Better Buildings in Japan
investigating the trade-off between longevity and cost

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Abstract

This paper sets out to describe the Japanese real estate market, describe the particular trait of fast depreciation of real estate assets and its causes as well as presenting a model that seeks to examine the trade-off between higher construction cost and longer service life in terms of the effect longer service life has on the market returns of the asset. The model will be tested in different scenarios related to both the type of asset, location as well as the nature of the depreciation regime as well as the period over which the asset is depreciated. By equating net returns from the same asset in with different depreciation models and periods, it is possible to calculate a multiplier, the $\phi$, to determine the extra cost incurred to reach the same amount of returns as the slowest depreciated asset. Results are ambiguous, however, as there is insufficient data points to do a simulation of a full depreciation period, and returns and variance on all assets are so low, that changes due to market variation are negligible meaning the $\phi$ is mostly the effects of the depreciation regime. That fact, however, is still valuable knowledge for professional investors in real estate, who needs to choose the depreciation method which in the short run is least detrimental to returns.
Chapter 1

Introduction

Energy conservation and effectiveness in almost all fields and industries are becoming increasingly important in the current world economy. Within the EU, several policies have been implemented to promote 'green' industries and energy forms, but Europe is not alone in this striving towards sustainability. The trend has manifested itself globally in several industries: Major car makers such as Toyota and General Motors compete in the market for hybrid cars, introducing models with ever increasing mileage and ever decreasing carbon emissions and purely electrical smart cars have seen their renaissance in the wake of the green tide. In the construction business, European electric giant Schneider Electronics vigorously markets their intelligent power conservation system for buildings, enabling owners and landlords to cut down power consumption by a significant amount and Danish window giant VKR is the originator behind the Activehouse project, which aims to construct model homes with a negative carbon footprint all around the world. This trend is true for Japan and Japanese industries in particular. The period leading up to the ongoing financial crisis and a political climate for the out-phasing of nuclear power
in Japan in the wake of the Fukushima incident has brought more and more attention, capital and business to corporations operating in the so-called 'green markets'. The potential is big in Japan. Anyone who have visited the Japanese metropolises will undoubtedly have noticed the cramped and shabby-looking housing, which comprises most of the housing stock. Karel Wolferen (1989) described the housing conditions in Japan as being in stark contrast to the perceived affluence of a country in rapid economic growth and Japanese people sometimes (dis)affectionately describe their dwellings as 'rabbit hutch', whose real value depreciation exceeds the rate of depreciation in terms of tax, resulting in a 'consumption good' nature of Japanese residential housing, where value loss is almost guaranteed. This can seem contradictory considering the blossoming real estate securitisation and investment industry, the low exposure to the American real estate bubble and therefore fall in demand for real estate, and Japan’s steady, albeit painfully slow, economic recovery.

Japan has been involved in the environmental movement started by the industrialised nations from its very beginning and has hosted the conference that led to the UN environmental protocol known as the Kyoto protocol in 1997 and the G8 summit in 2008 and is to this day a world leader of energy conservation, with a government providing subsidies for home-owners wishing to purchase an energy-efficient home or make improvements on the existing home to make it more energy efficient. Furthermore, in 2001, Japan changed legislation allowing for a prosperous real estate securitisation industry to blossom, which made investment in real estate more easily available. In the light of these things, it can seem strange that Japan still maintains an exceedingly wasteful housing market, where normal homes are demolished after only 30 years and annual construction starts are very disproportionate to the declining population growth. A market such as this in a country known for its adherence
to and enthusiasm for green solutions could very well present a market opportunity for companies specializing in sustainable construction and energy conservation solutions. In lieu of the giant earthquake in March 2012 large parts of the Northeastern coast have had their housing stock completely destroyed, which despite the catastrophic nature of the events, can provide an opportunity to improve on the quality of the housing stock.

1.1 Purpose of this paper

This paper wishes to explore and explain the aspects of Japan’s unique real estate market and furthermore test to what extent ‘green’ or ‘sustainable’ forms of construction with a longer service life is a remedy for the issues that the Japanese real estate market faces. As can be seen in Section 1.2, most of the current research literature in the field of Japanese real estate is centered around econometric models that estimates effects on both housing supply and demand from different factors, and while they on aggregate satisfactorily can describe the empirical findings on the current market, very few offer any solutions to the problems that the Japanese housing market face today. This paper seeks to investigate the traits of the Japanese housing market by analysing the findings of the several authors, who have already done research in the field, the consequences of the current state of the market for the consumers of housing and then look into the sources of its current state. Finally, it will determine the profitability of sustainable real estate on the Japanese housing market by analysing the trade-off between the higher construction costs of sustainable housing versus its longer service life in terms of market returns on the asset itself. The approach will be financial focusing on expected return of different
Japanese real estate assets, commercial and residential, in different scenarios relating to the depreciation of the asset then conclude upon how higher costs and longer service lives impact on market return. This approach will add a financial dimension with a focus on profitability and through this investigate whether higher quality housing is a solution for the current problems in the Japanese housing market. In short, this paper asks the questions:

Why and how is the Japanese real estate market different from other developed countries?

And further:

Is sustainable construction a remedy in terms of market returns?

1.2 Literature review

As this paper seeks to cover a lot of ground in determining the factors that has led to the current state of the Japanese housing market, the background literature selected for this paper spans from both sociological and economic literature from the period up to, during and after the bubble as well as technical reports and statistics that describes the current state of the market in numbers and figures. Additionally, the paper will draw on the conclusions of the econometric models of several authors, which has sought to identify effects related to factors such as legislation and subsidised mortgage loans. Several authors have addressed or sought to describe the issues of the Japanese
housing market. Koo & Sasaki (2008) writes about the short life cycle of Japanese housing, addressing the issues with legislation preventing efficient utilization of construction plots in Japan. The paper introduces what they refer to as a ‘wasteful cycle’, where legislation prevents efficient use of land in the major urban areas, which drives up land prices, which in turn leaves entrepreneurs with little money to construct a high-quality building, causing the building to last for only a relatively short period, further driving land prices up due to high demand for construction plots. The paper is mostly descriptive, but does conclude that there is a possible market for sustainable real estate in Japan that can break the cycle, and calls for a reform of legislation. Reference to the same laws are briefly mentioned by Cargill & Sakamoto (2008), which thoroughly describes the period leading up to the burst of the well-known Japanese real estate bubble in 1991 from both an economic theoretical and a political standpoint. The book describes the changes in the institutions providing oversight and monitoring in the Japanese sector, both political and business-affiliated, that lead to the flawed liberalisation of markets that subsequently created the bubble. Cargill and Sakamoto’s contributions are mainly historical; they describe the general relationship between businesses and state that allowed for large amounts of capital to flow into real estate without much oversight in a market strongly blinded by moral hazard. Describing the effects on the market in the bubble aftermath, Moriizumi & Naoi (2011) describes the housing market under the effects of the subprime crisis of America and constructs a model that estimates the timing of home ownership of younger households and the impact of the bubble of household tenure choice. They conclude that heightened income volatility and unemployment risk in the post-bubble economic situation in Japan affected especially young families, which impacted their home ownership rate negatively and
skewed them more towards renting. Iwata (2002) estimates the effects of the effects of the Japanese Tenant Protection Law (JTPL) on the Japanese rental housing market. He describes the general outlines of the law and estimates the effects of tenure lengths given different scenarios such as absence of the JTPL, and its implications for the rental housing in the Japanese market. He concludes that difficulties with evicting tenants and raising rents has a negative effect on the floor space of Japanese rental housing. His research is later continued by Seko & Sumita (2007), where they further explore the welfare effects of the impact of the JTPL. Seko (1993) has also studied the effects of the subsidised mortgage loan regime of the Japanese Housing Loan Corporation (JHLC) on the trade-off between quantity and quality of housing. With an econometric model, she estimates that home owners, who took out a loan with JHLC as opposed to a loan with a private mortgage provider, sacrifices floor space for quality.

1.3 Structure

The second chapter is an analysis of the Japanese real estate market and the state of the current housing stock found in Japan. Descriptive statistics related to the real estate market will be introduced and several causes to the current state of the market based on the economic analysis of several authors will be presented. Based on these, the paper will identify biggest factors leading to the current state of the Japanese real estate market and then look into the consequences for consumers of housing in the Japanese market in a user cost framework vis-a-vis consumers of housing in a Western market.

Chapter three gives a brief description of the data used in model described in chap-
1.3. STRUCTURE

Chapter four will introduce and describe the model that measures the trade-off between construction with a longer service life and the extra construction cost and simulations are then run using data from different Japanese real estate assets. After the simulations, Conclusions will be made on how each asset fare given different depreciation regimes and how much extra cost a consumer of housing, private or professional would have to incur to reach the same level of return.

Chapter four will contain the conclusion and final comments.
Chapter 2

The Japanese real estate market

2.1 Introduction

This chapter seeks to provide a historical overview of the development in the Japanese real estate market as well as supplying relevant data and information about real estate sectors in Japan in terms of figures and data from reliable sources, official and otherwise. The two sectors in question are residential and commercial, with industrial real estate being included in the commercial analysis.

2.2 The Heisei bubble of 1991

The Japanese real estate market faced expansion at an increasingly fast rate as the growth rates of the Japanese economy increased its pace during the sixties and seventies and stayed seemingly consistently high even after the oil shocks. The growth in the demand for real estate was fuelled partly by the ongoing economic growth, which lead both to increased wealth and therefore housing demand from the Japanese pop-
ulation and the increasing inflow of foreign workers into the metropolises as more and more international companies set up operation in the city centres of Japan, and partly by the global liberalisation of the capital markets that came with the collapse of Bretton Woods and the advances in computers and telecommunication, which allowed for easier movement of capital across borders and increased the supply of capital within Japan.

2.2.1 Collapse of Bretton Woods and the Keiretsu system

While the collapse of Bretton Woods meant an end to the for Japan extremely export-favourable JPY 308 / USD 1 exchange rate (as per July 20th 1971) to a floating currency regime, it did not significantly hamper the Japanese economic growth. Liberalisation of capital markets in Japan, gave corporations access to capital that in terms of liquidity were cheaper compared to the traditional bank financing through the Japanese keiretsu banks, where corporate creditors were required to deposit large compensating balances within the lending bank as a part of the cost of borrowing. In an attempt to regain market share, the keiretsu banks started to diversify their loan portfolios and expanded into consumer and mortgage credit through subsidiaries known as jusen, with, especially agricultural, credit co-operatives later joining the jusen industry as well (Cargill & Sakamoto (2008)). Equity and land prices, especially in Tokyo, however, started to grow at very rapid rates during 1985 and 1986, and by 1988 exhibited all signs of an asset bubble; a bubble that after its breakdown would become known as the Heisei real estate bubble of 1991, after the current Japanese emperor.
2.2.2 Monitoring and moral hazard

The corporate system in Japan before the bubble were of a very non-transparent nature compared to the open disclosure system of the Western world and risk monitoring relied on mainly two institutions: The role of the before-mentioned keiretsu banks as well as the relations of the amakudari system:

The Keiretsus were the post-war remnants of the highly diversified zaibatsu conglomerates that were made illegal and dissolved by the American occupational forces at the conclusion of the second world war. The new keiretsu consisted of a group of corporations centered around a single bank that provided them with the majority of their capital needs and held large amounts of their client companies’ stock as to prevent hostile takeovers and solidify the long-term relationship between bank and client (Gerlach (1992)). Because of the very one-sided nature of the bank financing and equity holdings, the keiretsu banks were able to accurately assess the risk of the undertakings of their client companies.

The Amakudari system is the Japanese name (translates to ’descending from heaven’) for the practice of cycling retiring government bureaucrats into the boards of large Japanese corporations. This practice creates a strong informal tie between businesses and state, enabling the Japanese government through Ministry of Trade and Industry to exact its influence over the development of the Japanese economy according to its plans and act on any signs of anomalies in the economic growth.

Despite having underwent a perceived financial liberalisation, no meaningful financial disclosure system existed to provide risk monitoring and financial statements from Japanese companies provided very little useful information for outsiders and risk monitoring were still very much dependent on the knowledge of the keiretsu banks and informal relations between corporate leaders and bureaucrats through
the amakudari systems (Gerlach (1992); Cargill & Sakamoto (2008)). However, as corporations increasingly took up credit abroad, often with a much higher risk profile, with which Japanese businesses had little experience, while operating in the home market, where the implicit assumption of unconditional bail-out by either the government or other market players were prevalent, while the banks increasingly engaged in asset and liability diversification, the system, rather than providing market guidance, created a strong moral hazard. This was especially prevalent in the jusen industry, where the agricultural credit co-operatives that were outside the amakudari system came to provide half the funds and hence large amounts of capital flowed into the real estate market without much oversight.

2.2.3 the relationship between lending, equity prices and real estate prices

Widespread use of land and real estate as collateral and the extensive cross-shareholding between corporations in the keiretsu system helped solidify and perpetuate the relationship between land prices, equity prices, bank capital and bank lending. This circular relationship came to play a key role in the asset inflation that became the Heisei bubble. The relationship were further strengthened in 1988 with the Basel I asset requirements, where Japanese officially successfully argued that part of the hidden reserves held by banks in the form of their extensive holdings of corporate shares should be included as a part of the bank’s official capital in computing risk-adjusted capital asset ratios. Ultimately, Japanese banks were allowed to include 45 percent of their hidden reserves in tier 2 capital in order to meet the 8 percent risk-adjusted capital requirement. The institutionalisation by Basel ensured that
higher equity and real estate prices would generate more lending; lending would increase corporate profits and therefore equity and real estate prices, which again would increase bank lending, and so on. The relationship between land and equity prices is evident when looking at Figure 2.2 up through the bubble period.

Cargill & Sakamoto (2008) describes the bubble the bubble taxonomy created by Minsky (1982). Minsky’s bubble follows four steps: Displacement, irrational exuberance, speculative access and liquidation. The change in fundamentals that was the liberalisation of the Japanese financial markets led to a displacement (that is, the 1985-86 jump) in real estate prices in Tokyo and some parts of Osaka above their historical trend due to increased foreign demand for Japanese urban real estate.

The irrational exuberance period is the onset of the bubble development, where prices depart from the prices determined by normal fundamentals and the expectations of consumers and investors are no longer founded in any economic arguments.
Figure 2.2: Relationship between land and equity prices in the period up the the bubble (European Central Bank Statistical Data Warehouse homepage (2012); Statistics Bureau of Japan homepage (2008))
Correlation coefficient = 0.7767
In Japan’s case, the self-reinforcing nature between equity, land prices and bank lending contributed to the bubble, as expansionist monetary policy from the government and likewise lenient lending policies from the banks fuelled - and was fuelled by - consumer demand. Especially the agricultural credit cooperatives in the newly liberalised financial market pursued aggressive portfolio diversification though highly speculative real estate assets, which contributed greatly to the inflation of real estate value in the last half of the 1980’s.

Speculative excess is the phase, where rational observers recognise prices as inflated and unsustainable, but herd behaviour by investors continue to push up prices at an even faster pace than in the irrational exuberance period, even though most investors know an asset crash is imminent. The liquidation phase was instigated by the Bank of Japan, who was growing increasingly concerned about the inflated real estate and equity prices as well as the growing rate of inflation. Despite opposition from the Ministry of Finance, the Bank of Japan raised the discount rate from 2.5 to 3.25 percent on May 1989 and later to 6 percent in August 1990. The Nikkei 225 index hit its high water mark in January 1990 at a value of 38.922, after which equity and land prices began its unprecedented decline, marking the end of the Heisei bubble. As of June 2012, the Nikkei 225 index value is 8.655, or 22 percent of its high watermark value.

2.3 Residential Real Estate

2.3.1 Statistics

As of 2008, the housing stock in Japan consisted of 49.598.000 individual residential housing units in total in with 94.13 square meters per dwelling on average (Statistics
Bureau of Japan (2008)), which is relatively little compared to many other industrialised countries. While the data shows an upward trend, the trend peaked in the 2003 survey, the 2008 census showed a small fall in floor space:

<table>
<thead>
<tr>
<th>Census year</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>85.92</td>
</tr>
<tr>
<td>1988</td>
<td>89.29</td>
</tr>
<tr>
<td>1993</td>
<td>91.92</td>
</tr>
<tr>
<td>1998</td>
<td>92.43</td>
</tr>
<tr>
<td>2003</td>
<td>94.85</td>
</tr>
<tr>
<td>2008</td>
<td>94.13</td>
</tr>
</tbody>
</table>

Table 2.1: The average floor space of a Japanese housing unit (Statistics Bureau of Japan (2008)).

The housing stock in Japan is relatively new compared to the housing stock in many European countries with a large number of construction starts annually despite a declining population (see Figure A.1). This is related to the quick depreciation of value of most Japanese residential real estate assets, where houses are essentially durable consumer products with a complete depreciation of value after tax after 15 years and termination of service life and subsequent demolishing after 30 years (Koo & Sasaki (2008); Hirayama & Ronald (2007)).

Japan boasts despite her prolonged economic stalemate after the Heisei bubble burst in 1991 a relatively large house ownership rate of 61.1 percent in 2008 (Statistics Bureau of Japan (2008)) and a large part of the housing stock being privately owned, relative to rental and public housing. Historically, the high rate of ownership can be attributed to the Japanese Housing Loan Corporation, who after the war and up until recent provided mortgage loans with low fixed interest rate to the Japanese public. Conversely, providing subsidised public housing were never a target for the
2.3. RESIDENTIAL REAL ESTATE

<table>
<thead>
<tr>
<th>Ownership type</th>
<th>no. of households(x1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owned</td>
<td>30.316</td>
</tr>
<tr>
<td>Public rental</td>
<td>3.007</td>
</tr>
<tr>
<td>Private rental</td>
<td>15.689</td>
</tr>
<tr>
<td>Other</td>
<td>1.605</td>
</tr>
<tr>
<td>Total</td>
<td>49.598</td>
</tr>
</tbody>
</table>

Table 2.2: Ownership breakdown of Residential housing in Japan (Statistics Bureau of Japan (2008))

Japanese government and as per 2003, public rental housing only consisted of 6.7 percent of the total housing mass (Hirayama & Ronald (2007)). As for rental housing, Japanese corporations have traditionally played a significant role in supplying affordable rental housing to employees. The ownership breakdown of Japanese residential housing is described in Table 2.2.

Japan’s metropolitan areas and Tokyo in particular suffer from extremely high housing prices when measuring price per square meter. At the peak of the bubble, Japan’s total land value were more than three times that of the US, with the price of a new home in Tokyo averaging at 7.7 times (4.4 times for Japan in general) of an average Japanese income (Kanemoto (1997)). While land prices have decreased significantly in the period after the bubble, housing prices in Japan remain at a very high level in international comparisons. As a consequence of the high prices, younger families stuck in the lower income levels of the largely seniority-based Japanese income system are largely barred from the housing market and ownership housing consumption pattern is skewed towards older families close to the period of retirement, where Japanese workers on average are paid better than their Western counterparts and can look forward to large retirement bonuses (Ohtake & Shintani (1995)). A strong culture of homes staying within the family through inheritance does, however, help to boost home-ownership for lower income groups as well. In
2008, 7.2 million Japanese homes were acquired by inheritance or grant (Statistics Bureau of Japan (2008)). The high land prices have naturally also manifested itself in rental prices, where Tokyo ranks consistently high in costs of renting when compared with major metropolitan areas in other industrialised countries.

### 2.3.2 Consequences of the 2011 earthquake

The great earthquake that ravaged Japan the 18th of March 2011 also had profound effect on the Japanese housing market in the North-eastern Japan. The physical damages on the housing stock in the affected areas can be seen in Table 2.3.

<table>
<thead>
<tr>
<th>Damage</th>
<th>Buildings affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full collapse</td>
<td>129,404</td>
</tr>
<tr>
<td>Half collapse</td>
<td>255,737</td>
</tr>
<tr>
<td>Totally or partially burned</td>
<td>281</td>
</tr>
<tr>
<td>Inundated above floor level</td>
<td>20,434</td>
</tr>
<tr>
<td>Inundated below floor level</td>
<td>15,513</td>
</tr>
<tr>
<td>Partially damaged</td>
<td>702,439</td>
</tr>
</tbody>
</table>

**Table 2.3:** Damages of the 2011 great Tohoku earthquake (National Police Agency of Japan (2011)). Affected prefectures: Hokkaido, Aomori, Iwate, Miyagi, Yamagata, Fukushima, Tokyo, Ibaraki, Tochigi, Gunma, Saitama, Chiba, Kanagawa.

The partial meltdown of three reactors at the *Fukushima Daiichi* nuclear power plant hit the Fukushima and neighbouring prefectures especially hard due to fears of radiation hazard and while the earthquake caused subdued demand for real estate in general due to lacking consumer confidence, the largest negative effect is in the condominium sector, where heightened awareness of risk factors such as elevator breakdown caused a slump in demand for high-rise condominiums in the Tokyo area (Matsumura (2011a)). However, as corporations quickly relocated away from the disaster-stricken areas (which includes Tokyo), demand for rental housing in other
large metropolitan areas, such as Osaka and Fukuoka, rose sharply. Expatriates in the Tokyo area temporarily returned home with their families when the disaster struck and returned later alone, which lowered demand for family-size rental units in the Tokyo area (Matsumura (2011a)).

2.4 Commercial Real Estate

2.4.1 Market

While the high water mark of the Japanese economy was in the 80’s and the attention today mostly is on the high-growth economies elsewhere in East Asia, the Japanese metropolises in general and Tokyo in particular are still home to branch offices of several international corporations, among whom many still use Japan as a base for their East Asian operations. The Japanese office sector has managed good rates of yearly return nearing 15 percent in the years up to the economic crisis and while the sector, like office sectors in similar countries, yielded negative returns in the years following the crisis, the sector has been able in recover and yielded a small positive return in December 2011 (IPD (2011)). Additionally, the market for commercial buildings saw comparatively good times in 2010 with the highest number of commercial real estate transactions after London, as the Japanese economy continued to grow due to continuous external demand and a favourable credit market towards real estate projects (research RREEF (2011)). Vacancy rate for office real estate in the five central Tokyo wards has gone from less than five percent in the years just prior to the crisis to around eight percent at the end of the first quarter of 2011 due to the slowing global economic activity, the adverse effects of the 2011 Tohoku earthquake and an imminent surge of new office supply expected in the period
2011-2012. Vacancy for newly constructed buildings is at a higher level levelling at around 20 percent in the same period (research RREEF (2011)).

2.4.2 Longevity

The commercial real estate stock in Japan generally has a longer service life than their residential counterparts. As requirements to fire safety and earthquake durability are higher for high-rise buildings and the choice of construction materials differ from the, mostly wooden-framed, two-floor homes, write-down periods are much longer for commercial real estate. After e-mail correspondence with representatives from several J-REITs, it has been made clear that tax code allows for a 60 year depreciation period on building assets, however, while some REITs seem to follow the tax code in terms of asset depreciation in the internal accounting, REITs not choosing to do so bases depreciation periods on construction material, some reporting the service life of a building constructed from reinforced concrete to be 46-50 years, while buildings with a steel structure has a service life of 30-40 years (email correspondence 1 (n.d.); email correspondence 2 (n.d.); email correspondence 3 (n.d.); email correspondence 4 (n.d.)).

2.4.3 Consequences of the 2011 earthquake

Office buildings in Tokyo escaped mostly unscathed from the earthquake, and while the aftermath of the earthquake and later the crisis related to the Fukushima nuclear power plant caused companies to temporarily relocate their activities to unaffected areas, the office market in Tokyo was expected to rebound in the end of 2011, and vacancy rates for office buildings in the Tokyo areas did indeed begin to im-
prove in the fourth quarter of 2011. Also, a survey concluded that new prospective commercial tenants have a growing concern for and focus on quake-resistance and quake prevention. The land prices in the Tokyo districts remained unchanged after the earthquake, excluding Shinjuku that experienced a fall in prices after the earthquake. In Chiba prefecture, areas strongly contaminated by fallout from the Fukushima incident experienced widespread liquefaction, which resulted in severe price drops in the area (Matsumura (2011b)).

2.5 Institutions in the Japanese real estate market

2.5.1 The Japanese government and Japanese Housing Loan Corporation

The Japanese government has made a continuous effort to promote home-ownership in Japan. The most concrete result of this is the public mortgage loan institution known as Japanese Housing Loan Corporation (JHLC). The JHLC was established in the 1950’s to provide stable financing and promote improvement of the housing standards amongst the largely devastated housing stock the second world war left in its wake. The JHLC worked through a commission system, where private actors would be in charge of the business of lending as well as the collection of debts. Through this system, holders of JHLC mortgage loans were able to manage their loan as well as make the payments in their local bank branch (Yasuko (1998)). In 2002, 40 percent of the total mortgage debt issued in Japan was issued by the JHLC (JPY 66 trillion out of JPY 184 trillion) (Konishi (2002)). The JHLC provided long-term
loans with a maximum repayment period of 35 years for up to 80 percent of the value of the house with interest rates fixed at low rates with favourable rates for seniors and loans taken out for the construction of energy-efficient housing (Konishi (2002); Yasuko (1998). Size also had an effect to determine the interest of the loan (Yasuko (1998); Seko (1993)). Due to a reform in 2001 aimed at streamlining government expenditure, it was decided that the JHLC was to be abolished within five years and loan origination from JHLC to be gradually reduced from 2002. The abolishment was finalized per April 1st 2007 (Konishi (2002)). The JHLC contributed heavily to create a Japanese society centered around home-ownership, with linking home-ownership to wealth and creating a housing culture, where progression from rental housing to owner occupied housing was a preference (Hirayama & Ronald (2007)).

2.5.2 J-REITs

The Japanese market for real estate securitisation is fairly new compared to the United States and Western Europe. The first two Japanese real estate investment trusts launched in 2001 with a market value of JPY 240 million. After three years, the number of publicly listed J-REITs had reached 13 and the market value had grown to exceed JPY 1.5 trillion (Sawada (2004)). As of 2012, the number of listed J-REITs has reached 34 with a total market value of JPY 2.94 trillion (ARES (2012)). J-REITs come in two types: specialized J-REITs with property portfolios of a single sector and general J-REITs with mixed portfolios. While it is true that the J-REIT portfolios cover all sectors to some extent, the preferred real estate asset held by the J-REITs are predominantly office assets with location in the Tokyo metropolitan area (see Figure A.2).

Rather than providing loan services to prospective home-owners, the REITs offers
real estate securitisation services, which makes it possible for investors interested in
real estate as an investment asset to invest in real estate portfolios with relatively
little capital; something that was only possible for larger institutional investors in
the market prior to securitisation. The risk factors of real estate investment is not
only sector-specific (e.g., residential vs. retail) but also location-specific, (Chinloy
& Cho (1997)) and as with exchange traded funds in the raw material sector, the
J-REITs offers diversified portfolios both in terms of location of assets and in sector
affiliation. The Heisei bubble collapse in 1991 brought real estate risk to the atten-
tion of corporate Japan and as many corporations in Japan still held on to real
estate assets a long time after the crash, the J-REITs initially faced a market with
access to a large number of cheap (largely commercial) real estate assets of rela-
tively high quality and a financing structure that made it possible for the J-REITs
to raise large amounts of cheap capital from numerous investors rather than relying
on traditional bank financing (Sawada (2004)).

Real estate securitisation as undertaken by the J-REITs work as follows: The
originator transfers real estate to a bankruptcy remote vehicle, known as the ’special
purpose entity (SPE)’ while implementing control functions on the asset in order to
maintain its creditworthiness. Investment products with a much greater liquidity
than the highly illiquid underlying real estate assets, such as negotiable securities,
are then issued backed by the real estate assets and the cash flow they generate.
The process of transforming the asset into one of greater liquidity is known as ’as-
set monitisation’. Bankruptcy remoteness of the SPE is essential for ensuring stable
cash flows to the investors even in the case of the bankruptcy of the originator, which
otherwise potentially could mean a liquidation of one or more underlying assets that
the investor would be unable to control or benefit from. The securitisation vehicle
operates under specific securitisation laws that enable dividends to be recognised as expenses providing certain conduit criteria are met, so as to avoid double taxation of investor return. The real estate securitisation products will commonly include a form of credit enhancement to increase credit worthiness or meet specific demands of investors. Internal credit enhancement can utilise the cash flow of the securitised asset; these include split capital structures with preferred and subordinate securities granting different levels of access to cash flows and losses. Also on the debt side, can preferred/subordinate structures be found and depending on the organisational structure, debt holders can be subordinate to equity holders, which is normally not the case. Despite Japan’s corporate history of largely redundant disclosure to shareholders - or maybe because of it - the J-REIT industry strives to provide a rigorous system of disclosure to provide sufficient information to prospective investors (ARES
2.5.3 Japanese banks

Traditional banks in Japan also hold real estate portfolios and mortgage provide loan services for the general population. As described in Section 2.2, Japanese banks did, through the jusen industry, manage extensive real estate portfolios in the period leading up to the bursting of the bubble. However, interest rate constraints on mortgage loans lasting until 1994 made it hard for private banks to compete with the JHLC in that market (Yasuko (1998)) Furthermore, the Heisei bubble resulted in a dramatic increase on focus on real estate asset risk and the traditional banks have since then tried to minimize their exposure to real estate; a trend that has no doubt been strengthened under the current crisis, which is also rooted in real estate assets and instruments. The desire to reduce real estate risk has meant a reduction of real estate portfolios and housing loan portfolios, which has meant tightening of credit for housing loans to the general population. However, the out-phasing of JHLC has left the whole mortgage financing market to the banks and loans are still being provided.

2.6 The longevity issue of Japanese housing

2.6.1 introduction

Despite the concentrated efforts by JHLC to promote higher quality housing in Japan, the general residential housing stock is generally of a lower quality with, according to Koo & Sasaki (2008) a complete depreciation of value after 15 years,
compared to houses in the Western world that are usually worth more than they cost to acquire after complete depreciation for tax purposes.

Where residential real estate in most other industrialised countries are considered dual goods in terms of possessing the attributes of both a consumption and an investment good, most residential real estate in Japan, both houses and condominiums, lose the investment good quality due to their quick depreciation of value. Koo & Sasaki (2008) describes that the negative consequences of the fast turnover cycle in the Japanese real estate market was less felt in the high growth period, as the depreciation in the value of the house was more than offset by the appreciation of value of the land it was built on. After the bubble, land prices in Japan entered a steady decline that did not level out until 2005, and in this period Japanese homeowners was enduring the double torture of both declining values of both land and home.

This chapter will analyse the effects the different actors and institutions in Japan have on the factors affecting the Japanese real estate market such as the choice of housing and financing.

2.6.2 user costs

Koo & Sasaki (2008) argues that the fast depreciation of value means that Japanese home-owners in most cases cannot resell their house at a profit and therefore are barred from building 'wealth on top of wealth' through home-ownership, Lunde (1998) disputes this argument. He argues that increases or decreases in real estate value on aggregate cannot affect the wealth of home-owners at all. Lunde’s argument follows the logic that net profits from real estate consumption can only be generated
by selling off your current real estate and acquiring a cheaper one. However, this 'trading down' is offset by prospective buyers, and home-owners, who wish to 'trade up' to a more expensive home, as they will have to endure additional expenses in a rising market. Wealth generated in the real estate market can only be realised on aggregate, if real estate is sold off to foreign investors, which is unrealistic on a large scale. On a more general consumption level, increasing house prices will mean an increase in the cost of housing consumption relative to other components of the consumption basket, which given finite wealth will mean less consumption of other components.

In order to determine the effects of value depreciation of the housing stock on the wealth of its home-owners, it is necessary to find a framework that not only looks at the actual loss of asset value that the investor (eg. the home-owner) incurs, but all the factors within the actual price of house consumption. To this end, Lunde (1998) introduces a definition of housing consumption costs that includes the opportunity costs of investing in a real estate asset called user cost.

For rental housing, user costs are equivalent to the monthly rent, except for the deposit done at the onset of the rental period and possibly any adjustments later made, or rent paid in advance. This capital does not normally generate any return and its opportunity cost should therefore be excluded from the equation. As this analysis focuses on the alleged loss of wealth for home-owners due to the characteristics of the Japanese real estate market, no further focus will be given to the user costs of rental housing.

User cost for owned housing is defined as all costs involved with housing consumption services, be it ownership or rental, excluding the costs, such as utilities, that to a significant extent are explained by variables exogenous to housing. The user cost
expression for owned housing is includes three variables:

*Depreciation of value, opportunity cost* of the invested capital and the *value appreciation discount factor*.

*Depreciation of value* could also be called the *real capital consumption* and defines the depreciation of value due to wear, tear and obsolescence in the period of consumption.

*opportunity cost* is defined as the net return that could have been achieved through an alternate investment of the capital with the same risk profile.

The *value appreciation discount factor* covers the trend of real estate assets of unchanged quality tend to rise in value proportionate with the general rise in price levels. Combined, the three factors can formally be described in the following expression, which excludes financing factors:

\[
uc_t = K_t (d_t + q_t + a \cdot T_{g,t} + e_t + i_t \cdot (1 - T_t) - p_{re,t})
\]  

(2.1)

Where \(K_t\) is the average market value of the real estate asset in period \(t\), \(d_t\) is expenses related to administration, operations and maintenance, \(q_t\) is the depreciation rate, \(a \cdot T_{g,t}\) is the land tax factor with \(a\) being the fraction of value of the property of the total value of the real estate asset, \(e_t\) is the the property value tax rate, \(i_t \cdot (1 - T_t)\) is the net opportunity cost of capital, where \(i_t\) is the nominal return for an asset with a similar risk profile and \(T_t\) is the relevant capital gains tax rate. Finally, \(p_{re,t}\) is the rate of price appreciation for the real estate asset in the period given no change in the quality of the asset, something which is usually the case in Western countries, which is subtracted to give the value appreciation
discount factor. The comparative example used here is user costs for Danish owned housing, as defined by Lunde (1998).

As mentioned briefly above, Equation 2.1 does not take into account factors related to financing. Several factors related to the use of owned capital versus borrowed capital in the financing and the opportunity costs and expenses related to both could, and indeed should, be included in the final expression, if one seeks to give an accurate picture of user costs related to home-ownership. Initially, however, the author wishes to determine the effects of the depreciation factor on the user costs of home-owners and financing is therefore held constant for now.

2.6.3 user costs in the Japanese case

While the quick depreciation of Japanese housing is covered in the depreciation factor, Japan has since the Heisei bubble burst in 1991 experienced falling land prices, and while the decline seemed to flatten in 2005, prices remained stagnant under the boom and saw further decline under the ongoing financial crisis (see Figure A.3). This environment is opposite to most Western economies, where a rise in real estate prices (e.g., the combination of land and building values) is expected. Based on the current situation in Japan, it therefore makes sense to change the operator in the discount factor. As described in Koo & Sasaki (2008), depreciation of value in a typical Japanese house happens within fifteen years, after which the value of the house is indistinguishable from the value of the land on which it is built. Therefore, it should be expected, that $q_t$ should hold a higher value in the Japanese example, e.g.:
To make this clear, the depreciation factor is denoted \( Q_t \) in the Japanese example. Additionally, local Japanese authorities when calculating the basis for taxation for most buildings set the value of the building itself at zero, essentially fixing \( a = 1 \) (Koo & Sasaki (2008)). Summing up, the Japanese user cost expression is as follows:

\[
uc_t = K_t(d_t + Q_t + 1 \cdot T_{g,t} + e_t + i_t \cdot (1 - T_t + p_{r,t})) \tag{2.3}
\]

Effects on user costs are obvious: A higher rate of depreciation and therefore land being a rising fraction of total value, results in higher user costs due to value loss and higher taxation along with a negative value increase to discount. User costs for a Japanese home-owner will almost certainly be higher.

### 2.6.4 Financing

The financing part of the user cost expression shifts focus from the asset side to the liabilities side of the home-owner’s budget and helps to link the term user costs with the term housing expenses. Financing of any asset can be done either by utilizing net capital or borrowed capital represented in the expression by \( E \) and \( F \), taken from the Danish ‘Egenkapital’ and ‘Fremmedkapital’ respectively. Costs for owned capital(\( E \)) is, as above, its net opportunity cost. Danish tax code allows for a discount on the effective interest rate of a mortgage loan, which makes the opportunity cost of borrowed capital \( F \) the interest, and thereby interest discount,
of an alternative loan with equal risk profile. Adding the above to the expression, it becomes as follows:

\[
uc_t = E_t \cdot i_{E,t} \cdot (1 - T_{E,t}) + F_t \cdot i_{F,t} \cdot (1 - T_{F,t}) \\
+ K_t(d_t + q_t + a \cdot T_{g,t} + e_t + i_t \cdot (1 - T_t)) - pre,t
\] (2.4)

In lieu of allowing for tax deduction of mortgage loan interest, the Japanese tax code allows for an income tax discount of 1.0-1.2 percent in ten years depending on factors such as requirements to fire safety and quake resistance and minimum floor space of the house for which the mortgage loan is taken out. Alternatively, a similar discount can be given for five years for home-owners taking out a loan for home improvements that involve energy renovations (the Ministry of Finance Japan homepage (2012)). Therefore, the tax discount factor \( T_{F,t} \) on borrowed capital of the Japanese user cost expression is linked to the income of the house-owner \( inc \) in the period \( t \) (and therefore becomes \( T_{inc,t} \) and the tax discount \( T_{discount} \) in the same period) rather than the amount borrowed \( F_t \) and its interest \( i_{F,t} \). Formally, this gives a tax discount factor for borrowed capital as follows:

\[
F_t \cdot i_t - (inc_t \cdot T_{discount,t})
\] (2.5)

Inserted in the user cost formula, it becomes:

\[
uc_t = E_t \cdot i_{E,t} \cdot (1 - T_{E,t}) + F_t \cdot i_t - (inc_t \cdot T_{discount,t}) \\
+ K_t(d_t + Q_t + a \cdot T_{g,t} + e_t + i_t \cdot (1 - T_t)) - pre,t
\] (2.6)
The tax component of the opportunity cost on capital \((1 - T_{E,t})\) depends on the capital gains tax (if any) in the country in question. In Japan's case capital gains are taxed 10 percent in the case of listed shares and 20 percent in the case of unlisted shares, which is somewhat mid-range amongst the industrialised nations. The absence of tax deductibility of mortgage loan interest will raise Japanese home-owner user costs relative to countries, where that is the case. However, due to the ongoing economic stalemate, interest rates on most backed loan types has been held at a low interest rate level. The discount factor of borrowed finance in the Japanese case is of a different nature from the Danish expression, and to determine which one has the biggest effect is beyond the scope of this paper.

As described above, buildings with low service life due to fast write-down regimes along with a, so far, continuous depreciation of land values (see Figure A.3) are main contributors to a higher cost of housing consumption for Japanese home-owners. It raises the cost in terms of the loss of value in the real estate asset, both building and land, as well as its effect on property taxation.

### 2.6.5 JHLC influence on housing consumption

Seko (1993) argues that the JHLC has significant influence on housing choice of Japanese home-owners in terms of quantity/quality trade-offs. In her microeconomic one-period model, consumers obtain utility from from housing services \(h\), with housing stock denoted \(H\). In the model, it is assumed that \(h\) is proportional to \(H\) and are dependent on quantity \(F\) (e.g. floor space) and quality \(F\):
2.6. THE LONGEVITY ISSUE OF JAPANESE HOUSING

\begin{equation}
    h(F, I) = mH(F, I)
\end{equation}

where \( m \) is a constant.

At time \( t \) the consumer has income \( y_t \) and consumes other goods \( c_t \) at price \( p_t \) and a house at \( P_{Ht}(I)F \) with the unit price of housing \( P_{Ht}(I) \) being a function of \( I \). For financing, the house purchase is financed by either owned capital, capital borrowed from JHLC and/or capital borrowed from private institutions. The proportion borrowed from JHLC is denoted \( D \) at the subsidised rate \( \xi \) and the proportion \( \beta \) from private institutions at rate \( \zeta \) (where \( \zeta > \xi \)). The ratio of self-financing then becomes \( 1 - \zeta - \xi \). The consumer also pays property tax \( \tau \). At the end of the period, the consumer sell off the house at price \( P_{H0}(I)(1 - de)F \), where \( de \) is the rate of depreciation. The consumer also pays principal on the loans, \( DP_{H0}F \) for the JHLC loan, and \( \beta P_{H0}(I)F \) for the loan from private institutions.

Seko then estimates the budget constraints for consumers choosing to borrow only from private institutions or borrow from private institutions as well as some fraction from JHLC. For mixed financing, the budget constraint becomes:

\begin{equation}
    y_0 = p_0 c_0 + [\zeta + \tau + de - 0.8(\zeta - \xi)P_{H0}(\overline{I})/P_{H0}(I) - de \cdot \zeta]P_{H0}(I)F
\end{equation}

Where \( P_{H0}(\overline{I}) \) is the standard construction cost. \( 0.8 \cdot P_{H0}(\overline{I}) \cdot F \) denotes the JHLC credit constraint.
And by approximation:

\[ y_0 \approx p_0c_0 + [\zeta + \tau + de - 0.8(\zeta - \xi)P_{H0}(\bar{I})/P_{H0}(I)]P_{H0}(I)F \]  \hspace{1cm} (2.9)

For consumers, who borrow only from private institutions, the constraint becomes:

\[ y_0 \approx p_0c_0 + (\zeta + \tau + de)P_{H0}(I)F \]  \hspace{1cm} (2.10)

Combining the two budget constraints, Seko (1993) are able to construct non-linear budget constraints. By constructing an index for quality and quantity (that is, housing size) of housing, Seko measures through regression the effects of JHLC loans on housing consumption. She finds, that the simple correlation between F and I are negative for consumers, who took out and JHLC loan and positive for consumers, who did not, and later, when estimating the characteristic housing demand model, that price and income elasticities increases for JHLC borrowers as homogenous floor levels grow meaning that JHLC loans distorts housing choice towards higher quality housing at the expense of floor space. As JHLC has operated in Japan from 1950-2007, its influence can explain the relative low floor size of Japanese housing, but its positive effect on housing quality is somewhat contradictory to the arguments of Koo & Sasaki (2008) and findings. However, in the 50+ years of JHLC operation, the housing stock in Japan has almost certainly increased in quality, both due to the influence of the JHLC and general advances in technology. This does not have to mean, however, that the housing stock of Japan quality-wise is on par with the Western world as postulated by Koo & Sasaki.
2.6.6 The effects of the legal structure on housing consumption

Iwata (2002) and later Seko & Sumita (2007) argue that the Japanese Tenant Protection Law (JTPL), revised in 2000, had a major impact on the floor size of rented housing in Japan and is a major factor in distorting housing choice towards owned housing, despite its high price. Iwata argues that before its revision in 2000, it was almost impossible for landlords to refuse renewal of a tenancy contract that expires, if the tenant wishes to continue it without going to court and prove just cause. Additionally, while initial rents are determined freely in the market, rent increases must go through the courts if the tenant refuses to accept them, and would, even if approved formally by the courts, generally be at a lower level. Iwata then argues then that this framework leads to a lower supply of rental housing, which raises initial rents and ultimately decreases rental welfare. According to the authors, this effect manifests itself in lower floor areas for rental homes in Japan. Iwata then constructs a model that seeks to describe the economy with or without the JTPL as a two-period partial equilibrium model assuming perfect capital markets. The market consists of two types of players: Tenants $T$ and landlords $L$. The tenants are then divided into two types: the ‘contract renewal-type’, whose fraction of the tenants is denoted $N$ and the ‘non-renewal and moving-type’, whose fraction of the tenants is denoted $M$. Therefore $M + N = T$. Several scenarios such as the presence, or lack thereof, of the JTPL, landlord risk aversion or risk neutrality, and asymmetrical information about tenant type, are then run to test the effects. Iwata concludes that, assuming asymmetric information and risk neutral landlords, the JTPL reduces the floor space, and therefore utility of tenants with short tenure length, but increased
floor space for tenants with long tenure length. In the scenario of asymmetric information and risk neutral landlords, the presence of the JPTL has a negative effect on the floor space and utility of both long and short tenure tenants. Given symmetrical information, the JPTL has no effect on floor space.

Seko & Sumita (2007) back some of Iwata's data and arguments related to the size of rental housing, their model focuses on different factors such as marriage and steady income on housing choice (rental vs. owned).

Koo & Sasaki (2008) as well as Cargill & Sakamoto (2008) argues that restrictive legislation regarding allowable floor area and 'rights to sunshine' was a key factor in pushing up land prices, making land a larger part of the consumption basket for the prospective home-owner, meaning he would have to sacrifice both house quality and floor space in his housing consumption. The restrictive legislation also means that where other heavily urbanised nations, such as Singapore, build upwards when land becomes scarce, the average height of a Japanese house is only two and a half stories. Effectively, floor space becomes a substitute for land in this restrictive environment. This creates a vicious cycle, where regulation restricts floor area, which pushes up land prices, which in turn leaves less money for constructing high quality homes.

while not mentioning it, Koo & Sasaki (2008) and Cargill & Sakamoto (2008) refers to the City Planning act, which outlines the directives for construction zones in city or quasi-city planning areas. The law provides extensive guidelines for zoning of urban districts (the Ministry of Land Infrastructure Transport & Tourism Japan (2012)).
2.7 **summing up**

In this chapter the traits of the current Japanese real estate market has been described as well as the institutional, legal and historical factors that helped to shape it. To sum up, the Japanese real estate market is comprised of a residential housing stock with floor space much smaller than its Western counterparts and of relatively low quality, which affects home-owners negatively in terms of raising their user costs, due to higher user costs $q_t$ and land taxation $a \cdot T_{g,t}$. Commercial real estate, however, is comprised of assets with service lives more like those in Western markets, however.

The short service life of the Japanese residential real estate is a result of restrictively high prices of land, which left little capital for constructing a high-quality building, which again was a result of the legal structure, and the City Planning Act in particular (Section 2.6.6), where government subsidised mortgage loans made home-owners choose quality over floor space (Section 2.6.5). Floor space is on the other hand driven up by the government subsidisation of mortgage loans (Section 2.6.5), while a restrictive rental legislation has a negative effect on floor space for rental housing (Section 2.6.6). Despite JHLC’s almost 60-year long history of providing the majority of mortgage loans for the Japanese populace, its attempts of promoting sustainable construction through loan incentives has largely failed due to the strong influence of the legislation that governs construction rights, such as the City Planning Act.

However, by holding legislation constant, it still makes sense to research if real estate with a longer service life can provide investors with better returns than conventional Japanese real estate assets as this can provide lawmakers with a powerful incentive
to alter the legislation to support the construction of real estate with a longer service life. This model will be presented in chapter 4. The next chapter will briefly describe and introduce the data being used in the model.
Chapter 3

data

3.1 introduction

In this section, the data as well as the models for estimating the characteristics in the data, which are needed for comparing performance will be outlined. For the actual estimations, see Section 3.2 and Section 3.3 respectively.

3.2 residential data

The residential data are price indices constructed from real estate transaction price data in the time period first quarter 2006 - first quarter 2012 (25 observations) taken from the the Ministry of Land & Tourism homepage (2012). Each of the indices are location-specific and will each represent a real estate asset in the residential portfolio. The price indices have been chosen on the grounds that most of the price inflation in real estate assets appears in Tokyo, and therefore price indices from eight wards from the Tokyo metropolitan area: Adachi, Chuo, Koto, Meguro,
CHAPTER 3. DATA

Minato, Shinagawa, Shinjuku and Sumida ward, have been constructed, as well as a price index from Saiwai ward, Kawasaki city, which is a typical Tokyo suburb as well as Nada ward, Kobe city to represent a more rural area. These values have been turned into net returns in order to estimate performance (see Section 4.6 and Section 4.5).

Indices have been constructed by selecting a transaction in each time period with idiosyncratic characteristics as identical as possible, such as location, floor area, dwelling type, etc. and with year of construction as new as possible. Common for all observations is that only buildings or condominiums used exclusively for housing have been selected. For the indices in Koto ward and Saiwai ward transactions of land and building has been selected, whereas the indices from the Tokyo metropolitan area have been constructed from transactions of condominiums. Whenever possible, buildings or condominiums with year of construction within the same year as the same time period have been selected, however, in any case the first data point (first period 2006) will act as a proxy for construction price.

Distributional characteristics of the residential real estate assets can be seen in Table 3.1. Returns and variance are very low, probably due to the low number of observations as well as the state of the Japanese economy as well as the global financial crisis. Given a $\chi^2$-squared distribution with $\alpha = 0.05$ and two degrees of freedom, returns from all residential assets seem normally distributed (critical value = 5.99). However, the $\chi^2$-squared distribution is not very precise in case of small sample sizes such as these ones with only 25 observations in each, and therefore caution is advised in terms of accepting the hypothesis of normal distribution in the returns(Bowman & L.R. (1975)).
### Table 3.1: Characteristics of distribution and return for the residential real estate assets

<table>
<thead>
<tr>
<th>Asset location</th>
<th>average price (JPY)</th>
<th>average $m^2$</th>
<th>$\bar{\sigma}$</th>
<th>$\sigma^2$</th>
<th>S</th>
<th>K</th>
<th>JB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adachi ward</td>
<td>31.36 million</td>
<td>63.6</td>
<td>-0.064</td>
<td>0.027</td>
<td>0.55</td>
<td>5.11</td>
<td>5.88</td>
</tr>
<tr>
<td>Chuo ward</td>
<td>44.24 million</td>
<td>56.8</td>
<td>0.011</td>
<td>0.080</td>
<td>-0.25</td>
<td>2.14</td>
<td>1.03</td>
</tr>
<tr>
<td>Koto ward</td>
<td>34.48 million</td>
<td>61.2</td>
<td>-0.014</td>
<td>0.039</td>
<td>-0.30</td>
<td>2.47</td>
<td>0.66</td>
</tr>
<tr>
<td>Meguro ward</td>
<td>53.80 million</td>
<td>66.2</td>
<td>0.020</td>
<td>0.141</td>
<td>0.03</td>
<td>2.62</td>
<td>0.15</td>
</tr>
<tr>
<td>Minato ward</td>
<td>46 million</td>
<td>58.2</td>
<td>0.000</td>
<td>0.043</td>
<td>0.38</td>
<td>3.56</td>
<td>0.93</td>
</tr>
<tr>
<td>Nada ward</td>
<td>39.48 million</td>
<td>65.6</td>
<td>-0.007</td>
<td>0.041</td>
<td>0.25</td>
<td>2.32</td>
<td>0.75</td>
</tr>
<tr>
<td>Saiwai ward</td>
<td>39.56 million</td>
<td>59.6</td>
<td>-0.002</td>
<td>0.013</td>
<td>-0.91</td>
<td>3.46</td>
<td>3.74</td>
</tr>
<tr>
<td>Shinagawa ward</td>
<td>54.2 million</td>
<td>60.2</td>
<td>-0.009</td>
<td>0.078</td>
<td>0.23</td>
<td>1.95</td>
<td>1.36</td>
</tr>
<tr>
<td>Shinjuku ward</td>
<td>50.24 million</td>
<td>59</td>
<td>-0.008</td>
<td>0.033</td>
<td>0.01</td>
<td>4.47</td>
<td>2.27</td>
</tr>
<tr>
<td>Sumida ward</td>
<td>39.36 million</td>
<td>57.2</td>
<td>-0.011</td>
<td>0.033</td>
<td>0.08</td>
<td>2.37</td>
<td>0.44</td>
</tr>
</tbody>
</table>

#### 3.3 commercial data

The commercial data used is actual portfolio data from one of the top three J-REITs based on market cap. The portfolio consists of 63 buildings located mostly in the Tokyo metropolitan area; the choice of data is made on the same grounds as the choice for residential data, only with a commercial angle: The Tokyo metropolitan area houses a large part of the commercial real estate in Japan. The data used for portfolio simulation spans over ten years from 2002-2011 with biannual observations in March and September (20 observations) and is the 'property value as per appraiser' as recommended by Brown & Matysiak (2000) and because the book values already have been corrected for asset depreciation, these values are then turned into net returns in order to estimate performance (see ??). Out of the 63 assets in the portfolio, 17 assets have been selected for analysis, as the rest of the assets had incomplete data for the whole period. Names of the properties as well as the name of the J-REIT remain undisclosed for legal reasons. Distributional characteristics of the commercial real estate assets can be found in Table 3.2.
Table 3.2: characteristics of distribution and return for the commercial real estate assets

<table>
<thead>
<tr>
<th>Asset</th>
<th>location(city)</th>
<th>structure</th>
<th>$\overline{r}$</th>
<th>$\sigma^2$</th>
<th>S</th>
<th>K</th>
<th>JB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tokyo</td>
<td>S/SRC</td>
<td>0.013</td>
<td>0.003</td>
<td>0.188</td>
<td>2.53</td>
<td>0.29</td>
</tr>
<tr>
<td>2</td>
<td>Tokyo</td>
<td>SRC</td>
<td>0.003</td>
<td>0.001</td>
<td>0.341</td>
<td>2.12</td>
<td>0.99</td>
</tr>
<tr>
<td>3</td>
<td>Nagoya</td>
<td>S/SRC/RC</td>
<td>-0.008</td>
<td>0.001</td>
<td>0.492</td>
<td>2.35</td>
<td>1.10</td>
</tr>
<tr>
<td>4</td>
<td>Fukuoka</td>
<td>SRC</td>
<td>0.001</td>
<td>0.001</td>
<td>-0.394</td>
<td>3.39</td>
<td>0.61</td>
</tr>
<tr>
<td>5</td>
<td>Tokyo</td>
<td>SRC</td>
<td>-0.001</td>
<td>0.002</td>
<td>-0.609</td>
<td>3.66</td>
<td>1.52</td>
</tr>
<tr>
<td>6</td>
<td>Tokyo</td>
<td>SRC</td>
<td>-0.001</td>
<td>0.002</td>
<td>0.213</td>
<td>2.25</td>
<td>0.59</td>
</tr>
<tr>
<td>7</td>
<td>Tokyo</td>
<td>SRC</td>
<td>0.004</td>
<td>0.001</td>
<td>-2.16</td>
<td>8.89</td>
<td>42.15</td>
</tr>
<tr>
<td>8</td>
<td>Tokyo</td>
<td>SRC</td>
<td>-0.001</td>
<td>0.001</td>
<td>0.228</td>
<td>2.17</td>
<td>0.70</td>
</tr>
<tr>
<td>9</td>
<td>Saitama</td>
<td>S/RC</td>
<td>-0.014</td>
<td>0.002</td>
<td>0.651</td>
<td>3.27</td>
<td>2.27</td>
</tr>
<tr>
<td>10</td>
<td>Kawasaki</td>
<td>S/RC</td>
<td>-0.011</td>
<td>0.001</td>
<td>0.385</td>
<td>1.69</td>
<td>1.83</td>
</tr>
<tr>
<td>11</td>
<td>Sendai</td>
<td>SRC</td>
<td>-0.008</td>
<td>0.003</td>
<td>0.948</td>
<td>4.03</td>
<td>3.68</td>
</tr>
<tr>
<td>12</td>
<td>Osaka</td>
<td>SRC</td>
<td>0.026</td>
<td>0.025</td>
<td>-3.25</td>
<td>13.22</td>
<td>116.04</td>
</tr>
<tr>
<td>13</td>
<td>Osaka</td>
<td>S/SRC</td>
<td>-0.001</td>
<td>0.003</td>
<td>-0.037</td>
<td>3.03</td>
<td>0.01</td>
</tr>
<tr>
<td>14</td>
<td>Fukuoka</td>
<td>S</td>
<td>-0.008</td>
<td>0.001</td>
<td>-0.383</td>
<td>4.06</td>
<td>1.35</td>
</tr>
<tr>
<td>15</td>
<td>Tokyo</td>
<td>S/SRC</td>
<td>0.009</td>
<td>0.003</td>
<td>0.285</td>
<td>2.84</td>
<td>0.28</td>
</tr>
<tr>
<td>16</td>
<td>Kyoto</td>
<td>SRC</td>
<td>-0.022</td>
<td>0.002</td>
<td>-0.532</td>
<td>2.71</td>
<td>0.97</td>
</tr>
<tr>
<td>17</td>
<td>Kanazawa</td>
<td>SRC</td>
<td>0.029</td>
<td>0.016</td>
<td>-3.049</td>
<td>12.17</td>
<td>96.02</td>
</tr>
</tbody>
</table>

Returns and variance are generally very low, most likely due to the short number of observations, the more 'choppy' nature of the appraisal data and the generally anaemic development in Japanese land and real estate prices in the period. Given the same caveat for the conclusions about normality in the data as in Section 3.2, distributions of returns tend to be normal overall with low $S$ and $K$ figures, with a couple of striking exceptions: In both asset 7, 12 and 17, the JB figure is very high and hence the hypothesis of normality is rejected. A closer examination of the data shows that the distribution of both assets 7, 12 and 17 are strongly leptokurtic and negatively skewed.
Chapter 4

The model

4.1 introduction

In the previous chapters this paper has sought to explore and discuss the Japanese real estate market and the factors that have led to its peculiar characteristics. Previous chapters have concluded that the many government policies that has sought to promote housing of a better quality have largely failed in the presence of the City Planning Act, which places great restrictions on how efficiently you can build on a given land plot and has helped to push up prices on land in central urban areas and raise user costs for normal house-owners as well as raising costs for commercial owners. However, in contemporary Japan, where green policies are gaining momentum in other fields such as power generation, garbage recycling, etc., it is possible that policy makers could be persuaded into changing the City Planning Act to accommodate real estate of a higher quality, if it can be shown that such real estate assets would be attractive investments over 'conventional' Japanese real estate assets. That is what this model sets out to test: This model wishes to test
the performance of Japanese real estate portfolios given different scenarios related to
the trade-off between the service life of the building and its construction cost. Both
portfolios of normal one-family dwellings (hereby referred to as ’residential hous-
ing’) and commercial real estate with no distinction between buildings for office,
industrial and retail purposes.

4.2 outline of the model

The goal of the model is to simulate in each data set the depreciation regimes for a
’high-quality’ real estate asset and a ’conventional’ real estate asset respectively and
subtract the depreciated value from the observations in order to create net returns,
eg. returns where depreciation has been accounted for, and estimate the effect of the
different depreciation models on returns. Finally, we estimate the construction cost
multiplier (see Section 4.3), when expected returns are the same for the high-quality
asset and the conventional asset. This creates a model that examine the trade-off
between construction cost and higher returns based on the effects of the depreciation
regime employed as well as the market effects, return and variance, of the asset in
question.

4.2.1 the model in a residential context

As described in Section 2.6.2 a longer service life will impact the Japanese real
estate user costs positively, thus making it attractive for a prospective home-owner
to purchase such a house relative to a ’conventional’ Japanese home as described by
Koo & Sasaki (2008). Effectively, in Equation 2.6, home-owners trade a lower $Q_t$
for higher financing costs $E_t \cdot i_{E,t}$ and $F_t \cdot i_{F,t}$ respectively. The model will estimate,
4.2. **OUTLINE OF THE MODEL**

given the same returns, at what cost, $\phi$, the high-quality house can be purchased. Inferences will then subsequently be made if the extra cost incurred is feasible given the higher financing costs (Equation 2.5).

### 4.2.2 The model in a commercial context

For commercial owners, such as a J-REIT, who holds mainly commercial buildings in their portfolios (see Figure A.2), longer service life means longer time to generate returns from rents and thus make a profit on the investment. As such, the trade-off between higher acquisition costs and longer service life is the same, provided that older commercial buildings possess the same ability to generate rental return as younger buildings.

**Hypothesis: the relationship between age and demand**

Anyone who has marginally studied Japan, and its real estate market in particular, could not have failed to notice the seemingly cultural preference for new goods, be they cars, appliances or housing and a brief internet search on the topic of Japanese housing will also reveal several home pages describe the high number of housing starts and high rental prices in the Japanese cities with an innate cultural preference for new things over used ones. If this was to hold true also in commercial real estate, demand would be inversely correlated with building age, which would reject the initial assumption of longer service life equalling more revenue.

To get an overview of the relationship between building age, occupancy rates of six buildings from our commercial sample have been plotted for all the buildings in the commercial data sample in Figure 4.1:

Visually, there is not much basis for concluding that there is a clear tendency of
falling occupancy rates over time in the six buildings sampled or in the total sample average. The sampling period of only ten years out of a service life of 30-50 years can seem short, but if the relationship indeed is inverse, some kind of observable effect should be expected after one third/one fifth of the service life. Also, it is worth noting that not all sample buildings were acquired when newly constructed (Sawada (2004)).
Another more plausible explanation for the changes in occupancy rate points more towards a lurking variable: The general state of the economy. A simple regression of average sample occupancy rate on the NIKKEI 225 index for the period confirms this strong relationship (see Table C.1), and we therefore reject this hypothesis.

4.3 description of the real estate assets

The model tests the performance of two different real estate assets: 'Conventional' Japanese real estate assets, which are the ones seen in the current market and 'high-quality' real estate assets, which is hypothesized to be characterised by a longer service life than the conventional real estate asset, but costs more to construct. The price of the high-quality real estate asset is defined as:

\[ V_{hq,t_0} = \phi \cdot V_{cv,t_0} \]  

(4.1)

Where \( V_{hq,t_0} \) is the construction price of the high-quality real estate asset, \( V_{cv,t_0} \) is the construction price of the conventional real estate asset and \( \phi \) is the construction cost multiplier, where \( \phi > 1 \).

Furthermore, as this paper wishes only to examine the effect on returns of the depreciation of the real estate asset itself and because land do not depreciate in the same way, the value of the real estate asset need to be separated from the value of the land. Given Japan’s low quality building stock, the value of the real estate asset \( V_{0,ld} \) has been fixed at twenty percent of total value:
\[ V_{0,bld} = 0.2 \cdot V_{0,\text{total}} \]  

(4.2)

and land value \( V_{0,\text{land}} \) therefore being:

\[ V_{0,\text{land}} = V_{0,\text{total}} - V_{0,bld} \]  

(4.3)

### 4.4 depreciation models

As can be seen in ??, portfolio performance will be tested in the presence of different write-down models. These will be outlined formally in this section.

#### 4.4.1 linear model

The linear depreciation model is a simple inverse linear function:

\[ V = -at + b \]  

(4.4)

where \( b \) is the intercept, \( a \) is the slope, and \( t \) is a given period in time

In this framework two boundary conditions are imposed. The first boundary condition is setting the value at \( t_0 \) equal to the starting value on the \( y \)-axis \( V_0 \):

\[ BC1 : V(t_0) = V_0 \]  

(4.5)
And secondly, that the time at the termination period \( t_{\text{end}} \) is equal to zero:

\[
BC2 : V(t_{\text{end}}) = 0 \quad (4.6)
\]

The boundary conditions can be used to identify the slope parameters \( a \) and \( b \). The derivations are described in Equation B.1 and Equation B.2 for boundary condition 1 and 2 respectively. The resulting model is as follows:

\[
V = \frac{-V_0}{(t_{\text{end}} - t_0)} \cdot t + V_0 \frac{t_{\text{end}}}{t_{\text{end}} - t_0} \quad (4.7)
\]
Figure 4.2: Example of a linear write-down model with $t = 50$ (e.g. 50 years, 1980-2029) and $V_0 = 1000$

### 4.4.2 non-linear model

The non-linear depreciation model is constructed from the following exponential function:

$$f(t) = be^{a(t-t_0)}$$  \hspace{1cm} (4.8)
where \( b \) is the intercept, \( a \) is the slope and \( t_0 \) is the starting period.

In this framework, two boundary conditions are imposed. First, it is imposed that the value at \( t_{\text{start}} \) should be equal to the starting value on the y-axis \( V_0 \):

\[
BC1 : f(t_{\text{start}}) = V_0
\]

(4.9)

And secondly, that value is halved at time \( t_{\text{half}} \):

\[
BC2 : f(t_{\text{start}} + t_{\text{half}}) = \frac{1}{2} V_0
\]

(4.10)

The two boundary conditions can be used to identify the slope \( a \) and the intercept \( b \). The derivation is described in Equation B.3 for boundary condition 1 and Equation B.6 for boundary condition 2. The resulting model is as follows:

\[
f(t) = V_0 e^{\left(\frac{\ln(2)}{t_{\text{half}}}(t-t_0)\right)}
\]

(4.11)

This creates a model, where the slope, e.g., the intensity of the write-down regime, can be adjusted, by adjusting \( t_{\text{half}} \). The model will only approximate zero value, but the asset will be considered fully depreciated, when less than one percent of the original value(\( V_0 \)) remain.

The calculated values of \( t_h \) presuming full depreciation at \( V_t < 0.01 \cdot V_0 \) for the different write-down models can be found in Table 4.1 for the different data sets: Two observations per year is the commercial data set and four observations per year being the residential data set. The empty spaces are due to the fact that a
**Figure 4.3:** Example of a non-linear write-down model with $t = 50$, (e.g. 50 years, 1980-2029) $t_0 = 1$, $t_{\text{half}} = 10$ and $V_0 = 100$

depreciation model for that amount of years is not being utilized in the performance analysis of that data set.

### 4.5 estimating net returns

In each time period, the depreciated value is calculated using either the linear model (Equation 4.7) using the value of the real estate asset (Equation 4.2) and tak-
4.5. ESTIMATING NET RETURNS

<table>
<thead>
<tr>
<th>full depreciation</th>
<th>2 obs./year</th>
<th>4 obs./year</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 years</td>
<td>-</td>
<td>9.63</td>
</tr>
<tr>
<td>30 years</td>
<td>9.03</td>
<td>-</td>
</tr>
<tr>
<td>35 years</td>
<td>10.54</td>
<td>-</td>
</tr>
<tr>
<td>40 years</td>
<td>12.04</td>
<td>-</td>
</tr>
<tr>
<td>50 years</td>
<td>15.05</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 4.1: calculated \( t_h \) for different depreciation models

ing into account that the value can never drop below the value of the land (Equation 4.3):

\[
V_{dep,t} = \frac{-V_{0,bld}}{t_{end} - t_0} \cdot t + V_{0,bld} \frac{t_{end}}{t_{end} - t_0} + V_{0, lnd}
\]  

(4.12)

and for the non-linear model (see Equation 4.11):

\[
V_{dep,t} = V_{0,bld} e^{\left(\frac{(t-t_0)}{t_{half}}\right)} + V_{0, lnd}
\]  

(4.13)

with the appropriate values depending on the scenario. Subsequently, the nominal depreciation is calculated:

\[
\Delta V_{dep,t} = V_{dep,t} - V_{dep,t-1}
\]  

(4.14)

which is then subtracted from the original observations to create net values:

\[
V_{net,t} = V_t - \Delta V_{dep,t}
\]  

(4.15)

Which are then ultimately turned into continuously compounded returns calcu-
lated relative to the original observations:

\[
    r_t = \ln\left(\frac{V_{net,t}}{V_{t-1}}\right)
\]  

(4.16)

4.6 estimating distribution and return

The returns are then used to calculate figures used for evaluating the performance of the data. When discussing returns in capital market theory, several data criteria needs to fulfilled: Rates of return has to be independent, follow a normal distribution and have constant variance. Brown & Matysiak (2000) provides an approach to test the returns for its distributional characteristics, called 'moments':

First movement is the mean or expected value, which in portfolio theory gauges the overall performance of an asset portfolio. For historical returns data the mean, or expected return, can be calculated from the following equation:

\[
    M1 = \bar{r} = \frac{1}{n} \sum_{i=1}^{n} r_i
\]  

(4.17)

where \( r_i \) represents each return at time \( i \) and \( n \) is the number of observations.

Second movement is variance, which represents the dispersion about the mean or expected value is the risk measurement in portfolio theory. For historic returns, the formula is as follows:
4.6. **ESTIMATING DISTRIBUTION AND RETURN**

\[ M2 = \sigma^2 = \frac{1}{n} \sum_{i=1}^{n} (r_i - \bar{r})^2 \]  \hspace{1cm} (4.18)

Standard deviation \( \sigma \) can be found by taking the square root of the variance.

Third movement is skewness, which is the measurement for how lopsided distributions are and can appear in the presence of an abundance of very high or very low returns. Skewness is calculated by taking the cube of the derivations from the mean as such for historic returns:

\[ M3 = \frac{1}{n} \sum_{i=1}^{n} (r_i - \bar{r})^3 \]  \hspace{1cm} (4.19)

Skewness can then be normalised by dividing with the cube of the standard deviation, which can be calculated from the variance:

\[ S = \frac{M3}{\sigma^3} \]  \hspace{1cm} (4.20)

The normalised skewness of a symmetric distribution such as a normal distribution will have a value of 0 if the distribution is normally distributed, a positive value if the distribution is positively skewed and a negative value if the distribution is negatively skewed.

The fourth movement is kurtosis, which measures how flat or how peaked a distribution is. To calculate kurtosis, it is necessary to take the fourth power of the
deviations from the mean. For historic data, the method is as follows:

\[ M_4 = \frac{1}{n} \sum_{i=1}^{n} (r_i - \bar{r})^4 \]  

(4.21)

And the normalising the value using the fourth power of the standard deviation:

\[ K = \frac{M_4}{\sigma^4} \]  

(4.22)

A normal distribution has a \( K \) value of 3 and is said to be mesokurtic. A value larger than 3 means that the distribution is 'fat-tailed', or leptokurtic, meaning a higher chance of observing extreme values relative to a normal distribution. A value lower than 3 means that the distribution is flat, or platykurtic, thus having fewer extreme values relative to a normal distribution.

After calculating \( S \) and \( K \) it becomes possible to conduct the Jaques-Bera (JB) test for normality, which compares sample skewness and excess kurtosis with the values they would take on given normality in the distribution:

\[ JB = \frac{n}{6} \left[ S^2 + \frac{(K - 3)^2}{4} \right] \]  

(4.23)

The JB statistics follows a \( \chi^2 \)-squared distribution when determining the limit values for rejecting or accepting the hypothesis of normality.

Results of the calculations can be seen in Table 3.1 for the residential assets and Table 3.2 for the commercial assets.
4.7 depreciation scenarios

4.7.1 residential assets

The difference between the high-quality asset and the conventional assets lies in the difference in the depreciation models they are subjected to. The difference in performance is therefore tested by running different scenarios related to the depreciation period and the model used. As described by Koo & Sasaki (2008), the depreciation period for conventional Japanese residential real estate assets is set to 15 years, while the depreciation period of the control asset, the high-quality residential real estate asset has been set 50 years. This gives two scenarios in total for residential real estate assets as outlined in Table 4.2.

<table>
<thead>
<tr>
<th>Asset type</th>
<th>15 yr. LM</th>
<th>15 yr. NLM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential asset</td>
<td>scenario 1</td>
<td>scenario 2</td>
</tr>
</tbody>
</table>

Table 4.2: Scenarios for residential real estate assets
control asset: 50 yr. LM and 50 yr. NLM respectively
legend: LM = linear model, NLM = non-linear model
4.7.2 commercial assets

The depreciation period for commercial real estate assets is dependent on construction materials (see Section 2.4.2). Construction materials for the commercial assets are listed in Table 3.2 and based on the feedback from the J-REIT representatives, depreciation periods have been chosen as can be seen in Table 4.3. From this, scenarios depreciation scenarios related to construction materials have been created (see Table 4.4). The control asset is again the high-quality asset with a 50 year depreciation period.
4.8 estimating the construction cost multiplier $\phi$

When expected net returns have been calculated, intuitively the high-quality asset with the less aggressive depreciation regime will yield a higher return. By equating the two expected returns:

$$r_{\text{con}} = r_{\text{hq}}$$

it is then possible to estimate the extra cost incurred, the $\phi$ for the high-quality asset. This creates a model which links cost to returns, given certain fixed parameters, such as the fraction of total value that is the value of the real estate asset. The values have been calculated numerically using an equation solver, the operation is described in Equation B.4 and Equation B.5.

The results of the different scenarios as well as comments on the workings in the model can be found in the following chapter.

4.9 results

4.9.1 introduction

In this section, the results from the model will be presented with comments on both the $\phi$-values as well as the workings of the model in general.
4.9.2 general comments on the model

Because returns and variance for all assets are very close to zero, most of the calculated \( \phi \)-value is determined by the difference in depreciation period, and market changes only having a minor effect and it is also predicted that values should be very similar when dispersion in return and variance is small. Also, it is important to note that the available data sets do not have sufficient observations to simulate the full depreciation periods and therefore the calculated \( \phi \)-values are after a ten-year period for the commercial assets and a six-year period for the residential assets. On the other hand, the differences in returns would approach zero pushing \( \phi \) towards 1 in data sets spanning a large period of time (50+ years) as the effects of the depreciation would diminish after both asset and control asset were fully depreciated.

4.9.3 Residential assets: Scenarios 1-2

<table>
<thead>
<tr>
<th>asset</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adachi ward</td>
<td>-0.00550</td>
<td>-0.00329</td>
</tr>
<tr>
<td>Chuo ward</td>
<td>-0.00675</td>
<td>-0.00383</td>
</tr>
<tr>
<td>Koto ward</td>
<td>-0.00432</td>
<td>-0.00255</td>
</tr>
<tr>
<td>Meguro ward</td>
<td>-0.00740</td>
<td>-0.00420</td>
</tr>
<tr>
<td>Minato ward</td>
<td>-0.00620</td>
<td>-0.00374</td>
</tr>
<tr>
<td>Nada ward</td>
<td>-0.00588</td>
<td>-0.00352</td>
</tr>
<tr>
<td>Saiwai ward</td>
<td>-0.00641</td>
<td>-0.00366</td>
</tr>
<tr>
<td>Shinagawa ward</td>
<td>-0.00439</td>
<td>-0.00270</td>
</tr>
<tr>
<td>Shinjuku ward</td>
<td>-0.00461</td>
<td>-0.00272</td>
</tr>
<tr>
<td>Sumida ward</td>
<td>-0.00424</td>
<td>-0.00261</td>
</tr>
</tbody>
</table>

Table 4.5: The difference in expected returns between the two depreciation regimes
\( \Delta \tau = \tau_{cv} - \tau_{hq} \)

The calculated differences in expected return for the residential real estate assets can be found in Table 4.5 and \( \phi \)-values can be found in Table 4.6. Differences
4.9. RESULTS

<table>
<thead>
<tr>
<th>Asset</th>
<th>scenario 1</th>
<th>scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adachi ward</td>
<td>6.66680442</td>
<td>1.95337023</td>
</tr>
<tr>
<td>Chuo ward</td>
<td>6.66638371</td>
<td>1.91455248</td>
</tr>
<tr>
<td>Koto ward</td>
<td>6.66727245</td>
<td>1.94351440</td>
</tr>
<tr>
<td>Meguro ward</td>
<td>6.66614545</td>
<td>1.91289070</td>
</tr>
<tr>
<td>Minato ward</td>
<td>6.66656565</td>
<td>1.96015522</td>
</tr>
<tr>
<td>Nada ward</td>
<td>6.66666671</td>
<td>1.95305526</td>
</tr>
<tr>
<td>Saiwai ward</td>
<td>6.66651488</td>
<td>1.91884831</td>
</tr>
<tr>
<td>Shinagawa ward</td>
<td>6.66666595</td>
<td>1.97671439</td>
</tr>
<tr>
<td>Shinjuku ward</td>
<td>6.66713848</td>
<td>1.94266616</td>
</tr>
<tr>
<td>Sumida ward</td>
<td>6.66730241</td>
<td>1.97524761</td>
</tr>
</tbody>
</table>

Table 4.6: calculated $\phi$-values for the residential assets

$\phi$-values are high for all assets in scenario 1, which indicates that the linear depreciation model has a stronger effect on returns thus resulting in a higher $\phi$. Variance in the $\phi$ due to market effects are strongest in the metropolitan wards of Koto and Sumida, suggesting a lower attractiveness for high-quality real estate in the Tokyo area in terms of return, but differences remain very small overall. The $\phi$-value for all residential assets are around 6.6, meaning that a home-owner would have to incur expenses related to borrowing capital and opportunity cost of net capital that were more than six times as great were he to achieve the same net return as the high-quality asset, and with differences in expected return between the two investments being so low, it is not a good investment.

Scenario 2 is the non-linear depreciation model and has similar $\phi$-values for all assets of around 1.9. $\phi$-values exhibit a little more variance meaning that the non-linear depreciation regime allows for more market effects to be visible. Metropolitan wards Shinagawa and Sumida has the highest values, again indicating that metropolitan areas are less attractive for high-quality asset investments, but with values only being marginally different, it is hard to say whether or not the effect is significant.
4.9.4 Commercial assets: Scenarios 3-8

<table>
<thead>
<tr>
<th>Asset</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
<th>Scenario 7</th>
<th>Scenario 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset 1</td>
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<td>-</td>
<td>1.42920917</td>
<td>1.24013897</td>
</tr>
<tr>
<td>Asset 13</td>
<td>-</td>
<td>-</td>
<td>1.42909498</td>
<td>1.23059697</td>
</tr>
<tr>
<td>Asset 14</td>
<td>1.66708293</td>
<td>1.31251856</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asset 15</td>
<td>-</td>
<td>-</td>
<td>1.42914947</td>
<td>1.23795772</td>
</tr>
</tbody>
</table>

Table 4.7: calculated $\phi$-values for the commercial assets (30/35 yr. depreciation)

<table>
<thead>
<tr>
<th>Asset</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
<th>Scenario 7</th>
<th>Scenario 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset 1</td>
<td>-</td>
<td>-</td>
<td>-0.00066</td>
<td>-0.00118</td>
</tr>
<tr>
<td>Asset 13</td>
<td>-</td>
<td>-</td>
<td>-0.00080</td>
<td>-0.00135</td>
</tr>
<tr>
<td>Asset 14</td>
<td>-0.00146</td>
<td>-0.00210</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asset 15</td>
<td>-</td>
<td>-</td>
<td>-0.00073</td>
<td>-0.00128</td>
</tr>
</tbody>
</table>

Table 4.8: The difference in expected returns between the two depreciation regimes $\Delta \tau = \tau_{cv} - \tau_{hq}$

<table>
<thead>
<tr>
<th>Asset</th>
<th>Scenario 5</th>
<th>Scenario 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset 2</td>
<td>-0.00045</td>
<td>-0.00081</td>
</tr>
<tr>
<td>Asset 3</td>
<td>-0.00050</td>
<td>-0.00085</td>
</tr>
<tr>
<td>Asset 4</td>
<td>-0.00050</td>
<td>-0.00088</td>
</tr>
<tr>
<td>Asset 5</td>
<td>-0.00046</td>
<td>-0.00082</td>
</tr>
<tr>
<td>Asset 6</td>
<td>-0.00044</td>
<td>-0.00080</td>
</tr>
<tr>
<td>Asset 7</td>
<td>-0.00049</td>
<td>-0.00088</td>
</tr>
<tr>
<td>Asset 8</td>
<td>-0.00052</td>
<td>-0.00091</td>
</tr>
<tr>
<td>Asset 9</td>
<td>-0.00056</td>
<td>-0.00094</td>
</tr>
<tr>
<td>Asset 10</td>
<td>-0.00053</td>
<td>-0.00090</td>
</tr>
<tr>
<td>Asset 11</td>
<td>-0.00047</td>
<td>-0.00081</td>
</tr>
<tr>
<td>Asset 12</td>
<td>-0.00029</td>
<td>-0.00058</td>
</tr>
<tr>
<td>Asset 16</td>
<td>-0.00043</td>
<td>-0.00080</td>
</tr>
<tr>
<td>Asset 17</td>
<td>-0.00028</td>
<td>-0.00053</td>
</tr>
</tbody>
</table>

Table 4.9: The difference in expected returns between the two depreciation regimes $\Delta \tau = \tau_{cv} - \tau_{hq}$

The calculated differences in expected return as well as the $\phi$-values for the commercial assets can be found in Table 4.8, Table 4.9, Table 4.10 and Table 4.7.
Table 4.10: calculated $\phi$-values for the commercial assets (40 yr. depreciation)

<table>
<thead>
<tr>
<th>Asset</th>
<th>Scenario 5</th>
<th>Scenario 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset 2</td>
<td>1.25054533</td>
<td>1.14330704</td>
</tr>
<tr>
<td>Asset 3</td>
<td>1.25049496</td>
<td>1.13915549</td>
</tr>
<tr>
<td>Asset 4</td>
<td>1.25049758</td>
<td>1.14190000</td>
</tr>
<tr>
<td>Asset 5</td>
<td>1.25054212</td>
<td>1.14470400</td>
</tr>
<tr>
<td>Asset 6</td>
<td>1.25055582</td>
<td>1.14458535</td>
</tr>
<tr>
<td>Asset 7</td>
<td>1.25050354</td>
<td>1.14384831</td>
</tr>
<tr>
<td>Asset 8</td>
<td>1.25047500</td>
<td>1.14243416</td>
</tr>
<tr>
<td>Asset 9</td>
<td>1.25043592</td>
<td>1.13774554</td>
</tr>
<tr>
<td>Asset 10</td>
<td>1.25046561</td>
<td>1.13885914</td>
</tr>
<tr>
<td>Asset 11</td>
<td>1.25052849</td>
<td>1.14120557</td>
</tr>
<tr>
<td>Asset 12</td>
<td>1.25084756</td>
<td>1.15412675</td>
</tr>
<tr>
<td>Asset 16</td>
<td>1.25058106</td>
<td>1.14830088</td>
</tr>
<tr>
<td>Asset 17</td>
<td>1.25087258</td>
<td>1.14859726</td>
</tr>
</tbody>
</table>

The pattern is the same for scenario 3, 5 and 7 as it is for scenario 1 in Section 4.9.3 in terms of higher $\phi$-values than the corresponding non-linear depreciation scenario and it is also clear that $\phi$-values drops towards 1 as the depreciation periods approaches that of the high-quality asset and vice versa. Again, the linear depreciation scheme affects results more, raising the $\phi$, and the non-linear depreciation scheme in scenario 4, 6 and 8 allows for more market effects to shine through. $\phi$-values over the board are very similar, again attesting to the fact that returns and variance are low for the commercial assets also. Again, assets in the Tokyo metropolitan exhibit marginally higher $\phi$-values, but because variances are so small and there is only a handful of assets outside Tokyo to act as control group, it remains inconclusive whether or not the effect in the Tokyo area is larger. Differences in expected return remain very low and very uniform, indicating that market effects account for very little of the $\phi$-value and that the gain by incurring the extra cost is relatively low.
Chapter 5

conclusion

The model presented in this paper sought to examine whether or not real estate of a higher quality was the remedy of the issues in the Japanese real estate market, which is mostly comprised of a housing stock with a very short lifetime compared to most Western markets. The model sought to examine the trade-off between a longer service life and higher construction costs in terms of return, which, if the extra cost incurred would be reasonable compared to the extra return generated, could prove as an incentive for the fledgling Japanese real estate securitisation industry to invest in sustainable real estate and for lawmakers to change legislation that could free up more capital for developers to invest in a real estate asset of a higher quality.

However, despite all assets having very low returns, calculated $\phi$-values ranged from 1.14 (14 percent more expensive) to 6.67 (667 percent more expensive) (Section 4.9.3 and Section 4.9.4) depending on the depreciation regime. In the best case scenario, an 14 percent increase in construction cost for a commercial real estate investor is not unfeasible. However, the difference in returns and therefore return on the investment is only very marginal (Table 4.9), making the extra cost almost redundant.
or at least a bad investment. The same logic goes for the private home-owners, who under a linear depreciation regime would suffer an extra construction cost equal to almost seven times the price of the original asset (Table 4.6), which is completely unrealistic. Additionally, the model is such that in a less stale market with larger returns and more volatility, $\phi$-values would jump even higher to close the gap between net returns in conventional and high-quality assets.

Does this mean that there is no market for sustainable construction in Japan? Not necessarily.

First of all the model suffers under the lack of data, which makes the simulation of the whole depreciation period impossible and brings the validity of the calculated $\phi$-values into question, as volatility in the net returns will indubitably smoothen out as the time period increases. It was considered to generate data sufficient for a full simulation using a prediction model, such as ARIMA, but it would in the case of the residential real estate assets mean that the equivalent of 40+ years worth of data would have to be predicted on the basis of only six years worth of data, making the predicted data all but worthless in terms of realism. If a longer time series for both asset types were to become accessible, it would become possible to calculate more accurate $\phi$-values.

Furthermore, this model only tested the trade-off between cost and service life in terms of market return on the real estate asset. The question is to what degree market return is essential to the investor in the asset. For the private home-owner, the real estate asset is a dual good, meaning both a consumption good and an investment. While the high-growth period leading up to the ongoing financial crisis (a pattern very similar to the period leading up to the burst of the Heisei bubble, and the Great Depression) private home-owners began to speculate in returns on
real estate to some degree, houses are mostly bought by private investors for the purpose of the consumption of housing. Investing in a housing asset with a longer service life would for the home-owner mean lower user costs in terms of costs related to depreciation and taxation (Equation 2.1), which is reason enough for making such an investment without having to consider returns. Furthermore, if a high-quality real estate asset also means an energy-efficient real estate asset, the home-owner can lower his costs related the expenses which are exogenous to the user costs used in this framework.

For the commercial investor, returns is usually measured in total returns meaning market returns on the asset plus rental income. A longer service life would mean more time to generate rental income to drive up total returns (Section 4.2.2), even if returns on the asset itself are low, meaning that there is an incentive to invest in more long-lived real estate either way.

What can be concluded from the results is this: The choice of depreciation regime has a significant impact on net returns in the short run even when dealing with assets with very low return and volatility figures. This can prove to be a valuable point for professional investors, who will have to consider both components of the total return in their reporting to investors and executives. In this framework, the $\phi$ can prove a valuable figure to measure the effect of the depreciation regime on the returns in internal reporting. In other words, while the model is probably not the best in terms of determining the attractiveness of sustainable real estate in Japan, it might serve as a valuable tool to determine the effects of depreciation on returns for commercial investors with such concerns.
CHAPTER 5. CONCLUSION
Appendices
Appendix A

graphs
Figure A.1: Age of Japanese housing stock

Figure A.2: Diversification of the J-REIT portfolios 2008-2010
Source: ARES (2012)
Figure A.3: The Japanese Urban Land Price Index 1967-2010
End of March 2000 = 100
Figure A.4: The Nikkei 225 index 1973-2010
source: European Central Bank Statistical Data Warehouse homepage (2012)
Appendix B

derivations

\begin{equation}
0 = \frac{-V_0}{t_{end} - t_0} \cdot t_{end} + b
\end{equation}

\[\updownarrow\]

\begin{equation}
0 = \frac{-V_0 \cdot t_{end}}{t_{end} - t_0} + b
\end{equation}

\[\updownarrow\]

\begin{equation}
b = V_0 \frac{t_{end}}{t_{end} - t_0}
\end{equation}
\[ 0 = a \cdot t_{\text{end}} + b \]
\[ \Downarrow \]
\[ 0 = a \cdot t_{\text{end}} + (V_0 - a \cdot t_0) \]
\[ \Downarrow \]
\[ -V_0 = a \cdot t_{\text{end}} - a \cdot t_0 \] (B.2)
\[ \Downarrow \]
\[ -V_0 = a(t_{\text{end}} - t_0) \]
\[ \Downarrow \]
\[ \frac{-V_0}{(t_{\text{end}} - t_0)} = a \]

\[ f(t) = b \cdot e^{a(t-t_{\text{start}})} = V_0 \]
\[ \Downarrow \]
\[ b \cdot e^0 = V_0 \] (B.3)
\[ \Downarrow \]
\[ b = V_0 \]

\[ \sum \ln \left( \frac{\frac{V_{0,\text{con}}}{t_{\text{end}} - t_0} \cdot t + 0.2V_{0,\text{con}} \phi(t_{\text{end}} - t_0) + 0.8V_0}{V_{t-1,\text{con}}} \right) - \]
\[ \sum \ln \left( \frac{\frac{V_{0,\text{hq}}}{t_{\text{end}} - t_0} - 0.2V_{0,\text{hq}}}{V_{t-1,\text{hq}}} + 0.2V_{0,\text{hq}}(t_{\text{end}} - t_0) + 0.8V_0 \cdot \phi \right) = 0 \] (B.4)
\[ \sum \ln \left( \frac{V_{t,\text{con}} + V_{0,\text{con}} \phi \left( \ln \frac{t}{t_{\text{half}}} \right)(t - t_0) \cdot 0.2 + 0.8V_{0,\text{con}} \phi}{V_{t-1,\text{con}}} \right) - \sum \ln \left( \frac{V_{t,\text{hq}} + V_{0,\text{hq}} \left( \ln \frac{t}{t_{\text{half}}} \right)(t - t_0) \cdot 0.2 + 0.8V_{0,\text{hq}}}{V_{t-1,\text{hq}}} \right) = 0 \] 

(E.5)

\[ f(t_{\text{start}} + t_{\text{half}}) = b \cdot e^{a(t - t_{\text{start}})} = \frac{1}{2} V_0 \]

\[ V_0 e^{a(t_{\text{start}} + t_{\text{half}} - t_{\text{start}})} = \frac{1}{2} V_0 \]

\[ V_0 e^{a \cdot t_{\text{half}}} = \frac{1}{2} V_0 \]

\[ e^{a \cdot t_{\text{half}}} = \frac{1}{2} \]

\[ \log(a \cdot t_{\text{half}}) = \log \left( \frac{1}{2} \right) \]

\[ a \cdot t_{\text{half}} = \log \left( \frac{1}{2} \right) \]

\[ a = \frac{\log(\frac{1}{2})}{t_{\text{half}}} \]
Appendix C

Regressions

Table C.1: Total Occupancy Rate of the Sample Portfolio regressed on the NIKKEI 225 index
Sampling period: 2002-2011, with two observations each year in March and September

The model has been tested for autocorrelation using the Durbin-Watson test. The DW value is 1.3029, which, given 20 observations and one explanatory variable, falls between the limit values for certain first-order positive and negative autocorrelation, and there is therefore inconclusive evidence regarding the presence or absence of autocorrelation (Gujarati N. & Porter (2009)).

|                  | Estimate | Std. Error | t value | Pr(>|t|) | adj-R² |
|------------------|----------|------------|---------|----------|--------|
| (Intercept)      | -94378.0240 | 20052.8646 | -4.71   | 0.0002   | 0.5871 |
| oc.total         | 1110.6061  | 209.8425   | 5.29    | 0.0000   |        |
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email correspondence 4. *e-mail correspondence with representative from Daiwa office REIT*. conducted February 15th 2012.


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