{t-1}}$, to represent growth performance.

$\mathrm{Agglomeration}_{\mathrm{jct}}$, as the main explanatory, is the proxy for the agglomeration level of the HNT industry. As aforementioned, the EG index is adopted to measure the agglomeration level. The acronym EG refers to the Ellison-Glaeser index of industrial agglomeration at the city level. If the firms located in areas with a higher level of agglomeration can achieve superior profit and growth performance, α_1 should be positive.

$\mathrm{X}_{\mathrm{ijct}}$ is a vector of control variables, including firm age, firm size, current assets, ownership share and a city's R&D expenditure. I use the natural logarithm of employment as a proxy for firm size, and firm age is measured as the difference between the year of establishment and the sample year. In previous studies, firm age and firm size have been discussed for their impact on firm performance [26–28]. Furthermore, current assets reflect internal working capital turnover of firms, which may affect a firms' performance [22]. This variable is normalized by the number of total assets. In addition, Hu et al. (2015) [16] found that the ownership plays an important role on firm performance. Thus, ownership share variables, foreign owned share and private owned share, are included in the regression. Foreign owned share is the percentage ratio of total shares held by foreign, Hong Kong, Marco, and Taiwan investors, while private owned share is the ratio of total shares held by individual investors. Finally, to further control for the possible influence of a city's R&D expenditure, this macro-level variable is also included, taking the logarithm type [23, 29, 30].

The disturbance term has four components: μ_i is the firm-specific fixed effect, and μ_j is the industry-specific effect by including HNT industry dummies. Representations of time and city-specific effect dummy variables are also included in the empirical model, denoted by μ_t and μ_c, respectively. ϵ_{ijct} is an idiosyncratic error term; α_1, α_2 are coefficients to be estimated.

4.2 Empirical study methodology

It is necessary to point out that agglomeration variable is likely to be endogenous due to reverse causality and self-selection problem. The phenomenon of industrial agglomeration might be a result rather than a reason of firm development. As discussed before, HNT industrial agglomeration is directed by Chinese government. Therefore, there exists a possibility that SEZ administration choose more productive firms to enter the zones so that it would be easier for them to create a "successful SEZ" in some sense [31]. Moreover, if the firms are certificated by local government to settle in the SEZs, they can enjoy many preferential policies such as tax deductions, discounted land-use fees and financial supports [11, 19, 20]. Thus, some firms may self-select to enter these SEZs for the purpose of utilizing these preferential policies.

To cope with the endogeneity concern, I employ the two-stage least squares (2SLS) estimation procedure with instrumental variables to identify the industrial agglomeration effects on firm performance. The choice of an exogenous instrument that is correlated with the agglomeration variable but does not have a direct impact on the firm performance variable is a crucial aspect in 2SLS estimation. Following Li and Lu (2009) [32], the historical population in China is adopted as the instrumental variable. To be specific, the historical population is measured by the natural logarithm of the population in each city in the year 1984 (The city-level population data is extracted from China City Statistical Yearbook. China City Statistical Yearbook was first published in the year of 1984, which report the population data in the year of 1983.

Unfortunately, there are many missing population data in the yearbook published in 1984. Thus, I employ the population data in the year of 1984, which was reported in the City Statistical Yearbook 1985.). The logic for adopting this instrument is based on the following argument: historical population is relevant to the degree of agglomeration because manufacturing firms tend to agglomerate in a city with a larger population due to its higher market demand [33–36] while historical population should not be directly correlated to firm performance. In other words, historical population should influence firm performance only through the way of industrial agglomeration.

Since the population in 1984 is time-invariant, I interact the population data with the year dummies to change the time-invariant instrument into a time-varying one [40]. The first stage of the panel instrumental variable regression is:

$$\text{Agglomeration}_{\text{jct}} = \beta_0 + \beta_1 \ln(\text{ population })_{\text{c},1984} \times \mu_{\text{t}} + \mu_{\text{t}} + \varepsilon_{\text{ijct}} \quad (5)$$

However, except for the endogeneity problem caused by industrial agglomeration variable, it is also possible that other independent variables exhibit endogeneity. Hence, the system generalized methods of moments (GMM) estimation designed by Arellano and Bond (1991) [37] and Blundell and Bond (1998) [38], is also employed to address the remaining endogeneity issue as robustness checks.

For the first-differenced equations in the system GMM, two or more period lagged endogenous variables are used as instrumental variables in (4), while firm age, ownership share, city's R&D expenditure and industry, city, year dummy variables are regarded as exogenous variables. One-period lagged dependent variables, $\text{Performance}_{\text{ijct}-1}$ ($\text{labor productivity}_{\text{ijct}-1}$ and $\text{sales growth}_{\text{ijct}-1}$) are included in the dynamic model.

For the system GMM, two tests are proposed to assess the validity of instrumental variables. The first, for confirming instrument exogeneity, is the Hansen test of overidentifying restrictions. The Sargan test is not adopted because it is not robust to heteroscedasticity. The second, for the serial correlation of error term (ϵ_{ijct}), is the autoregressive (AR) test. Following Arellano and Bond (1991) [37], first-order serial correlation of the error term is allowed in difference regression, while if there exists a second-order serial correlation for the error term, the null hypothesis of AR(2) test will be rejected.

5 Estimation results and discussion

5.1 Baseline results

Table 3 reports the 2SLS estimation results. The first stage of 2SLS estimation results are presented in Panel B of Table 3. The coefficients for all the instruments are positive and statistically significant, indicating that firms are more likely to agglomerate in the areas with even higher population densities. The result of the underidentification test implies that the agglomeration variable is endogenous indeed. Moreover, since the F-statistic in the first stage regression exceeds the Stock-Yogo critical values [39], It can conclude that our instrumental variables are strong.

Panel A and Panel C of Table 3 report the effect of industrial agglomeration on promoting HNT firm performance. The coefficients for the EG index are significantly and positively correlated with HNT firm productivity and sales grow after the industrial agglomeration variables are instrumented. This finding is consistent with many existing studies [16, 40–43]. The positive relationship between the two may be attributed to the externalities. As discussed, industrial agglomeration generates positive externalities, such as economies of scale, thick local labor market, as well as information and knowledge spillovers, thereby stimulating firm performance. Specifically, when there are many HNT firms located in the same area, they may be able to share infrastructure, transportation and other production resources, which can reduce transaction costs for individual firms and improve firm productivity. Second, a large pool of skilled labors and talented employees attracted by industrial clusters offer specialized knowledge and skills, thereby promoting the operational efficiency of the firms. Third, information and knowledge spillover effect helps the firms learn about new production techniques from neighboring firms, so that the performance of the firms located in the same area can be improved. This aspect is particularly important for HNT firm as it enable them to leverage the latest technological advances and accelerate innovation activities, which can achieve sustainable growth.

To check whether the exclusion restriction of the instruments is satisfied in this study, I undertake an informal test in Table 4. If the historical population affects firm performance only through the path of industrial agglomeration, then when both agglomeration and historical population variables are included in the estimation simultaneously, the historical population should not have any significant impact on performance variables. As presented in column 1 and

column 2 of Table 4, all the historical population variables no longer have statistically significant coefficients, confirming that our instrumental variables are exogenous.

Besides the 2SLS estimations, as a robustness check, I further conduct the two-step system GMM estimation to address the remaining potential endogeneity problem of the independent variables. The results are shown in column 2 and column 4 of Table 3. The Hansen test of overidentifying restrictions suggests that all the instruments used for the estimation are exogenous, and the results for AR(2) also cannot detect the serial correlation of ϵ_{ijct}. Thus, these results confirm the validity of the instruments used. Consistent with our previous findings, the industrial agglomeration variables remain significantly and positively associated with firm productivity and sales growth.

Regarding the influence of firm characteristics, the results suggest that younger HNT firms perform better in respect of both productivity and sales growth. Young firms typically have higher flexibility and innovation, which allows them to adapt more quickly to market demands and changes, adopting the latest technologies to enhance productivity and sales growth. Moreover, young firms tend to focus more on product research and development in the early stages, continuously improving the quality of their products, thereby establishing a certain band value and gaining a competitive advantage in the marketplace. In addition, larger scale firms are more likely to achieve greater productivity. This finding is consistent with Hu et al., (2015) [16]. Large firms usually own more resources and technological advantages, helping them better utilize economies of scales and division of labor to stimulate productivity and production efficiency.

Table 3 Agglomeration, labor productivity and sales growth: instrumental variable estimation results and two-step GMM results[1]

	Panel IV	Two-step system GMM	Panel IV	Two-step system GMM
	Panel A: Second stage Dep. Var. = Labor productivity	Dep. Var. = Labor productivity	Panel C: Second stage Dep. Var. = Sales growth	Dep. Var. = Sales growth
Column	1	2	3	4
Labor productivity$_{t-1}$		0.418*** (6.87)		
Sales growth$_{t-1}$				0.297*** (7.15)
Agglomeration (EG index)	0.069*** (3.16)	0.101** (2.14)	0.032*** (2.85)	0.079** (1.98)
Firm size[2]	0.157*** (2.94)	0.231** (2.23)	-0.092*** (-2.99)	-0.137** (-2.36)
Firm age	-0.001*** (-3.26)	-0.002*** (-3.46)	-0.019** (-2.43)	-0.008* (-1.94)
Current assets/total assets	0.228* (1.89)	0.181** (2.37)	0.092 (1.38)	0.236* (1.79)
Industry dummy	yes	yes	yes	Yes
City dummy	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes
Foreign owned share	0.064*** (2.59)	0.079** (2.28)	0.033** (1.99)	0.029* (1.83)
Private owned share	0.085 (1.42)	0.074* (1.92)	0.056** (2.23)	0.071*** (2.85)
City R&D	0.007 (0.89)	0.005* (1.69)	0.059 (1.43)	0.063 (0.86)
Constant	1.947 (0.75)	1.734* (1.71)	1.395 (0.74)	1.239 (1.46)
p-value of Hansen test		0.286		0.174
AR(2)		0.192		0.239
No. Obs	235,413	208,796	235,413	208,796
	Panel B: First stage Dep.var. =Agglomeration (EG index)			
Population1984×year 2004	0.285** (2.53)			
Population1984×year 2005	0.317*** (3.48)			
Population1984×year 2006	0.221*** (3.85)			
Population1984×year 2007	0.135** (2.39)			
Population1984×year 2008	0.276** (2.48)			
Population1984×year 2009	0.296*** (3.71)			
Population1984×year 2010	0.282*** (4.17)			
Population1984×year 2011	0.315** (2.26)			
Population1984×year 2012	0.326*** (2.91)			
Population1984×year 2013	0.261*** (2.87)			
Population1984×year 2014	0.294** (2.48)			
Population1984×year 2015	0.268*** (2.95)			
F-statistics	54.73			
Underidentification test p-value	0.0000			
Adj R-square	0.094			

[1] The table presents instrumental variable estimation results and Blundel and Bond's two-step system GMM results. The dependent variable is labor productivity ($\ln(\text{value added}/\text{labor})$) and sales growth ($\frac{\text{sales}_t - \text{sales}_{t-1}}{\text{sales}_{t-1}}$). z-statistics are reported in parentheses.

[2] Firm size is calculated as the natural logarithm of firm's employment.

* Significant at 10%. **Significant at 5%. ***Significant at 1%.

5.2 Agglomeration effects under different ownership structures

In China, local economic growth varies depending on the ownership structures. For example, state-owned firms, wholly or partially funded by the government, still dominate commanding heights sectors such as energy, railway, electronic communication, aerospace and satellite technology. These firms usually hold a considerable share in the market and receive preferential treatment from the government in respect of access to financing and other resources [40].

Table 4 Informal test for exogeneigy of the instrumental variables: OLS estimation results[1]

	Dep.var. = Labor productivity	Dep.var. = Sales growth
Column	1	2
Population1984×year 2004	0.187 (1.37)	0.094 (0.74)
Population1984×year 2005	0.173 (0.58)	0.089 (1.62)
Population1984×year 2006	0.098 (0.72)	0.092 (1.49)
Population1984×year 2007	0.169 (0.94)	0.097 (0.96)
Population1984×year 2008	0.164 (1.28)	0.083 (1.61)
Population1984×year 2009	0.171 (1.45)	0.076 (0.72)
Population1984×year 2010	0.189 (0.73)	0.095 (0.59)
Population1984×year 2011	0.183 (1.47)	0.081 (0.54)
Population1984×year 2012	0.191 (1.31)	0.079 (1.24)
Population1984×year 2013	0.189 (0.69)	0.083 (0.71)
Population1984×year 2014	0.185 (0.83)	0.086 (1.46)
Population1984×year 2015	0.194 (1.52)	0.092 (0.67)
Agglomeration (EG index)	0.078** (2.14)	0.025*** (2.62)
Firm size[2]	0.249*** (3.26)	-0.068* (-1.95)
Firm age	-0.008*** (-2.88)	-0.002*** (-3.24)
Current assets/total assets	1.218*** (4.37)	0.629* (1.83)
Industry dummy	yes	yes
City dummy	yes	yes
Year dummy	yes	yes
Foreign owned share	0.285*** (3.29)	0.147** (2.19)
Private owned share	0.174 (1.58)	0.062 (0.64)
City R&D	0.072	0.036
Constant	1.472 (0.72)	0.395 (1.29)
Adj R-square	0.241	0.178
No. Obs	235,413	235,413

[1] The table presents OLS estimation results. The dependent variable is labor productivity ($\ln(\text{value added}/\text{labor})$) and sales growth ($\frac{\text{sales}_t - \text{sales}_{t-1}}{\text{sales}_{t-1}}$). z-statistics are reported in parentheses.

[2] Firm size is calculated as the natural logarithm of firm's employment.

* Significant at 10%. ** Significant at 5%. *** Significant at 1%.

Recently, however, they have gradually lost their advantages due to inefficiency, bureaucracy and corruption [44]. On the other hand, private-owned firms do not receive as much support from the government as state-owned firms do. As a result, they have to be more efficient and innovative in order to survive and achieve sustainable growth in the marketplace.

Therefore, given the heterogeneous roles that ownership plays in the Chinese economy, in this section, I aim to shed light on the heterogeneity analysis based on different ownership structures by separating the firms into foreign, private, and state-owned.

The 2SLS estimation result are reported in columns 1-3 of Table 5 and 6, with column 1 for foreign-owned firms, column 2 for private-owned firms, and column 3 for state-owned firms. The first stage estimation results are presented in Panel B of Table 5. All the instruments are significantly and positively correlated with industrial agglomeration. Moreover, our estimation is not plagued by weak instrument problem, as evidenced by the F-statistic.

A striking observation is that only foreign-owned firms benefit from the agglomeration effect in promoting labor productivity. Agglomeration variable in column 1 of Table 5 has significantly positive coefficient, while the ones in column 2 and 3 are insignificant.

Why agglomeration effect fails to work for private and state-owned HNT firms? Xu (2011) [45] suggests that many of the concentration of private-owned firms in China today can be traced back to the township-village enterprises (TVEs) established in the early 1990s, and the majority of these firms are engaged in labor-intensive sectors, such as textile, footwear, cashmere, metal products, etc [23, 43, 46]. In these sectors, by breaking down the production process of a product into many small steps, private enterprises can easily join the industrial agglomeration because the entry barriers in terms of technology and capital are lowered [42, 47]. However, compared to labor-intensive sectors, it is much harder for private firms in the context of HNT industries to overcome the entry barrier of technical expertise and the need for substantial capital investment. In a result, private HNT firms have yet to form sizable agglomerations and have failed to capitalize on the productivity-enhancing effects of agglomeration. Furthermore, the lack of an impressive performance may prove to be a significant hindrance for private HNT firms seeking entry into government-managed SEZs [31]. Therefore, private HNT firms, particularly nascent ones, may not be able to benefit from agglomeration effects in respect of increasing productivity. Whereas for state-owned firms, they can achieve their development without relying on agglomeration effects because they have already received considerable support from the government.

Table 5 Agglomeration effects under different ownership structures (agglomeration and labor productivity): instrumental variable estimation results and two-step GMM results[1]

	Panel IV			Two-step system GMM		
	Panel A: Second stage Dep.var. = Sales growth			Dep. var. = Labor productivity		
	Foreign-owned firm	Private-owned firm	State-owned firm	Foreign-owned firm	Private-owned firm	State-owned firm
Column	1	2	3	4	5	6
Labor productivity$_{t-1}$				0.375*** (4.37)	0.259*** (3.21)	0.421*** (3.84)
Agglomeration (EG index)	0.076*** (3.71)	0.045 (1.08)	0.059 (1.54)	0.164*** (2.78)	0.112 (1.36)	0.082 (0.74)
Firm size[2]	0.132*** (2.87)	0.087** (2.17)	0.094*** (2.59)	0.226* (1.74)	0.119** (1.98)	0.143* (1.86)
Firm age	-0.002** (-2.45)	-0.006 (-0.93)	0.0009 (0.89)	-0.003*** (-3.25)	-0.001 (-1.34)	0.0008 (1.62)
Current assets/total assets	0.319* (1.78)	0.175** (2.36)	0.093 (1.54)	0.275** (2.33)	0.048 (1.28)	0.203* (1.93)
City R&D	0.018* (1.91)	0.003 (1.37)	0.026** (2.45)	0.009 (1.17)	0.017 (0.79)	0.009*** (2.86)
Industry dummy	yes	yes	yes	yes	yes	yes
City dummy	yes	yes	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes	yes	yes
Constant	1.374 (0.84)	0.857* (1.66)	0.749 (1.53)	0.661* (1.87)	0.373 (0.28)	0.289 (0.77)
p-value of Hansen test	0.214	0.189	0.272	0.163	0.194	0.329
AR(2)	0.375	0.537	0.421	0.269	0.469	0.582
No. Obs	130,414	70,925	34,074	117,380	63,834	30,660
	Panel B: First stage Dep.var. = Agglomeration (EG index)					
Population1984×year 2004	0.219** (2.54)	0.265*** (3.82)	0.188*** (3.57)			
Population1984×year 2005	0.312*** (4.16)	0.334*** (3.26)	0.298** (2.21)			
Population1984×year 2006	0.194*** (3.28)	0.279** (2.34)	0.242*** (4.72)			
Population1984×year 2007	0.185*** (4.64)	0.169** (2.42)	0.114*** (3.79)			
Population1984×year 2008	0.258** (1.98)	0.312*** (3.29)	0.248** (2.18)			
Population1984×year 2009	0.317*** (3.74)	0.293*** (3.69)	0.278** (2.39)			
Population1984×year 2010	0.249*** (3.17)	0.327*** (2.63)	0.216** (2.44)			
Population1984×year 2011	0.351*** (3.45)	0.281*** (2.67)	0.324*** (2.97)			
Population1984×year 2012	0.319** (2.38)	0.282** (2.35)	0.326*** (2.83)			
Population1984×year 2013	0.229** (2.57)	0.274*** (3.26)	0.262** (2.25)			
Population1984×year 2014	0.197*** (3.24)	0.236** (2.38)	0.259*** (2.96)			
Population1984×year 2015	0.218*** (2.64)	0.262** (2.28)	0.279** (2.17)			
F-statistics	27.84	32.93	25.48			
Underidentification test p-value	0.0000	0.0000	0.0000			
Adj R-square	0.087	0.076	0.081			

[1] The table presents instrumental variable estimation results and Blundel and Bond's two-step system GMM results. The dependent variable is labor productivity $(\ln(\text{value added}/\text{labor}))$. z-statistics are reported in parentheses.
[2] Firm size is calculated as the natural logarithm of firm's employment.
* Significant at 10%. **Significant at 5%. ***Significant at 1%.

Table 6 Agglomeration effects under different ownership structures (agglomeration and sales growth): instrumental variable estimation results and two-step GMM results[1]

	Panel IV[2]			Two-step system GMM		
	Panel A: Second stage Dep. var. = Sales growth			Dep. var. = Sales growth		
	Foreign-owned firm	Private-owned firm	State-owned firm	Foreign-owned firm	Private-owned firm	State-owned firm
Column	1	2	3	4	5	6
Sales growth$_{t-1}$				0.462*** (5.38)	0.349*** (5.61)	0.451*** (4.28)
Agglomeration (EG index)	0.037*** (3.51)	0.021** (2.53)	-0.016 (-1.18)	0.042* (1.83)	0.031** (2.35)	-0.013 (-0.94)
Firm size[3]	-0.085** (-2.45)	-0.054* (-1.75)	0.124 (0.78)	-0.063* (-1.68)	-0.078* (-1.82)	0.098* (1.94)
Firm age	-0.021*** (-2.87)	-0.015* (-1.86)	0.086* (1.91)	-0.035*** (-3.16)	-0.022** (-2.46)	0.073 (1.64)
Current assets/total assets	0.187* (1.89)	0.069 (0.53)	0.072** (2.27)	0.138 (0.86)	0.206 (1.24)	0.099* (1.78)
Industry dummy	yes	yes	yes	yes	yes	yes
City dummy	yes	yes	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes	yes	yes
City R&D	0.052 (0.93)	0.009 (1.45)	0.071* (1.73)	0.028** (2.52)	0.007* (1.77)	0.015 (0.54
Constant	1.48 (1.62)	0.97 (0.48)	1.37 (0.62)	1.53 (1.45)	1.84* (1.93)	0.92 (0.73)
p-value of Hansen test				0.289	0.379	0.361
AR(2)				0.659	0.584	0.517
No. Obs	130,414	70,925	34,074	117,380	63,834	30,660

[1] The table presents instrumental variable estimation results and Blundel and Bond's two-step system GMM results. The dependent variable is sales growth $(\frac{\text{sales}_t - \text{sales}_{t-1}}{\text{sales}_{t-1}})$ z-statistics are reported in parentheses.
[2] The first stage of instrumental variable estimation is omitted here as the results are the same as that of Table 5.
[3] Firm size is calculated as the natural logarithm of firm's employment. *Significant at 10%. ** Significant at 5%. *** Significant at 1%.

Next, to re-run the regressions for sales growth separating firms by their type of ownership. The result is reported in Panel A of Table 6. A noticeable change was observed in the estimated coefficient of the agglomeration variable for private firms, with the coefficient becoming significant. This result implies that industrial agglomeration can help unlock the growth potential for private firms. Nevertheless, state-owned firms still cannot benefit from agglomeration effects to improve sales growth.

An informal test was conducted to check whether the instruments are entirely exogenous.

Table 7 Informal test for exogeneigy of the instrumental variables (Agglomeration effects under different ownership structures): OLS estimation results[1]

	Dep.var. = Labor productivity			Dep. var. = Sales growth		
	Foreign-owned firm	Private-owned firm	State-owned firm	Foreign-owned firm	Private-owned firm	State-owned firm
Column	1	2	3	4	5	6
Population1984×year 2004	0.293 (1.32)	0.187 (1.55)	0.254 (0.74)	0.174 (1.57)	0.214 (0.89)	0.275 (0.74)
Population1984×year 2005	0.238 (0.81)	0.174 (0.64)	0.169 (0.82)	0.264 (1.06)	0.314 (1.13)	0.236 (0.97)
Population1984×year 2006	0.250 (1.62)	0.228 (0.92)	0.156 (1.59)	0.173 (1.35)	0.169 (0.99)	0.204 (0.37)
Population1984×year 2007	0.183 (0.46)	0.148 (0.38)	0.215 (1.49)	0.206 (0.41)	0.182 (1.29)	0.169 (1.32)
Population1984×year 2008	0.228 (1.36)	0.315 (1.29)	0.263 (1.43)	0.189 (0.39)	0.203 (0.41)	0.241 (0.81)
Population1984×year 2009	0.171 (0.62)	0.194 (0.36)	0.159 (0.29)	0.218 (0.62)	0.204 (1.21)	0.132 (1.38)
Population1984×year 2010	0.239 (1.58)	0.302 (1.46)	0.273 (0.52)	0.181 (1.58)	0.196 (0.27)	0.218 (0.43)
Population1984×year 2011	0.149 (0.47)	0.231 (0.38)	0.195 (0.49)	0.182 (0.83)	0.210 (1.37)	0.253 (1.52)
Population1984×year 2012	0.171 (1.04)	0.197 (0.54)	0.205 (1.26)	0.235 (0.37)	0.167 (0.72)	0.179 (0.48)
Population1984×year 2013	0.231 (0.66)	0.285 (1.79)	0.249 (0.62)	0.304 (0.89)	0.274 (1.27)	0.184 (1.38)
Population1984×year 2014	0.159 (1.51)	0.185 (1.49)	0.148 (0.59)	0.159 (1.35)	0.173 (0.82)	0.162 (0.74)
Population1984×year 2015	0.248 (0.47)	0.215 (0.91)	0.193 (1.54)	0.189 (1.20)	0.231 (1.42)	0.218 (1.30)
Agglomeration (EG index)	0.019*** (3.73)	0.025 (1.62)	0.017 (1.47)	0.025*** (2.88)	0.041* (1.93)	0.073 (0.94)
Firm size[2]	0.125** (2.18)	0.214* (1.91)	0.195** (2.51)	-0.024** (-2.47)	-0.017** (-2.15)	0.072* (1.89)
Firm age	-0.0007*** (-2.93)	-0.001 (-1.25)	0.0009 (1.17)	-0.002** (-1.98)	-0.0008* (-1.74)	0.0006** (2.38)
Current assets/total assets	0.163** (2.45)	0.092*** (3.27)	0.131** (2.26)	0.102* (1.69)	0.114** (2.37)	0.143 (0.98)
Industry dummy	yes	yes	yes	yes	yes	yes
City dummy	yes	yes	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes	yes	yes
City R&D	0.015	0.019	0.023	0.057	0.061	0.103
Constant	1.383 (0.85)	1.294 (0.53)	0.385 (1.53)	0.832 (0.67)	0.161 (1.37)	0.089 (0.47)
Adj R-square	0.116	0.088	0.092	0.132	0.128	0.106
No. Obs	130,414	70,925	34,074	130,414	70,925	34,074

[1] The table presents OLS estimation results. The dependent variable is labor productivity ($\ln(\text{value added}/\text{labor})$) and sales growth ($\frac{\text{sales}_t - \text{sales}_{t-1}}{\text{sales}_{t-1}}$). z-statistics are reported in parentheses.
[2] Firm size is calculated as the natural logarithm of firm's employment.
* Significant at 10%. ** Significant at 5%. *** Significant at 1%.

The results in Table 7 show that all the instruments are exogenous. In addition, as shown in columns 4-6 of Table 5 and 6, the two-step system GMM estimation provides us a similar result, indicating that our previous findings about the agglomeration effects across ownership are robust.

6 Conclusion and future policy implication

Exploring the impact of policy-directed industrial agglomeration is important to assess the effectiveness of government policy to improve firm productivity and growth. Unlike previous studies that focused on a comprehensive range of industries, in this article, I examine the effect of industrial agglomeration in the context of HNT industry, which is regarded as a critical driving force for industrialization in transitional economies. Moreover, I investigate how the ownership structure of Chinese HNT firms affects their capacity to take advantage of agglomeration effect. Using the historical population as the instrumental variable, the 2SLS estimation results suggest that a higher level of industrial agglomeration stimulates both labor productivity and sales growth of HNT firms. However, the effect of industrial agglomeration varies across ownership. Only foreign-owned HNT firms benefit from the agglomeration effect to enhance productivity, while neither private nor state-owned firms benefit from it. However, both foreign and private-owned firms manage to leverage the agglomeration advantages in terms of sales growth.

The findings of this study also provide important insights for Chinese policymakers. First, both national and local governments should continue supporting the SEZ program to stimulate the agglomeration effect for the HNT industry. Specifically, when formulating SEZ programs, the government should pay more attention to private-owned firms and introduce more supportive policies, such as tax reductions, scientific and technological innovation subsidies, preferential land use and other financial assistance. The more firms that agglomerate within the SEZs, the greater they can enjoy the positive externalities generated by agglomeration to stimulate firm performance. Second, in order to further enhance the agglomeration effect, the government could promote the establishment of new types of SEZs with different functions and characteristics. For example, Yao and Whalley (2016) [48] pointed out that the China (Shanghai) Pilot Free Trade Zone (SPFTZ), set up in 2013, aims to relax investment restrictions and increase the openness of the financial system. The government relaxed market access and limits its administrative power, which emphasize the important role of market forces. The establishment of the SPFTZ is expected to help overcome trade barriers and support China's new strategy for opening up and reform. If this expectation is met, the set-up and expansions of SEZs accompanied by policy

change should be promoted nationwide.

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