



THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE ■

UNDERGRADUATE PROGRAMMES

SUMMATIVE SUBMISSION TEMPLATE

CANDIDATE NUMBER: <i>(Five digit number available via LSE for You – this is not the same as the number on your LSE ID card!)</i>	<table><tr><td>3</td><td>2</td><td>4</td><td>1</td><td>0</td></tr></table>	3	2	4	1	0
3	2	4	1	0		
COURSE CODE:	SP399 - Dissertation on an Approved Topic					
LONG ESSAY TITLE:	Productivist, Pragmatic, and...Progressive?: A Cointegration analysis of Public Housing, Economic Growth and Equality in Singapore					
WORD COUNT: <i>Excludes references and appendices</i>	7995					

Please tick this box to confirm you have completed the research ethics checklist ☒

*Please tick this box if you **DO NOT** want your assessment to be shared with future cohorts*

☐*

Productivist, Pragmatic, and...Progressive?: A Cointegration analysis of Public Housing, Economic Growth and Equality in Singapore

Abstract

Public housing lies at the centre of Singaporean welfare, housing over 85% of the population – most of whom are homeowners – and serving an important retirement asset and safety net. I employ and expand on Holliday's (2000) Productivist welfare regime framework to explain a theoretical link between this policy and Singapore's economic development. Beyond its economic operationalisation, I argue via the concept of 'ideological hegemony' that public housing was also pragmatically stylised to serve a universal, progressive welfare function. However, there is a dearth of evidence on the actual empirical links between public housing and economic growth as well as equality in Singaporean. This paper seeks to address the gap by empirically examining the relationship between housing prices, economic growth and equality. Using cointegration analysis, it confirms a short and long-run positive relationship between public housing resale prices and GDP per capita as well as a short-run positive effect between prices and top 10% income share. The long-run relationship between prices and top 10% income share is not statistically significant. The paper makes important conceptual contributions to existing literature as well as empirical contributions on the positive economic effects of public housing, but remains less conclusive on its effects on equality.

Section 1: Introduction

Public housing in Singapore has been widely-recognised for its quality and accessibility, making home ownership the norm in the densely-populated city-state (Phang 2007). This poses a far cry from the small island nation's housing situation mere decades ago. In 1954, 84% of families lived in single-room accommodation. More than 50% of households were categorised as 'acutely overcrowded' and cases of tuberculosis were rife (Tai, 1988 p1-45).

The Housing Development Board (HDB) was founded in 1961 by a newly-elected and dominant People's Action Party (PAP) government. Many scholars have argued for the positive effects of public housing policies on economic growth, via the provision of low-cost, stable housing, which indirectly subsidised labour costs, and mortgage obligations which encouraged continuous formal employment (e.g. Chua, 2014). I employ Holliday's (2000) categorisation of Singapore as a Productivist welfare regime, to explain how this *social* policy serves *economic* ends via welfare creation for productive segments of the population. I further argue that public housing also directly created economic growth, embedding Productivist literature in the overarching 'East Asian developmental state' strategy.

HDB has since grown to house 85% of the population, 92% of which are homeowners (as of Joo and Wong, 2008). No other industrial-capitalist nation has achieved these "near-universal" levels of public housing provision (Chua, 1991 p26). Public housing provision is also often considered progressive, offering income-based subsidies, grants and loans to enable wider ownership (Lee and Qian, 2007). I adopt Chua's application of a Gramscian "ideological hegemony" to explain a state-citizen dynamic of control and compliance. The authoritarian state employed and co-opted citizens in the *superficially* apolitical ideology of 'pragmatism' following independence to unilaterally construct and centre public housing ownership at the heart of individual welfare. I extend Chua's thesis in arguing that this promotion of universalised public housing policy via structures of extremely strong incentives and coercion not only facilitated Singapore's rapid economic growth but also contributes significantly to a progressive, universal form of welfare. As a result, we would also expect the development of public housing to be positively correlated with equality.

Despite the wealth of literature theoretically linking public housing prices to economic growth and equality, there has been very little *empirical* study on the matter. While Phang (2001) similarly hypothesised the positive economic and social effects of public housing, he only presents empirical trends of housing wealth growth, without establishing a statistical relationship between public housing and economic growth. Moreover, despite attempts to argue for the progressive and universal effects of public housing policy, no literature has established an empirical relationship between public housing and equality. This paper fills the gap in literature by analysing relationships between public housing, economic growth and equality. My analysis will focus on two research questions:

- a. Is there a relationship between public housing prices and economic growth?
- b. Is there a relationship between public housing prices and inequality?

To answer these questions, this paper will adopt a cointegration analysis to understand short and long-run relationships between the variables over time. Following Sanguin's (2021, p2) study of housing and fertility, I use resale prices of public housing flats to "model a household making interrelated decisions about maximising capital gains". This assumes households account for systems of incentives and coercion involved in the public housing market, be it consciously or not, when making a flat purchase. GDP per capita is used to measure average economic growth in the nation. Finally, the national income share of the top 10% of earners is used to measure inequality. A higher figure would suggest more inequality as wealth is concentrated at the top while a lower figure would suggest more equitable distribution.

The paper is organised as follows. Section 2 will introduce the public housing system and provide some background into the political and economic state of Singapore. Section 3 will explore existing literature on public housing in Singapore in the context of economic growth and equality. Section 4 will introduce conceptual frameworks of Productivist regime and 'ideological hegemony' which posit theoretical explanations for the economic and social impacts of housing policy. This paper adopts cointegration analysis to examine the proposed relationships between housing prices, economic growth and equality.

Data and methodology will be elaborated on in Section 5. Section 6 will present my main empirical findings and Section 7 will link these back to the conceptual frameworks employed. Section 8 concludes.

Section 2: Background

2.1 Housing a Nation

Singapore's Housing Development Board (HDB), in charge of the building and sale of all 'HDB flats'¹, offers homes on a lease basis. Holding a lease qualifies as home ownership and typically lasts 99-years, with the first wave of public flats only now approaching the 60-year mark. The public housing market in Singapore, restricted to permanent residents and citizens, consists of two sorts: newly-built "Built-to-Order" (BTO) flats, where buyers purchase directly from HDB, and resale flats, where buyers purchase a flat (with its remaining lease period) from the public housing market.

At the time of HDB's founding, Singapore was still a British colony which only recently attained self-governance. HDB was "tasked with building large quantities of low-cost housing (flats or apartments) with modern sanitation and facilities" to address pressing issues of overcrowding (Lye, 2020 p7). Shortly after, the government moved to encourage home ownership – reasons for which will be further explored in Sections 3 and 4. Home-ownership subsidies are generous. First-time buyers are entitled up to SGD\$160,000 (£91,997) in housing grants for both BTO and resale flats. Housing loans are also available to cover up to 85% of the flat value for families earning a gross monthly income of less than \$14,000 (£8,049), substantially above median household income (HDB, 2022). However, flat ownership is subject to strict conditions:

"...(all) essential occupiers must not own, dispose or have an estate or interest in any other local or overseas property in the 30 months before the date of the new flat application..." Lye (2020, p7)

No individual/household may own property additional to their HDB flat. The implication of this is that most Singaporeans only own one piece of property in their lives (Chia et al., 2017). HDB flats are often a family's most valuable retirement asset.

¹ A colloquialism for public housing units

2.2 The Developmental State

This paper argues that the relationship between public housing and economic growth operates within the East Asian developmental state categorisation and its characteristics. This section thus first introduces Singapore's political and economic climate via developmental state literature. These states embarked on a strategy which a) opened up local economies to foreign direct investment (FDI), b) protected and supported the emergence of new export industries in potentially competitive areas and c) maintained macroeconomic stability through low inflation and the encouragement of high levels of savings/investment (Chang, 2003). Singapore embarked on a path of export-oriented industrialisation, embracing the entrance of Multinational Companies (MNCs) which worked in partnership with state-directed Government Linked Companies (GLCs) (Low, 2001). Overall, this strategy could be described as highly state interventionist and export-oriented. Governments attained goals of economic expansion via active policies to position their nations as an attractive site for foreign investment and trade.

Authoritarian rule is a further characteristic closely associated with the East Asian developmental states (Low, 2001). Authoritarian rule has been touted as enabling strong state intervention for economic growth – from forced land nationalisation to protecting emerging industries (Kwon, 2007). Singapore's penchant for authoritarianism could be explained by Malaysia's unilateral decision to expel Singapore from the Federation in 1965. The fragile socioeconomic state Singapore was left in and growing racial tensions between the island's majority Chinese population and minority Malay groups eventually boiled over into multiple riots throughout the 1960s. The choice of authoritarianism was a 'pragmatic' one - a strong political base was deemed necessary to build stronger social structures and attain economic growth (Chua, 1991). The People's Action Party (PAP), still the ruling party, possesses near-complete political hegemony – not a single opposition member was elected into parliament until 1984, 16 years into independence. I argue this state control enabled the PAP to enact its strategy of public housing policies that facilitated national economic growth, a strategy we return to in section 4.2.

While a wealth of literature exists on the developmental state, these are often rooted in explaining economic growth via the macro-level strategies espoused above. Section 4 attempts to embed the

economic effects of public housing within the overarching developmental state in Singapore via two conceptual frameworks. These are Holliday's (2000) Productivist state which presents social policies, like public housing, as serving economic goals and Chua's (1991) ideological hegemony which explains the public housing 'by-product' of universal welfare creation as part of the state's pragmatic pursuit of growth.

Section 3: Existing Evidence

3.1 A Pillar of Development

Scholars such as Oswald (1996) and Causa et al. (2019) conjecture that high home-ownership in Western-industrialised economies led to higher unemployment by inhibiting residential mobility and efficient labour allocation. Such theories are less applicable to Singapore, a city-state of only 728.6 km². Upon independence, a lack of industrialisation and a very small agricultural sector meant the population was largely unemployed or informally employed (Chua, 2004). Singapore's early economic goals were thus centred around employment creation. Contrary to other contexts, many scholars argue that the promotion of home ownership has contributed substantially to full employment. According to Low (2001):

“Housing and Development Board...and the Economic Development Board (EDB)...were twin institutional pillars of the developmental state...providing homes and jobs, respectively”

Chua (2014) argues that HDB and EDB acted in tandem, with public housing facilitating “the formation of a formal labour force necessary to a capitalist economy” (p3). The creation of modern housing with “electricity, piped water and modern sanitation” (Lye, 2020 p3) firstly and directly addressed massive housing shortage and greatly improved living conditions.

Public housing policy is also closely and continuously associated with Singapore's economic strategy as an attractive business and investment destination. In addition to improving general standards of living, Goh (1998) argues that public housing lowered living costs, relieving wage pressure without sacrificing labour productivity for employers. This maintained Singapore's position as a competitive and attractive site for business investment. Within a few years of its introduction, governmental agenda shifted towards encouraging home ownership via the introduction of 99-year leases in 1964 (Lye, 2020). A critical complement to this new focus was the Central Provident Fund (CPF). The CPF is a national

compulsory savings scheme to fund social provisions like education, retirement, healthcare, and housing. It functions as:

“(A) compulsory personal saving on the part of the employee, complemented by the employer’s contribution” (Lee and Qian, 2017 p922).

Consequently, it is only available to individuals in formal employment. The introduction of CPF enabled (formally employed) Singaporeans to afford housing without significantly impacting their disposable income (Tremewan, 2006). Citizens are allowed to finance up to 100% of their HDB flat down-payment and make direct monthly mortgage payments from their CPF accounts (Phang, 2007;Lye, 2020). In fact, given strict restrictions surrounding pre-retirement withdrawals from one’s CPF, there is a large incentive to spend on public housing (Lee and Qian, 2017). Essentially, this draws on future retirement income to finance present housing needs. At retirement, homeowners liquidate this asset and downsize or move in with their children². The CPF account (i.e. retirement fund) is then replenished and bolstered with the sale proceeds. The choice of public house applicants to purchase (rather than rent) rose from 13.6% in 1964 to 44% in 1968, the year this policy was introduced (Chua 1991, p31). Phang (2001) further estimated that net housing wealth relative to GDP increased from 0.18 in 1980 to 1.11 in 1997, representing substantial growth in the wealth creation effects of public housing.

Chua (2014) thus claims that public housing ownership anchored workers to continuous formal employment via the obligation of monthly mortgage payments. Moreover, eligibility for public housing loans is preconditioned on continuous formal employment³. This weakened collective wage bargaining rights, placing further downward pressure on wages. Tellingly, there is no minimum wage in Singapore while unemployment rates have rarely exceeded 3% between 1988-2022 (Trading Economics, 2022). Furthermore, scholars like Desmond and Gershenson (2016) argue housing security and employment are empirically linked. These conceptual pathways position permanent, stable housing

²See <https://www.hdb.gov.sg/cs/infoweb/residential/buying-a-flat/buying-procedure-for-new-flats/application/priority-schemes?anchor=mcps> for Multi-Generation Priority Schemes and 3Gen flats

³See <https://www.hdb.gov.sg/residential/buying-a-flat/financing-a-flat-purchase/housing-loan-options/housing-loan-from-hdb> for full eligibility requirements

as a precursor to and facilitator of Singapore's development into a formal economy. Recalling Singapore's developmental state strategy, the use of macroeconomic policy is highly constrained by her openness to trade and exports. In recession, public housing policy has proven an effective short- and long-term tool to ease economic burden and stabilise the economy. For example, HDB's dominance allowed for flexibility in housing loan policies, such as instalment payments for mortgage payment arrears and medium-term reductions in mortgage payments following the 1997 Asian Financial Crisis (Phang, 2001).

3.2 Housing a Welfare State

Public housing in Singapore has indeed reached "near-universal" levels, providing subsidised, safe shelter and a stable retirement asset (Chua, 1991 p26). By 1989, the income ceiling for subsidised public housing ownership covered 90% of all Singaporean households. Furthermore, governmental spending on housing is highly progressive in nature. Grants and loans tend to award larger values to low-income families, and are complemented repayment deferments for struggling households⁴. Figure 1 provides an extensive overview of different loans/grants available for buyers.

⁴See <https://www.hdb.gov.sg/residential/living-in-an-hdb-flat/sers-and-upgrading-programmes/upgrading-programmes/pay-upgrading-cost/subsidies-and-financial-assistance-measures> for more extensive list of measures

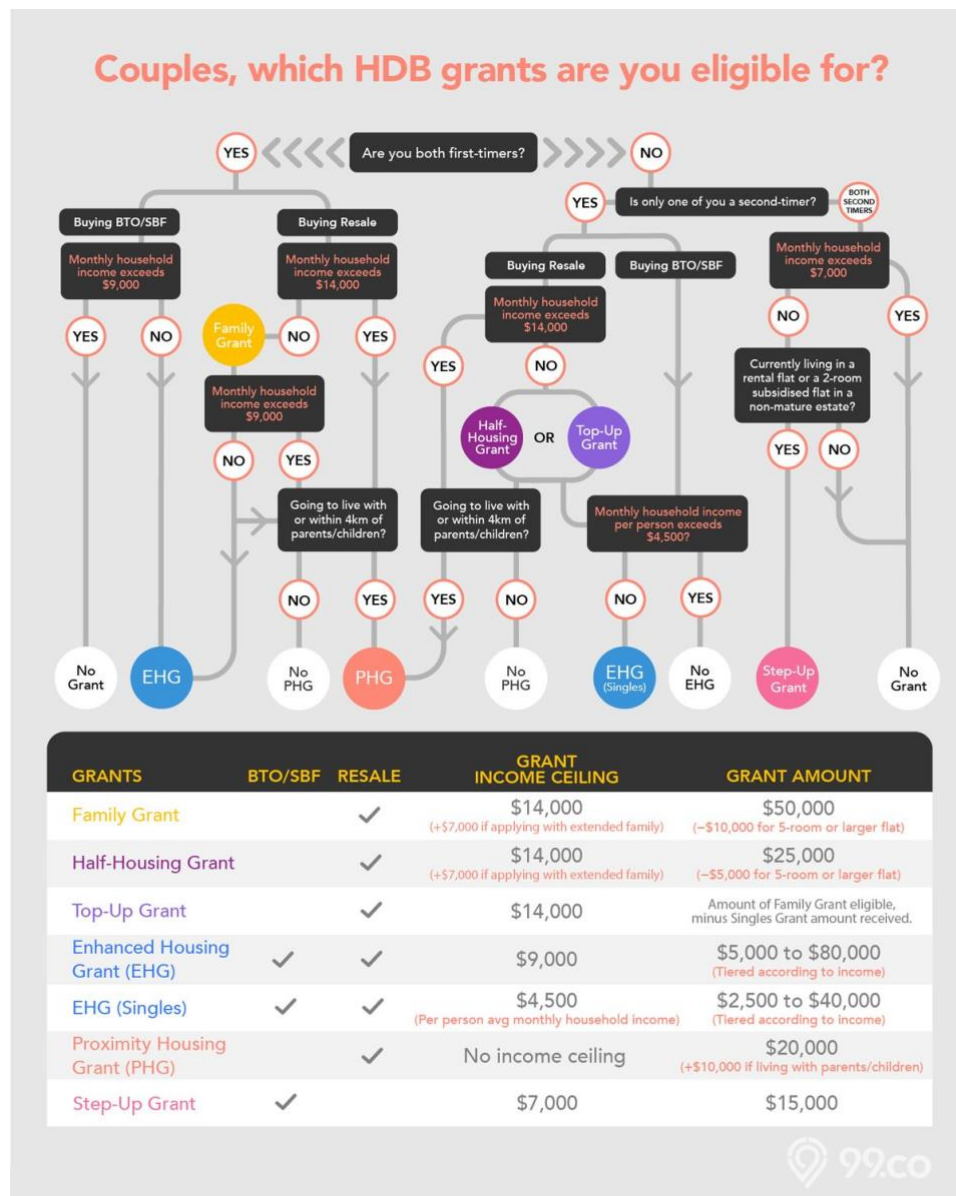


Figure 1: Overview of HDB grants (retrieved from: www.99.co/singapore/insider/hdb-grants-for-couples/)

The social policy of increasing home ownership access serves two critical pillars of welfare: it creates stable assets for old-age, espoused in Section 3.1, and provides a retreat from financially uncertain rental markets (Schelkle, 2012). Low-income renters in Singapore are offered generous subsidies/loans to purchase their existing rental units from the HDB (Chua, 1991). Home ownership policies are thus redistributive in nature, drawing from tax revenue to fund the entry of home owners who could not otherwise afford this position. Despite its refusal to explicitly title HDB policy universal, Singapore has followed the trend of widening accessibility to home ownership, once the reserve of wealthy households.

Overall home ownership rates increased from 58.8% in 1980 to 90.4% in 2020 (Trading Economics, 2022).

Tremewan (2006) reaches a different conclusion. He posits public housing in Singapore as inherently unequal. By incentivising all income brackets towards home ownership, workers who earn less must sacrifice other consumption. Thus far, there has been no study on the *empirical* interaction between public housing policy and equality – this paper aims to fill that gap.

Section 4: Conceptual Framework

4.1 The Productivist Regime: Social policies for Economic Growth

Productivist welfare regime literature is closely aligned with but independent from developmental state literature. Holliday (2000, p709) identifies a Productivist welfare state by features of “a growth-oriented state and subordination of...social policy, to economic/industrial objectives”. Essentially, social policies, like public housing provision, are *subservient* to economic expansion. Consequently, this paper argues that beyond this subservience, public housing policy was also created as a direct tool for economic growth.

Productivist literature distinguishes itself from developmental state literature in its focus on domestic social policies as tools to “*facilitate*” macroeconomic goals (Holliday, 2000 p709). The goal of a social policy is not welfare creation as an end in itself. Instead, it is viewed as a mechanism to attain wider economic growth via direct wealth creation and supplying necessary social provisions while minimising state spending for ‘productive’ segments of the population (i.e. the formally employed). Singapore, in particular, is classified as “developmental-particularist” in which the state “[directs] individual welfare provision” effectively mitigating a large state welfare budget (Holliday, 2000 p709). This was accomplished via the interaction between HDB and CPF, discussed in section 3.1. The “self-financing mechanism” of having citizens fund retirement via housing alleviated the financial burdens of governmental provision in old-age (Joo and Wong, 2008 p326). The welfare system of HDB and CPF is thus relatively inexpensive, with Singapore registering the lowest social spending across East Asian developmental states (Lee and Qian, 2017). An appreciation in public housing prices represents success in its asset accumulation function for retirement. Hence, we would expect a *positive* relationship between public housing prices and economic growth.

While Holliday (2000) focuses mainly on the facilitative or inexpensive welfare functions of social policy, I argue that the most important Productivist feature served by public housing in Singapore was as an essential and direct precursor to formal employment. As discussed, the introduction of stable,

permanent housing in the form of public housing facilitated a shift to a formal, capitalist economy and attractive low-cost investment destination. These flats housed newly-employed industrial workers. Recalling Section 3.1, these workers were compelled by monthly mortgage or rental payments to stay in continuous formal employment with moderate wages. A *disciplining* effect was imposed on workers, increasing labour productivity (Chua, 2003). Public housing policies are thus not to be viewed solely for its inexpensive welfare function for the productive workforce but also more deeply embedded in Singapore's developmental state, constructed and implemented explicitly for the goals of a) nurturing openness and attractiveness to investment b) developing competitive export industries (which requires continuous employment of formal workers), and finally c) macroeconomic stability through the balance of near-full employment with low wage inflation. The next section will explore how the fulfilment of these economic objectives was encouraged by the anchorage of worker welfare in public housing.

4.2 The Pragmatic Imperative: Political and Economic Logic behind Universal, Progressive Policy-making

This section explains how the state achieved such strong levels of control over its citizens, enabling and favouring the anchorage of citizen welfare to public housing policy. I theorise this dynamic saw universal public housing policy contribute both to economic growth and equality. I use a Gramscian notion of 'ideological hegemony' to explain why progressive and universal public housing, detailed above, was promulgated by the growth-oriented state. Chua (1991, p27) defines "ideological hegemony" as when the:

“governed and the ruling group constitute themselves as a political whole in pursuit of a social order according to the organi(s)ing concepts provided by the ruling group.”

In a Singaporean context, these organising concepts refer to her government's reliance on authoritative control. The government adopted authoritarianism to remain in power while the people complied with such due to the system of welfare incentives and penalties, elaborated on in this section. Given the

unexpected circumstances of independence, the PAP government adopted a permanent ‘crisis’ mentality. This justified the employment of authoritarianism under the guise of ‘pragmatic’, technocratic rule for rapid socioeconomic development. Such ‘pragmatic’ authoritarianism was perhaps best illustrated in housing. The wide-reaching ‘Land Acquisition Act’ (1966) enabled the state to nationalise all land without protest (Kwon, 2007). In contrast to colonial British neglect of citizen welfare, the post-independence government possessed strong “moral high ground” in land seizures from a landowning minority (Chua, 1991 p30). This authoritative and far-reaching invasion of property rights was justified and widely accepted in its objective to house the overcrowded, landless majority. This logic of control and compliance can be contextualised as part of an ‘ideological hegemony’ of ‘pragmatism’ between state and citizens.

Subsequently, the HDB could build low-priced flats on this cheaply acquired land without substantial governmental costs (Phang, 1996). As forementioned, Home ownership was intended for citizens to self-fund retirement by liquidating their flats. From a citizen perspective, authoritarianism is accepted and complied with on this pragmatic basis. Public housing provision was presented as improving welfare outcomes for most (i.e. formally employed) citizens, even if not the primary objective of the government. Public housing thus became an optimal economic tool partly due to its by-product of welfare creation which encouraged citizen compliance. I posit that this state-citizen dynamic provision and compliance further explains public housing as a source of universal and progressive welfare for citizens. Where Holliday’s (2000) Productivist regime only aids explanation of the economic function of public housing, I propose an application of ‘ideological hegemony’ to explain the universal welfare function of public housing within the growth-oriented developmental state model.

This control extended explicitly into politics (Kong and Teo, 1997). Planned housing upgrades in the 1990s prioritised PAP-held wards while, more recently, the Prime Minister of Singapore, Lee Hsien Loong said in response to differential prioritisation for the planned Lift Upgrading Programme (LUP):

“Why is the opposition ward not treated at least as good as...the PAP ward?...the answer is there has to be a distinction because the PAP wards supported the government.” (The Straits Times, 2005)

The government has centralised its citizens' welfare around HDB flat ownership. By linking quality improvements to one's flat and neighbourhood to political patronage, citizens are obliged by 'pragmatism' to support political status quo to maintain the value of their largest retirement asset (Tremewan, 2006). Authoritarianism is not maintained only with top-down control but obliged and supported for its welfare function. Empirically, the PAP secured 27 out of 29 constituencies in the 2020 General Elections (Mohan and Phua, 2020). Simultaneously, the government is obliged to continually maintain accessibility to while upgrading the quality of modern housing, contemporarily branching into more luxurious flats or prime locations to meet growing aspirations (Siew and Kong, 1997; HDB 2022). Public housing prices have appreciated substantially over time, fulfilling its economic and welfare objectives.

The structures of incentive and dynamics of power involved in the public housing market are largely and willingly accepted by citizens. Citizens are both consumers and capital for growth. The prominent position housing holds to citizen's welfare anchors them to continuous employment in the formal labour market at low governmental costs, supporting economic growth. Simultaneously, compliance to state ideology is ensured by the essential and progressive welfare function served by public housing. There exists both rewards for support and penalties of contestation which encourage the 'pragmatic' state-citizen dynamic of compliance to and provision of universal public housing as a central tenet of welfare.

4.3 Conceptual Framework

These frameworks shape my research questions which examine the relationship between the empirical development of public housing, its intended aims and other social consequences (i.e. equality), given

its central welfare position. The debate remains as to whether public housing successfully supports economic growth and equality via the provision of progressive, universal welfare.

Figure 2 synthesises the above frameworks to inform my forthcoming analysis. My analysis focuses specifically on two related theoretical frameworks: Holliday's (2000) 'Productivist regime' and Chua's (1991) 'ideological hegemony'. The interrelated concepts of pragmatism and productivism explain the exertion of authoritative control over Singapore's public housing system for economic ends.

A Productivist welfare regime suggests that public housing provision is instrumentalised to serve economic expansion. The appreciation of public housing prices indicates its success in attaining this economic objective. Simultaneously, 'ideological hegemony' explains how the authoritarian regime employed public housing as a critical source of universalised welfare, via reasons of 'pragmatism', to serve its own developmental aims of economic expansion. Thus, the appreciation of public housing prices indicate *not only* a fulfilment of its progressive welfare function but also imply success in the state's economic objectives.

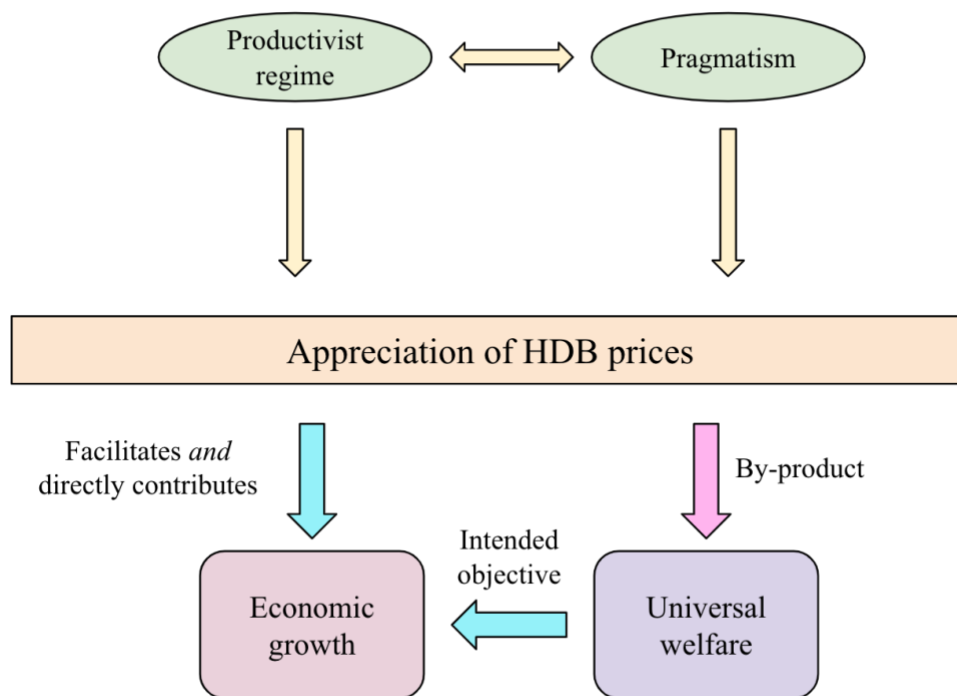


Figure 2: Conceptual Framework

In a nation where 85% of the population reside in public housing, public housing price appreciation is generally favoured (Phang, 2001). The Singapore government has thus instituted an explicit agenda of appreciating the prices of public flats to serve critical economic and welfare functions, as discussed above. Indeed, the public housing price index has grown from 24.3 in 1990 to 131.5 in . My research aims to examine whether we can establish a relationship between the movement of public housing prices and economic growth as well as inequality in Singapore, as per the conceptual pathways set out above.

Section 5: Data and Methodology

This paper employs quantitative methods to investigate the relationship between public housing prices, economic growth and inequality as described in section 4.3. I primarily utilise cointegration analysis to understand whether public housing prices are correlated with economic growth and inequality in the long run.

5.1 Data

All data used in this paper was sourced from publicly available government and international databases. These consist of the Singapore Department of Statistics, the World Bank and the World Inequality Database (WID). The time period covered is 1990-2020. The choice of period was informed by overlapping availability of data. There were no measures of HDB resale index prior to 1990 and no measures of GDP per capita following this period. This period, spanning three decades, was deemed sufficiently long for analysis and representative of the evolution of public housing. All three time series were standardised in my analysis to award each variable equal weight despite possessing vastly different scales. Table 1 provides summary statistics of each variable prior to standardisation.

Table 1: Summary statistics for variables

Summary Statistics					
Variable	N	Mean	Standard Deviation	Minimum	Maximum
HDB Price	31	90.20	37.947	24.3	148.6
GDP per capita	31	36,827	17,387.74	11,862	66,679
Top 10% Income Share	31	0.420	0.0459	0.335	0.467

Note: All figures rounded off to 3d.p.

The main dependent variable is the HDB resale index for measuring public housing prices in Singapore. This index, computed by HDB, tracks all transactions to capture overall price movement within the

public resale market. This was deemed the best measure of public housing prices considering the paper's focus on the economic and welfare functions of HDB flats, as fulfilled by price appreciation (see Section 4.3). Prices of newly-built flats, pre-subsidy, are pegged to the value of resale flats (Chua, 2014). Hence, the resale index was considered a sufficiently adequate proxy for overall price movement given a lack of price data on the latter. Resale flats capture both the effects of government subsidies, which would have been available at the time of initial purchase, and the appreciative capacity of public housing as a household's sole and largest retirement asset. The HDB resale index uses 2009 as the base year with a value of 100. The index values given for every other year between 1990-2020 are thus to be taken as relative to the base year.

Gross Domestic Product (GDP) per capita, which measures average growth in incomes overtime, is used to capture Singapore's economic growth. This time series was sourced from the World Bank and is measured in US dollars at contemporary prices.

For inequality, two separate measures were considered. The Gini coefficient is perhaps the most widely-used indicator of inequality. It compares the cumulative proportions of a population with the cumulative proportion of national income they received (OECD 2015). However, exact calculations of Gini coefficients can differ. Despite being an OECD member, Singapore does not adopt the same calculation of Gini Coefficient (Department of Statistics, 2022). Hence, there is an absence of official OECD measures of inequality regarding Singapore. Meanwhile, the Singapore Government has not published a continuous measure of the Gini Coefficient predating 2000 while Mukhopadhaya's (2014) calculations of Singapore's Gini coefficient from 1984-2011 are consistently higher than government estimates. Due to these inconsistencies, a different measure of inequality was sourced. The World Inequality Database (WID), first compiled by Piketty and Zucman (2015), uses a range of national historical data to calculate income shares within countries over time. This paper chose the measure of pre-tax income share of the top 10% in Singapore. This measures the proportion of national income

held by the top 10% of earners in Singapore. A larger value on this indicator would imply that income is more heavily concentrated at the top while a lower value would imply a more even distribution of income and thus, a relatively more equal society.

5.2 Cointegration Analysis

In order to investigate the interaction between housing prices, income and inequality, a cointegration analysis (Johansen, 1991) was employed. Cointegration tests are used to establish if two or more time series are correlated over time. This allows us to identify long-run relationships between multiple time-dependent variables. In this case, my variables are HDB prices, Gross Domestic Product (GDP) and the Top 10% Income Share between 1990-2020. My research uses the Johansen cointegration test. The Johansen test is suitable for establishing a relationship between multiple time series, where more traditional methods such as the Engle-Granger test can only handle at most two variables.

Cointegration techniques are critical in analyses which involve time series. Granger and Newbold (1974) found that performing linear regression on time series may result in spurious correlation, where variables may appear to be causally related when in reality they are not. Another issue is that most time series are non-stationary. Stationarity refers to a time series in which the unconditional joint probability distribution does not change when shifted in time (i.e. it is, on average, the same regardless of time period). Hence, non-stationarity refers to a situation whereby the time series has a distribution that shifts with time and is less predictable. Non-stationary time series do not have stable parameters, such as mean and standard deviation, and thus inherently cannot be modelled using traditional methods.

Engle and Granger (1987) proposed a solution to these problems in the form of cointegration analysis. The authors found that multiple non-stationary time series can be integrated together in such a manner that they do not deviate from an equilibrium in the long-run i.e. their combination is stationary (See equation 5.1). This is important to identify a stable long-run relationship between our variables. However, a precondition for cointegration analysis is that the non-stationary time series are stationary

at first differences (i.e. the differences between consecutive data points⁵) (Johansen, 1991). These preconditions were found to hold true via a Phillips-perron unit root test for stationarity at levels (i.e. using the original data points) and at first differences (Appendix A).

As stated above, non-stationary time series are cointegrated if a linear combination of said time series exists that is stationary i.e. $I(0)$. Formally, we could say Y_t is cointegrated if there exists an $(n \times n)$ vector $\beta = (\beta_1, \dots, \beta_n)$ such that:

$$\beta' Y_t = \beta_1 y_{1t} + \dots + \beta_n y_{nt} \quad (5.1)$$

5.3 Vector Error Correction Model (VECM)

Engle and Granger (1987) proved that a cointegrating relationship implies the existence of an Vector Error Correction Model (VECM). Essentially, once we prove that a cointegrating relationship exists, the relationships between variables can be represented in a Vector Error Correction Model. The VECM allows us to map out both short and long-term relationships between our variables. My analysis will primarily utilise the VECM to test long-run significance between the variables.

This paper utilises Johanson multivariate formulation of a vector error correction model (VECM) to analyse the cointegration results. VECM is generally specified as follows:

$$\Delta y_t = \pi_0 + \Pi y_{t-1} + \sum_{i=1}^{k-1} \phi_i \Delta y_{t-i} + \varepsilon_t \quad (5.2)$$

where $\Pi = \alpha\beta'$, and α and β are $(k \times r)$ matrices, and ϕ_i is a $(k \times r)$ matrix. ε_t refers to the vector of error terms and is assumed to be independently and identically distributed i.e. $\varepsilon_t \sim N_k(0, \Sigma)$. The r columns of β refer to the cointegration vectors, and the rank r is the cointegration rank.

⁵ To elaborate, if Y_t denotes the value of the time series at time t , $Y_{t+1} - Y_t$, $Y_t - Y_{t-1}$, ..., $Y_1 - Y_0$ denotes the first differences

The VECM enables us to look at both short-term and long-term dynamics. My analysis is most interested in the Error Correction Term (ECT), measured by Πy_{t-1} , which combines short-run adjustments (α) with long-run tendencies (β) to measure deviations from the stationary mean of the cointegrated equation at time y_{t-1} . We can say that the relationship between variables is stable in the long-run if the coefficient, Π , of the ECT is *negative* and *significant* (Asari et al. 2013). Essentially, if the coefficient is negative and significant, we can imply that the direction and magnitude of the long-run relationship found in our cointegrating equation is indeed stable and significant.

5.4 Structural Analysis of VECM: Impulse-Response Function (IRF)

The VECM also enables us to construct an Impulse-Response Function (IRF) for structural analysis. This plot provides estimations of the relationships between the variables in our VECM in the short-to-medium term. The Impulse-Response Functions map the responses of one variable to an one standard deviation shock in another variable over a set future time horizon (Winarno et al., 2021). For example, it enables us to study how a one standard deviation shock to the HDB resale price index (=37.947, see Table 1) will affect Top 10% Income Share or GDP per capita. This enables us to examine the shorter-run dynamics between the variables. Additionally, the Forecast Error Variance Decomposition was plotted for Top 10% Income Share to decompose the variance of one variable into contributions from other variables. Essentially, it estimates the comparative explanatory value of each variable on a specified variable.

Section 6: Results

6.1 Visual Representation

Figure 3 plots the movement of the Resale Flat Price Index, Top 10% Income Share and GDP per capita between 1990-2020 (standardised). The figure illustrates all three series steadily increasing with occasional peaks and dips suggesting the possibility of co-movement between time series.

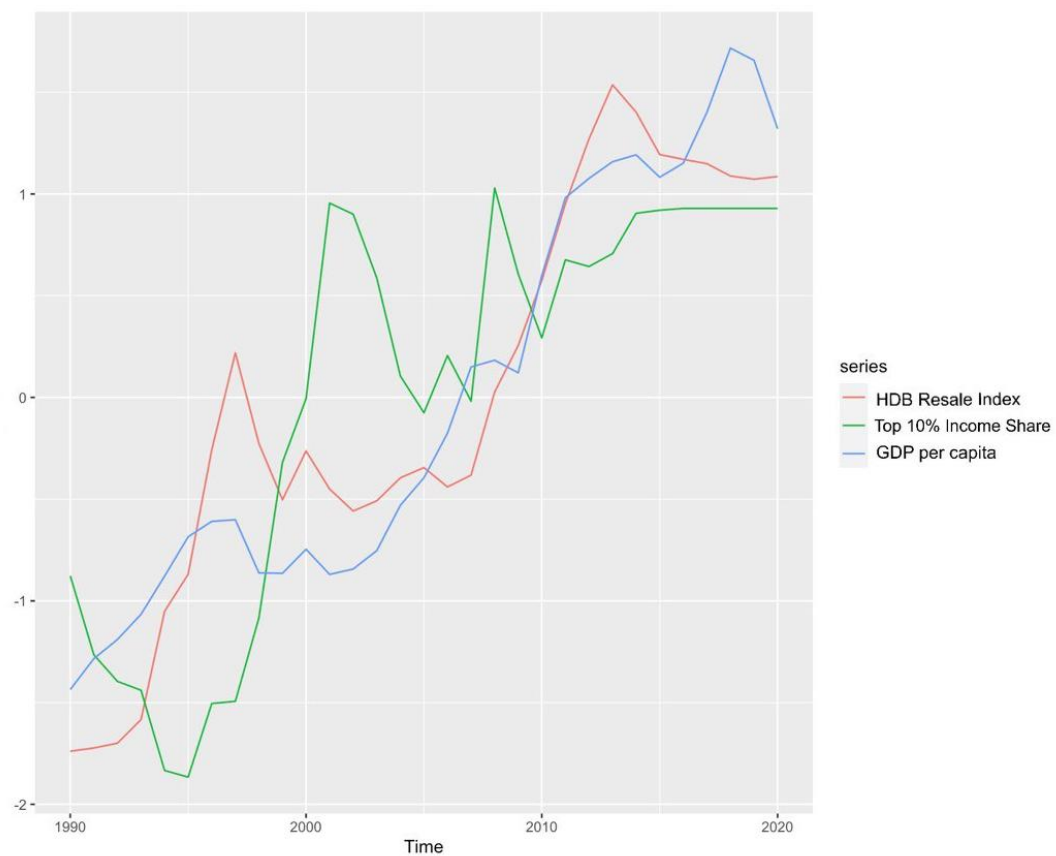


Figure 3: Standardised HDB Resale Price Index, Top 10% Income Share and GDP per capita (1990-2020)

6.2 Johansen Cointegration Test

A Unit Root test was first conducted to justify consideration of cointegration. The full results of this test are presented in Appendix A. It was found that all three variables are non-stationary but stationary

at first difference, supporting the use of the Johansen Cointegration test (Hyndman and Athanasopoulos, 2018).

Table 2 presents the result from a Johansen Cointegration test using the Trace method. This test tells us the number of cointegrating relationships present between our variables. The null hypothesis (H_0) of 1 or less cointegrating relationships ($r \leq 1$) is rejected at 1% significance level while the null hypothesis of 2 or less cointegrating relationships ($r \leq 2$) is not rejected. This suggests that there are at most 2 cointegrating relationships between the three variables. Since there is a cointegrating relationship, it can be represented in a Vector Error Correction Model which maps both short and long-run dynamics, as detailed in section 5.3. Here I use a VECM model with 5 time lags, which was selected based on the Akaike Information Criterion (AIC). Focusing on one cointegrating which uses HDB Price as the dependent variable, HDB Price is normalised to 1 in the vector error correction model for easy comparison between variables. This allows us to establish how GDP per capita and Top 10% Income Share shift per unit shifts in HDB prices.

Table 2: Johansen Cointegration testing (Trace method)

Variables: HDB Resale Price Index, GDP per capita, Top 10% Income Share		
H_0	Trace Statistic	1% Critical Value
$r \leq 1$	29.54***	24.60
$r \leq 2$	6.51	12.97

Note: ***Significant at 1% level. Lag selection criteria is Akaike Information Criterion (AIC), allowing a maximum of 6 lags.

As detailed in Section 4.3, we expect a positive relationship between HDB prices and GDP per capita and a negative relationship with Top 10% Income Share. Table 4 presents the estimates from our cointegrated equation as specified in Equation (5.2). The signs of the cointegrating equation results presented in Table 3 confirm a positive relationship between HDB prices and GDP per capita, indicating economic growth. Similarly, there is a negative relationship between HDB prices and Top 10% Income Share, indicating improving equality. A unit increase in HDB Prices would lead to a 0.8261097 increase in GDP per capita and a very slight decrease of $-7.806e^{-18}$ in Top 10% Income Share. As the variables were standardised, the coefficients are relative and do not represent real values.

The Error Correction Term (ECT) measures deviations from the long-term equilibrium. The absolute value of the coefficient explains the speed at which the variables return to equilibrium. The negative values and significant values for HDB Price and GDP per capita indicate that the relationship between both variables is significant at the 5% level. The ECT for Top 10% Income Share is not significant at the 5% level which means we cannot conclude a significant relationship between public housing and equality. The absolute value of the ECT for each variable indicates the percentage of correction within one time period (i.e. a year). 176% of disequilibrium in HDB Price is corrected and 127% of disequilibrium in GDP per capita is corrected within a year which indicates that it takes less than a year to reach equilibrium level.

Table 3: Summary of VECM results using Johansen Cointegration method

HDB Price	GDP per capita	Top 10% Income Share
Cointegrating Equation (Johansen method)		
1.00	0.826	-7.806e ⁻¹⁸
Error Correction Term (ECT)		
-1.764 (0.454)**	-1.275 (0.331)**	-0.421 (0.791)

Note: All figures rounded off to 3d.p.

A number of robustness checks were performed on the VECM including the Portmanteau test on serial correlation, a test for Autoregressive Conditional Heteroskedasticity (ARCH) effects and a Jarque-Bera test for normality of residuals (Appendix Table B1). My model passed all three tests indicating the necessary conditions for a meaningful and robust VECM. The full results of these robustness checks are presented in the appendix.

6.3 Impulse-Response Function and FEVM

The analyses so far have shown a significant, positive long-run relationship between HDB prices and GDP per capita and a not significant, negative long-run relationship between HDB prices and Top 10% Income Share. Here, I present a shorter-run projection of the effects of HDB prices on GDP per capita and Top 10% Income Share

A one-standard-deviation shock in HDB resale prices is 37.947 (Table 1). Figure 4 (a & b) shows the response of Top 10% Income Share and GDP per capita to a one-standard-deviation shock in HDB resale prices over the next 15 years. The plot is derived from a bootstrap of 100 runs and maps the response of variables Top 10% Income Share and GDP per capita respectively with a 95% confidence interval. The exact values on the vertical axis are less important as they hold no units but instead represent the magnitude of the standard error for the response variable. A one-standard-deviation shock in HDB resale prices initially sees an increase in Top 10% Income Share before this effect steadily

dissipates, remaining above the equilibrium in the medium-term. This implies that the top 10% income share rises with a rise in HDB prices but this effect wanes overtime. Meanwhile, a one-standard-deviation shock in HDB resale prices sees a positive response of a steadily increasing GDP per capita with slight dips. This implies that a rise in HDB resale prices has a continued positive impact on GDP per capita over the short and medium-run.

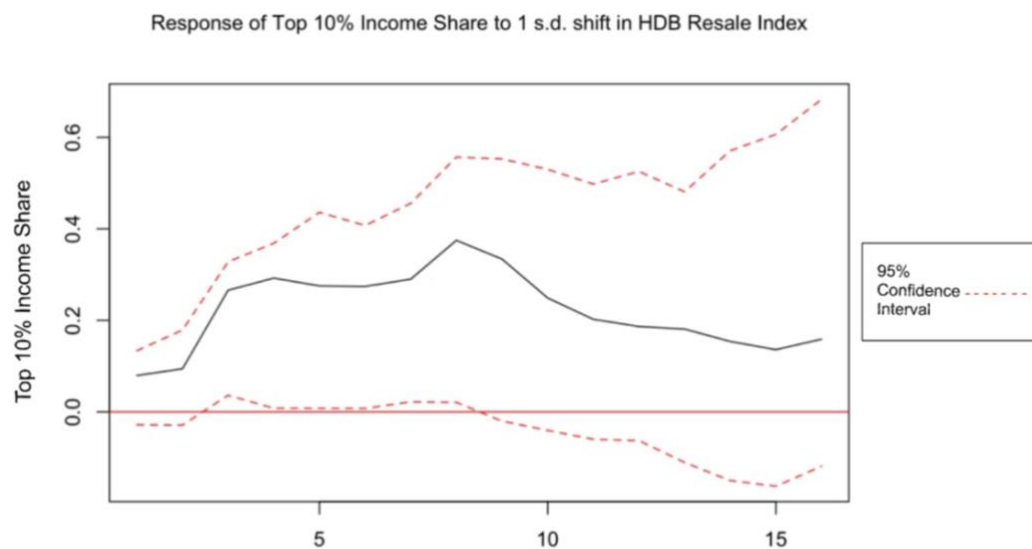


Figure 4a: Impulse-response function of Top 10% Income Share to HDB Resale Price Index

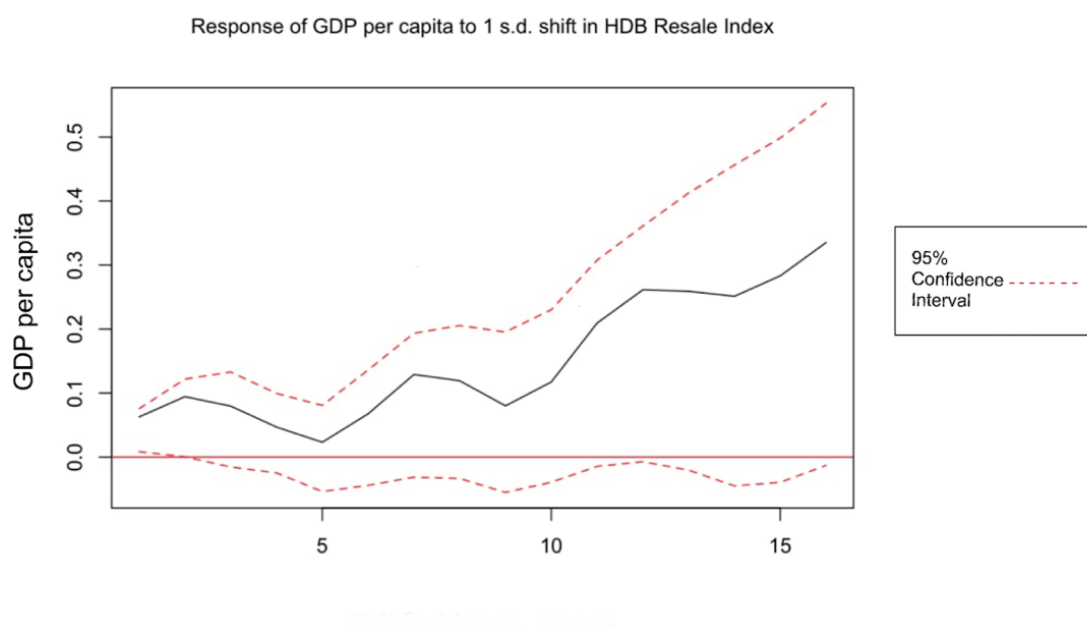


Figure 4b: Impulse-response function of GDP per capita to HDB Resale Price Index

Additionally, a Forecast Error Variance Decomposition (FEVD) is presented for Top 10% Income Share. Where the full results and plots for all three variables are presented in Appendix C, an interesting point to note here is that variances for Top 10% Income Share is increasingly explained by the HDB Resale Price Index, reaching >50% over a 10-year horizon (Figure 5). This suggests that HDB prices do possess substantial explanatory capacity for Top 10% Income Share, even if the direction and magnitude of this relationship is not significant in the longer-run.

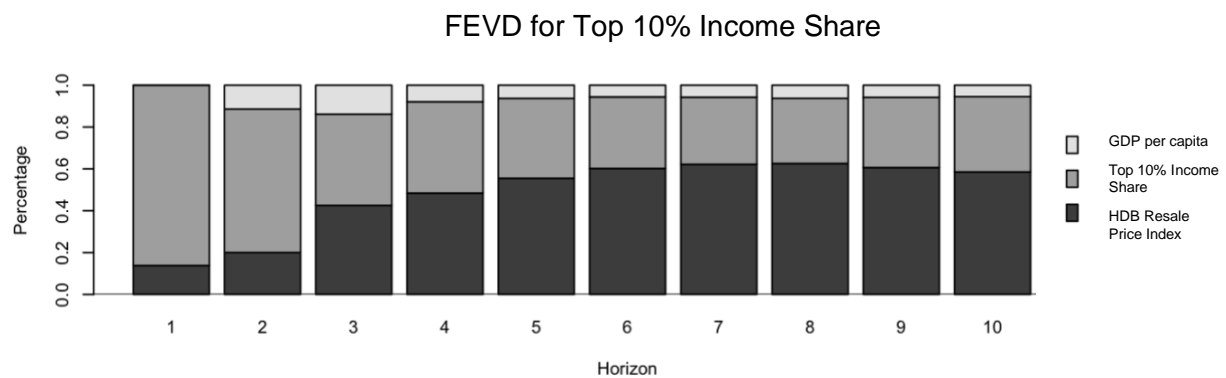


Figure 5: FEVD for Top 10% Income Share

Section 7: Discussion

This study provides strong evidence of both short and long-run positive relationship between public housing and economic growth. These results are consistent with the literature relating appreciating public housing prices with economic growth (e.g. Chua, 2014; Phang, 2001) and empirically supports my conceptual embedment of Holliday's (2000) Productivist welfare theories in developmental state literature.

The paper also provides some short-run evidence supporting the claim that public housing prices are slightly and positively related to inequality. However, these results are not significant in the long-run where a slight negative but not statistically significant relationship is observed instead. Perhaps, the insignificant results can be explained by the counteractive effects of public housing policy on equality espoused in earlier sections. Access to public home ownership is progressively subsidised through the imposition of an income ceiling on the purchase of new flats as well as generous grants and loan conditions for lower-income households which has enabled high levels of home ownership in Singapore, across income groups. Conceptually, I propose this to be a part of an explicit governmental agenda to strongly incentivise citizens towards public housing ownership in order to anchor them in continuous formal employment and strengthen political support. Yet the short-run positive relationship could be explained by how these strong incentives in fact reproduce inequality by coercing households into home ownership at the expense of other consumption (Tremewan, 2006). These effects could dissipate overtime as the value of the flat appreciates and realises its retirement/welfare function, explaining a shift in direction of the relationship between public housing and equality. Nonetheless, further research is necessary to statistically substantiate these postulations. The FEVD suggests the substantial explanatory power of public housing prices on inequality, encouraging further research – particularly, with more expansive data – into this relationship.

Tests for autocorrelation, normality of residuals and ARCH effects demonstrate the robustness of my models (Appendix A2). However, a number of limitations render my analysis indicative at best. Inherent to cointegration analysis, the use of lagged values diminish the statistical power of analysis

(Sanguin, 2020). This could have been reduced by the inclusion of pre-1990 data however, this was not available. Relatedly, the number of observations ($N=31$) was somewhat limited both in time period (1990-2020) and frequency (i.e. annually). My results may be different and more nuanced given a greater availability of data. Future studies could aim to extend the time frame of analysis to improve validity, particularly given the conceptual emphasis on Singapore's early post-independence development. However, this would require the publication of additional estimates of housing prices. Singapore is highly unique in its ubiquitous public home-ownership, even amongst other East Asian Development states. The effects of housing on economic growth and equality could perhaps be made more robust by comparative studies with similarly small, dense and urban populations such as Hong Kong, see e.g. Qiu (2020), where there also exists a fairly sizable public housing market (Chiu, 2007; Forrest & Yip, 2014).

Moving forward, there remains the perennial and only growing trade-off between appreciating HDB prices and maintaining affordability for new entrants as the public housing market begins to mature, given the pegging of new flats to resale prices. The government has recently tightened loan limits for public housing purchases to cool rising prices, protecting affordability at the expense of wider accessibility (Mokhtar 2021). While the government could invest in more generous subsidies to mitigate this conflict, such a policy path would be incongruous with Productivist welfare provision – nor would it be particularly 'pragmatic' (Holliday, 2000; Chua, 1991). Even at present levels, the HDB does not turn a profit on the construction and sale of flats but maintains a stable deficit of approximately SGD\$1.87b (£1.08b) (HDB, 2021). Ultimately, these interventions tackle symptoms more than root causes. What remains for policy-makers is a continuous need to balance maintaining the appreciative value of public housing as a retirement asset, keeping up with rising costs of living and inflation, whilst also keeping the public housing market affordable and accessible (Chua, 2014). This problem will only be exacerbated in coming years as low-to-middle household income growth is not expected to match housing prices (Chua, 2014). The future of the public housing market, and its operationalisation in economic growth and welfare creation, is likely subject to change. The implications this holds for the intrinsic policy structure underlying public housing remains uncertain.

Nonetheless, this paper has served an important function in demonstrating the significant empirical effect of public housing policy on economic growth in Singapore. This result is encouraging, justifying the continued use of public housing for economic ends. It has also conceptually posited public housing as a source of progressive and universal welfare. Critically, this paper proposes that the aforementioned purported welfare function of public housing has enabled its operationalisation as an economic tool via the co-opting of citizens in a ‘ideological hegemony’ of pragmatism. While the empirical effects of this policy on equality are less conclusive, it remains plausible that the simple *appearance* of universal, progressive welfare serves the same purpose of securing compliance. However, this remains a speculative claim. Moreover, as a growing wealth of scholars insist equality to be a precondition for sustainable economic growth (See for example Mukhopadhaya, 2014; Piketty 2017), there is a growing justification to focus greater attention on empirically establishing and protecting the progressive welfare function of public housing policy.

Section 8: Conclusion

The operationalisation of public housing policy as a tool for economic growth and welfare has long been an explicit part of governmental agenda. Findings from this study thus have important implications for policy-making. My research has made two major contributions to public housing literature in Singapore. Conceptually, I embed Holiday's (2000) Productivist theories in wider East Asian developmentalism literature. Moreover, I attempt to expand on the economic aims of productivism to incorporate the universal and progressive welfare function of public housing in Singapore via concepts of ideological hegemony. Empirically, this serves as one of few studies which establishes a statistically significant and positive short- and long-run relationship between public housing and economic growth. Specifically, a unit increase in public housing prices lead to a relative 0.826 unit increase in GDP per capita. These results support my conceptual claims that public housing was developed for economic expansion.

The results also suggest a short-run positive relationship between public housing and inequality. However, we cannot conclude a significant long-run relationship between the two. I proposed a negative relationship between public housing and inequality via Chua's (2014) conceptualisation of ideological hegemony of pragmatism between the state and her people which positioned public housing as a form of progressive and universal welfare. Although I was unable to conclude a significant long-run relationship, the study is novel in its attempt to study equality as by-product of governmental housing agenda. The Impulse-Response Function suggests some positive effects of public housing prices on inequality, challenging theoretical explanations. Perhaps, following Tremewan (2006), the strong system of control created has instead produced a system of inherent inequality in which different income groups are uniformly coerced into home ownership, at the expense of other consumption. This would explain an immediate link between public housing and inequality. However, further research is required to understand if this effect persists or if housing price appreciation serves a greater welfare function in the long-run, as was proposed in the conceptual framework. Nonetheless, my overall study has made novel contributions to the public housing literature in Singapore. It has not only synthesised an array of

explanations on and empirically established the economic gains of public housing but also proposed a theoretical link between its explicit economic function and the attainment of equality.

References:

- Asari, F.F., Baharuddin, N.S., Jusoh, N., Mohamad, Z., Shamsudin, N., & Jusoff, K. (2013). A Vector Error Correction Model (VECM) Approach in Explaining the Relationship Between Interest Rate and Inflation Towards Exchange Rate Volatility in Malaysia.
- Bloomberg. (2021, December 15). Singapore Imposes Property Curbs to Help Cool Housing Market. *Bloomberg.Com*. <https://www.bloomberg.com/news/articles/2021-12-15/singapore-to-impose-property-curbs-to-calm-housing-market-frenzy>
- Causa, O., Woloszko, N., & Leite, D. (n.d.). *Housing, Wealth Accumulation and Wealth Distribution: Evidence and Stylized Facts*. 80.
- Chang, H. (2004). The Role of Social Policy in Economic Development: Some Theoretical Reflections and Lessons from East Asia. In T. Mkandawire (Ed.), *Social Policy in a Development Context* (pp. 246–261). Palgrave Macmillan UK. https://doi.org/10.1057/9780230523975_11
- Chang, H.-J. (2003). Chapter 6. The East Asian Development Experience. In *Rethinking Development Economics* (p. 23).
- Chen, Y.-L., & Li, W. (2012). Neoliberalism, the Developmental State, and Housing Policy in Taiwan. *Locating Neoliberalism in East Asia: Neoliberalizing Spaces in Developmental States*, 196–224. <https://doi.org/10.1002/9781444346657.ch8>
- Chia, W.-M., Li, M., & Tang, Y. (2017). Public and private housing markets dynamics in Singapore: The role of fundamentals. *Journal of Housing Economics*, 36, 44–61. <https://doi.org/10.1016/j.jhe.2017.03.001>
- Chiu, R. L. H. (2007). Planning, Land and Affordable Housing in Hong Kong. *Housing Studies*, 22(1), 63–81. <https://doi.org/10.1080/02673030601024614>

- Chua, B. H. (2014). Navigating Between Limits: The Future of Public Housing in Singapore. *Housing Studies*, 29(4), 520–533. <https://doi.org/10.1080/02673037.2013.874548>
- Chua, B.-H. (1991). Not Depoliticized but Ideologically Successful: The Public Housing Programme in Singapore. *International Journal of Urban and Regional Research*, 15(1), 24–41. <https://doi.org/10.1111/j.1468-2427.1991.tb00681.x>
- Cook, S., & Kwon, H.-J. (2007). Social Protection in East Asia. *Global Social Policy*, 7(2), 223–229. <https://doi.org/10.1177/1468018107078165>
- Engle, R. and Granger, C. (1987) Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica*, 55, 251-276.
- Department of Statistics (2022). *Understanding the Gini Coefficient* [Infographic]. Singstat. https://www.singstat.gov.sg/-/media/files/visualising_data/infographics/households/understanding-gini-coefficient.ashx
- Desmond, M., & Gershenson, C. (2016). Housing and Employment Insecurity among the Working Poor. *Social Problems*, 63(1), 46–67. <https://doi.org/10.1093/socpro/spv025>
- Fong, P. E., & Lim, L. Y. C. (2015). Labor, Productivity and Singapore's Development Model. *Singapore Economic Review*, 60(3), 1550033. <https://doi.org/10.1142/S0217590815500332>
- Forrest, R. (2014). Public Housing Futures. *Housing Studies*, 29(4), 463–466. <https://doi.org/10.1080/02673037.2014.912867>
- Forrest, R., & Yip, N.-M. (2014). The Future for Reluctant Intervention: The Prospects for Hong Kong's Public Rental Sector. *Housing Studies*, 29(4), 551–565. <https://doi.org/10.1080/02673037.2013.878020>
- Goh, L. E. (1988). Planning That Works: Housing Policy and Economic Development in Singapore. *Journal of Planning Education and Research*, 7(3), 147–162. <https://doi.org/10.1177/0739456X8800700307>

- Goodman, R., Kwon, H.-J., & White, G. (Eds.). (2006a). The making of social policy in Hong Kong: Social welfare development in the 1980s and 1990s. In *The East Asian Welfare Model* (0 ed., pp. 177–192). Routledge. <https://doi.org/10.4324/9780203019160-16>
- Goodman, R., Kwon, H.-J., & White, G. (Eds.). (2006b). Welfare and governance: Public housing under Singapore's party-state. In *The East Asian Welfare Model* (0 ed., pp. 95–123). Routledge. <https://doi.org/10.4324/9780203019160-12>
- Goodman, R., White, G., & Kwon, H. (2000). The East Asian Welfare Model: Welfare Orientalism and the State. *Pacific Affairs*, 73(2), 273. <https://doi.org/10.2307/2672185>
- Granger, C.W.J. and Newbold, P. (1974) Spurious Regressions in Econometrics. *Journal of Econometrics*, 2, 111-120.
- Holliday, I. (2000). Productivist Welfare Capitalism: Social Policy in East Asia. *Political Studies*, 48(4), 706–723. <https://doi.org/10.1111/1467-9248.00279>
- Housing Development Board. (2021). *Report on the Audit of the Financial Statements of the Housing and Development Board for the Year ended 31st March 2021* (Report No. 4/2021). Retrieved from <https://www.hdb.gov.sg/about-us/news-and-publications/financial-statements>
- Housing Development Board. (2016). *Housing and Development Board Annual Report 2015/16*. <https://www20.hdb.gov.sg/fi10/fi10221p.nsf/arxvi/index.html>
- Hyndman, R., & Athanasopoulos, G. (n.d.). *Forecasting: Principles and Practice (2nd ed)*. Retrieved 12 March 2022, from <https://Otexts.com/fpp2/>
- Johansen, S. (1991). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. *Econometrica*, 59(6), 1551–1580. <https://doi.org/10.2307/2938278>
- Joo, T.T.K., Wong, TC. (2008). Public Housing in Singapore: A Sustainable Housing Form and Development. In: Wong, TC., Yuen, B., Goldblum, C. (eds) *Spatial Planning for a Sustainable Singapore*. Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-6542-2_8

- Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics*, 54(1-3), 159–178.
- Lee, E. W.-Y. (1998). The political economy of public sector reform in Hong Kong: The case of a colonial-developmental state. *International Review of Administrative Sciences*, 64(4), 625–641.
<https://doi.org/10.1177/002085239806400406>
- Lee, S. A., & Qian, J. (2017). The Evolving Singaporean Welfare State. *Social Policy & Administration*, 51(6), 916–939. <https://doi.org/10.1111/spol.12339>
- Low, L. (2001). The Singapore developmental state in the new economy and polity. *The Pacific Review*, 14(3), 411–441. <https://doi.org/10.1080/09512740110064848>
- Lye, L.-H. (n.d.). *Public Housing In Singapore: A Success Story In Sustainable Development*. 21.
- Mohan, M., & Phua, R. (n.d.). *GE2020: PAP wins with 61.24% of vote; WP claims two GRCs including new Sengkang GRC*. CNA. Retrieved 4 March 2022, from <https://www.channelnewsasia.com/singapore/ge2020-general-election-final-result-pap-wp-952471>
- Mukhopadhyaya, P. (2014). *Income Inequality in Singapore*. Routledge.
- Nau, B. (2014). *Notes on the random walk model*. 19.
- OECD (2015), *In It Together: Why Less Inequality Benefits All*, OECD Publishing, Paris.
- Tan, T.K.J., Wong, TC. (2008). Public Housing in Singapore: A Sustainable Housing Form and Development. In: Wong, TC., Yuen, B., Goldblum, C. (eds) *Spatial Planning for a Sustainable Singapore*. Springer, Dordrecht.
- Oswald, Andrew J. (1996) A conjecture on the explanation for high unemployment in the industrialized nations: part 1. Working Paper. Coventry: University of Warwick, Department of Economics. *Warwick economic research papers (No.475)*.

- Phang, S.-Y. (2001). Housing Policy, Wealth Formation and the Singapore Economy. *Housing Studies*, 16(4), 443–459. <https://doi.org/10.1080/02673030120066545>
- Phang, S.-Y. (2007). The Singapore Model of Housing and the Welfare State. In *Housing and the New Welfare State: Perspectives from East Asia and Europe* (p. 30). Taylor & Francis Group.
- Qiu, J. Z. (2020). The Visible Hand In Housing Market: Singapore's Housing Model And Its Implications On Hong Kong. *Joseph Wharton Scholars*, 46.
- Saguin, K. (n.d.). *No Flat, No Child in Singapore: Cointegration Analysis of Housing, Income, and Fertility*. 22.
- Schelkle, W. (2012). A Crisis of What? Mortgage Credit Markets and the Social Policy of Promoting Homeownership in the United States and in Europe. *Politics & Society*, 40, 59–80. <https://doi.org/10.1177/0032329211434690>
- Takats, E. (2010). Ageing and Asset Prices. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.1672638>
- Teo, T., & Kong, L. (1997). Public Housing in Singapore: Interpreting 'Quality' in the 1990s. *Urban Studies*, 34(3), 441–452. <https://doi.org/10.1080/0042098976069>
- Trading Economics. (2022). *Singapore Home Ownership Rate—2021 Data—2022 Forecast—1980-2020 Historical*. Trading Economics. <https://tradingeconomics.com/singapore/home-ownership-rate>
- Winarno, S., Usman, M., Warsono, Kurniasari, D., & Widiarti. (2021). Application of Vector Error Correction Model (VECM) and Impulse Response Function for Daily Stock Prices. *Journal of Physics: Conference Series*, 1751(1), 012016. <https://doi.org/10.1088/1742-6596/1751/1/012016>
- Zivot, E., & Wang, J. (2006). 12. Cointegration. In *Modelling Financial Time Series with S-PLUS* (2nd Edition, pp. 429–478). Springer.

Appendices

Appendix A: Unit Root Test

While the co-movement of time series may suggest a cointegrating relationship, we must first prove the presence of unit roots. Unit roots indicate that the time series are non-stationary but stationary at first difference. This is a necessary precondition for the employment of cointegration analysis, without which my analysis may be invalid (Johansen, 1991). Conducting a Phillips-perron unit root test found that all three time series are not stationary justifying the consideration of cointegration analysis. Performing the test on the first differences of each series found that they are stationary at first difference, fulfilling the precondition for a cointegration test.

This is indicated in Table 2 by a significance at the 10% level or below that we can reject the null hypothesis of non-stationarity. A Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test (Kwiatkowski–Phillips–Schmidt–Shin, 1992) was also employed as a secondary check of stationarity (Appendix A2). Hence, the Unit Root Decision for each variable is I(1), meaning they are not stationary at levels but stationary at first difference.

These results indicate the time series follow a random walk model which states that each difference represents a random step away from the value of the previous time period that is independently and identically distributed i.e. stationary (Nau, 2014). This supports the use of the Johansen cointegration test.

Table A1: Phillips-Perron Test on variables at first difference

Variable	Phillips-Perron Test	Unit Root Decision
HDB Price	0.0497**	I(1)
GDP per capita	0.06887*	I(1)
Top 10% Income Share	0.01***	I(1)

Note: ***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

Table A2: KPSS Test on variables at first difference

Variable	KPSS Test	Unit Root Decision
HDB Price	>0.1	I(1)
GDP per capita	>0.1	I(1)
Top 10% Income Share	>0.1	I(1)

Note: ***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

Appendix B: Robustness Check

Table B1: Robustness checks and decisions

Robustness Check	Hypothesis (H_0)	P-value	Decision
Portmanteau Test (asymptotic)	No serial correlation	0.2061	Not rejected at 5% level
Autoregressive conditional heteroskedasticity (ARCH) effects	No Arch Effects	1	Not rejected at 5% level
Jarque-Bera test for normality of residuals	Residuals are normally distributed	0.9646	Not rejected at 5% level

Appendix C: Forecast Error Variance Decomposition (FEVM)

In reality, the explanatory power of different variables are likely to overlap. Thus, the exact proportions of explanatory power may not be precise. What is of interest is the FEVD's capacity to let us roughly map changes in the variance decomposition overtime.

Figure C1 displays the Forecast error variance decomposition (FEVD) for the three variables. This tells us the share of one variable's variance that is explained by each variable over a 10 year horizon. We can see that changes in the Top 10% Income Share is increasingly explained by HDB resale prices. This suggests that HDB prices have a lagged effect in affecting the Top 10% Income Share. For GDP, we see a short-term effect of HDB resale prices on changes in GDP. This effect more or less stabilises in the longer-run. Meanwhile, Top 10% Income Share increasingly explains variations in GDP over the longer-run. HDB resale prices are increasingly explained by the Top 10% Income Share overtime.

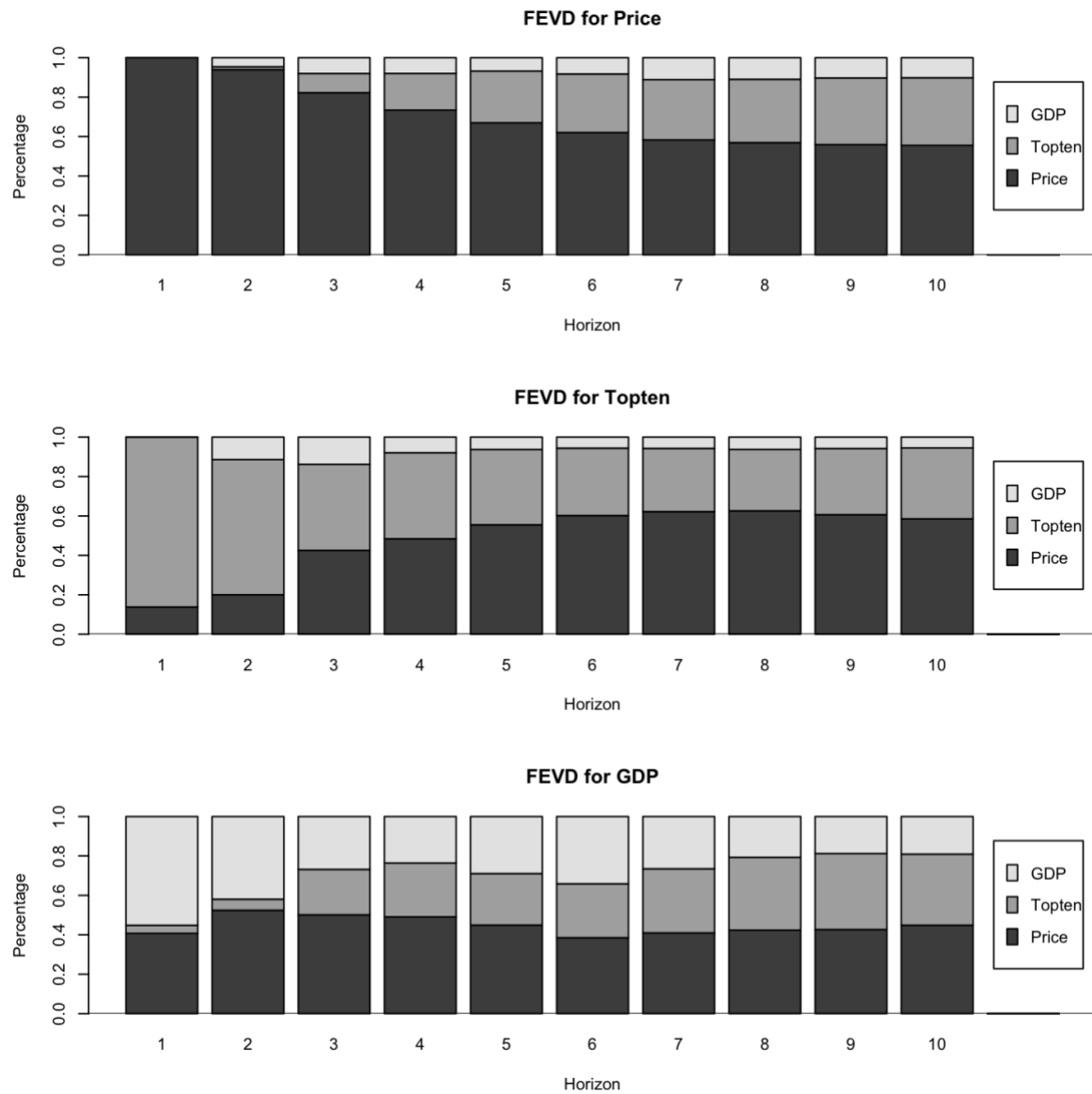


Figure C1: Forecast Variance Error Decomposition for HDB Resale Price Index, Top 10% Income Share and GDP per capita