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The Costs of Construction and Housing Prices: A Full-Cost Pricing or Tendering Theory?

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Abstract: While construction costs and housing prices are implicitly examined in the construction economics literature, dedicated studies on their theoretical underpinning are rare. In this study, we investigated the application of different pricing theories in Auckland by testing the relationship between house prices and construction costs in Auckland from 1995 to 2021. The results contrast the tendering pricing theory, which posits that construction prices are optimal mark-ups unaffected by market demand, with the full-cost pricing theory, which acknowledges the market-dependent nature of pricing. By using the Toda-Yamamoto's granger-causality test and Pesaran's Autoregressive Distributive Lag (ARDL) bound tests, we analysed the relationship between the house price index (HPI) and construction cost index (CCI). The result suggests a significant relationship between housing prices and construction costs in both the short and long term, supporting the predominance of the full-cost pricing theory in Auckland's housing market. The finding highlights the potential need for property industry participants to evaluate the market structure of the construction industry, fostering a more competitive environment and paving the way for more effective supply-related housing policies.

Keywords: full-cost pricing; tendering theory; construction cost index; house price index

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1. Introduction

Studies on the housing market often focus on understanding the dynamics of housing demand, while investigations into the supply side, particularly construction costs, have received relatively less attention [1,2]. Early research on residential construction costs primarily examined productivity in homebuilding [3]. In a related study, Rosenthal [4] explored the connection between construction costs and structure value, finding evidence of their co-integration. Despite the crucial role of construction in the housing market, there is limited direct empirical research examining the relationship between construction costs and housing prices [5,6]. While the impact of construction costs on house prices has been implicitly studied in previous literature, there is a noticeable gap when it comes to understanding how house prices impact construction costs. Few studies have delved into this aspect, leaving a significant area of research unexplored. This presents an opportunity for further investigation and research, as understanding this relationship could provide valuable insights into the dynamics of the housing and construction markets.

To bridge this research gap, this study is uniquely positioned to conduct an empirical investigation in Auckland, New Zealand—a global city known for its costly construction sector provides an ideal setting to examine and analyse the dynamics between housing prices and construction costs in depth. This approach aligns with the suggestions of Adams and Fuss [7], who argue that studying the effects of house prices on construction costs in conjunction with the impact of construction costs on house prices could prevent the overestimation of effects and provide a more accurate understanding of the industry conditions. Specifically, we are testing two competing theories that explore the connection between housing prices and construction costs in this study: the tendering theory [8] and the full-cost pricing theory [9]. Despite the theoretical base of these pricing theories, a significant research gap exists in their empirical implications and validation, particularly within the context of the market structure of the construction industry. This study addresses this research gap by providing empirical evidence supporting the application of these pricing theories within the construction industry. We argue that the choice of theory is contingent upon the local market structure, with monopoly markets more likely to favour the adoption of full-cost pricing, while monopolistic competition is more aligned with the tendering theory.

According to the tendering theory [8], construction tendering prices represent optimal mark-ups and remain unaffected by fluctuations in market demand. In this theory, bidders set their tender prices based on cost estimates plus a constant percentage mark-up, aiming to secure a predetermined fraction of contracts. The winning bid is determined by the cost estimate plus a mark-up derived from a probability density function. In a rational and competitive market, all bidders would apply a consistent mark-up, adjusting only for differences in the original cost estimate. Thus, tendering theory suggests that tendering is a process that facilitates communication between buyers and builders, reflecting the price at which both parties are willing to transact services. Housing prices, therefore, should not influence construction tendering costs in a competitive market.

On the contrary, full-cost pricing theory [9] argues that the construction industry's inherent uncertainty makes cost estimation and pricing challenging. As per this theory, the prevailing pricing policy in the industry is based on absorption or full-cost pricing. This approach primarily considers production costs such as labour, materials, plant, and overheads. If construction prices are cost-based, any differences in contract amounts would directly stem from variations in production costs. Therefore, the construction industry pricing practice aligns more with marketing discipline principles rather than neo-classical economics [10]. Following the full-cost pricing policy, construction tenders are highly influenced by market demand, including housing prices. Full-cost pricing is widely adopted as a pricing strategy in construction service industries. Backman [11] notes the widespread belief that 'prices are or should be determined by costs of production', and Gabor [12] suggests that cost estimates are often used to gauge competitors' likely quotes. The practice of full-cost pricing aims to minimise any potential loss and maximise profitability [13]. In markets characterised by an oligopolistic structure, collusion among a few large construction firms can significantly impact the overall market. Thus, determining construction costs can be influenced by market demand and housing prices.

If the full-cost pricing theory holds, it will imply that the escalating house price index could exert further upward pressure on already high construction costs. This outcome could necessitate strategic adaptations by industry players, such as cost management initiatives or shifts in project scopes, to maintain project feasibility in the face of rising costs. On the other hand, if the tendering pricing theory is supported, this would suggest a potential lead-lag relationship between rising construction costs to higher house prices. This finding could have profound implications for the Auckland housing market, potentially exacerbating existing affordability issues and influencing policy discussions around housing and construction industry regulations. Furthermore, this research could contribute to the broader understanding of pricing mechanisms in the construction industry, providing a basis for more informed decision-making by stakeholders. This is particularly relevant given the current uncertainties in the industry, such as the decrease in sales from group housing companies and the significant number of issued residential consents for multi-unit homes that have not yet started construction.

As such, we propose the hypothesis that, *ceteris paribus*, housing prices will demonstrate a long-term positive relationship with construction costs, thereby advocating the prevalence of full-cost pricing in New Zealand's construction industry. To empirically probe these theories, we utilise the building consent dataset from BCI New Zealand PTY Limited (BCI NZ) to construct a construction (tendering) price index for Auckland using the hedonic pricing model. Furthermore, we leverage residential property transaction data from CoreLogic to construct a housing price index for Auckland using the repeat-sales method [14]. Our research design incorporates Granger-causality tests to inspect the short-term relationship between the construction (tendering) price index and the housing price index. In addition, we apply the Autoregressive Distributive Lag (ARDL) bound test to examine the long-term co-integration between these two indices. Our empirical findings reveal that there is Granger causality between the two indices in the short run; the result of the Granger causality test shows that the house price index leads to changes in the construction cost index in the short run, but the construction cost index does not lead to changes of house price index. Meanwhile, in the long run, while the construction cost index does not instigate changes in the house price index, alterations in the house price index do precipitate shifts in the construction cost index, as substantiated by significant results from the ARDL bound tests. This research not only validates the full-cost pricing theory but also elucidates the short-term and long-term dynamics between house prices and construction costs. This nuanced understanding contributes to the literature by filling the existing gap that often overlooks the distinction between short-term and long-term dynamics.

2. Background of the Housing Development Market in New Zealand

New Zealand's construction industry has experienced steady growth over the past five years, contributing approximately 18.6 billion New Zealand dollars to the country's gross domestic product (GDP) in the year ending September 2022. This highlights the significant role of the construction sector in New Zealand's economy as it addresses the infrastructure and housing needs of the growing population.

The number of enterprises operating in the construction industry has also shown an upward trend, projected to increase from around 38,000 in 2013 to over 50,000 by 2022. This growth signifies a vibrant and expanding construction landscape in New Zealand.

The construction industry has been a major employer, with the number of people employed in the sector fluctuating over time. As of June 2022, it was estimated that approximately 250,000 individuals were working in construction-related roles. Moreover, businesses providing services related to the construction industry are expected to create more job opportunities, with projections indicating an increase from around 100,000 jobs in 2013 to over 130,000 by 2022.

The value of building work completed in New Zealand has been substantial, reaching approximately $7 billion NZD as of June 2022. This includes both residential and non-residential construction projects. Specifically, the value of residential building work is projected to grow from around $20 billion NZD in 2018 to over $25 billion NZD by 2022, emphasising the significant investment in the residential housing sector.

Residential building consents, a key indicator of construction activity, are also on the rise. The value of residential building consents issued in New Zealand is expected to increase from around $12 billion NZD in 2017 to over $16 billion NZD by 2022. Furthermore, the number of residential building consents for all dwellings is projected to rise from approximately 30,000 in 2017 to over 40,000 by 2022, reflecting the increasing demand for new housing units.

In 2022, it is anticipated that around 45,000 building consents will be issued for houses, while approximately 15,000 consents will be issued for apartments, further demonstrating the diverse nature of residential construction in New Zealand.

Overall, the construction industry in New Zealand is experiencing growth and is expected to continue its upward trajectory. However, challenges such as labour shortages and rising material costs need to be addressed to ensure sustainable development and meet the evolving needs of the population. These statistics provide valuable insights into the construction industry's scale and importance in New Zealand's economy, laying the foundation for understanding the implications and impact of Full-Cost Pricing and Tendering Theory in this dynamic sector.

3. Literature Review

3.1. Full-Cost Pricing

According to the article by Hall and Hitch [15], firms often set prices based on full costs plus a standard mark-up. The price is determined by the total costs incurred in the production of a good or service, including both direct and indirect costs. The mark-up is then added to this total cost to determine the selling price. This mark-up is typically determined by the desired rate of return and the perceived market conditions. However, the exact setting of the mark-up can vary between firms and industries. The mark-up is often expressed as a percentage of the total cost and is set to cover profit margins and any potential cost variances [16].

Housing demand does influence the housing price under the full-cost pricing theory. However, the extent of this influence can vary depending on the market structure and conditions. In a perfectly competitive market, builders are price takers and cannot influence prices. However, in markets with less competition, builders have more discretion to set prices and may adjust their prices in response to changes in housing demand. The article by Baumol et al. [17] suggests that market demand, and hence the housing price, plays a role in full-cost pricing. Builders often consider the demand elasticity when setting prices. If demand is inelastic, firms may set a higher price, while if demand is elastic, builders may set a lower price to increase sales volume. For instance, in the airline industry, Borenstein and Rose [18] found that price dispersion due to systematic peak-load pricing should be correlated with the variability in airlines' fleet utilisation rates and airports' operations rates.

The full-cost pricing theory could lead to higher profits in monopoly or oligopoly markets. This is because firms in these markets have greater market power and can set prices above marginal cost. However, the extent of these profits depends on the elasticity of demand and the ability of the firm to differentiate its product from others. The paper by Krugman [19] provides an interesting perspective on this. It suggests that shifts in the perceived elasticity of demand could arise from shifting market share in an oligopolistic market. The basic rule of Cournot competition in the constant elasticity case is that a firm will face a perceived elasticity of demand equal to E/s, where E is the market elasticity and s is the firm's market share. The higher the import market share, the lower the elasticity of demand perceived by the foreign firm and, thus, the higher its price for any given marginal cost. Similarly, the higher the import share, the higher the elasticity of demand perceived by the domestic firm and, thus, the lower the domestic firm's price. This implies that in an oligopolistic market, the full-cost pricing theory could potentially lead to higher profits, depending on the firm's market share and the elasticity of demand. Borenstein and Rose [18] found that monopolists have the most negligible price dispersion, followed by symmetric duopolists and market players in competitive markets. This suggests that firms in monopoly or oligopoly markets may be able to use full-cost pricing to increase their profits by reducing price dispersion, essentially the bid-ask spread associated with the agent negotiation process [20].

Several other factors can also influence pricing decisions under the full-cost pricing theory, especially the cost of products or services. In the construction industry, different factors contribute to the total construction cost. The land cost is the most significant for residential housing development, directly impacting the overall construction cost. The holding cost during the land holding period and expenses related to materials, labour, infrastructure, amenities, and government fees further add to the overall cost [1,21,22]. The land cost, constituting approximately 15% to 25% of the overall development cost, plays a crucial role [23]. Research by Ho and Ganesan [23] indicates that land supply levels significantly affect housing prices, with a two-year lag effect in Hong Kong. Likewise, Oikarinen and Peltola [24] found that the price of undeveloped land is influenced by the value of developed projects, demonstrating a correlation between house prices and undeveloped land prices. Studies have also explored the relationship between construction costs and housing prices. Tsai [25] examined the construction cost index and house price index and found that construction costs influence housing prices in Taiwan. The findings supported the perspective that construction costs affect housing prices from the supply side. In addition, the interdependence between land prices and housing prices is evident, where high land costs contribute to increased housing prices, and higher housing prices may elevate land prices [25]. Other factors, such as material costs, labour costs, and government fees, also contribute to the overall construction cost [26,27]. Mansur et al. [26] identified fuel prices, production costs, high demand, and price manipulation as key factors affecting house prices. Kamal et al. [27] highlighted the impact of construction material costs and labour costs on housing prices, emphasising their influence from a developer's perspective.

3.2. Tendering Theory

Tendering Theory, as revisited by Runeson and Skitmore [9], provides a unique perspective on pricing in industries where each object is unique. This concept is supported by the findings in the first document [10]. This theory departs from the traditional view of the tendering process, extending beyond the winning tender as determining the price of an individual contract. It involves price derivation based on estimated costs and mark-ups, operating under simultaneous bidding with individual valuations, transparent market information, and many bidders, creating a competitive equilibrium [10].

The tendering theory assumes constant mark-ups unaffected by variations in demand, with the price calculated as costs plus a constant mark-up [9]. This aligns with the findings in the second document, which confirms that the theory excludes the possibility of systematic variations in the mark-up [9]. It does not account for potential activities and counter-strategies of competitors. Any differences between competitors arise from the necessity to estimate the cost prior to the execution of the contract and any aberrations caused by the process of submitting a single, unchangeable bid [10].

The competition among rational market participants results in similar cost estimations and constant price mark-ups, leading to consistency in construction prices unless slight differences in project design exist [10]. The Tendering Theory also posits that a change in demand will not change tendering behaviour, as this would represent a systematic change in strategy, and systematic changes are excluded by assumption [10]. It states that tender prices will only change if costs or the composition or number of competitors change [10].

In contrast, full-cost pricing theory considers total costs and aims to achieve satisfactory profits without direct consideration of market competition [10]. In an oligopoly market structure, where large companies may cooperate and have consensus, the impact of ignoring market competition in the full-cost pricing strategy can be minimised. The price of construction services becomes relevant to the property market, and higher housing prices provide room for satisfactory profits [9].

3.3. Related Literature

Although relatively few studies focus on a direct test of the impact of construction cost on house price, some studies have broadly investigated this relationship in previous literature. For example, Wang and Zhang [28] studied the fundamental factors of the housing market in China, and they suggested that for the cities in the scope of their study, construction cost contributes to the actual housing price appreciation. Alkan [29] identified construction cost as an important factor influencing house prices in Turkey. Pangestu et al. [30] provide an analysis of the budget plan for constructing mass buildings, highlighting the significant role of construction costs in housing market dynamics. However, there is a noticeable gap in the literature when it comes to understanding how house prices may impact construction costs. Few studies have delved into this aspect, leaving a significant area of research unexplored. This presents an opportunity for further investigation and research, as understanding this relationship could provide valuable insights into the dynamics of the housing and construction markets. For example, Borowiecki [31] also suggested that construction costs in Switzerland would impact the house price. The author also suggested that the result implies that competition in the Swiss construction industry was relatively low since the increased construction cost are almost fully transferred to the house price the buyers pay. However, it is crucial to understand the bi-direction relationship between house price and construction cost to conclude the relationship between them and interpret the industry conditions. Adams and Fuss [7] also suggested that even though they only studied the effect of construction cost on house price, they also considered that the change in house price could lead to a change in construction cost. Meanwhile, they also suggest that the effect of house prices should be studied together with the impact of construction costs. If only studying the effect of construction costs on house prices and not considering the potential effect of house prices on construction costs, it could overestimate the effects. Therefore, the current research aims to fill the gap by examining the bi-directional impact of house prices on construction costs along with the impact of construction costs on house prices, thereby contributing to the existing body of knowledge in this field.

4. Development of Hypotheses

The literature reviewed to date introduces the full-cost pricing theory, which asserts that firms establish prices based on their total costs—encompassing both direct and indirect expenses—along with an added mark-up. This theory purports that prices are shaped by factors such as demand, prevailing market conditions, and the firm's targeted return on investment. Within the construction industry, certain elements, such as land costs, material expenses, labour costs, and governmental charges, play a significant role in influencing the total construction cost. This, in turn, impacts the price under the full-cost pricing paradigm. Previous studies have demonstrated that construction costs and the supply levels of land significantly affect housing prices, thereby bolstering the viewpoint that construction costs influence housing prices from a supply-side perspective.

Conversely, the tendering theory proposes that prices are derived based on projected costs and mark-ups under the circumstances featuring simultaneous bidding with individual valuations, transparent market data, and a considerable number of bidders. This theory presupposes constant mark-ups that are impervious to fluctuations in demand. Under such circumstances, tender prices will only alter if there is a change in costs or the composition or count of competitors.

The correlation between the construction cost index and the house price index can indeed shed light on the relevant pricing theory in the construction industry. If the house price index sways the construction cost index, it implies that the full-cost pricing theory, which considers market structures, is more applicable. Conversely, if this is not the case, it suggests that the tendering theory—with its assumption of constant mark-ups and minimal influence by demand variations—is more relevant. On this basis, we propose the following hypotheses:

Hypothesis 1 (H1). *Ceteris paribus, if the house price index significantly leads the construction cost index, the full-cost pricing theory is applicable in the construction industry.*

This hypothesis draws from the full-cost pricing theory, which posits that prices are set by total costs combined with a standard mark-up. If the house price index significantly impacts the construction cost index, it suggests that pricing in the construction industry is largely determined by a range of costs—comprising land costs, material expenses, labor charges, and governmental fees—which aligns with the full-cost pricing theory.

Hypothesis 2 (H2). *Ceteris paribus, if the construction cost index significantly leads the housing price index, the tendering theory is applicable in the construction industry.*

This hypothesis is rooted in the tendering theory, which suggests that prices are derived based on estimated costs and mark-ups under conditions of simultaneous bidding with individual valuations, transparent market information, and a sizeable number of bidders. If the construction cost index significantly affects the housing price index, it suggests that pricing in the construction industry is less influenced by demand variations and more determined by costs and the composition or quantity of competitors, aligning with the tendering theory.

5. Research Design

5.1. Data

To investigate the relationship between property market trends and construction market trends, the House Price Index (HPI) and Construction Cost Index (CCI) are employed as indicative measures, respectively.

House Price Index (HPI)

The HPI, derived from residential property transaction data in Auckland from 1995 to 2021 (supplied by CoreLogic), is constructed using the repeated-sales method. Presales are excluded to avoid the effects on prices [32]. The repeat-sales model, first suggested by Bailey et al. [33], was later elaborated by Case and Shiller [34]. The principle of this approach lies in controlling quality variations by comparing prices of properties transacted multiple times across different periods. Given that property characteristics and their implicit prices remain constant between sales, price differences can be attributed exclusively to temporal effect, thus circumventing the issues of specifying attributes inherent in the hedonic method. Under the assumption that the characteristics and their implicit prices of the same property do not alter between the first (t_1) and second sale (t_2), Bailey et al. [33] introduced the following repeat-sales model:

$$\mathrm{Ln}\left(\frac{P_{it_2}}{P_{it_1}}\right) = \sum\nolimits_{i=1}^{T} \alpha_t D_{it} + \varepsilon_{it_1t_2} \tag{1}$$

where P_{it} denotes the sales price of property i in period t (i = 1, . . ., n; t = 0, . . ., T); α_t denotes the estimated coefficient for time dummy D_{it}, and $\varepsilon_{it_1t_2}$ is the error term. The time dummies are set to take the value −1 if $t = t_1$, +1 if $t = t_2$ and zero otherwise. Note that α_0 has been set to zero so as to normalise the price index at time period 0. Model 1 serves as the baseline model for comparison purposes.

Construction Cost Index (CCI)

For the Construction Cost Index (CCI), the BCI NZ building consent dataset is utilised to compile a construction (tendering) price index for Auckland using the hedonic pricing model. The hedonic regression method, proposed for estimating the CCI [35], posits that construction costs can be inferred from observable characteristics. To generate the construction cost index, we implement the Time dummy variable method, wherein each month is assigned a dummy variable in the linear regression alongside a select set of characteristic variables such as floor area and number of dwellings. The log-linear regression model will encompass time dummies for all time periods (months) and several characteristic variables.

$$C_n = \alpha + \sum\nolimits_{t=1}^{t} \delta_t \mathrm{D}_t + \sum\nolimits_{k=1}^{k} \beta_k \mathrm{Z}_{kn} + \varepsilon_n \tag{2}$$

In Equation (2), C_n represents the construction cost of residential dwelling n; D_t is the time dummy variable, each period will be given a one-time dummy variable, and $D_t = 1$ in time period t otherwise $D_t = 0$. Z_{kn} is the characteristic k and it represents the quantity of characteristic k of dwelling n in when it is in time period t. β_k is the estimated coefficient for characteristic K, while the δ_t is the coefficient of time dummies. In order to produce the construction cost index, we exponentiate the coefficient of time dummy variable. The hedonic regression method provides good control of quality changes of the properties in different time periods. Since we have enough amount of data, this method is suitable for us to produce the construction cost index. Figure 1 shows the trends of constructed HPI and CCI, both indices kept the upward trend from 1995 to 2021 indicating a continual growth in both property market and construction sector. However, while both HPI and CCI increased from 1995 to 2021, HPI exhibited more volatility, whereas CCI maintained a steady, consistent rise.

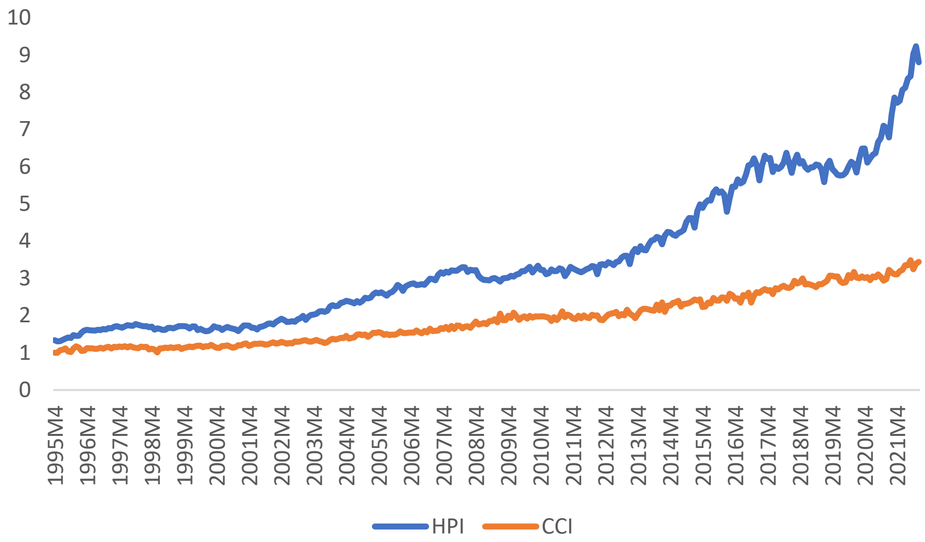

Figure 1. The housing price index and construction cost index.

5.2. Method

In this research, we will use (1) the Granger causality test to examine the short-term and (2) the Error correction model (ECM) analysis (3) the bound test of Autoregressive Distributed Lag (ARDL) to investigate the long-run relationship between the construction cost index and house price index in Auckland. In order to test the relationship between the House price index and the construction cost index, the Granger Causality test can be used to test whether the House price index and Construction cost index is one of the causations of each other. Meanwhile, as our time series dataset spanned over a decade, therefore it is necessary to test the long-run relationship between the construction cost index and the house price index; in this research, the long-run relationship between the Construction Cost Index (CCI) and House Price Index (HPI) will be examined by the ECM analysis and validated by ARDL bound test.

The Granger Causality test is able to test the causality between two time series variables. For example, for time series X and Y, When Y can be predicted better by using both the time series of X and Y than by using the Y itself, we can identify that X Granger cause Y. Meanwhile, if the time series of X and Y can predict X better than using X itself, then we can say that Y is granger cause X. In this research, we can test whether construction cost index granger-cause house price index and house price index granger-cause with the following specification:

$$HPI_t = a_0 + a_I HPI_{t-I} + \cdots + a_p HPI_{t-p} + b_1 CCI_{t-I} + \cdots + b_p CCI_{t-p} + u_t \tag{3}$$

$$CCI_t = c_0 + c_1 CCI_{t-1} + \cdots + c_p CCI_{t-p} + d_1 HPI_{t-1} + \cdots + d_p HPI_{t-p} + \nu_t \tag{4}$$

Equation (3) tests whether the construction cost index (CCI) granger-cause house price index (HPI). HPI_{t-p} is the house price index in the time period that P periods before t. CCI_{t-p} is the X in the time period that P periods before t. $a_0 \ldots\ldots a_p$ are the coefficients of the house price index, $b_1 \ldots b_p$ are the coefficients of the construction cost index. The purpose of this test is to test whether $CCI_{t-I} \ldots CCI_{t-p}$ can contribute to the prediction of HPI_t. The null hypothesis of Equation (1) is H0: $b_1 = b_2 = \ldots = b_p = 0$, then HA: H0 "is not true". The result of this test is able to show us whether X does not Granger cause Y.

Equation (4) tests whether the house price index granger-cause construction cost index. Similarly, the $d_1 \ldots d_p$ represents the coefficient of HPI_{t-1} to HPI_{t-p}. The null hypothesis is H0: $d_1 = d_2 = \ldots = d_p = 0$. HA: 'H0 is not true'. This is the test for Y that does not granger-cause X, and when we reject the null hypothesis, Y granger-cause X. For the time series data, it can be categorised by stationary and non-stationary data. The time series data has stationarity when the statistics of the data are consistent. For instance, the mean and the variance of the data are consistent, and there is no trend or seasonal effects or any other systematic structures. We can define that the time series is stationary. If the time series data shows certain trends and seasonal effects, then the data is non-stationary. The mean and variance of non-stationary data change over time.

We use the modified Granger causality test from Toda-Yamamoto [36]. It is a statistical procedure used to determine whether one time series can forecast another. It is an extension of the standard Granger causality test but provides a significant advantage by circumventing the need for pre-testing for unit roots and co-integration, issues that can lead to unreliable test results due to their low power and potential for size distortions. The Toda-Yamamoto procedure involves estimating an augmented Vector Autoregression (VAR) model with an order of (p + dmax), where p is the optimal lag length, and dmax is the maximum order of integration suspected in the system. A Wald test is then conducted to examine the null hypothesis that the coefficients of the first p VAR lags of the suspected causing variable(s) are zero in the equation of the variable that is being caused. The Toda-Yamamoto approach, therefore, offers a robust method for testing Granger causality in the presence of unit roots and co-integration.

In this study, our initial approach to ascertain the long-run relationship between the HPI and CCI involves the use of an Error Correction Model (ECM). The ECM is a dynamic model that incorporates an error correction term, which represents the adjustment toward the long-term equilibrium. The error correction term is derived from the lagged residuals of the long-run relationship equation. The ECM equation includes lagged differences of the variables to account for short-term dynamics and a lagged error correction term (the residual from the cointegrating regression) to represent the long-term equilibrium relationship. The coefficient of the error correction term, known as the adjustment coefficient, shows the speed at which the variables return to equilibrium following a shock.

$$\Delta Y_t = \mu + \sum_{i=1}^{n-1} a_i \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma_i \Delta X_{t-i} - \pi e_{t-1} + \varepsilon_t \quad (5)$$

As shown in Equation (5), ΔY_t represents the change in dependent variable Y in time t, $\sum_{i=1}^{n-1} a_i \Delta Y_{t-i}$ captures the short-term dynamics of Y by considering $n-1$ lagged differences of Y; $\sum_{i=0}^{m-1} \gamma_i \Delta X_{t-i}$ represents the short-term dynamics of X and Y, considering $m-1$ lagged differences of X; e_{t-1} denotes the error correction term (ECT), the lagged residual from co-integration regression which reflects the long-run equilibrium relationship between Y and X; π is the coefficient of the ECT, indicating the speed of adjustment back to the long-run equilibrium; ε_t is the error term at time t. In our analysis, the HPI and CCI would be analysed based on the ECM, respectively. However, it should be noted that the ECM is typically suited for series that are integrated in the same order. The presence of a mix of I(1) and I(0) series in our data can potentially lead to spurious results; this is due to the requirement in ECM that the residuals from the long-term relationship are stationary or I(0), which may not be the case when incorporating an I(0) variable in the co-integration regression (For a detailed discussion, vide [37]).

In order to address this concern and to verify the robustness of our results, we adopt the Autoregressive Distributed Lag (ARDL) bound testing approach as a cross-check following the ECM. The ARDL bound test is advantageous as it allows for robust examination of the long-run relationship between variables irrespective of whether the regressors are purely I(0), purely I(1), or fractionally cointegrated. This approach thus enables us to mitigate the risk of potential spurious results due to the mix of I(0) and I(1) series in our data, enhancing the reliability of our findings. The ARDL model includes both the lagged dependent and explanatory variables. It is a method used in econometrics to test for a long-run relationship between variables. The ARDL model allows us to differentiate between dependent and independent variables, allowing for different optimal lag lengths. This allows the model to capture long-term dynamics. The bounds test, part of the ARDL approach, tests for the existence of a level relationship or long-run equilibrium. It does this by testing the joint significance of the coefficients on the lagged levels of the variables in the error correction form of the ARDL model. The bounds test has an advantage in that it can be applied regardless of whether the underlying variables are stationary (I(0)) or integrated of order one (I(1)), avoiding the need for pre-testing the order of integration, which can often be unreliable. The presence of a statistically significant level relationship implies a long-run relationship between the variables.

$$y_t = \beta_0 + \beta_1 y_{t-1} + \cdots + \beta_k y_{t-p} + a_0 x_t + \alpha_1 x_{t-1} + \cdots + \alpha_q x_{t-q} + \varepsilon_t \quad (6)$$

The ARDL model is shown in Equation (6); the model contains lagged dependent variable Y and the lagged explanatory variable X. While 'p' represents the number of lag periods used for 'y' as a variable that explains itself, 'q' is the number of lag periods used for 'x' as an explanatory variable. 'β' represents the coefficient of the autoregressive variable 'y', 'α' is the coefficient of explanatory variable 'x'.

According to Pesaran et al. [37,38], the ARDL bound test can be used for the mix of time series data that are stationary at 'level' and stationary after 'first difference'. This characteristic is valuable for this research since, in our dataset, some of the time series are not stationary at 'level'.

The ARDL bound model contains both the short-run relationship examination and the long-run relationship examination. As shown in Equation (7):

$$\Delta Y_t = \beta_0 + \left[\sum_{i=1}^{p} \lambda_i \Delta Y_{t-i} + \sum_{i=0}^{q} \delta_i \Delta X_{t-i}\right] + \varphi_1 Y_{t-1} + \varphi_2 X_{t-1} + v_t \quad (7)$$

The first part of the equation that falls in the middle of the square bracket is the ARDL short-run term which enables us to examine how the lagged Y, X and lagged X influence the Y in the short run. Meanwhile, the latter part of Equation (6) represents the long-run term of this equation. This part replaced the 'error-correction term' in the traditional ECM. In traditional ECM, as shown in Equation (8)

$$\Delta Y_t = \beta_0 + \left[\sum_{i=1}^{p} \lambda_i \Delta Y_{t-i} + \sum_{i=0}^{q} \delta_i \Delta X_{t-i}\right] + \varphi z_{t-1} + e_t \quad (8)$$

The latter part, z_{t-1}, is the error correction term which is derived from the long-run co-integration regression of the OLS residual series. In our ADRL bound test model, we replace the error correction term Z with the term Y_{t-1} and X_{t-1} and unrestricted the coefficients. The selection of the lag period is determined by the Schwarz criterion. Schwarz criterion is a type of 'information criteria' which is based on a high log-likelihood value; when it includes more lags to achieve the high log-likelihood value, it will be penalised. Therefore, the smallest value of the 'information criteria' is the better choice of lag period.

By using the Augmented Dicky-Fuller test, the order of integration of the time series data can be tested. However, due to the house price index and construction index being indices that are vulnerable to the external environment, the external shocks in the market may cause a structural break in both indices. Therefore, traditional unit root tests such as the Augmented Dickey-Fuller (ADF) test assume that the series follows a stable process over time. This means they assume that the characteristics of the series (such as its mean and variance) do not change.

However, if there is a structural break in the series, this assumption is violated. The break can lead to a shift in the mean or variance of the series, causing traditional unit root tests to be biased towards not rejecting the null hypothesis of a unit root. In other words, they might incorrectly classify a stationary series with a structural break as non-stationary. Accounting for structural breaks can lead to more accurate estimates of the parameters of your model and more reliable statistical inference. For example, if there is a structural break in the series, the parameters of the model before and after the break might be different. Ignoring the break could lead to biased and inefficient estimates of these parameters.

In order to tackle the issue of potential structural break, Zivot-Andrews's [39] unit root test is adopted. The Zivot-Andrews test is a unit root test that allows for a one-time structural break at an unknown point in time. The structural break can be in the level of the series, the trend of the series, or both. It was developed by Eric Zivot and Donald Andrews in 1992 to address the issue that traditional unit root tests, such as the Augmented Dickey-Fuller (ADF) test [40], can be biased towards failing to reject the null hypothesis of a unit root when a structural break is present. It provides a more robust analysis of the order of integration of a time series when a structural break may be present. By allowing for a structural break, the test can avoid the issue of biased results that can occur with traditional unit root tests. This can lead to more accurate modelling of the data and more reliable statistical inferences. The main process of the methodology has been specified in Figure 2.

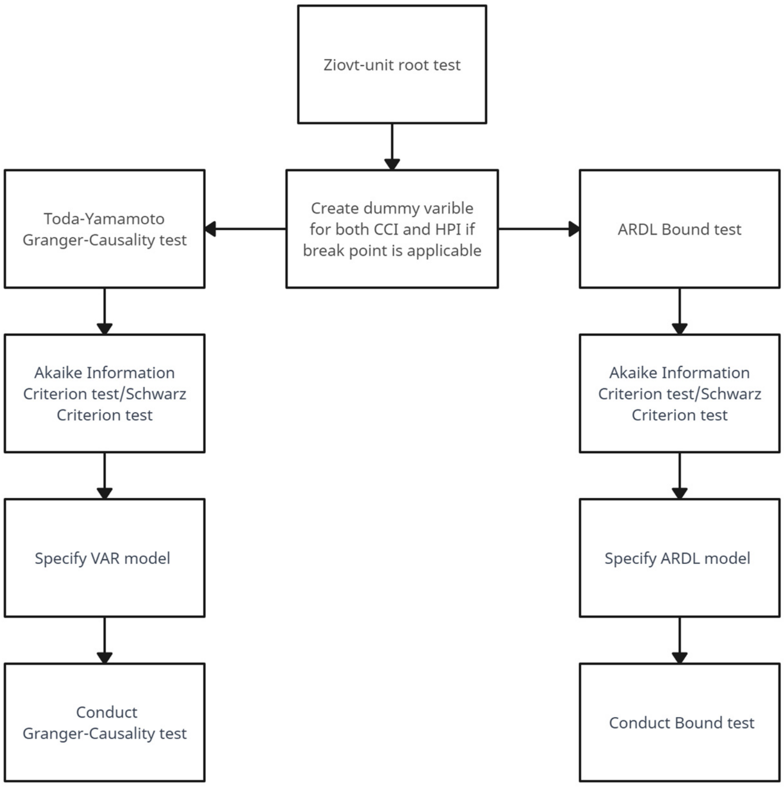

Figure 2. The main steps of the methodology.

The result of the Zivot-Andrews test is shown in Table 1, the order of integration of CCI is 0, and the breakpoint occurs at April 2011, while the order of integration of HPI is 1 and the breakpoint is at 2017M06.

Table 1. Zivot-Andrews test result.

	Prob.	t-Statistic	5% Level	Break Point
CCI	0.003613 **	−2.747828	−5.08	2011M04
HPI	0.164482	−3.664582	−5.08	2014M06
D(HPI)	9.28×10^{-5} ***	−4.181508	−5.08	2017M06

Notes: *** and ** denotes statistical significance at the 1% and 5% level, respectively.

6. Results

In the Granger causality test, the result is shown in Table 2, the construction cost index does not granger-cause the house price index (p-value = 0.3756, i.e., cannot reject the null), while the house price index granger-cause the construction cost index (p-value = 0.0233, i.e., reject the null).

Table 2. Results of Toda-Yamamoto Modified Granger-causality test between CCI and HPI.

Year	Construction Cost Index Granger Cause House Price Index	House Price Index Granger Cause Construction Cost Index
1995–2021	$p = 0.3756$	$p = 0.0233$ **

Notes: ** denotes statistical significance at the 5% level.

The results of the ECM analysis are shown in Table 3; the ECT for the model of HPI as an independent variable is not statistically significant with a *p*-value of 0.1291; meanwhile, the ECT for the model of CCI as a dependent variable is statistically significant with a coefficient of −0.18698 and *p*-value 0.0000 which signifies that approximately 18.7% of the disequilibrium in CCI is corrected in each subsequent period and restoring towards the long-run equilibrium. The ECT represents the disequilibrium in the CCI from the previous period due to a deviation from its long-term relationship with HPI. The significant ECT means that there is a mechanism at play that adjusts CCI in response to this disequilibrium, bringing CCI back towards its long-term equilibrium with HPI. Therefore, this result confirms the long-run equilibrium.

Table 3. Results of Error correction model between CCI and HPI.

Error Correction Term	HPI and CCI (HPI as Dependent Variable)	CCI and HPI (CCI as Dependent Variable)
Coefficient	0.02399	−0.18698
p-value	0.1291	0.0000 ***

Notes: *** denotes statistical significance at the 1% level.

In the long-run ARDL bound test, as shown in Table 4, the F-statistic of the test when the House price index is the dependent variable is 2.929, which is less than the I(0). This result indicates that the construction cost index does not lead to a change in the house price index in the long run. In the test that the Construction cost index is the dependent variable, the F-statistic of the test is 7.555 and exceeds the I(1), showing us that the house price index leads the change of the construction cost index.

Table 4. Results of ARDL bound tests between CCI and HPI.

	HPI and CCI (HPI as Dependent Variable)	CCI and HPI (CCI as Dependent Variable)
F-statistic	2.929	7.555
I (0)	3.23	3.23
I (1)	4.35	4.34

These results provide strong support for Hypothesis 1, which posits that if the house price index significantly influences the construction cost index, then the full-cost pricing theory is more applicable in the construction industry.

Conversely, our findings do not validate Hypothesis 2. This hypothesis posited that if the house price index (HPI) did not significantly influence the construction cost index (CCI), it would indicate that the tendering theory is more applicable to Auckland's construction industry. The absence of a significant impact of the CCI on the HPI challenges the premises of the tendering theory. This theory proposes that prices are set based on projected costs and mark-ups in a scenario of simultaneous bidding with individual valuations, transparent market information, and a substantial number of bidders. The evidence, however, does not support this theory in the context of Auckland's construction industry.

7. Robustness Check

To further confirm the relationship between HPI and CCI, the relationship between the HPI and building consent (BC) is tested as a robustness check. Under the situation of full-cost pricing, the HPI may influence the BC, but not the other way around. If that is the case, it will serve as a piece of stronger evidence to confirm the full-cost pricing and reveal the rationale behind how pricing theory influences the property market. The data on building consent from Stats NZ is employed, and it includes three types of information on building consent: the number of building consent, the area of the constructions in the building consent and the value of the developments in the building consent.

In the result between the building consent area and house price index (Tables 5 and 6), the building consent area does not Granger cause house price index (p = 0.3468), and the house price index Granger cause building consent area (p = 0.000).

Table 5. Results Granger-causality test between HPI and BC.

	House Price Index Granger Cause Building Consent (Area)	House Price Index Granger Cause Building Consent (Number)	House Price Index Granger Cause Building Consent (Value)
1995–2021	p = 0.0000 ***	p = 0.0000 ***	p = 0.0000 ***

Notes: *** denotes statistical significance at the 1% level.

Table 6. Results Granger-causality test between BC and HPI.

	Building Consent (Area) Granger Cause House Price Index	Building Consent (Number) Granger Cause House Price Index	Building Consent (Value) Granger Cause House Price Index
1995–2021	p = 0.3468	p = 0.2844	p = 0.0238 **

Notes: ** denotes statistical significance at the 5% level.

In terms of the number of building consents and house price index (Tables 5 and 6), the result shows that the house price index Granger causes building consent number but building consent number does not Granger causes House price index.

Regarding the value of building consents and house price index, we can observe a granger-causation between these two variables (p-value = 0.0000 and 0.0238, respectively).

The results imply that house price influences the building consent, reflecting the market's new constructions. When house price increase, a number of new investments would be stimulated by the higher property price, while when house price decreases, it will depress the desirability of investing in property development. The result of the relationship between the construction cost index and the house price index can be verified by the result of the Granger causality test between the building consent and the house price index. The result shows that the construction cost does not lead change in the house price is consistent with the result that the building consent does not lead to a change in the house price.

8. Discussion

The Granger-causality test and ARDL bound test results show the short-run and long-run relationship between HPI and CCI, respectively. The results do not only support each other but also imply different pricing mechanisms. In the short run, the result implies that construction companies in the industry would adjust their prices based on prevailing house prices; this could be seen as a reflection of the full-cost pricing theory, where firms adjust their mark-ups quickly to align with current market conditions, and this immediate response could be driven by the need to maintain profitability in a rapidly changing market. This indicates that these firms have closely monitored market fluctuations and adjusted their mark-ups on relatively short notice. This could be due to sudden changes in market demand, economic conditions, or other factors that can cause house prices to change rapidly. The firm's ability to quickly adjust its mark-ups in response to these changes shows its agility and adaptability in managing its pricing strategies in the face of market volatility.

In the long run, the ARDL bound test results suggest that construction firms have been considering long-term trends in house prices when setting their mark-ups. This again aligns with the full-cost pricing theory, which allows for strategic planning and gradual adjustments of the mark-up based on long-term market trends. This strategic approach to pricing is a key aspect of the full-cost pricing theory and contrasts with the tendering theory, which does not account for long-term market trends in its pricing strategy. The observed long-term adjustments in mark-ups further support adopting the full-cost pricing theory in the construction industry. The test results also suggest a long-term relationship where an increase in house prices leads to the initiation of more building projects. This increased demand for construction over time eventually leads to an increase in construction costs. This also aligns with the full-cost pricing theory, where prices are determined by total costs (which would increase with increased demand) plus a standard mark-up. The lag in response could be attributed to the time it takes to initiate new construction projects, which includes planning, the permission of building consents, sourcing materials, and other preparatory activities, which is another explanation of the long-run relationship.

The finding also aligns with the four-quadrant model raised by Dipasquale and Wheaton [41]. In Dipasquale and Wheaton's four-quadrant model, the property market is determined by four significant sectors: the space market, ownership market, new construction, and new stock. The space market reflects the relationship between housing stock and rent price level. The rent price level influences the ownership of houses and determines the house price level in the market; when the rent price is high, the cash flow of income-generating properties as an investment is high, which turns the house into a valuable choice asset investment. Therefore, the house price would be increased when the rent price level is high. In the new construction market, the developers' decision-making would be influenced by the asset price of houses. Developers would increase the volume of constructions when the asset price of houses is high since the project would become more profitable. When the volume increases, the demand for the raw material and labour for the construction will increase, and then the construction cost will also increase.

In the result, the house price index granger caused the consent number, consent area and consent value, which fit the logic of the four-quadrant model. As stated before, due to several factors from the demand side, such as the high population of Auckland, immigration from overseas, income and mortgage interest rate, overseas investors also actively engaged in the New Zealand property market, especially in the Auckland property market, before 2018. These actions increased the demand for properties in Auckland. When the demand for property in Auckland increases, given that the stock of property cannot change immediately, the rent price level is pushed up. The increase in rent price will cause the growth of asset price of properties, and the high value of properties will encourage developers to start more constructions and then increase the construction cost. In DiPasquale and Wheaton's model [41], when the construction number increases, the housing stock in the market will also increase, and the increased stock would drop the rent price and the asset price consequently. However, as we noticed, the housing demand in Auckland is exceptionally high due to the low-interest rate in the study period, and the effect of changing house supply on the house price is relatively small compared with the effect of extremely high demand on the house in Auckland. Therefore, in the result, we are not able to achieve a significant result that construction cost granger causes the house price.

The result of both the Granger-causality test and ARDL bound test shows that the property price leads to the construction price, but not the other way around, which supports the full-cost pricing and shows that the construction company would adjust the construction price by following the property price. The study period is from 1995 to 2021; as shown in Figure 1, the property market was constantly up-rising. The booming market provides the opportunity for construction companies to adopt the full-cost pricing strategy since the full-cost pricing strategy would allow them to maximise their profit by adding a satisfactory profit margin, and the amount of price that developers are willing to pay for construction would increase as the property price increase since the developers would have a wider profit margin in the up-rising market. This finding provides evidence that market conditions can influence the pricing strategies of construction companies and highlights the importance of adapting pricing strategies to maximise profits in changing economic environments. It also adds to our understanding of how full-costing pricing theory can be used effectively in the construction industry, providing a potential framework for construction companies to enhance their pricing strategies during booming property markets.

The results suggest that the HPI leads to changes in the CCI, implying that construction costs in the market follow house prices. When house prices are high, it stimulates more property development projects. Given that construction material costs do not change rapidly, the increased demand for construction materials drives up the overall price of construction materials, thereby increasing the overall construction costs of properties. This finding is consistent with Tsai's study [25], which found that the HPI in Taiwan leads to changes in the CCI and the rental price index.

Despite the significant role of construction cost in housing supply in the market [42], our results do not provide evidence that the supply side causes high housing prices in Auckland. Instead, we propose that high housing prices in Auckland are primarily driven by demand-side factors. As previous literature [42–44] suggested, demand-side factors in the housing market include income, mortgage interest rates, unemployment rates, and population growth. In contrast, the low mortgage interest rate from 2010 to 2020, coupled with the high population density in Auckland, likely contributed to the high demand for housing, leading to increased house prices. Therefore, even though construction cost is a significant factor on the supply side of the market, we do not observe its contribution to the high house price level in Auckland, as the rapid increase in house prices appears to be primarily driven by demand-side factors.

Our findings validate the full-cost pricing theory's presence in Auckland's construction industry. This suggests that large construction companies may establish pricing based on property market demand and housing prices. This pricing strategy seems to stem from the unique market structure of Auckland's construction industry, which is primarily controlled by a handful of large firms. The significant influence of the house price index (HPI) on the construction cost index (CCI), as demonstrated by our results, bolsters this interpretation.

In an oligopolistic market, large corporations can set prices considering multiple factors, such as land costs, material costs, labour costs, and government fees, in addition to a standard mark-up. During periods of high house prices, these companies find more leeway to accommodate increased construction costs while maintaining their mark-up, subsequently boosting their profits. This trend aligns with the full-cost pricing theory, indicating that these large firms predominantly govern pricing in Auckland's construction industry.

However, it is important to note that this oligopolistic structure may also result in reduced competition and elevated prices for consumers. Companies can legally 'collude' to set prices in such a market, focusing on property market demand and house prices rather than competition. Consequently, this could lead to inflated construction costs and, ultimately, increased house prices. To counteract this, fostering competition in the construction industry becomes crucial. To support small construction companies, the government could contemplate measures such as reducing the tax burden for small businesses and minimising the cost and time required to apply for building consent. By doing this, it could potentially undermine the dominance of large firms, stimulate competition, and potentially lead to more affordable housing prices in Auckland.

Moreover, the construction industry in New Zealand is characterised by a high number of participants, and this number has been growing over recent years. In 2009, there were around 53,000 participants in the construction industry. However, after the global financial crisis, the number dipped, reaching its lowest point in 2012 before starting to recover in 2013. Since then, the number of market participants has been rising sharply. By 2018, there were a total of 61,860 construction companies (Figure 3). Despite these numbers, the competition in the market may not be as high as the total number of participants suggests.

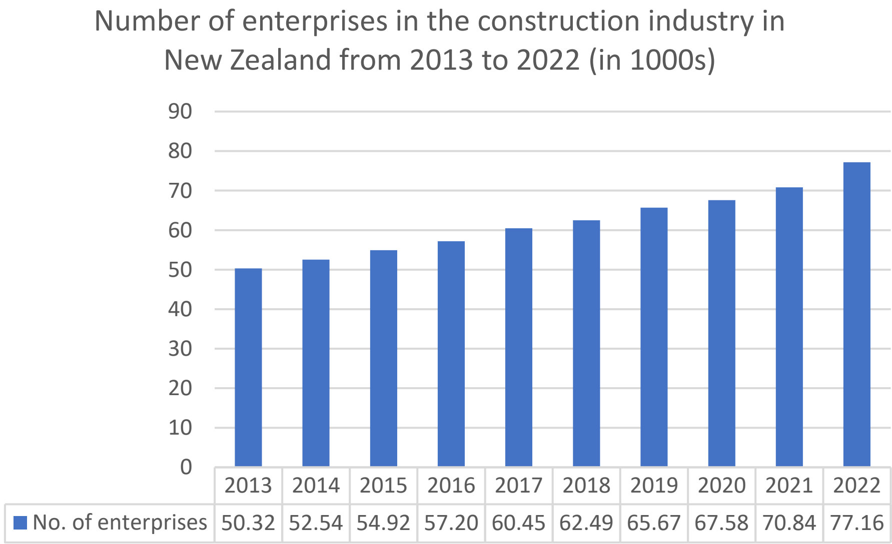

Figure 3. The number of market participants in the construction industry.

As per data from 2018, the largest residential construction company, G J Gardner, held around 4.6 percent of the market share, while the second-largest, Mike Greer, accounted for 2.3 percent. The top ten most prominent construction companies collectively held 16.8 percent of the market share. This trend of large construction companies owning more market shares has been growing over the past two decades. Among the top 100 construction companies, they occupied around 40 percent of the market share, given that the total amount of companies is over 60,000. It is clear that even though there are over 60,000 companies in the construction industry, the largest 100 companies hold more than 40 percent of the market share.

It is suggested that more stringent health and safety requirements may make it difficult for small businesses to operate and expand, contributing to the dominance of large companies. In addition, larger construction firms may offer more cost-efficient prices due to economies of scale, particularly at a time when housing affordability is a significant issue in New Zealand, especially in Auckland. As a result, people tend to opt for more cost-effective choices. Thus, in light of the monopolistic market structure and dominant large construction companies, the government needs to undertake strategic measures to foster a competitive environment, especially for small businesses, in Auckland's construction industry.

Further validation of our findings can be supported by incorporating insights from Australasian studies. For instance, research by Ma et al. [45] revealed that in Australia, owner-occupier and investor demand significantly contribute to house price increases, with investor demand exerting an even greater influence. Conversely, they found that the new housing supply does not have a significant impact on mitigating rising house prices.

This understanding underscores the limited role of the supply side in shaping market dynamics, a similar sentiment from our research which concludes that construction costs do not significantly alter house prices in Auckland, and the pricing strategy of constructions would follow the housing market dynamics. It raises the possibility that, similar to the Australian market, demand factors, particularly those driven by investment, might dominate Auckland's housing market dynamics. Over the past decades, such demands have contributed to escalating house prices, disrupting the conventional demand-supply equilibrium, and then transferred to the construction market as the increased demand for construction services and materials.

While our research asserts the need to foster a competitive construction industry, these findings also underline the importance of managing demand-side factors for the efficient operation of both the real estate market and the construction industry. Support for these implications can also be found in the study of the supply-constraint housing market [46]. Their study on Hong Kong's real estate market found no relationship between house prices and supply before the reform of the land supply system. However, when the government reformed the land supply to a demand-oriented system, house prices began to influence the housing supply, but '. . .proactive supply of land to the market might not have impacted on the housing market price level as the society would have hoped. . .'. This suggests that managing supply-side factors alone may not be sufficient to maintain a stable real estate market, reinforcing the emphasis on demand-side interventions" [2].

Both Australia and Hong Kong markets have demonstrated the prevailing impact of demand-side factors on housing prices and limited force from supply. These findings, combined with our research in Auckland, underline a common trend: while supply-side factors such as construction costs and housing supply could play a certain role, it is the demand-side, particularly those steered by investors, significantly drives the housing prices. As a result, to maintain a balanced and efficient real estate market and a healthy construction industry, policy interventions need to adopt a broader perspective that include both supply and demand factors, with a special emphasis on curbing investment-driven demand [47].

9. Conclusions

Drawing from a comprehensive analysis of property and construction market trends in Auckland between 1995 and 2021, this study concludes that the construction industry in Auckland largely implements full-cost pricing. The House Price Index (HPI) and Construction Cost Index (CCI) were critical indicators in this investigation. The Granger causality test and Autoregressive Distributed Lag (ARDL) bound test were used to study their short-term and long-term relationships, respectively. The results suggest that property prices inform construction prices, indicating the prominence of full-cost pricing in Auckland's construction industry. The outcomes highlight the significant impact of the monopoly market nature on the profitability of full-cost pricing during booming property markets. In a booming housing market, the full-cost pricing theory becomes particularly relevant for the construction industry. Under this theory, firms set prices based on total costs, including both direct and indirect costs, plus a standard mark-up. This mark-up is typically determined by the desired rate of return and the perceived market conditions. In a booming market, where house prices are high, construction firms may have the flexibility to set a higher mark-up. This is because the high house prices can potentially support a higher selling price for construction projects, allowing firms to cover their costs and still achieve satisfactory profits. Therefore, in a booming market, the full-cost pricing theory suggests that construction firms may adjust their prices upwards in response to the high house prices. This dynamic underscores the influence of market conditions on pricing decisions in the construction industry and highlights the applicability of the full-cost pricing theory in such contexts.

Addressing monopoly issues in New Zealand's construction sector requires a holistic approach. The government's efforts to enforce robust regulations, bolster skills and workforce development, reform procurement practices, and improve the building system are praiseworthy. These initiatives stimulate a more competitive and dynamic construction sector, encouraging fair market conditions and driving innovation. The government ensures construction firms operate at heightened professionalism levels by reinforcing regulations to boost building standards and accountability. The emphasis on skills and workforce development is crucial to mitigate skill shortages and augment the industry's capacity to meet demand. Procurement reform fosters transparency and collaboration, minimises risks, and levels the playing field for all industry participants. Furthermore, enhancing the building system through regulatory improvements, streamlined processes, and technological advancements promotes efficiency and quality throughout the construction lifecycle. These comprehensive measures aim to nurture innovation, adaptability, and resilience, creating a robust and sustainable construction industry that caters to the market's evolving needs. By tackling monopoly issues and fostering a vibrant and competitive construction sector, New Zealand paves the way for sustained growth and success in the industry.

The findings of this research fill a crucial gap in the existing literature, which has largely focused on the impact of construction costs on house prices, with limited exploration of how house prices may impact construction costs. By examining this bi-directional relationship, the study offers a more comprehensive understanding of the dynamics between house prices and construction costs. This study also enriches the existing literature on pricing strategies in the construction industry and offers valuable insights for construction firms navigating shifting market conditions. It highlights the importance of comprehending market trends and adapting pricing strategies accordingly, providing a potential blueprint for improving profitability in the construction industry. While this study offers insightful perspectives on Auckland's construction industry pricing strategies during a market boom, further research is needed to understand these strategies' evolution under varied market conditions. Specifically, investigating pricing strategies employed during a recessionary market trend could offer a more in-depth understanding of how construction firms modify their pricing strategies in response to market downturns and whether they shift towards tendering pricing for enhanced resilience during downturns or maintain a full-cost approach despite challenging economic conditions. This study, while providing valuable insights into the relationship between house prices and construction costs in Auckland, New Zealand, does have certain limitations. Firstly, the geographical scope of the study is confined to Auckland, which may limit the generalizability of the findings to other regions or countries with different market dynamics. Secondly, the study primarily focuses on the full-cost pricing theory and the tendering pricing theory. While these theories provide a solid foundation for analysis, other pricing theories or models could potentially offer additional insights. Lastly, the study is focused solely on the residential sector, which may not capture the dynamics present in other sectors of the real estate market, such as commercial or industrial. Given these limitations, there are several opportunities for further research. Future studies could expand the geographical scope to include other regions or countries, providing a comparative analysis that could enhance the understanding of these relationships in different market contexts. Additionally, conducting detailed case studies of specific construction projects could offer more nuanced insights into the interplay between house prices and construction costs. Furthermore, a comparative study between the dynamics of residential and commercial real estate markets could provide a broader perspective on the applicability of different pricing theories across various sectors of the real estate market. These research directions could further enrich the existing body of knowledge in this field. Moreover, the impact of the COVID-19 pandemic on the construction industry and its pricing strategies calls for further exploration. The pandemic has instigated unprecedented market conditions and structural changes, potentially influencing how construction firms perceive value and set prices. Examining post-COVID-19 data could reveal whether and how pricing strategies have adapted in response to these unique circumstances, enriching our understanding of the adaptability and resilience of construction industry pricing strategies. These prospective research directions could provide valuable insights for construction firms navigating an evolving market landscape.

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