

Research paper**Maritime Aquaculture as Sustainable Resource Use: A Hong Kong Case Study of the Pompano**Lawrence W.C. Lai^{1 2 *}, K.W. Chau^{1 3}

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Abstract

The emergence and proliferation of maritime aquaculture is an important response to the overexploitation and subsequent depletion of open-access maritime resources. This paper uses the case study of the market substitution of two species of caught pomfret (*Pampus chinensis* and *Pampus argenteus*) with cultured pompano (*Trachinotus blochii*) in Hong Kong's retail market to demonstrate aquaculture's contribution to overcoming the so-called “tragedy of the commons” and achieving sustainability. Prices of open-access resources typically fluctuate, resulting in an unreliable supply and high price volatility. Transforming an open-access resource into an exclusive one can provide a steadier supply at a lower, more stable price, as previous studies of caught and cultured fish of the same species have identified. In this case, a steady supply of lower-priced cultured pompano has replaced the unreliable supply of the two more expensive species of caught pomfret. What makes this case unique is that the pompano is sold in retail outlets and restaurants under a Chinese name that is identical to that of the two far more expensive species of caught pomfret, which further enhances their substitutability. Although it is a small place with a population of less than 8 million, Hong Kong is the eighth largest consumer market for fishery products. This study demonstrates the importance of proper institutional arrangements for conserving and nurturing resources.

Keywords: Aquaculture · Institutional Arrangement · Sustainable Development · Pompano · Pomfret**1. INTRODUCTION: THE IMPORTANCE OF AQUACULTURE IN SUSTAINABLE DEVELOPMENT**

The global gap between maritime aquaculture and fish catches narrowed from 1950 to 2022 (FAO, 2024). This is a good proxy of the potency of sea farming in not only curbing “rent dissipation”, or the depletion of open-access resources under competition in terms of quantity, but also in nurturing fishery resources through Research and Development (R&D) and eco-management in terms of quality, thus promoting sustainable development (Lai, 2025; Lai et al., 2025).

The quantity aspect is at the heart of the so-called tragedy of the commons, which underpins research on sustainability. Some regulatory measures to address this include fishing bans and quotas. The quality dimension emerges when open-access sea areas are converted into communal or private farming zones, typically through licensing pioneers who occupy the land, as with netted salmon farming in Norwegian fjords and floating cages in Hong Kong.

This conversion provides the institutional framework necessary to encourage investment and innovation. The result is a stable supply of quality-controlled fish in terms of size, weight and species in a managed environment.

This supply-side development would stimulate growth in new seafood marketing and consumption methods. R&D and freedom of enterprise under rule of law are pivotal to such growth. The ecological impact of sea farming varies from country to country, depending on the standards and effectiveness of food and ecological security auditing.

However, one thing is certain: rather than curtailing fishing efforts through regulation, maritime aquaculture would increase the quantity and quality of species reared, thus boosting total employment in the fishing industry

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and avoiding the win-lose dilemma of output *versus* employment or economy *versus* ecology. This would also lead to the development of novel ways of consuming fish.

Although the above synopsis seems complicated, the logic is identical to that of land farming, involving the conversion of wild chickens into organic, free-range farm chickens.

This paper uses the daily wholesale prices of three species of marine fish in Hong Kong, (a) *Trachinotus blochii* (snubnose pompano), (b) *Pampus chinensis* (Chinese pomfret) and (c) *Pampus argenteus* (silver or white pomfret), from 3 September 2021 to 31 March 2025, building on the work of Ong, Che et al. (2022), who found that the daily wholesale prices of (b) and (c), when surveyed over a period of one year, showed high volatility, whereas the prices of (a) remained stable.

The caught fish (b) and (c) are referred to by their traditional Chinese names in Cantonese as ying chong [鷹鯧] (eagle chong) and white chong [白鯧/燕子鯧] (white chong or swallow chong), respectively. These Chinese names are descriptive of their fins. The cultured fish (a) is written in traditional Chinese and called wong lap chong [黃立鯧] (yellow stand chong) in Cantonese. The three fish have become known locally as “chong” [鯧] fish, i.e. pomfret, due to their written Chinese and Cantonese names.

Previous studies found that: (a) farmed fish were consistently sold at lower and more stable prices than caught fish, and (b) consumers accepted the cheaper farmed fish, as reflected in the weight of fish purchased. This study does not compare the prices of the same species of fish produced in different ways, but rather compares the prices of three species of fish (two caught and one farmed) that are traded under a common Chinese name as if they were the same species.

Earlier studies compared wholesale and retail prices by species over a period (by monthly average) and/or by weight (see, for instance, Lai & Yu, 1995; Chau & Ho, 2002). This study examines daily price variations over a period of 3.5 years, demonstrating price stability and discounts between (a) two species of caught pomfret and (b) the interchangeability of the cultured pompano with the two species of caught pomfret.

According to the law of demand, lower prices entail a greater quantity demanded for cheaper cultured fish than for their wild-caught equivalents. Furthermore, the collapse of wild species due to overfishing means that cultured fish are the only sustainable alternative.

However, this follow-up study focuses less on prices *per se* and the substitution of two wild pomfret species by a cultured pompano species, and more on the institutional factors behind the pompano's quick and early success in establishing itself as a “pomfret” in Hong Kong, and the implications of this for sustainable development.

This finding is important as it shows that substitution between caught and cultured counterparts does not have to involve the same species, suggesting a broader range of aquaculture possibilities to enhance sustainability. A good analogous example, mentioned below, is the lab-produced hybrid *Epinephelus lanceolatus* X *Epinephelus fuscoguttatus* (Sabah grouper) and the wild *Epinephelus lanceolatus* (giant grouper).

2. INDUSTRY BACKGROUND

The sustainable culture of marine fish would depend on supplying breeders with fry instead of wild fish (Lai and Yu, 2000). The aquaculture of pompano had an early sustainable beginning in Asia, with Taiwan being a leading fisheries R&D centre. “Fry production began in Taiwan in 1989. Since then, pompano culture has been carried out continuously and profitably in Taiwan, China and Singapore. However, in the Philippines, pompano farming is not popular” (Surtida, 2000). India began culturing a new species of pompano in the 2010s (Ranjan et al., 2018).

In Hong Kong, the practice of culturing pompano by squatters using caught fry can be traced back to 1979 (Lai & Yu, 2002). Following the introduction of the Marine Fish Culture Ordinance in 1982, which established an annual licence system (originally non-transferable), marine squatters obtained the right to culture marine fish in designated zones. However, the pompano was not as prevalent in these zones as the higher-value groupers, seabreams or sea perch. However, by the 1990s, the pompano had definitely established itself as a live fish swimming in glass display tanks in Hong Kong's live seafood restaurants. By 2010, it had become an ordinary iced fish appearing in fish shops and fresh food markets (including supermarkets) as a frozen product.

The cultivation of pompano in the US progressed more slowly than in Asia. “In the 1960s and 1970s, researchers and commercial producers examined the potential of Florida pompano as an aquaculture species. Although early spawning, larval rearing and juvenile grow-out trials were successful, reliable hatchery, nursery and grow-out methods were not developed. In the late 1990s, researchers and commercial farmers began to reevaluate the culture of pompano because of advances in techniques for captive broodstock maturation,

spawning and larval rearing; the development of methods for producing new live foods; and new feed formulations for marine fish” (Main 2007). See Pfeiffer & Riche (2011), for example, for scientific details.

In November 2024, the CSIRO announced a campaign to cultivate its native pompano in Australia. “Successful breeding trials identified the pompano (*Trachinotus anak*) as an ideal candidate to broaden the limited white-flesh fish options available in Australia.”

3. THEORETICAL BACKGROUND AND METHOD OF STUDY

This case study draws on neo-institutional economics (NIE) concepts of property rights, which classify rights along two dimensions: *de jure*, distinguishing between “common” and exclusive (communal or private, including state-owned) rights; and *de facto*, distinguishing between open access and restricted (managed) access (Lai, 2022).

According to the corollary of the Coase Theorem, changes in institutional arrangements result in changes in the use of resources (Lai, 2007; Lai & Hung, 2008). In quantitative terms, the effects of this change will manifest in the levels and/or variances of input or product prices. Qualitatively, the transformation of resources through investment and innovation, as affected by R&D, may result in new products and consumption patterns (Lai et al., 2025). This NIE study examined the market performance of pompano as a managed resource in terms of wholesale prices relative to the other two species of “chong fish” that it substitutes for, as well as the role of marketing as an institutional phenomenon of consumption in sustainability.

The idea of aquaculture as a natural solution to the tragedy of the commons (Lai, 1993; Lai & Yu, 1995; De Alessi, 2000) and sustainable development was proposed by theorists outside the NIE School as early as the mid-1970s. Evidence of this can be found in the works of Anderson Jr. (1975), who studied sea hunting in Hong Kong and Malaysia, and Brown (1978), who pointed out that “Fish farming has been practiced for thousands of years and has been widely discussed for the past decade” in the context of looming overfishing problems.

Brown expressed regret that fish farming “still accounts for only a minute share of world fish consumption”. Brown's position is similar to that of Anderson Jr., as well as mainstream economists and property rights experts such as Smith (1981) and Bell (1986). These scholars regarded fish farming as the solution to the tragedy of the commons. However, they lacked industry knowledge of the emerging mariculture practices in countries such as Norway, Taiwan, and Hong Kong when they published their works.

Mainstream NIE economists have arguably neglected to consider fish farming as a significant innovation in the nurturing of oceanic resources, analogous to land farming. This oversight is likely a consequence of their terrestrial lifestyles. In contrast, Nordic researchers, during the formative years of fish farming in their respective countries, seldom recognised the substantial contribution of Scandinavian commercial aquaculture to sustainable development. This is notable given the global focus on land farming innovations, such as miracle rice, during this period. Willoch (1995), for instance, mentioned that government intervention in Nordic countries hindered innovations in fish farming without noting the immense service of this rising industry, which became a model for many countries to follow to conserve maritime resources and feed the world's growing population (Willoch, 1995).

In a similar vein, Pálsson (1996) demonstrated a predilection for a Marxian commodification narrative of the fish wars, as opposed to emphasising the imminent reduction in reliance on ecologically unsustainable commercial fishing in Northern Europe, despite a cursory allusion to the history of Asia's freshwater fish farming industry (p. 81).

In the mid-1970s, the research literature on maritime aquaculture was dominated by the views of academic fisheries experts. These experts treated the subject with great caution and, at best, regarded it as a supplement to fish hunting. The following two examples serve to illustrate this observation. Firstly, the following comment on Iversen's (1977) *Farming the Edge of the Sea* was proffered by Bardach (1977):

One of the rationales for engaging in aquaculture in coastal areas, as posited by the author, is to regulate the supply of seafood. “That aquaculture hardly begins to do so remains a good reason for pushing on with removing some biotechnical obstacles to sea farming. The first and foremost of those obstacles is low larval survival and control over the reproductive physiology of several fish and invertebrates potentially popular for culture that have very small eggs, like most of their kind. Improvement of those skills will allow us to do a lot more “improvement through artificial selection” (a chapter heading of the book) and hopefully put marine animals near the ball park, one day, now occupied by chickens or pigs.” (Bardach 1977: 2427) In another study, Rettig & Johnston (1977: 136) undertook an initial assessment of salmon culture: “A new development is the recent growth in salmon aquaculture. This growth has taken two directions – fish farming and fish ranching. Fish farming consists of growing salmon entirely in a controlled system, producing “pan-sized” salmon of consistent

size and quality. This form of aquaculture is biologically independent of ocean salmon fisheries but economically interrelated, and latently quite competitive. Fish ranching refers to private hatcheries. Salmon produced in these hatcheries would be common property while in the ocean, and thus would be available for harvest by trollers and sport fishermen, assuming species are raised that take hooks. The private firms assume a sufficient percentage of the run will return to the hatchery to cover the costs of the operation, plus a return on investment. Fish ranching could be a positive factor to some segments of commercial and sport fisheries, but some fishery managers fear that the aquaculture fish could be biologically competitive with wild fish and fish from public hatcheries and could lead to a less desirable ocean salmon stock.” (Rettig & Johnston 1977: 136).

The research conducted by Donnelly & Agnello (1975) on the contrast between wild *versus* cultivated oysters yielded a counterintuitive finding: namely, that an open-access species is subject to a negative premium compared to a cultivated species. However, subsequent examinations of open access *versus* communal or private fisheries resources sold in Hong Kong, the global seafood market, by Lai (1993), Lai & Yu (1995), Chau & Ho (2002), and Lai & Lorne (2016) did not replicate this finding. The probable reason for this is that wild oysters under open access have been nearly fully dissipated as rent under competition, but oyster culturists have significantly improved the quality of their produce.

Villasante et al. (2013) found from FAO-published annual statistics for all countries that the prices of cultivated species were higher than those for the same species that were “harvested from the sea.” However, a close examination of their work found that: (a) the premiums were principally for freshwater species, most notably carp, and (b) wild oysters from 2002 fetched a premium over cultured ones (Panel D, Figure 2, 942). This finding stands in contrast to the conclusions of Donnelly & Angelo, who specialised in the analysis of the American market during the 1970s. The three main “sea fish” species examined in this study were salmon, trout and smelt. However, it should be noted that these species can also be considered freshwater.

3.1 Empirical Analysis

The empirical study by Agnello & Donnelley (1975) of wild *versus* cultured oysters reported higher prices and lower price variance for the latter. However, all Hong Kong studies of caught *versus* cultured fish of the same species (Lai 1993, Lai & Yu 1995, Chau & Ho 2002, Lai & Lorne 2020), based on annual wholesale and retail prices, reported the opposite. This phenomenon is consistent across wild *versus* cultured shrimp, as evidenced by daily retail price data (Lai et al. 2006). Lai et al. (2006) and Ong Che et al. (2022) studied the daily wholesale and retail prices of caught coral fish in comparison to their cultured substitutes. The primary focus of this study was the *Plectropomus leopardus* (leopard coral grouper) and the hybrid Sabah grouper. The two papers did not contradict the working hypothesis, which states that a resource (for example, cultured fish) under well-managed, exclusive property rights tends to have lower prices and price volatility than an open-access one (as in the case of wild fish).

However, the focus of this work is not solely on the successful branding of a more economical farmed fish as a higher-end caught fish of a different species, but on market substitution enabled by aquaculture, which also enhances sustainability. In order to conserve high-value marine fish species, such as salmon and Pacific Bluefin tuna (see Metian et al. 2014 and Aung et al. 2024), it is considered that aquaculture is the most sustainable option.

Previous statistical studies on the prices (mainly mean monthly prices) of caught *versus* cultured fish by species over specific periods have been shown to be influenced by the law of demand, with cultured species being sold at discounts and exhibiting lower price volatilities, thus dominating their consumer markets.

The study utilises a 42-month timeframe to analyse the daily price differentials of three distinct species: the captured Chinese and white pomfret *versus* the farmed pompano, which has been traded and accepted in Hong Kong, Singapore, and even Melbourne as a pomfret.

For this study, the authors drew upon a biologist's collection of the wholesale prices of cultured snubnose pompano (pompano), as well as two caught pomfrets (Chinese pomfret and white pomfret) during the period from 3 September 2021 to 31 March 2025 from the Fish Marketing Organization (FMO).

It was hypothesised that pompano would prove to be a close substitute for pomfret (Substitutability Hypothesis), on the basis of their similar appearance and taste, as well as their joint marketing under the Chinese name “chong fish” (Ong et al., 2022).

The observed similarities between these species suggest that consumers lacking in knowledge and/or those with particular preferences may regard them as interchangeable, “more or less the same” marine fish.

In order to formally test this hypothesis, a cointegration analysis was employed. If Pompano and pomfret are indeed close substitutes, then it can be hypothesised that their prices should have been influenced by the same

set of market fundamentals. This would result in cointegration, i.e. their prices should have moved together over time, reflecting a long-term equilibrium relationship.

Whilst there is the possibility of observing cointegration between complementary goods, this is unlikely in the present case, since pompano and pomfret are seldom consumed in combination in a single dish or both featured on the same menu.

In the absence of a refutation of the Substitutability Hypothesis, the subsequent step would be to assess whether the farmed variety (pompano) exhibited lower and more stable prices compared to its wild-caught counterpart (pomfrets), thereby evaluating one of the economic benefits of cultured fish.

3.2 Institutional Arrangements for Maritime Fish Production and Consumption

Aquaculture is a pivotal solution to the issue of fish species depletion in public waters, through the production of more quality-controlled fish species, innovation and management. The potential exists for the production of new products not native to open-access water bodies via R&D. With regard to food production, the aforementioned Sabah grouper serves as a notable example. This specimen is a hybrid of the male Giant and female Tiger Grouper, both of which were produced through In Vitro Fertilisation (IVF) (Lai et al., 2020). For those engaged in the hobby, cross and selective breeding of aquarium fish is a well-known practice. The wild goldfish (*Carassius auratus*) is a species that may have become extinct in most regions. In comparison to farmed goldfish, wild goldfish are less diverse and aesthetically pleasing. This paper will provide a concise narrative, informed by the authors' local knowledge, of the emergence of pompano in Hong Kong as a “chong fish,” given its initial presentation as a live sea fish in seafood restaurants, yet its comparatively limited availability as compared to fried fish in Hong Kong-style cafes or iced fish in fish markets.

4. FINDINGS AND OBSERVATIONS

Table 1 presents the descriptive statistics of the wholesale price of cultured pompano (POM) and two pomfrets (WP and CP) over the period from 3 September 2021 to 31 March 2025.

Table 1. Descriptive Statistics of Wholesale Prices of Pompano and Pomfrets

	Variable name	Mean	Median	Maximum	Minimum	Std. Dev.
Cultured Pompano (<i>Trachinotus blochii</i>)	POM	73.74	72.50	85.00	69.75	2.77
Caught White Pomfret (<i>Pampus argenteus</i>)	WP	145.82	132.66	479.51	90.94	36.25
Caught Chinese Pomfret (<i>Pampus chinensis</i>)	CP	533.27	577.50	761.00	82.67	138.60

Prior to conducting a co-integration test to evaluate the Substitutability Hypothesis, it was imperative to ascertain whether the price series exhibited integration of order one $I(1)$, signifying non-stationarity at the level but stationarity at the first difference.

Stationarity was tested using the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979), with the optimal lag length being determined using the Schwarz Information Criterion (SIC) (Said and Dickey, 1984). It was confirmed that all series were integrated of order one, $I(1)$.

The Johansen cointegration test (Johansen, 1988) was then applied to the POM and WP, as well as the POM and CP. The findings of the test indicated that POM cointegrated separately with WP and CP at the 1% significance level. This outcome was not inconsistent with the Substitutability Hypothesis.

In order to ascertain the most suitable tests for the purpose of comparing price level and stability, it was necessary to verify the validity of the normality assumption. Given the relatively large sample size of 1,126 paired observations, a range of complementary approaches was applied to ensure robust inference.

Initially, the Shapiro-Wilk test was performed, which is sensitive to both skewness and kurtosis and is considered reliable for small to moderately large samples (Shapiro & Wilk, 1965). The Jarque-Bera test was also applied to assess deviations from normality by jointly testing skewness and excess kurtosis (Jarque & Bera,

1980). Finally, the Anderson-Darling test was employed, a method that places greater weight on discrepancies in the tails of the distribution (Stephens, 1974).

In all three tests, the null hypothesis of normality was rejected at the 1% significance level for each price series. The findings of this study suggest that the empirical distributions of fish prices were not normally distributed, a potential consequence of skewness, leptokurtosis, or both. The findings of the present study provided the impetus for the subsequent employment of non-parametric and distributionally robust methods in the context of further tests.

In order to ascertain the discrepancy in central tendency between POM and WP, as well as between POM and CP, non-parametric tests were conducted, which are deemed to be appropriate for paired, non-normally distributed data. The Wilcoxon signed-rank test (Wilcoxon, 1945), the sign test (Dixon and Mood, 1946), and a permutation-based test of medians (Good, 2000) were employed in this study.

Each test was applied separately to the pairs POM *versus* WP and POM *versus* CP. In both comparisons, the results from all three tests consistently rejected the null hypothesis of equal medians at the 1% significance level. In every instance, the median of POM was found to be significantly lower than those of WP and CP.

In order to investigate differences in relative price variability, the coefficients of variation (CV) of POM and those of WP and CP were compared using the following methods:

1. Modified Signed-Likelihood Ratio Test (MSLR): This test has been shown to offer enhanced size and power in comparison to classical tests when evaluating CVs under non-normal conditions (Krishnamoorthy & Lee, 2014). It is considered appropriate for independent or paired samples.

2. Bootstrap Resampling: Non-parametric bootstrap tests were performed by resampling paired observations and constructing the empirical distribution of the CV differences (Efron & Tibshirani, 1993). The computation of confidence intervals was conducted through the utilisation of 5,000 replicates.

In both pairwise comparisons, i.e. POM *versus* WP and POM *versus* CP, the results consistently rejected the null hypothesis of equal coefficients of variation at the 1% significance level. In each instance, the POM demonstrated a considerably lower CV, signifying more stable prices over time in comparison to its WP and CP.

4.2 Story of the Rise of Pompano

The term “chong fish” was used to describe Pompano from the outset, when it became a cage-reared fish in culture zones during the early 1980s. The nomenclature of the specimen in question was most likely determined by its congruence with the two well-established pomfret specimens under study. In any case, by the late 1980s or early 1990s, this fish was commonly observed to be swimming swiftly within glass aquariums in live seafood restaurants, in the presence of other species of sea fish, including the less mobile groupers. The fish in these tanks were selected by diners for immediate slaughter and cooking, typically by steaming, for consumption. However, in the context of major Chinese-style banquets, the fish selected was typically grouper, not pompano, due to the latter's smaller size and perceived inferior taste. The Chinese pomfret was considered a delicacy, yet it was never served at significant events such as birthdays and wedding banquets. This can be attributed to the fact that the Chinese word for “chong” is associated with ulcers and wounds.

By this time, the number of live seafood restaurants had decreased, and their fish tanks had become dominated by the bright orange-coloured leopard coral grouper and the Sabah grouper. In all restaurants, including those serving Hong Kong-style seafood, the fish known as “chong fish” was invariably iced pompano and Sabah grouper. In the event that establishments such as hotels and high-end restaurants offered pomfret, typically in a Western style, it would be customary for the Chinese names of the fish to be clearly displayed on the menu, accompanied by English translations. Pompano, whether prepared as steamed or fried fish, was invariably presented whole on a dish.

5. INTERPRETATION

The price trends of Pompano and Pomfret demonstrate the predicted beneficial effects of aquaculture over fish hunting.

However, the more interesting theoretical point about the success of Pompano, though it was no match for cultured groupers (especially Sabah grouper) as live fish, in being the iced fish of choice in Hong Kong restaurants, is that its Chinese name was good for marketing as a substitute for the expensive iced pomfret. Pompano and pomfret are different fish species, despite the fact that they may appear similar in terms of colour and shape. The former is a jackfish, which is characterised by its firm and meaty texture, while the latter is a butterfish, whose meat is distinguished by its softer and flakier consistency.

It is hypothesised that if Hong Kong fish farmers had opted for an alternative appellation, such as seabreams [鱸] (translated as “lap”), the species known as pompano would not have come to dominate the market for restaurant fish dishes alongside Sabah grouper. This case study indicates that the efficacy of a product name is a significant factor in its marketing strategy, with the concept of sustainability also playing a pivotal role.

Pompano has not been able to surpass Sabah grouper in terms of popularity as a live fish in restaurants. This grouper, which was first produced in 2006 by scientists at the Universiti Malaysia Sabah, has been the preferred choice in Hong Kong since its introduction. The authors hypothesise that the rationale behind this phenomenon is that the latter was designated Sabah dragon tug [沙巴龍躉] (“Sabah lung dun”) in Chinese, as a specific Giant grouper, lun dun [龍躉], as opposed to an “ordinary” grouper, which is written in Chinese as “grouper” [斑] (“pan”) and is greatly favoured for Chinese banquets. Consequently, Pompano's strategic focus is oriented towards the middle and lower-end market segments.

The present study is constrained to the consideration of generality based on price statistics in a city (Hong Kong). However, the authors hypothesise that analogous price differentials exist between wild pomfret and farmed pompano, based on their observations of the city-state of Singapore. As observed in the case of Hong Kongers, Singaporeans also demonstrate a clear preference for pomfret over golden pompano, as evidenced by the significantly higher prices of the former (Tay, 2021).⁴

6. DISCUSSION: SOME IMPLICATIONS FOR POMPANO CULTURE IN AUSTRALIA

The early introduction of pompano and many other types of fish to the low-tech, family-run Hong Kong fish farming industry is testament to the favourable market fundamentals of the British colony's open, laissez-faire boom economy from the 1970s to the 1990s, when ecological sensitivity was not a major consideration. Hong Kong has long been a renowned global testing ground for various consumer products, including mobile phones, personal computers, and imported food. The mariculture case in Hong Kong has implications for the rearing of pompano in Australia.

The CSIRO's introduction of pompano to Australia, some 25 years after its introduction to Hong Kong, may be due to the country's high ecological sensitivity, which necessitates more time to study the impact of introduced species on the local environment, as well as a smaller fish market. However, pompano is considered a sustainable food source and could benefit Australia, whose coastal waters have been under great ecological stress due to commercial fishing (Bohm, 2008).⁵

The first implication concerns the more ecologically and economically viable method of farming. Hong Kong's low-tech cage culture has been superseded by coastal cage culture in mainland China, with Hong Kong's cages often being used for reception and storage. Local production could have been far more sustainable from an ecological and economic perspective had there been provisions for long-distance, offshore fish culture zones to achieve economies of scale. The Hong Kong government found this to be viable while experimenting with deep-sea culture in Port Shelter. The experiment was an immediate success, but the idea was dropped due to theft. Culturists may find that large-scale offshore farming of pompano and other fish is more viable than high-density coastal farming. A land-based pond or recirculating aquaculture system (RAS)⁶ culture could also be an effective measure against vandalism.

For ecological reasons, the Australian trial is being conducted in an RAS to obtain fry from domestic hatcheries for the fillet market. The high costs involved would make it difficult to break into the market for

⁴ Here is interesting information regarding the Chinese silver pomfret and pompano: These four fish species are grouped together because they are all known as “Chior” [鯧] by the Teochews [Cantonese: Chiu Chow]/Hokkiens, although scientifically, they belong to different families. They are similar in size and shape, but quite different in flavour and texture. The pomfret is a prized fish locally and specially regarded by the Teochew as the best food fish bar none. We Teochews even have a saying about marriage and good food that goes like this: “Ai chua ngia bou, sou lak nior! Ai jia hor her peh dou chior.” The literal translation is, “If you want a beautiful wife, sou lak nior! (an ancient, voluptuous Chinese beauty). If you want to eat good fish, white bellied pomfret!” The strange thing is that pomfret seems to only achieve such legendary status with Teochews in particular and the Chinese in general. It is hardly used in Western cooking. In Australia, the word, “pomfret,” refers only to the black pomfret, while the revered silver pomfret doesn't even merit an entry in the Western Australian Museum's Field Guide to Marine Fishes of Tropical Australia and South East Asia (4th ed., square brackets added by the authors).

⁵ <https://wwf.org.au/what-we-do/oceans/overfishing/>

⁶ The RAS was adopted to farm Giant grouper at a private fish farm in Tsim Bei Tsui, Hong Kong (Lai & Lorne 2020).

iced whole fish, which has many cheap imported substitutes. On 14 March 2025, the wholesale price of imported whole iced pompano fish from Malaysia at Melbourne's Queen Victoria Market was around US\$11/kg.⁷ Several fish species have been successfully reared in Australia using RAS. Notable examples include the barramundi (Asian sea bass), which is the most commonly farmed species in RAS in Australia, and the yellowtail kingfish.

A second issue is the naming of the product in Chinese. The fact that pompano has been accepted as a 'chong fish' in Hong Kong means that marketing it in Australia using the same Chinese name would appeal to Chinese Australians, who also prefer to have whole fish presented on their dinner tables. At Queen Victoria Market, pompano was sold as "Golden pomfret".

This aligns with SDG 12, Responsible Consumption and Production. However, most academic works have focused on the regulatory aspects rather than the fishing industry as a contributor to sustainable investment opportunities (Andersen, 2021). This demonstrates that cultured pompano, as a substitute for wild pomfret, is subject to open-access dissipation. The sustainability implications are the same for laboratory-made Sabah grouper hybrids substituting for the giant grouper.

7. CONCLUSION

This descriptive Hong Kong property rights case study, which uses pompano as a substitute for Chinese and white pomfret and is supported by daily wholesale prices for the three fish over more than three years, contributes to the discussion of aquaculture as an innovative way to respond to the "tragedy of the commons" for maritime resources. Branding the cultured, and therefore more sustainable, species with similar names to those of the wild species, due to their similar shape and colour, should facilitate product substitution.

The results of this study indicate that any market substitution between captured and cultured fish does not require the species to be identical, pointing to a broader range of aquacultural options for promoting sustainability.

⁷ The price of pompano in the Wanchai Market was only US\$8.75/kg on the same date.

AUTHOR CONTRIBUTIONS

Lawrence W.C. Lai: Conceptualisation, Drafting

K.W. Chau: Modelling and Testing, Review

DECLARATIONS

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REFERENCES

- Agnello, R.J. & L.P. Donnelley. (1975). Property rights and efficiency in the oyster industry. *Journal of Law and Economics* 18, 521-533.
- Andersen, E.G. (2021). *Responsible Consumption and Production*. Storebrand Asset Management.
- Anderson Jr, E.N. (1975). 'Chinese fishermen in Hong Kong and in Malaysia.' In R. Casteel and G. Quimby eds. *Adaptations of the Pacific*. Mouton Publishers, The Hague, 231-246.
- Aung, T., Abdul Razak, R., & Rahiman Bin Md Nor, A. (2025). Artificial intelligence methods used in various aquaculture applications: A systematic literature review. *Journal of the World Aquaculture Society*, 56(1), e13107.
- Bardach, J.E. (1977) Review of Iversen, E.S. (1977), *Farming the Edge of the Sea*. Fishing News Books, Ltd., Farnham Surrey, England. *Journal of the Fisheries Board of Canada* 34, (12), 2427.
- Bell, F.W. (1986). Mitigating the tragedy of the commons. *Southern Economic Journal* 52(3) 653-664.
- Bohm, C. (2008). 'Guiding Australian consumers to sustainable seafood choices' in Ward, T. & Phillips, B.(eds) *Seafood Ecolabelling: Principles and Practice*, Hoboken, New Jersey: Wiley-Blackwell, 389-402.
- Brown, Lester R. (1978). *The twenty-ninth day: Accommodating human needs and numbers to the earth's resources*. Worldwatch Institute, Washington D.C.
- Cauvin, Dennis M. (1977). Review of economic impacts of extended fisheries jurisdiction. *Journal of the Fisheries Board of Canada* 34, (12), 2427-2429.
- Chau, K.W. & Ho, K.O. (2002). A time-series analysis of the price of *Epinephelus*. *Aquaculture Economics & Management* 6 (3&4), 215-229.
- De Alessi, Michael. (2000). 'Fishing for solutions: The state of the world's fisheries.' In Ronald Bailey ed. *Earth Report 2000: Revisiting the True State of the Planet*, New York: McGraw-Hill, 85-114.
- De Alessi, Michael. (2008). 'International fisheries.' Competitive Enterprise Institute.
- Dickey, D.A., & Fuller, W.A. (1979). Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association*, 74(366), 427-431.
- Dixon, W. J., & Mood, A. M. (1946). The statistical sign test. *Journal of the American Statistical Association*, 41(236), 557-566.
- Efron, B., & Tibshirani, R. J. (1993). *An Introduction to the Bootstrap*. Chapman and Hall/CRC.
- FAO (Food and Agriculture Organization of the United Nations). (2024). *The State of World Fisheries and Aquaculture: Blue Transformation in Action*. Rome.
- Feltz, C.J., & Miller, G.E. (1996). An asymptotic test for the equality of coefficients of variation from k populations. *Statistics in Medicine*, 15(6), 647-658.
- FMO (Fish Marketing Organisation)
- Good, P. (2000). *Permutation Tests: A Practical Guide to Resampling Methods for Testing Hypotheses* (2nd ed.). Springer.
- https://globalfundsearch.com/wp-content/uploads/2019/09/Responsible_Consumption_and_production_white-paper.pdf
- https://www.fmo.org.hk/price?path=12_43
- Jarque, C. M., & Bera, A. K. (1980). Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters*, 6(3), 255-259.

- Johansen, S. (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control*, 12(2–3), 231–254.
- Kerton, F.M. (2023). UN Sustainable Development Goals 14 and 15–Life below water, Life on land. *RSC Sustainability*, 1(3), 401–403.
- Krishnamoorthy, K., & Lee, M. (2014). Improved tests for the equality of normal coefficients of variation. *Computational Statistics*, 29(1), 215–232.
- Lai, L.W.C., & Hung, C.W.Y. (2008). The inner logic of the Coase Theorem and a Coasian planning research agenda. *Environment and Planning B: Planning and Design* 35(2), 207–226.
- Lai, L.W.C. & Lorne, F.T. (2020). State-assisted entrepreneurial ventures: the case of aquacultural development and the seafood industry in Hong Kong. *International Journal of Entrepreneurial Venturing*, 12(4), 439–458.
- Lai, L.W.C. & Yu, B.T. (2004). Implementing Sustainable Development: Institutional Features. *Encyclopaedia of Life Support Systems (EOLSS)*, UNESCO.
- Lai, L.W.C. (2007). ‘The Problem of Social Cost’: the Coase theorem and externality explained: Using simple diagrams and examples to illustrate the role of land use planning in tackling externalities. *Town Planning Review* 78(3), 335–368.
- Lai, L.W.C. (2025). Some reflections on Hardin's property rights solution to the tragedy of the commons. *Economic Affairs*, 45(1), 140–146.
- Lai, L.W.C., & Lorne, F.T. (2014). Transaction cost reduction and innovations for spontaneous cities: Promoting a ‘meeting’ between Coase and Schumpeter. *Planning Theory* 13(2), 170–188.
- Lai, L.W.C., Chau, K.W., Wong, S.K., Matsuda, N. & Lorne, F.T. (2005). Marine fish production and marketing for a Chinese food market: a transaction cost perspective. *Aquaculture Economics & Management* 9(3), 289–316.
- Lai, L.W.C., Che, R.O., & Chau, K.W. (2020). A triumph over the tragedy of the commons: the Hong Kong story of Sabah grouper from a Coasian-Schumpeterian perspective. *World Aquaculture*, 51(3), 27–33.
- Lai, L.W.C., Lam, K.K., Lorne, F.T., & Wong, S.K. (2006). Economics of Gei Wai shrimp culture in Hong Kong: from commercial aquaculture to bird production. In Leung, P.S. & Engel, C. (eds.) *Shrimp Culture: Economics, Market, and Trade*, Blackwell, 167–186.
- Lai, L.W.C., Lorne, F.T., Davies, S.N.G., & Chau, K.W. (2025). Innovative planning for sustainable development: A win-win approach through conversion of negative into positive externalities. *Land Use Policy*, 157 107643.
- Main, K.L., Rhody, N., Nystrom, M., & Resley, M. (2007). Species profile-Florida pompano. Southern Regional Aquaculture Center, 7206.
- Metian, M., Pouil, S., Boustany, A., & Troell, M. (2014). Farming of bluefin tuna–reconsidering global estimates and sustainability concerns. *Reviews in Fisheries Science & Aquaculture*, 22(3), 184–192.
- Ong Che R, Kwok S.S., & Lai L.W.C. (2022). Pomfret or Pompano? Aquaculture as a solution to the tragedy of the commons in Hong Kong. *Journal of Aquaculture and Fisheries*, 6: 044.
- Pálsson, G. (1996). ‘Commodity fiction and cod fishing.’ *Nordic Journal of Political Economy* 23(1), 75–86.
- Pfeiffer, T.J., & Riche, M.A. (2011). Evaluation of a low-head recirculating aquaculture system used for rearing Florida Pompano to market size. *Journal of the World Aquaculture Society*, 42(2), 198–208.

- Ranjan, R., Megarajan, S., Xavier, B., Ghosh, S., Santhosh, B., & Gopalakrishnan, A. (2018). 'Broodstock development, induced breeding and larval rearing of Indian pompano, *Trachinotus mookalee* (Cuvier, 1832): A new candidate species for aquaculture.' *Aquaculture*, 495, 550-557.
- Rettig, R.B. & Johnson R.S. (1977). 'Anadromous species and extended jurisdiction.' Anderson, L.G. ed. In *Economic Impacts of Extended Fisheries Jurisdiction*. Proceedings of a Symposium Sponsored by the University of Delaware Sea Grant College Program and the National Marine Fisheries Service, Ann Arbor Science, Ann Arbor, 1977, 133-136.
- Said, S.E., & Dickey, D.A. (1984). Testing for unit roots in autoregressive-moving average models of unknown order. *Biometrika*, 71(3), 599–607.
- Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). *Biometrika*, 52(3–4), 591–611.
- Smith, R.J. (1981). Resolving the tragedy of the commons by creating private property rights in wildlife. *Cato Journal* 1, 439.
- Stephens, M. A. (1974). EDF statistics for goodness of fit and some comparisons. *Journal of the American Statistical Association*, 69(347), 730–737.
- Surtida, M.B. (2000). The pompano. *SEAFDEC Asian Aquaculture*, 22(3), 27.
- Tay, L. (2021). 'Singapore Fish Files: Pomfrets and Pompanos' June 28, 2021. <https://ieatishootipost.sg/singapore-fish-files-pomfrets-and-pompanos/>
- Villasante, S., Rodríguez-González, D., Antelo, M., Rivero-Rodríguez, S., & Lebrancón-Nieto, J. (2013). Why are prices in wild catch and aquaculture industries so different? *Ambio* 42, 937-950.
- Wilcoxon, F. (1945). Individual comparisons by ranking methods. *Biometrics Bulletin*, 1(6), 80–83.
- Willoch, K. (1995). What can other countries learn from the Scandinavian experience? II. *Nordic Journal of Political Economy* 22, 177-182.