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Household Asset Allocation**

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Abstract

Dette speciale undersøger, hvordan aktivers relative priser påvirker danske husholdningers allokering af finansielle aktiver. Med afsæt i Tobins porteføljeteori anvendes en dynamisk version af Almost Ideal Demand System (AIDS) modellen til at analysere husholdningssektorens porteføljevalg i forhold til ændringer i relative priser. Modellen estimeres ved hjælp af Local Projections (LP) og Seemingly Unrelated Regressions (SUR) på kvartalsvise data fra Danmarks Statistik for perioden 2005 Q1 til 2020 Q1.

Resultaterne viser, at danske husholdninger tilpasser deres porteføljer som reaktion på ændringer i aktivernes relative priser, men at omfang og retning af reaktionerne varierer betydeligt på tværs af aktivklasser. De mest markante og statistisk signifikante reaktioner observeres mellem aktier og forsikringstekniske reserver, hvor prisstigninger i det ene aktiv medfører reduktioner i allokeringen til det andet. Kontanter og indskud reagerer mere afdæmpet, med faldende allokering ved stigende aktiepriser, mens en positiv egenpriseffekt indikerer øget eksponering, når afkastet på kontanter og indskud stiger. Obligationer udviser ingen meningsfulde eller statistisk signifikante reaktioner og fremstår som en passiv holdt aktivklasse.

De estimerede impulsresponsfunktioner indikerer, at husholdninger foretager gradvise og selektive porteføljeallokeringer, hvilket er i overensstemmelse med Tobins teori om porteføljevalg.

Metodisk bidrager specialet ved at tilpasse og anvende en klassisk efterspørgselsmodel i en dynamisk ramme til at analysere finansielle porteføljeallokeringer på sektorniveau. Specialet konkluderer, at ændringer i aktivers relative priser har en indflydelse på danske husholdningers porteføljesammensætning.

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1. Introduction

Household financial management has a long history, with evidence of informal record-keeping stretching back centuries (e.g., early ledgers and double-entry bookkeeping practices). However, systematic tracking of balance sheets across all sectors at the national level gained momentum in the 20th century. In the post-war era, many countries began developing sectoral accounts to formally monitor the assets and liabilities of households and other sectors. For example, the United Kingdom's Radcliffe Report of 1959 played a key role in encouraging the compilation of comprehensive flow-of-funds statistics, and the United States Federal Reserve initiated flow-of-funds accounts in the 1950s. This formalization reflected a growing recognition that household finances were relevant and increasingly essential for understanding macroeconomic dynamics (Thomas & Nolan, 2016).

Alongside these institutional developments, theoretical advances in economic thought, for example, James Tobin's seminal work on portfolio selection, shifted how economists viewed household saving behavior.

Tobin's contribution showed that risk-averse agents allocate wealth across different asset classes not only in pursuit of returns but also to achieve diversification and manage risk exposure. This insight laid the groundwork for modern portfolio theory by establishing that portfolio composition responds systematically to changes in expected returns, risk, and individual preferences. Although originally developed with individual investors or representative agents, this framework has inspired extensive empirical research into how real-world households manage complex portfolios (Tobin, 1958).

By the mid-20th century, as researchers and statistical agencies began producing detailed household balance sheets, it became increasingly possible to empirically study such portfolio behavior at the aggregate level (Thomas & Nolan, 2016). These data reveal that households play broader economic roles beyond labor and consumption. As savers, investors, and debtors, they hold essential balance sheets for financial stability and economic growth.

In the decades after World War II, household finance underwent significant transformations. An important development was the expansion of pension systems and other social safety nets, which substantially impacted how households accumulated financial assets. With the rise of public and private retirement programs post-World War II, ordinary households increasingly acquired financial assets (such as pension fund reserves and life insurance savings) that would support them in old age. Researchers have noted a "post-war rise of popular wealth" fueled largely by housing and funded pensions, which are asset classes broadly held by the middle class rather than just the rich. For example, Waldenström (2021) finds that whereas wealth around 1900 was concentrated in the hands of elites (e.g., large estates and business equity), by the late 20th century, a growing share of wealth was held in home equity and pension accounts by typical households. This shift de-

mocratized wealth to an extent and meant that household balance sheets grew in size. In many advanced economies, household wealth-to-income ratios climbed steadily after 1950, reflecting widespread homeownership and the accumulation of retirement assets. The rapid growth of pension entitlements, in particular, provided households with substantial financial assets by the late 20th century, reshaping the composition of household portfolios and the distribution of wealth (Waldenström, 2021).

A wave of financial market liberalization beginning in the 1970s and 1980s further transformed household finance. Many developed countries deregulated their banking and capital markets, lifted interest rate caps, and eased restrictions on capital flows during this period. These reforms expanded the investment options and credit availability for households, allowing them to choose between more diverse financial products. For instance, removing foreign exchange controls and other barriers in places like the United Kingdom and the United States opened the door for households to invest in mutual funds, stocks, and other securities that were previously difficult to access. At the same time, banks and new financial intermediaries rolled out consumer credit products and mortgage offerings on an unprecedented scale. According to the United Kingdom Office for National Statistics (ONS), by the late 1980s, the financial sector in liberalized economies was essentially "free of direct controls" implemented in earlier decades (Thomas & Nolan, 2016).

By the early 2000s, households were much more involved in financial markets. In the United States, stock ownership among middle-aged households rose from 40% in 1989 to 61% in 2001. Similar trends appeared in other wealthy countries, with more people investing in stocks, mutual funds, and retirement accounts. United States families also shifted more of their wealth into stocks, with the share rising from 4% in 1989 to 11% by 2016. This growing exposure would likely mean that household spending and saving now react more to market ups and downs, as wealth and investment income changes affect consumer confidence (Ravikumar & Karson, 2018).

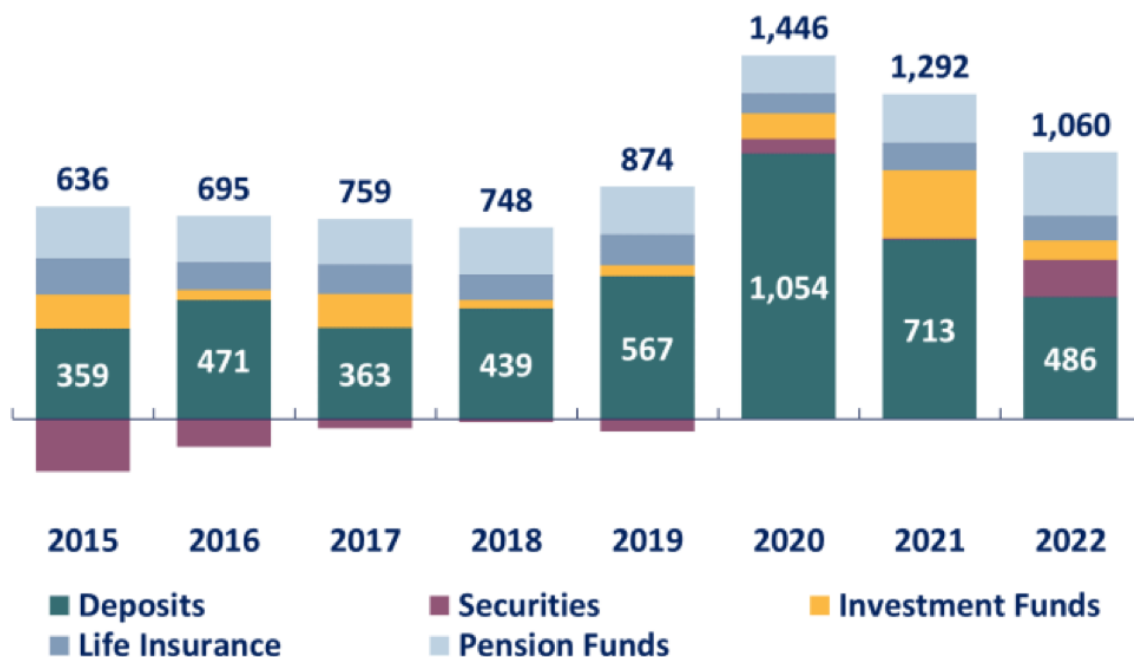
This deeper financial involvement also came with greater risk. The global financial crisis of 2008–2009 highlighted the need to study household financial behavior closely. In the years leading up to the crisis, many households in the United States and Europe took on high levels of debt, especially mortgage debt, and made risky financial investments, ultimately worsening the downturn. The crisis made clear that household balance sheets and their vulnerabilities can have macroeconomic consequences. As noted in a Bank of England review, the financial crisis "re-emphasized the importance of tracking the financial transactions of different agents in the economy and how those flows affect their balance sheet positions," particularly when assessing risks to financial stability (Thomas & Nolan, 2016). In sum, the crisis started a broader appreciation that understanding households' financial choices is essential for microeconomic welfare and macroeconomic stability.

In recent years, the focus of household finance research has been shifting. While household debt, such as mort-

gage borrowing and consumer credit, received considerable attention in the context of the crisis, there is now a growing interest in the asset side of household balance sheets, particularly in how households allocate their wealth and the implications for inequality and economic behavior. Analysts have increasingly turned their attention to questions of wealth composition and distribution. For example, the OECD (2018) points out that wealth inequality has become a topic of heightened concern among policymakers and the public (Balestra & Tonkin, 2018). In short, the research agenda has expanded from a predominant concern with household leverage to a more comprehensive examination of net worth and its components, reflecting the view that both sides of the balance sheet are critical for understanding economic well-being and risks. As household financial behavior has become more complex and impactful, such as increased market participation and recent crises, there is a growing need for more refined analytical tools. This shift in focus is also reflected in the evolving patterns of household asset acquisition. Recent data show that households have increasingly diversified their portfolios across deposits, securities, investment funds, life insurance, and pension funds (Thomas & Nolan, 2016).

Figure 1.1 from Delbecque (2024) illustrates the diversification of households' net asset acquisitions from 2015 to 2022 for European citizens. The figure shows not only the total net acquisitions but also how diversification can vary greatly from year to year. This highlights the importance of gaining further insights into how households make asset allocation decisions and substitute between different asset types.

Figur 1.1: Net Asset Acquisition by Households (EUR billions)



Source: (Delbecque, 2024, p. 6)

In this context, the thesis introduces a new approach by using the Almost Ideal Demand System (AIDS) model, originally developed by Deaton & Muellbauer (1980) to study consumer demand, to analyze how households allocate their wealth across different financial assets. The model helps estimate how households adjust the distribution of their wealth across deposits, equities, pensions, and other assets as asset prices change.

The case of Denmark is particularly interesting. Danish households are among the most financially active in Europe, with broad participation in different financial markets (Delbecque, 2024), making Denmark a valuable setting for exploring how households allocate their financial assets and how these allocation decisions might change in response to asset prices.

With this in mind, this thesis aims to contribute to the field by using the Almost Ideal Demand System framework to study how Danish households allocate their financial assets. The goal is to gain a better understanding of how households reallocate their financial assets and how the composition of those assets evolves. In doing so, this thesis not only explores portfolio choices in a Danish context but also tests the AIDS model in a financial context, extending its traditional application in consumer demand analysis to the domain of asset allocation.

1.1. Research Question

Building on the areas of interest outlined above, the central research question of this thesis is:

How do relative asset prices affect Danish households' allocation of financial assets?

While the question is relevant in itself, this thesis also contributes methodologically by adapting and extending the Almost Ideal Demand System (AIDS) model to a financial context to study household asset allocation. In this setup, financial asset classes are treated as demand categories, asset-specific price proxies represent relative prices, and total household wealth, defined as the household's total stock of financial assets, serves as the budget constraint.

To capture the dynamic nature of portfolio adjustments, the model is embedded in a dynamic framework and estimated using a combination of Local Projection (LP) models and Seemingly Unrelated Regressions (SUR) estimation method. This approach allows for flexible estimation of price effects over time while accounting for cross-equation correlations across asset types. Using aggregate data from the Danish national accounts ensures consistency and broad representativeness, making it well-suited for demand system analysis at the household sector level.

By applying a classical demand system in a macro-financial context, this thesis addresses the research question and simultaneously introduces a novel empirical approach. A more detailed presentation of the empirical method, data, and estimation strategy is provided in Sections 4.2, 5, and 6, respectively.

1.2. Scope and Delimitations of the Research Question

This section outlines the thesis's key delimitations. These have been made to clarify the scope and applicability of the thesis in relation to the research question, which is bounded by data availability, theoretical and methodological frameworks, geographical scope, and the overall scale of the thesis.

This thesis examines how relative asset prices affect Danish households' allocation of financial assets. This focus is reflected in the research question, which geographically delimits the analysis to Danish households and thereby excludes households in other countries. In addition, the analysis is limited to the asset side of the household balance sheet, leaving out any examination of liabilities.

Theoretically, the thesis draws on Tobin's portfolio theory as a conceptual framework for interpreting and contextualizing the empirical results. Even though the theory is not directly embedded in the empirical model, it still offers a good framework for understanding the substitution patterns and trade-offs in household asset allocation in response to changes in relative prices. This means that the theory is used mainly as a framework for interpretation rather than as a structural basis for the model.

From an empirical and methodological perspective, the thesis applies a dynamic version of the Almost Ideal Demand System (AIDS) model to household sector data, which are available at an aggregated level. The model is estimated using a combination of Local Projections (LP) and Seemingly Unrelated Regressions (SUR), which together allow for flexible estimation of dynamic responses and account for contemporaneous correlations between asset classes. This estimation represents a novel application of the AIDS framework in a financial context. However, the analysis is conducted at an aggregated level and does not account for household-level heterogeneity, such as differences in income or socioeconomic status. The study also does not aim to establish causal identification or to explore broader economic outcomes such as income or wealth inequality.

While it would be valuable to explore how households with different income levels or socioeconomic backgrounds substitute between asset types in response to changing relative prices, such an extension lies beyond the scope of this thesis.

The thesis also applies a temporal delimitation, using data from 2005 Q1 to 2020 Q1. This specific time frame was chosen because it includes all necessary data for estimating the model for Denmark while deliberately excluding the COVID-19 pandemic to avoid periods with structural breaks or significant anomalies in the data. A more detailed overview of data limitations is provided in Section 5.

2. Overall Structure and Method

This section briefly presents the structure of the thesis, as well as the methodological and epistemological considerations.

2.1. Structure of the Thesis

This thesis aims to answer the research question: *How do relative asset prices affect Danish households' allocation of financial assets?* To address this question, the thesis is structured into nine main sections, combining existing literature, economic theory, empirical analysis, and a broader discussion.

Section 1 introduces the topic of the thesis, presents the research question, and outlines the scope and delimitations of the analysis. Section 2.2 presents the methodological and epistemological considerations that form the foundation of the study's analytical approach.

Section 3 positions the thesis within the existing literature. It begins by outlining studies on household portfolio allocation, followed by an overview of empirical applications of the AIDS model. The section concludes by clarifying how this thesis contributes to and differs from previous research.

In Section 4, the theoretical and empirical framework is presented. This includes an outline of Tobin's portfolio theory and the concept of sectoral balance sheets, which together provide the conceptual foundation for the analysis. The section then introduces the empirical methodology, including the Almost Ideal Demand System (AIDS), Local Projections (LP), and Seemingly Unrelated Regressions (SUR).

Section 5 presents the data handling and the descriptive statistics forming the basis for the empirical model. First, the financial assets held by Danish households are processed and analyzed. This is followed by a corresponding treatment of the prices of these assets, including the selection and construction of appropriate price proxies.

Section 6 outlines the model setup used to estimate the relationship between relative asset prices and household portfolio allocation. This includes the structure of the dynamic AIDS model and how it is estimated using LP and SUR methods. Section 7 presents the empirical results. It outlines the estimated effects and examines how relative asset prices affect Danish households' allocation of financial assets.

Section 8 discusses the main findings in relation to the thesis' delimitations, the reviewed literature, and relevant behavioral perspectives. It also includes a reflection on methodological decisions regarding the choice of data, price proxies, and modeling techniques. The section concludes by outlining suggestions for future research. Finally, Section 9 presents the conclusion of the thesis, summarising the main findings and answering the research question.

2.2. Methodological and Epistemological Considerations

This section presents the methodological and epistemological considerations underlying the analytical framework of this thesis.

The thesis adopts a quantitative approach, which means that knowledge is gathered through measurable dimensions and numerical values, allowing for systematic analysis of patterns and relationships (Aarhus Universitet, 2023b). The data used is of a quantitative nature, consisting of macroeconomic time series data that can be analyzed numerically. This type of data is essential for applying the Almost Ideal Demand System (AIDS) model, which is central to the framework of the thesis and enables a structured analysis of household portfolio allocation.

By using a quantitative method, the thesis seeks a high degree of external validity, meaning that the findings are intended to be generalizable beyond the specific case studied (Aarhus Universitet, 2023a). However, this generalizability is naturally limited by the study's specific scope and delimitations presented in Section 1.2. Given the macroeconomic scope of the analysis, the data is secondary, meaning that it has been obtained from pre-existing sources, specifically Danmarks Nationalbank Statistikbanken and the Federal Reserve Bank of St. Louis (FRED).

The thesis applies a deductive approach, meaning that the analysis is guided by existing theories rather than seeking to develop new theoretical frameworks (Aarhus Universitet, 2023b). The theories presented in Section 4.1 form the basis for addressing the research question. While the analysis does not involve formal hypothesis testing in the statistical sense, the theoretical framework still sets expectations for the empirical findings. Theoretical insights are compared with the empirical results throughout the thesis, particularly in the discussion.

In summary, this thesis applies a deductive and quantitative methodology, using theory to guide the analysis and numerical data to examine household portfolio allocation.

Epistemology refers to the study of the nature and origin of knowledge, including the assumptions about how reality can be understood and explained (Sonne-Ragans, 2019, p. 209-2010). This thesis is based on a rationalist epistemology, which holds that valid knowledge is obtained through logical reasoning and the structured application of theory. Rationalism assumes that individuals act rationally and predictably based on available information to make decisions that maximize utility. In this context, models such as the AIDS model and Tobin's portfolio theory are used not only as analytical tools but also as formal representations of rational decision-making processes under economic constraints.

Consistent with this epistemological foundation, the thesis applies a deductive research approach, where theo-

retical frameworks guide the empirical analysis. The research design begins with established economic theory, which provides expectations for how households may respond to changes in relative prices and returns. These theoretical expectations shape the analysis of observed macroeconomic data and guide the interpretation of empirical findings. This approach reflects the rationalist perspective that empirical insights must be grounded in logically consistent frameworks, and that theoretical models can provide a structured basis for understanding economic behavior.

The thesis assumes that households respond systematically to changes in prices and returns and that this behavior can be captured using demand-theoretic relationships. This perspective treats financial decision-making as a process managed by rational choices instead of random behavior, and it points out that empirical analysis can reveal patterns that align with or deviate from theoretically derived expectations. This understanding is consistent with the rationalist view that scientific knowledge results from reasoned analysis rather than mere observation (Sonne-Ragans, 2019, p. 215-2016).

3. Literature Review

This section presents a structured review of theoretical and empirical contributions to the study of household portfolio allocation. It outlines how preferences, constraints, and institutional factors influence portfolio choices and examines the use of demand system models, particularly the Almost Ideal Demand System (AIDS) and the Financial Almost Ideal Demand System (FAIDS) frameworks, in explaining observed behavior. The reviewed literature identifies key mechanisms relevant to the empirical approach and provides a basis for interpreting and discussing the results later in the thesis.

3.1. Household Portfolio Allocation: Theory and Evidence

This section reviews key theoretical and empirical contributions to the study of household portfolio allocation. It examines how preferences, constraints, and behavioral factors influence investment decisions and how these decisions vary systematically with wealth, age, risk tolerance, and institutional context. Although the thesis focuses on aggregate-level dynamics, insights from the micro-level literature provide a basis for interpreting the empirical results. These mechanisms help contextualize aggregate responses to changes in relative asset prices, which are central to the analysis. The literature also informs the discussion of the study's methodological limitations and provides a point of comparison with existing empirical findings.

Household portfolio allocation has long been a central topic in finance and economics, with early theoretical contributions establishing the basic trade-offs that households face in allocating wealth across assets. In particular, Tobin (1958) laid the foundation by formalizing how risk-averse investors optimally divide their wealth between less risky and riskier assets, demonstrating the principle of a risk-return trade-off under uncertainty. This work built on the mean-variance framework of Markowitz (1952) and introduced the notion that even the most cautious investors will hold some risky assets as long as the expected returns justify the risk. Tobin's insight implies that risk preferences play a crucial role: more risk-tolerant households should allocate a higher proportion of their portfolio to risky assets (equities, for example), while more risk-averse households tilt towards safer assets (bonds, cash).

In theory, differences in risk aversion and subjective expectations lead to heterogeneity in portfolios, and later research has indeed confirmed significant heterogeneity in household financial decisions. For instance, surveys that elicit risk aversion find that households with lower risk aversion are far more likely to participate in the stock market and hold a larger share of equities, whereas very risk-averse individuals avoid stocks altogether. At the same time, households' asset allocation decisions are shaped by various constraints and behavioral factors beyond classical utility maximization. This observation has motivated a rich empirical literature on how real households actually allocate their portfolios, often deviating from the normative benchmarks of theory

(Guiso & Paiella, 2008).

A consistent empirical finding in the field of household finance is the surprisingly low participation of households in the stock market. Despite equities offering historically higher long-term returns than other assets, many households withhold from investing in them. This pattern highlights a significant gap between the predictions of standard financial theory and observed household behavior. Explanations for this limited participation include fixed entry costs, low levels of financial literacy, and limited trust in financial institutions, all of which can discourage stock market involvement (Campbell, 2006). Households that do invest in risky assets tend to be wealthier, better educated, and more financially literate. Moreover, evidence suggests that risk-taking increases with wealth; as households become richer, they appear more willing and able to bear financial risk. This is consistent with decreasing relative risk aversion and the idea that higher wealth relaxes participation constraints. For example, using detailed Swedish administrative data, Calvet & Sodini (2014) shows that both equity market participation and financial risk-taking rise significantly with total assets and lifetime income.

Similarly, using Italian household survey data, Guiso & Paiella (2008) document a clear positive relationship between wealth and risk tolerance. Wealthier individuals are more willing to bear financial risk, which helps explain why they tend to hold riskier portfolios. In a separate study based on detailed administrative data from Sweden, Bach et al. (2020) find that wealthier households consistently earn higher average returns, partly due to differences in portfolio composition and access to superior investment opportunities. Together, these findings suggest that wealth inequality is reinforced not only by differences in asset ownership but also by differences in risk preferences and returns, implying that the rich both invest more and earn more on their investments.

These empirical findings have informed a broader research agenda examining how asset allocation differences affect wealth inequality over time. In particular, Benhabib & Bisin (2018) presents a framework in which differences in portfolio composition are central to wealth accumulation and the persistence of inequality. Poorer households, by contrast, typically keep their limited resources in safer, more liquid assets such as bank deposits, which generate lower returns and may hinder long-term wealth accumulation.

Apart from wealth, age and the life cycle are key determinants of portfolio choices. Classic life-cycle portfolio theory suggests that younger investors, who have long investment horizons and whose human capital represents implicit wealth, should invest heavily in risky assets (since they have time to recover from fluctuations) and then gradually shift toward safer assets as they age and their investment horizon shortens (Samuelson, 1969). Real-world data only partly support this pattern and sometimes remain difficult to reconcile with theoretical predictions. Poterba & Samwick (2001) provided one of the early comprehensive analyses of age-

portfolio profiles in United States household data. They documented that stock ownership rates and the fraction of financial assets held in stocks tend to increase with age, at least until late middle age, and that even households beyond retirement often maintain substantial equity exposure. They also identified significant cohort effects, as generations exposed to different economic environments tend to exhibit distinct investment preferences. For example, individuals who came of age during the high-inflation 1970s or the booming stock markets of the 1980s displayed different risk preferences in their portfolio choices compared to earlier cohorts. Subsequent studies, such as Ameriks & Zeldes (2004), confirm that there is no dramatic reduction in equity holdings at retirement, as the simplest life-cycle models would predict. Instead, they show that equity shares conditional on stock ownership remain nearly constant with age, even among older households. This persistence in risky asset holdings may reflect behavioral factors such as inertia, a desire to leave bequests, or cohort effects related to past exposure to equity markets. In practice, the pure life-cycle gradient of declining risk exposure in older age appears muted. Nevertheless, younger households face unique constraints. For instance, they typically have limited wealth to invest and are exposed to significant background risks, such as labor income uncertainty, which effectively makes them more cautious with the smaller financial wealth they usually have (Guiso et al., 1996).

Mian & Sufi (2010) illustrated the consequences of overexposure to certain risks in their study of the Great Recession. United States counties where households had aggressively leveraged into housing, with high debt levels and a large concentration of real estate in their portfolios, suffered disproportionately when the housing bubble burst. This triggered severe household deleveraging and reduced consumption, which deepened the recession. Their findings highlight that life-cycle stages, such as young families with large mortgages, and portfolio composition, such as heavy exposure to housing and debt compared to diversified financial assets, can have macroeconomic implications. When many households make similar portfolio choices, these decisions can collectively amplify economic booms and downturns. Taken together, life-cycle effects on portfolio allocation are complex. Age, income profile, debt, and individual experiences all interact in shaping household financial decisions.

While age alone is a modest predictor of portfolio choice, once wealth, demographics, and cohort effects are considered, certain life-cycle patterns still emerge. In particular, middle-aged households tend to be more active in equity markets than younger and older groups (Arrondel et al., 2014). Beyond these individual-level characteristics, national context and institutional environment also play a key role. Households across countries face different financial systems, tax regimes, social security structures, and cultural attitudes toward investing, contributing to substantial cross-country variation in household portfolio allocation (Guiso et al., 2003). A broader comparative study using data from 15 European countries documents these differences clearly. For

instance, in countries like Germany and Italy, households hold a large share of their assets in bank deposits and have historically been more averse to equity market participation (Arrondel et al., 2014). In contrast, households in France and Belgium tend to invest more in life insurance and bonds, partly due to tax incentives. Meanwhile, Southern European countries exhibit particularly low equity participation rates, which may reflect lower levels of financial literacy, limited trust in financial markets, and a strong preference for tangible assets such as real estate. In contrast, the United States, the United Kingdom, and Scandinavian countries, to some extent, have a culture and institutional framework that encourages stockholding. This is facilitated through employer-sponsored retirement plans, mutual funds, and a broad retail investment industry, which together contribute to higher equity participation (Campbell, 2006).

Denmark represents a notable case, as Danish households traditionally hold substantial pension wealth due to the structure of the pension system, which includes mandated labor-market pensions and a strong private pension pillar. Therefore, a large share of household savings is automatically channeled into pension funds, which invest in diversified portfolios on behalf of households, including global equities and bonds. As a result, Danish households hold a significant portion of their wealth in equities, although primarily through indirect exposure via pension schemes. According to Byrialsen et al. (2022), the build-up of funded pension wealth in Denmark from the 1980s onward significantly increased households' overall financial asset holdings and market participation, making them among the wealthiest in Europe regarding net financial assets.

Outside of pensions, Danish households have traditionally favored conservative forms of saving, particularly bank deposits and real estate (Byrialsen et al., 2022). However, this pattern began to shift in the late 2010s. According to Danmarks Nationalbank (2021), the share of household financial assets held in equities and mutual fund shares rose substantially between 2019 and 2021, both in Denmark and across many EU countries. Denmark recorded one of the largest increases in equity shares in the EU during this period, suggesting a broader move away from low-yielding deposits in pursuit of higher returns. Although multiple factors contributed to this development, the historically low interest rates likely played a key role in prompting portfolio reallocation, even among typically risk-averse households.

Shocks and evolving economic conditions also influence household portfolio decisions. The 2008 Global Financial Crisis and the later European sovereign debt crisis profoundly impacted investor behavior. Following these crises, many households became more cautious. In France, for example, the number of individual shareholders (direct stock owners) fell by approximately 50% between 2008 and 2014, reflecting a retreat from equities and a shift toward safer savings products during a period of heightened uncertainty. Only in recent years, following economic recovery and policy changes such as France's 2018 flat tax on capital income and the phase-out of the wealth tax on financial assets, has this trend begun to reverse, with some households re-

entering the equity market (Arrondel & Coffinet, 2021).

Beyond institutional and policy-driven influences, recent research has also highlighted the role of social and behavioral dynamics in shaping household investment behavior. Bohlin & Rosvall (2014) provides a striking example of peer effects in portfolio choice. Analyzing data on Swedish investors, they show that investors with similar stock portfolios tend to make similar trading decisions going forward. In other words, investors who initially held comparable portfolios were later found to engage in similar trading behavior. The authors interpret this as evidence of imitation or reliance on shared information sources, such as neighbors or social networks exchanging stock tips or individuals reacting similarly to the same news. Such herd behavior and network effects indicate that portfolio allocation is not purely an individual decision but can diffuse through social groups, contributing to phenomena such as asset bubbles or synchronized market entry and exit among retail investors. These behavioral considerations add an important dimension to the understanding of household finance and complement the more traditional emphasis on preferences, constraints, and institutional factors.

In sum, the literature reviewed in this section provides a nuanced understanding of the factors shaping household portfolio behavior, including individual preferences and constraints, institutional structures, policy environments, social influences, and the impact of economic events. Although this thesis focuses on aggregate patterns due to data constraints, the theoretical and empirical insights presented here help interpret these patterns. These insights also provide a foundation for discussing the empirical results in light of the thesis's scope and limitations.

3.2. Empirical Applications of the (F)AIDS Model

Building on the broader review of household portfolio behavior, this section examines a parallel strand of literature that applies demand system models to asset allocation analysis. In particular, the Almost Ideal Demand System (AIDS) and its financial extension (referred to by some researchers as FAIDS) offer a theoretically consistent and empirically flexible approach to modeling how households and institutions allocate wealth across different asset types. These models provide an alternative to traditional portfolio allocation approaches by embedding asset allocation in a demand-theoretic framework that satisfies standard neoclassical properties such as homogeneity, symmetry, and budget constraints. The literature demonstrates how demand systems can accommodate multiple assets, account for dynamic adjustments, and incorporate real-world frictions that affect portfolio behavior. This makes the AIDS and Financial AIDS (FAIDS) frameworks particularly relevant for analyzing aggregate behavior in a way that remains anchored in microeconomic foundations. While the AIDS model is well established in studies of consumption, its application to financial asset allocation remains relatively limited. In particular, the FAIDS framework has received little attention, and existing studies

have been challenging to locate, suggesting that this remains a relatively underexplored field. By reviewing this literature, the section establishes the methodological foundations for the present study, which adapts the AIDS framework to the asset side of the Danish household sector's national accounts using a dynamic system estimation approach.

Barr & Cuthbertson (1991) were among the first to apply the AIDS model in a financial context, focusing on the United Kingdoms personal sector's demand for liquid assets. Rather than relying on traditional portfolio theory, they estimated a system of equations using dynamic adjustments and employed Three-Stage Least Squares (3SLS) to address simultaneity. Their results showed that wealth, income, interest rates, and inflation all significantly influenced the demand for liquid funds. The AIDS framework enabled them to impose and test theoretical restrictions typically absent in single-equation models, illustrating its potential for structured portfolio analysis. The study represents a foundational attempt to reconcile empirical money demand modeling with consumer demand theory and marked an early step in the integration of portfolio behavior into broader economic modeling traditions.

Expanding on this approach, Dinienis & Scott (1993) applied the AIDS model to British pension funds, highlighting its relevance for institutional investors. They developed a dynamic, multi-period model incorporating adjustment costs and forward-looking behavior. Estimating the model as a simultaneous system, they found that interest rates and wealth were key drivers of portfolio allocation. Their empirical specification also allowed for the estimation of forward-looking parameters such as discount factors and demonstrated the model's consistency with classical demand theory under certain restrictions. Their work demonstrated how the AIDS model could be extended beyond individual households to account for strategic behavior in large, professionally managed portfolios, providing insights into how institutional frictions and planning horizons shape demand.

The AIDS framework has also been applied to developing economies. Adam (1999) applied the model to household portfolio choice in Kenya, incorporating inflation and credit rationing into the specification. He estimated a cointegrated demand system and found that high inflation prompted a shift toward real assets (in the form of equity claims) as households sought to preserve wealth. Credit constraints further shaped asset composition by limiting access to formal financial instruments. The study emphasized the importance of accounting for institutional and macroeconomic conditions when applying demand models in developing economies. Adam's work showed how portfolio behavior adjusts to financially repressive environments and offered a framework for future research in contexts where asset markets are underdeveloped or heavily regulated. The study also underscores that coherent empirical models can yield meaningful insights into household preferences and constraints even in highly distorted economic environments.

Blake (2004) introduced the FAIDS model, broadening the scope of AIDS to include both financial and non-

financial wealth. Using annual United Kingdom data spanning several decades, he estimated household demand for five wealth components: net financial wealth, housing and durables, public pensions, private pensions, and human capital. Blake's results highlighted that wealth and asset returns were central to allocation decisions but that demographic and institutional variables also played a substantial role. A key insight was the sluggish adjustment of portfolios over time, pointing to frictions such as transaction costs or behavioral inertia. Blake also quantified several key elasticities, including how households substitute between financial and non-financial assets in response to shifts in relative returns. His methodological innovations and rich dataset enabled a nuanced understanding of portfolio dynamics across different life cycle stages and macroeconomic environments. Blake's FAIDS framework laid the groundwork for most of the later studies using FAIDS.

In a German context, Scharnagl & Ramb (2010) applied a FAIDS model to a long quarterly dataset, using cointegration analysis and multivariate error correction models. Their findings mirrored those of Blake, with wealth and return elasticities close to one and evidence of substitution effects across assets. They also confirmed that demand restrictions such as homogeneity and symmetry could be tested and were broadly consistent with observed behavior. These results supported the view that FAIDS models can capture both long-run equilibrium relationships and short-run dynamics in household portfolios. Moreover, their use of detailed quarterly data allowed for fine-grained identification of how portfolio shares respond to monetary policy shifts, such as changes in interest rates, demonstrating the FAIDS model's ability to track evolving household behavior in real-time. Their work illustrates how financial data, when paired with theoretically grounded models, can generate policy-relevant insights into the saving and investment responses of households.

Bashar Al-Zu'bi and Khalid Al-Zu'bi (2014) extended the AIDS approach to a regional comparative setting, estimating household demand systems for Israel, Jordan, and Turkey. Using panel estimation and SUR techniques, the study identified shared and country-specific portfolio allocation patterns. Net wealth and returns were central variables, and theoretical restrictions held in most specifications. The study demonstrated the adaptability of the AIDS model to diverse financial systems and highlighted the importance of institutional development in shaping asset responses to economic conditions. In particular, Bashar Al-Zu'bi and Khalid Al-Zu'bi (2014) showed how financial maturity affects the sensitivity of asset demand to interest rate changes and how structural characteristics influence substitution patterns among asset classes. The cross-country design made it possible to isolate general behavioral tendencies from local market idiosyncrasies, enriching the interpretation of results. This comparative element is beneficial for understanding how transferable model structures are across different economic and institutional environments.

In France, Avouyi-Dovi et al. (2019) estimated a FAIDS model on data from 1978 to 2016, incorporating bo-

th financial asset returns and macroeconomic indicators such as uncertainty and business cycle variables. The model revealed strong own- and cross-price effects, indicating widespread substitution between asset types. A policy simulation based on the model predicted that the 2018 flat tax on capital income would shift household portfolios toward equities and away from life insurance products, illustrating the model's potential for policy evaluation. The inclusion of policy variables and simulation capacity demonstrates how the FAIDS framework can be used to predict responses to institutional reforms. Their findings highlight the model's relevance for policymakers interested in understanding the wealth distributional effects of tax changes. The study serves as an example of how empirically grounded models can bridge academic research and applied policy analysis.

Although most applications of the AIDS model in this review relate to financial assets (FAIDS), Altayeb & Daoud (2022) illustrates its continued relevance for analyzing household consumption decisions. Their estimates revealed distinct patterns of income and price elasticities across consumption categories and demonstrated that while classical demand theory restrictions were rejected, the model still provided meaningful insights. This application underscored the broader relevance of the AIDS framework in capturing household behavior across different economic domains. In particular, their results emphasized how differences in necessity and luxury goods consumption can inform policy design in developing economies, especially in contexts where income policy is constrained, and price-based interventions are more feasible. Although the context differs from financial asset allocation, the study demonstrates that the AIDS model can estimate coherent demand systems across categories and under varying constraints.

Last year, Petropoulou & Murinde (2024) extended the FAIDS framework by incorporating Financial Technology (FinTech) adoption as a determinant of asset allocation. Using cross-country panel data across OECD economies, they analyzed the impact of FinTech growth on household portfolio shares. Employing SUR estimation and controlling for wealth and returns, they found that FinTech has a positive effect on the budget share of currency and deposits in the United Kingdom, European Union, and Australia, while in the United States, it increases the share of equity and bank loans but decreases the share of debt securities. Their model revealed that digital platforms and technological innovations reduced frictions and encouraged risk-taking, aligning with portfolio theory predictions and emphasizing how evolving financial infrastructure affects demand patterns.

The literature reviewed in this section confirms that the AIDS and FAIDS models offer a robust and adaptable framework for analyzing portfolio allocation. Across a wide range of contexts, studies show that wealth and asset-specific returns are key determinants of portfolio composition. Cross-asset effects are typically dominated by substitution, and the pace of adjustment varies by market. Some studies report gradual portfolio rebalancing due to frictions such as transaction costs or inertia, while others observe more immediate responses

to price signals. Extensions that incorporate credit constraints, policy changes, or technological innovations further demonstrate the model's flexibility and relevance. This body of research illustrates that demand system models not only accommodate diverse economic environments but also allow for theoretically consistent estimation of substitution patterns and wealth effects. These insights motivate and support the empirical approach taken in this thesis, which builds on the AIDS tradition to investigate how Danish households adjust their asset holdings in response to changing relative prices.

3.3. Positioning This Thesis in the Literature

While the Almost Ideal Demand System (AIDS) is well established in the analysis of consumption behavior, its application to financial asset allocation remains relatively limited. In particular, studies employing the financial adaptation of the model to national household portfolio data are scarce. Although the broader empirical literature confirms that these models provide a coherent and versatile framework for analyzing portfolio behavior, most empirical contributions are from earlier decades, and relatively few recent studies have expanded on this tradition. This pattern is especially pronounced in the case of Financial AIDS models, which has received considerably less attention compared to the original AIDS.

Moreover, studies applying a financial AIDS model to aggregated household-sector data disaggregated by asset type are even more rare. Among the reviewed literature, only the German study by Scharnagl & Ramb (2010) explicitly uses detailed financial account data broken down by asset class over a long time horizon to estimate household asset demand. Most other studies rely on more detailed data and consequently do not model household portfolio allocation at the same aggregated level as the present thesis within a consistent macroeconomic framework. The relative difficulty in identifying comparable studies suggests that using AIDS with aggregated financial balance sheet data at the household sector level remains an underexplored empirical approach in the literature.

This thesis contributes to filling this research gap by applying the AIDS framework to the asset side of the financial balance sheet for the Danish household sector, using aggregated national account data disaggregated by asset type. Employing a dynamic estimation strategy that combines Local Projections (LP) with Seemingly Unrelated Regressions (SUR), the study introduces a novel empirical approach to modeling household asset allocation. In doing so, it extends the empirical use of the AIDS model. It offers new insights into how households in a modern European welfare state adjust their portfolios in response to changes in relative asset prices. The contribution lies not only in the methodological design and the use of asset-level sector data but also in demonstrating the continued relevance and adaptability of the AIDS framework in a contemporary macro-financial context. The next Section provides the theoretical and methodological framework on which the study's empirical model is based.

4. Theoretical and Empirical Framework

This section consists of two main parts. The first part outlines the theoretical foundations, beginning with Tobin's portfolio theory and continuing with the sectoral balance sheet framework, which defines and classifies financial assets. The second part presents the empirical methodology, combining the Almost Ideal Demand System model with Local Projections and Seemingly Unrelated Regressions to estimate the dynamic relationship between asset prices and household portfolio allocation. The section concludes with a summary that links the theoretical insights and empirical tools to the final model setup.

4.1. Theoretical Foundations

This section outlines the theoretical foundations for analyzing household asset allocation. It begins by presenting Tobin's portfolio theory, which explains how individuals make optimal portfolio choices under risk. The section then extends to a macroeconomic perspective by incorporating sectoral balance sheets, thereby linking micro-level theory with the broader financial structure of the economy.

4.1.1. Tobin's Portfolio Theory

James Tobin's portfolio theory provides the theoretical foundation for this thesis, which analyzes how households allocate their financial assets. Tobin's theory explains how economic agents make decisions about allocating their financial wealth across various asset types, taking into account returns, risk, and liquidity. According to Tobin, households maximize their expected utility subject to a budget constraint and select a portfolio composition that reflects their preferences for risk and return. An important assumption in Tobin's theory is that assets are not perfect substitutes. This implies that changes in the relative returns between assets lead to partial adjustments in the portfolio composition, rather than complete reallocations. Therefore, households aim to construct diversified portfolios that maximize expected utility within their budget constraints (Tobin, 1958).

Formally, Tobin's theoretical framework can be described as an optimization problem, where the utility U of households is maximized, subject to a budget constraint that ensures proper allocation of all resources. This optimization problem can be expressed as follows:

$$\max_{w_i} U(w_1, w_2, \dots, w_n) \quad \text{such that} \quad \sum_{i=1}^n w_i = 1 \quad (4.1)$$

Here, w_i represents the proportion of total wealth invested in asset i . This budget constraint ensures that the entire wealth is allocated and no more than the available wealth is invested.

Tobin's framework is embedded in microeconomic theory and focuses on individual portfolio choices under risk. However, when aggregated across households, these choices shape the financial structure of the household sector as a whole. By incorporating sectoral balance sheets, the analysis extends Tobin's logic to a macroeconomic context, thereby justifying its application in empirical models of household asset allocation using sector-level data.

4.1.2. Sectoral Balance Sheets

In this macroeconomic context, balance sheets record the value of assets and liabilities for institutional units at a given time. These entries represent the stock of assets and liabilities held at a specific time and are valued at market prices at both the beginning and end of the period (Godley & Lavoie, 2007). The sum of assets and liabilities across all sectors of the economy must equal zero, which reflects the accounting identity. Any change in the assets or liabilities of one sector is offset by a corresponding change in another sector, as economic transactions always involve at least two counterparties. This principle follows the core accounting rule that the total sum of economic changes is neutral. Each institutional sector, including households, corporations, the public sector, and the rest of the world, holds assets grouped into eight standardized financial categories, regardless of whether they have matching liabilities. These categories, defined by the Statistics Department - International Monetary Fund (2007), classify financial instruments based on the nature of the claim, marketability, and economic function.

Presenting these categories provides a clear foundation for analyzing household portfolio choices, as they represent the types of financial instruments in which households can allocate their wealth. Although this thesis focuses exclusively on the asset side of the household balance sheet, it is still important to acknowledge the existence of counterpart liabilities. These help to clarify the origin of financial claims and maintain consistency with the sectoral balance sheet framework. Some asset categories correspond directly to liabilities in other sectors, while others, such as gold reserves or financial derivatives, may not have an identifiable liability counterpart. The following list outlines each financial asset category as defined by the Statistics Department - International Monetary Fund.

- **Gold Reserves:** These are considered financial assets for conventional reasons, as they can be used by monetary authorities to settle economic claims. Gold reserves are a financial asset with no corresponding liabilities.
- **Currency and Deposits:** These are the most liquid financial assets. Currency consists of notes and coins with a fixed nominal value used for transactions. Currency is issued by central banks and governments. Deposits are categorized into transferable and other deposits, with transferable deposits being exchangeable at their nominal value and used directly for transactions.

- **Securities other than Shares (Bonds):** These are negotiable instruments that represent evidence of an entity's obligations, typically the payment of interest and the repayment of principal at maturity. Short-term securities, particularly those issued by deposit-taking corporations, can be close substitutes for deposits.
- **Loans:** Non-negotiable financial claims created when a creditor provides funds directly to a borrower. Loans typically carry interest, which can be either fixed or variable depending on contractual terms.
- **Shares and Other Equity (Equity):** Ownership instruments that entitle holders to a share of a corporation's residual value after debts are paid. They may yield dividends and are typically held for potential capital gains. Their return is not fixed and depends on corporate performance.
- **Insurance Technical Reserves:** Obligations of insurance companies and pension funds to their members. These obligations include households' net equity in life insurance reserves, net equity in pension funds, amounts outstanding but not earned when premiums are prepaid, and amounts reserved for outstanding claims.
- **Financial Derivatives:** Instruments linked to a specific financial asset, indicator, or commodity. These allow specific financial risks (such as interest rate risk, currency risk, equity and commodity price risk, credit risk, etc.) to be traded in financial markets. The value of a derivative instrument stems from the price of the underlying asset or index.
- **Other Receivables/Liabilities:** Includes trade credit, advances, and a wide variety of miscellaneous creditor/debtor relations that do not fall under other categories.

This thesis focuses exclusively on household financial assets. Consequently, the analysis does not directly incorporate household liabilities such as loans or the net worth. Instead, it examines how households allocate their financial wealth across different types of assets in response to changes in relative asset prices. To support this approach, the table below presents a simplified representation of the household balance sheet, based on the sectoral accounting framework inspired by Godley & Lavoie (2007).

Table 4.1: Household Financial Assets and Counterpart Liabilities

	HH	NFC	FC	GOV	NPI	ROW	Sum
Currency and Deposits (C)	$+C_{hh}$		$-C_{fc}$	$-C_{gov}$			0
Bonds (B)	$+B_{hh}$	$-B_{nfc}$	$-B_{fc}$	$-B_{gov}$		$-B_{row}$	0
Equity (E)	$+E_{hh}$	$-E_{nfc}$	$-E_{fc}$		$-E_{npi}$	$-E_{row}$	0
Insurance Technical Reserves (I)	$+I_{hh}$		$-I_{fc}$				0
Sum	0	0	0	0	0	0	0

Note: Where Households is noted as HH, Non-financial companies as NFC, Financial companies as FC, The public sector as GOV, Non-profit institutions as NPI and Rest of the world as ROW

Table 4.1 displays a selection of key asset categories held by the household sector, including Currency and Deposits, Bonds, Equities, and Insurance Technical Reserves. The table also shows the sectors from which these assets originate. These sectors include non-financial corporations, financial corporations, the general government, non-profit institutions, and the rest of the world. Each household asset holding is shown as a positive entry, while the corresponding liabilities are recorded in the columns of the issuing sectors. The table is constructed so that each row sums to zero, thereby maintaining the fundamental accounting identity underpinning the balance sheet framework.

For example, household ownership of Equities appears as a positive entry in the household column, while the corresponding negative entries are recorded under non-financial corporations, financial corporations, non-profit institutions, and the foreign sector, which are the entities issuing these Equity instruments. Likewise, Bonds held by households are mirrored as liabilities in the public sector, financial corporations, non-financial corporations, and foreign issuers. Insurance Technical Reserves, such as pensions and life insurance policies, are recorded as assets for households and as liabilities for financial corporations. Currency and Deposits are primarily issued by financial corporations and the central bank, which is part of the general government sector.

Table 4.1 illustrates how each asset held by households is directly linked to a liability in another sector of the economy. This representation clarifies which sectors issue the corresponding claims and traces the connections between household asset composition and the sectors holding the associated obligations. The analysis links Tobin's microeconomic theory of portfolio allocation with a macroeconomic framework by embedding household portfolio choices within a sectoral accounting structure, thereby providing a consistent foundation for studying aggregate portfolio behavior.

4.2. Empirical Methodology

This section describes the empirical approach to estimating the dynamic relationship between relative asset prices and household asset allocation. The analysis applies an Almost Ideal Demand System (AIDS) specification, extended dynamically through Local Projections (LP), and estimated using Seemingly Unrelated Regressions (SUR). This combination provides a framework that captures substitution patterns across assets, allows for dynamic responses to price changes, and exploits efficiency gains from system estimation while ensuring consistency with microeconomic theory.

4.2.1. Almost Ideal Demand System (AIDS)

The Almost Ideal Demand System (AIDS), developed by Deaton & Muellbauer (1980), provides the basis for modeling household asset allocation in this thesis. The model was originally designed to explain how consumers allocate expenditure across goods and services, and the framework is well suited for portfolio settings in

which households distribute their wealth across different asset categories. Its flexibility and theoretical consistency make it appropriate for capturing asset substitution patterns in response to changes in relative prices and overall wealth. The Almost Ideal Demand System can be estimated as follows:

$$w_i = \alpha_i + \sum_{j=1}^n \gamma_{ij} \log p_j + \beta_i \log \left(\frac{X}{P} \right) \quad (4.2)$$

Here, w_i is the budget share allocated to good i , p_j is the price of good j , X is total expenditure (or wealth), α_i captures the baseline budget share for good i , γ_{ij} measures how the price of good j affects the budget share of good i , and β_i reflects the sensitivity of the budget share for good i to changes in total expenditure relative to the Stone price index P , which can be written as:

$$\log P = \sum_{j=1}^n w_j \log p_j \quad (4.3)$$

The model incorporates several theoretical restrictions to ensure coherence with microeconomic demand theory and to provide economically meaningful results. These restrictions reflect fundamental consumer and investor behavior principles and help anchor the empirical specification.

The adding-up condition requires that the sum of budget shares across all asset categories equals unity:

$$\sum_{i=1}^n w_i = 1 \quad (4.4)$$

Equation 4.4 reflects the budget constraint households face, which implies that wealth must be fully allocated across available assets.

The homogeneity restriction implies that demand depends solely on relative prices and not on their absolute levels. Thus, proportional changes in all prices and wealth should leave portfolio shares unaffected. This is imposed by constraining the sum of price coefficients in each equation to zero:

$$\sum_{j=1}^n \gamma_{ij} = 0 \quad (4.5)$$

This condition reflects the idea that only real price differences matter for household decisions, ensuring that nominal price changes alone do not affect allocation patterns.

Finally, the symmetry restriction implies that substitution effects between assets are mutual. That is, the effect of a price change in asset j on the budget share of asset i is identical to the effect of a price change in

asset i on the budget share of asset j :

$$\gamma_{ij} = \gamma_{ji} \quad (4.6)$$

In other words, the effect of price changes is assumed to be reciprocal and consistent with the principles of consumer choice.

Together, these restrictions ensure that the AIDS model remains grounded in economic theory while allowing for flexible and interpretable substitution patterns among financial assets. By imposing adding-up, homogeneity, and symmetry, the model captures realistic household portfolio decisions in a way that respects both budgetary constraints and the mutual interdependence of assets.

While the AIDS model provides a solid theoretical structure for analyzing portfolio allocation, it does not account for how these decisions evolve over time. To address this limitation, the analysis incorporates a dynamic extension of the AIDS model using Local Projections.

4.2.2. Local Projections (LP)

The Almost Ideal Demand System (AIDS) provides a static representation of household asset allocation, describing how wealth is distributed across asset categories at a given point in time based on relative prices and total wealth. However, changes in asset prices or household wealth typically lead to adjustments that occur gradually rather than immediately. This gradual adjustment reflects the presence of friction, adjustment costs, and behavioral inertia.

To analyze this adjustment process, Local Projections (LP) are used to estimate a dynamic version of the AIDS model. This approach extends the static framework by allowing budget shares to adjust over time in response to changes in relative prices. The Local Projections approach provides a flexible tool for analyzing these dynamics across multiple horizons.

Local Projections can be estimated using the following specification:

$$y_{t+h} = \alpha^h + B_1^h y_{t-1} + \dots + B_p^h y_{t-p} + \varepsilon_{t+h}, \quad h = 0, 1, \dots, H-1 \quad (4.7)$$

where α^h denotes a vector of constants, B_i^h represents the parameter matrices associated with lag i at forecast horizon h , and ε_{t+h} is the error term.

In this model, only the dependent variable is projected h periods ahead, while the independent variables remain fixed at their values at time t . Alternatively, the independent variables can also be shifted forward while the dependent variable is held fixed at its current period, depending on the research design and the nature of

the shock or price variation under investigation (Adämmer, 2019). Corresponding impulse response functions (IRFs) are then generated for each specification, visually representing how household portfolio shares adjust over time in response to relative price changes.

Because the Local Projections framework generates a system of equations, with one equation for each asset in the AIDS model and for each forecast horizon, where each equation depends on the prices of all assets, it is essential to account for potential correlations across these equations. The analysis employs a system estimation technique to address this, described in the following section.

4.2.3. Seemingly Unrelated Regressions (SUR)

The estimation of the dynamic AIDS model via Local Projections produces a system of equations, that each corresponds to a specific asset category and forecast horizon. Given the interconnected nature of portfolio decisions, unobserved shocks are likely to affect multiple asset categories simultaneously. This creates the potential for correlation across the error terms of these equations, which can reduce the efficiency of standard estimation methods.

To address this issue, Seemingly Unrelated Regressions (SUR), introduced by Zellner (1962), is applied. SUR is an econometric technique designed to estimate multiple regression equations simultaneously when the disturbances across equations may be correlated. By accounting for the covariance structure of the error terms, SUR produces more efficient parameter estimates than would be obtained from estimating each equation separately using Ordinary Least Squares (OLS).

The SUR framework is expressed as:

$$Y_i = X_i\beta_i + \epsilon_i, \quad i = 1, \dots, k \quad (4.8)$$

where Y_i is an $n \times 1$ vector of observations for the dependent variable in equation i , X_i is a matrix of explanatory variables, β_i is the vector of coefficients, and ϵ_i represents the error terms. A defining feature of SUR is that these error terms are allowed to be contemporaneously correlated across equations:

$$\text{Cov}(\epsilon_i, \epsilon_j) = \sigma_{ij} \quad \text{for } i \neq j \quad (4.9)$$

Estimation proceeds in two stages. In the first stage, each equation is estimated separately using OLS, and the residuals are used to estimate the covariance matrix of the disturbances. In the second stage, the system is re-estimated using Generalized Least Squares (GLS), which incorporates the cross-equation correlations of the error terms. This two-step procedure yields more efficient parameter estimates compared to estimating each equation separately using OLS.

4.3. Summary of the Framework

This section has outlined the theoretical and empirical foundations underpinning the analysis of household asset allocation. At its core is Tobin's portfolio theory, which provides a microeconomic rationale for how households diversify their financial assets based on risk, return, and liquidity preferences. To connect individual portfolio choices to the macroeconomic context, the framework incorporates sectoral balance sheets, focusing specifically on the asset side of household balance sheets. This establishes a conceptual link between Tobin's microeconomic theory and the empirical investigation of household asset allocation.

On the empirical side, the Almost Ideal Demand System (AIDS) serves as the primary model for capturing how households allocate wealth across asset categories in response to changes in relative prices and total wealth. To account for the dynamic nature of portfolio adjustments, the model is extended using Local Projections (LP), which trace how asset shares evolve over time. Finally, Seemingly Unrelated Regressions (SUR) are applied to efficiently estimate the system of equations while accounting for contemporaneous correlations between assets.

Together, these components establish a theoretically consistent and empirically grounded framework for addressing the thesis's research question: *How do relative asset prices affect Danish households' allocation of financial assets?* The model captures own-price and cross-price substitution patterns as well as dynamic adjustment processes, providing a comprehensive lens for understanding household portfolio behavior.

The theoretical framework presented in Section 4.1 informs the interpretation of the empirical results, while the empirical methodology outlined in Section 4.2 provides the basis for the model specification in Section 6. Together, these sections form a coherent structure for analyzing the dynamic adjustment processes and substitution patterns across asset categories in household portfolio allocation.

5. Data Handling and Descriptive Statistics

The following section lays the empirical groundwork for the analysis by presenting the financial asset and price data used to estimate the AIDS model. It outlines the data sources, variable construction, and key transformations while also providing descriptive insights into the development of both asset shares and prices over time. The section concludes with a discussion of the measurement quality, addressing the validity and reliability of the variables applied.

5.1. Household Financial Assets

This section introduces the household financial assets used in the empirical analysis. It outlines the data sources and processing steps, provides descriptive statistics, and explains the selection of the four financial assets included in the AIDS model. Finally, the development of the corresponding asset weights is presented and justified in line with the model's theoretical requirements.

5.1.1. Data Processing

Data on household assets are retrieved from Danmarks Nationalbank's dataset DNFIK¹ (Danmarks Nationalbank, Statistikbanken, 2020). The dataset reports values in billion DKK on a quarterly basis for the period from 2005 Q1 to 2020 Q1. In addition to data household assets, annual GDP figures for Denmark are also collected. These variables are obtained from the dataset NAN1² and, like the household asset data, are reported in billion DKK. This ensures that GDP shares are calculated using consistent units (Danmarks Nationalbank, Statistikbanken, 2024).

The decision to use quarterly data for household assets and annual data for GDP follows Eurostat's conventions for national accounts (Statistics Eurostat, 2024). This approach provides approximate consistency with the values reported by Eurostat in its dataset on Denmark's quarterly financial balance sheets³, thereby supporting the reliability of the adopted method. As a result, all asset values are initially presented as a percentage of GDP in the descriptive analysis and later expressed as the weights of each asset category used in the final model.

5.1.2. Descriptive Statistics

This section presents three figures illustrating the financial assets used in the model. The first figure, 5.1, shows a plot of all the financial items found on the asset side of the household balance sheet. Figure 5.2 dis-

¹DNFIK: Quarterly financial accounts by sector, account entry, financial instrument, and counterpart sector, DKK billion

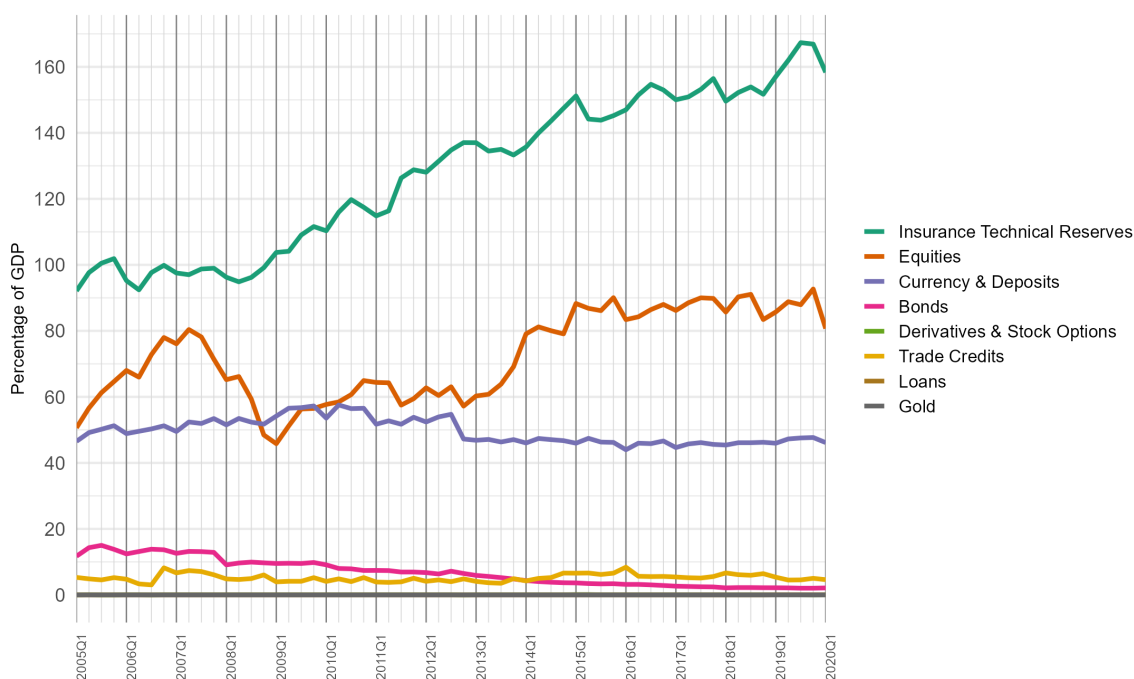
²NAN1: Demand and supply by transaction and price unit

³National accounts (ESA2010) (Statistics Eurostat, 2024).

plays the four selected financial assets used to establish the AIDS model. The final figure, 5.3, depicts the development of the weights of the four selected assets over time. All three figures cover the entire analysis period, presented in quarterly data from 2005 Q1 to 2020 Q1.

Examining Figure 5.1, it is evident that the various household financial assets display differing trends over the analysis period. For instance, Insurance Technical Reserves exhibit a steady and continuous increase. Equities also show a general upward trend, albeit with more pronounced fluctuations. As expected, Equities display the highest volatility among the assets and are particularly more affected by the financial crisis than other assets. Currency and Deposits remain relatively stable, although a slight decline is observed from around 2012 Q4 to 2020 Q1, compared to earlier years. Bonds and trade credits constitute only a minor share of total household assets, with bond holdings gradually declining over time and eventually falling below the level of trade credits around 2014 Q1. Gold holdings remain effectively zero throughout the entire period, which is unsurprising given that private households typically do not hold gold as a financial asset. Similarly, the category of derivatives and stock options is negligible, with a maximum value of just 0.09 percent of GDP, and thus not visually distinguishable in the figure. Loans are not included in the figure, as they pertain to the liability side of the balance sheet, and the focus here is exclusively on assets. A full description of the household sector's balance sheet components, including both assets and liabilities, is provided in Section 4.1.2.

Figure 5.1: All Household Financial Assets (and Liabilities)

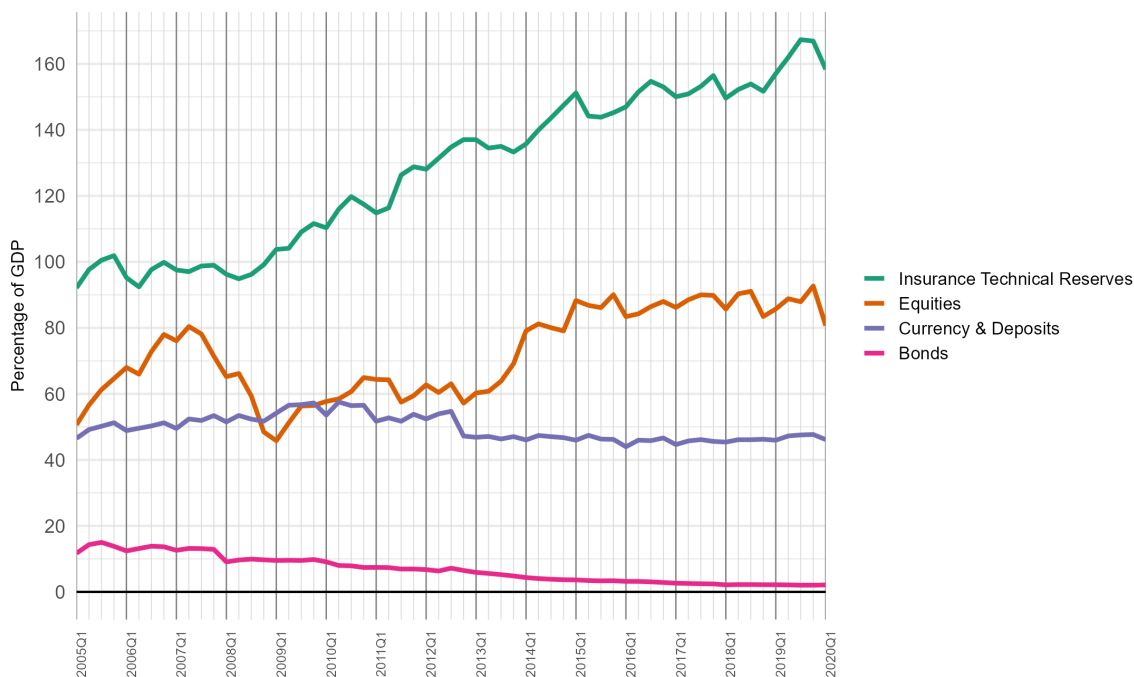


Source: Own presentation of data obtained from (Danmarks Nationalbank, Statistikbanken, 2020), compiled as stated on 2025-03-20

Based on the overview in Figure 5.1, a selection of four household financial assets is made for the specification of the AIDS model. These are presented in Figure 5.2 and include Insurance Technical Reserves, Equities, Currency and Deposits, and Bonds. These assets are chosen mainly due to their relative size in household portfolios, their consistent availability in the dataset, and their ability to represent distinct types of financial investment behavior. Specifically, Insurance Technical Reserves are included because they constitute a large and growing share of household financial wealth. Equities capture households' exposure to market risk and return-seeking behavior. Currency and Deposits reflect highly liquid and low-risk savings, offering a contrast to more volatile assets. Bonds are incorporated as fixed-income, lower-risk instruments that add further diversification across asset types.

Assets such as Gold, Trade Credits, and Derivatives and Stock Options are excluded. Gold is omitted due to negligible holdings throughout the analysis period. Trade credits are excluded because they represent a relatively small share of household financial assets, and it is difficult to construct a consistent relative price series for them over the entire analysis period at the required frequency (daily, monthly, or quarterly). Derivatives and Stock Options are disregarded due to their minimal presence in household portfolios. Lastly, Loans are not considered, as they belong to the liability side of the balance sheet and fall outside the scope of this analysis, which focuses exclusively on financial assets.

Figure 5.2: Household Financial Assets used in the AIDS Model



Source: Own presentation of data obtained from (Danmarks Nationalbank, Statistikbanken, 2020), compiled as stated on 2025-03-20

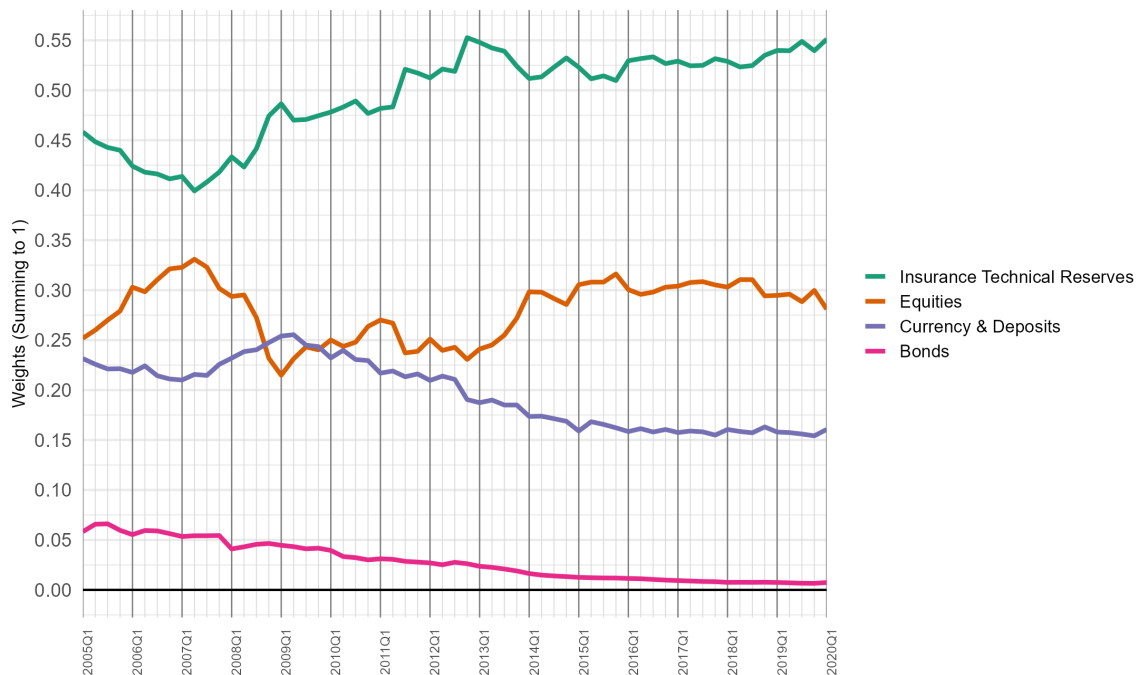
As presented in Section 4.2.1, the consumer goods included in the AIDS model, in this case financial assets, must be expressed as expenditure shares. This means that each asset is represented by its weight relative to the total value of all assets. This involves calculating the total value of the four selected financial assets, after which each asset's share can be determined. Figure 5.3 illustrates how these weights evolve over the analysis period from 2005 Q1 to 2020 Q1. The asset weights broadly mirror the trends observed in Figures 5.1 and 5.2 but present a clearer picture of the relative size of each asset in the household portfolio. Most notably, Insurance Technical Reserves consistently account for the largest share. It accounts for about 45% at the start of the period and increases to approximately 55% by the end.

Equities show more fluctuation. Around the time of the financial crisis, their weight declined notably, likely reflecting both price revaluations and transactions. However, these underlying mechanisms are not explored in detail in this thesis. Between 2005 Q1 and 2014 Q1, the equity share varied between approximately 22% and 33% before stabilizing near 30% for the remainder of the period.

Currency and Deposits exhibit relatively modest variation. At the beginning of the period, they account for around 23% of the portfolio, fluctuating between 21% and 25% up to 2009 Q1. Thereafter, their share gradually declines, reaching just over 15% by 2020 Q1.

Bonds represented the smallest proportion throughout the period, declining steadily from about 6% at the beginning to approximately 1% by the end.

Figur 5.3: Household Financial Assets Weights used in the AIDS Model



Source: Own presentation of data obtained from (Danmarks Nationalbank, Statistikbanken, 2020), compiled as stated on 2025-03-20

As expected in a correctly specified weight system, any increase in one asset's weight is offset by a decrease in at least one other, which is clearly observed in Figure 5.3. Another notable feature is the relative stability of the asset shares from 2014 Q1 onward, with only minor fluctuations. This stability supports the feasibility of modeling these weights in relation to corresponding asset prices.

It is important to emphasize that the asset weights shown in Figure 5.3 are used in their presented form in the AIDS model. This approach is consistent with the theoretical framework, where weights represent the actual shares of total financial assets allocated to each asset category. While the weights may exhibit non-stationary behavior, transforming them by differencing would remove their economic interpretation as portfolio shares. Therefore, using asset weights as they are here is theoretically justified and necessary for maintaining internal consistency within the AIDS model.

Based on this overview of the asset weights, the following section presents the corresponding price series used for each asset, along with the theoretical considerations and econometric choices underlying their construction.

5.2. Prices of Household Financial Assets

This section introduces the price data used in the empirical analysis. It describes the data sources and processing steps, outlines the selection of appropriate price proxies for each financial asset, and discusses the transformations necessary to align the series with both the theoretical structure of the AIDS model and the econometric requirements of stationarity. Finally, the transformed series used in the AIDS model are presented.

5.2.1. Data Processing

The price proxies used in the final model are collected from various official sources and transformed to ensure frequency, scale, and interpretation consistency. Price proxy data for the asset categories Insurance Technical Reserves and Currency and Deposits are sourced from Danmarks Nationalbank's Statistikbanken. Specifically, Revaluations of Insurance Technical Reserves are used as a proxy for the price of that asset category. The Certificate of Deposit rate serves as a proxy for the price of Currency and Deposits.

Data on Revaluations of Insurance Technical Reserves are retrieved from the dataset DNFIK⁴ (Danmarks Nationalbank, Statistikbanken, 2020), just like the household financial assets are, which reports quarterly observations in billion DKK. The Certificate of Deposit rate is obtained from the dataset DNRENTD⁵ (Danmarks Nationalbank, Statistikbanken, 2025), where it is available at a daily frequency. To harmonize this with the quarterly format of the other obtained variables, the daily Certificate of Deposit rate is converted to quarterly frequency by averaging the daily observations within each quarter.

⁴DNFIK: Quarterly financial accounts by sector, account entry, financial instrument and counterpart sector, DKK billion

⁵DNRENTD: Danmarks Nationalbank's official interest rates and money and capital market interest rates (daily observations)

For the remaining two asset categories, which are Equity and Bonds, price proxies are collected from the FRED database maintained by the Federal Reserve Bank of St. Louis. The proxy for Equities is the Share Prices for Denmark series, which is available at a quarterly frequency and indexed to 2010 Q1 = 100⁶ (Federal Reserve Bank of St. Louis, 2025a). The proxy for Bonds is the 10-year government bond yield for Denmark, available at a quarterly frequency. For consistency with the Equities proxy, this series has been transformed into an index with a base period of 2010 Q1 = 100⁷ (Federal Reserve Bank of St. Louis, 2025b).

To ensure comparability across all price proxies, the series from Danmarks Nationalbank, including the Revaluations of Insurance Technical Reserves and the transformed Certificate of Deposit rate, are also converted into indices with a base of 2010 Q1 = 100. This transformation facilitates the direct comparison of relative price movements across asset categories in the subsequent model estimation.

All data are collected quarterly and span the full analysis period from 2005 Q1 to 2020 Q1, except for the Certificate of Deposit rate, which is originally reported daily and has been converted to quarterly.

5.2.2. Selection of Price Proxies

The selection of appropriate price proxies for the four financial asset categories included in the AIDS model is guided by a combination of theoretical considerations, economic interpretability, and practical constraints related to data availability. In line with the requirements of the AIDS framework, the price variables must exhibit sufficient variation over time to identify substitution patterns and price responsiveness in household portfolio choices (Deaton & Muellbauer, 1980). Furthermore, the proxies must be available at a quarterly frequency as a minimum and cover the whole analysis period from 2005 Q1 to 2020 Q1 to ensure temporal consistency with the corresponding asset data.

For each asset category, proxies were selected that most accurately capture the economic concept of price relevant to household decision-making while also ensuring alignment with the corresponding asset. The selected proxy for Equity is the Share Prices for Denmark index. This series directly captures fluctuations in equity valuations and is well-suited to reflect the market-driven dynamics that influence households' exposure to risk and return through their Equity holdings (OECD, n.d.). The proxy for Bonds is Denmark's 10-year Government Bond Yield. This yield serves as a benchmark rate that reflects market expectations regarding inflation and monetary policy. It is directly relevant to households' investment decisions, as it represents the return they can expect on fixed-income securities, making it a conceptually grounded and empirically robust indicator for Bond valuation (OECD, n.d.).

⁶FRED Economic Data, Financial Market: Share Prices for Denmark

⁷Interest Rates: Long-Term Government Bond Yields: 10-Year: Main (Including Benchmark) for Denmark

The Certificate of Deposit rate is used for the Currency and Deposits category. This short-term interest rate reflects the opportunity cost of holding highly liquid and secure financial assets, as it represents the return foregone by not investing in higher-yielding alternatives (Mishkin & Eakins, 2018, Chapter 11). Given its empirical variation across the sample period, the Certificate of Deposit rate is capable of capturing the relative price dynamics required by the AIDS model. As an alternative, the interest rate was considered. However, it was excluded due to prolonged periods of constancy, rendering it ineffective in capturing price-induced behavioral adjustments in portfolio composition.

The case of Insurance Technical Reserves presents a greater empirical challenge due to the lack of a direct market price. In this instance, a proxy is constructed using the revaluations of this asset category reported in the financial accounts. While this measure is not a market price in the conventional sense, it captures changes in the estimated value of pension-related financial claims over time. These revaluations are influenced by factors such as changes in underlying interest rates, investment performance, and actuarial recalculations. As such, the series serves as a pragmatic and economically meaningful approximation of price movements within this asset class (OECD, 2017).

In sum, the selected price proxies balance theoretical coherence, data availability, and empirical adequacy. Each proxy reflects a price or price-like signal relevant to household investment decisions and consistent with the structural assumptions of the AIDS model. While compromises are unavoidable in empirical research, the chosen proxies offer interpretable and internally coherent representations of relative prices for household financial assets.

Table 5.1 lists the four selected asset categories alongside their associated price proxies to support clarity in the model setup and later referencing. The notation in parentheses shows how each asset and price is denoted in the final specification of the model. When referring to a specific asset's price, the corresponding price variable can be identified directly from this table.

Table 5.1: Overview of Each Asset and corresponding Price Data Used in the AIDS Model

Asset Category (w_i)	Price of that Asset (p_j)
Insurance Technical Reserves (w_1)	Revaluations of Insurance Technical Reserves (p_1)
Equities (w_2)	Share Price Index for Denmark (p_2)
Currency and Deposits (w_3)	Certificate of Deposit rate (p_3)
Bonds (w_4)	10-year government bond yield for Denmark (p_4)

Note: The notation in parentheses illustrates how each asset and price is represented in the final specification of the model. The corresponding price variable can be identified here when referring to the price of a given asset.

5.2.3. Descriptive Statistics

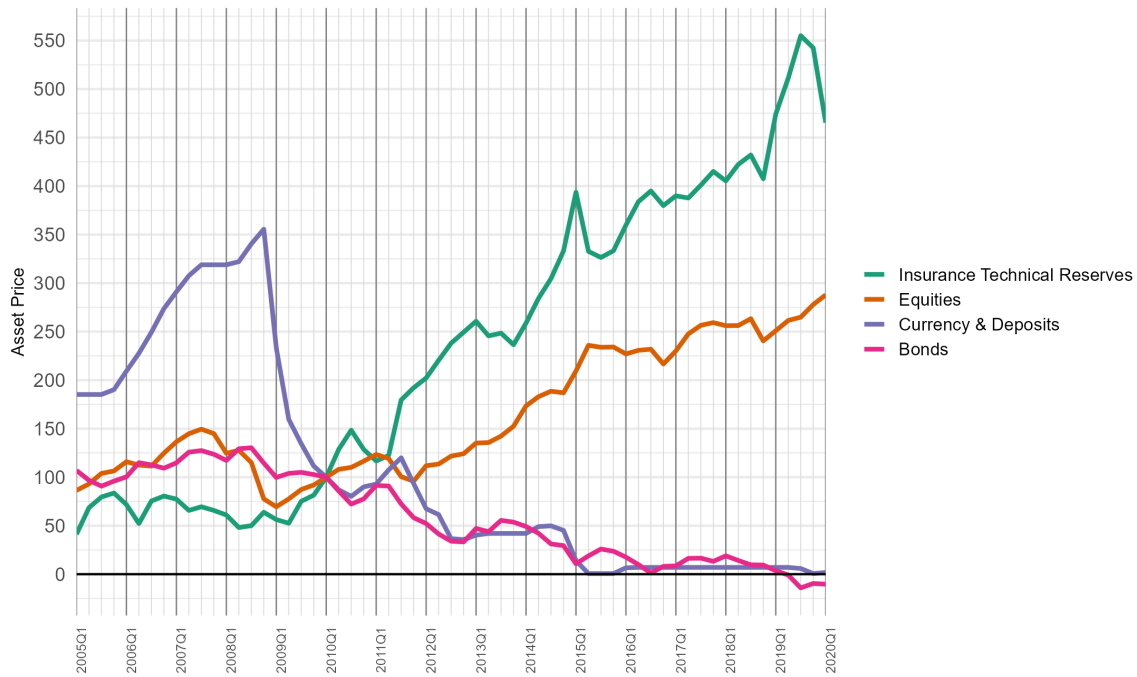
This section provides an overview of the price used in the model. First, the original price proxies are presented as indices with a base period of 2010 Q1 = 100 to illustrate their general development over time. Next, unit root tests are conducted to examine the series' stationarity. Based on the test results, the price data are transformed accordingly, and the final price series used in the AIDS model is presented.

In Figure 5.4, the four price proxies previously discussed are shown for each of the financial assets included in the final AIDS model. The series have been transformed to indices with a base of 100 in 2010 Q1 to facilitate direct comparison across assets. The price of Insurance Technical Reserves (Revaluations of Insurance Technical Reserves) shows that the price remained relatively stable from 2005 Q1 until 2009 Q2. From that point onward, it shows an upward trend for the remainder of the analysis period, with both minor and somewhat larger fluctuations along the way.

If the price of Equities (Share Prices for Denmark) is considered instead, it can be seen that it increased until 2007 Q4, after which it experienced a relatively large decline until 2009 Q1. From 2009 Q1 to 2011 Q1, the price of Equities increased again. Between 2011 Q1 and 2011 Q3, there was another decline. However, from then until the end of the analysis period, the price generally shows an upward trend, with both smaller and larger fluctuations, similar to the pattern observed for the price of Insurance Technical Reserves.

Figure 5.4 also shows how the price of Currency and Deposits (Certificate of Deposit rate) evolved over the analysis period. This series follows a different path than the two previously discussed price proxies. The price for Currency and Deposits increased relatively much from the beginning of the period, around 2005 Q2, until 2008 Q3. After that, it fell sharply until 2010 Q2, followed by a slight increase until 2011 Q2. From then on, it declined again until 2012 Q2 and remained stable until the end of 2014. From 2015 Q1 until the end of the analysis period, the price stayed relatively low, with fluctuations so small in some periods that they are barely detectable in the model; it even shows two observations that look almost equal to zero in this figure, even though they are just right above zero.

The price of Bonds (10-year Government Bond Yield for Denmark) in Figure 5.4 shows a slight decline in the first two quarters of the analysis period, followed by a weak upward trend until 2008 Q2. From then on, it displays a downward trend with varying fluctuations until 2019 Q1. In the final four periods of the analysis, the bond price is actually below zero. However, the overall pattern of bond price development appears relatively stable in most periods.

Figur 5.4: Prices of Household Financial Assets Indexed to 2010 Q1 = 100

Source: Own presentation of data obtained from (Danmarks Nationalbank, Statistikbanken, 2020), (Federal Reserve Bank of St. Louis, 2025a), (Danmarks Nationalbank, Statistikbanken, 2025) and (Federal Reserve Bank of St. Louis, 2025b) compiled as stated on 2025-03-20

Note: The figure shows the prices of household financial assets, indexed to 2010 Q1 = 100. The price proxies are: Revaluations for Insurance Technical Reserves, Share Prices for Denmark for Equities, the Certificate of Deposit rate for Currency and Deposits, and the 10-year government bond yield for Denmark for Bonds.

Overall, the observations in Figure 5.4 are not surprising, given the broader economic context. However, the fact that the Bond price becomes negative in the final four observations could challenge the construction of the AIDS model. This issue is addressed in the discussion in section 8.5.

While the price developments illustrated in Figure 5.4 reflect plausible economic dynamics, they also display signs of non-stationarity, such as persistent trends and large fluctuations. Since the AIDS model requires stationary price series for consistent estimation, it is necessary to examine the statistical properties of the prices.

To ensure the stationarity of the price series used in the AIDS model, Augmented Dickey-Fuller (ADF) tests have been conducted on the indexed price series, their logarithmic transformations, and the first differences of the logarithmic prices. The results of the ADF test are presented in Table 5.2, and the theory behind the ADF test can be found in Appendix A. As shown in the table, none of the indexed price series are found to be stationary. All test statistics lie well above the 10% critical value of -1.61 , indicating strong evidence of unit roots. The same pattern holds for the log-transformed price series, where none of the four $\log(\text{price})$ series reject the null hypothesis even at the 10% level. This implies that both the prices in index form and their logarithmic transformations are non-stationary.

However, when testing the first differences of the log-transformed prices, all four series are found to be stationary. The price proxy for Bonds, Equities, and Currency and Deposits reject the null hypothesis at the 1% level, while the Insurance Technical Reserves price series is rejected at the 5% level. These results show that all price series become stationary after taking the first difference of the logarithmic transformation.

This transformation is particularly important in the context of the AIDS model. Since the model is specified in terms of the logarithms of prices, applying differencing prior to the log transformation, such as using $\log(\text{diff}(\text{Prices}))$, would be both theoretically incorrect and numerically undefined in some cases, for example, when price changes are zero or negative. Instead, applying the logarithmic transformation first and then differencing, such as $\text{diff}(\log(\text{Prices}))$, ensures that the model respects its theoretical structure while also satisfying the statistical requirement of stationarity.

Table 5.2: ADF Test Results on Price Series

Price Proxy of	Test statistic	Rejection level
<i>Prices (Indices)</i>		
Insurance Technical Reserves	2.7893	None
Equities	1.3329	None
Currency and Deposits	-1.4777	None
Bonds	-1.4301	None
<i>Log-Prices</i>		
Insurance Technical Reserves	1.8604	None
Equities	0.9612	None
Currency and Deposits	-1.3865	None
Bonds	-0.9908	None
<i>First differences of log-prices</i>		
Insurance Technical Reserves	-2.3738	5%
Equities	-3.1851	1%
Currency and Deposits	-3.5950	1%
Bonds	-4.1856	1%

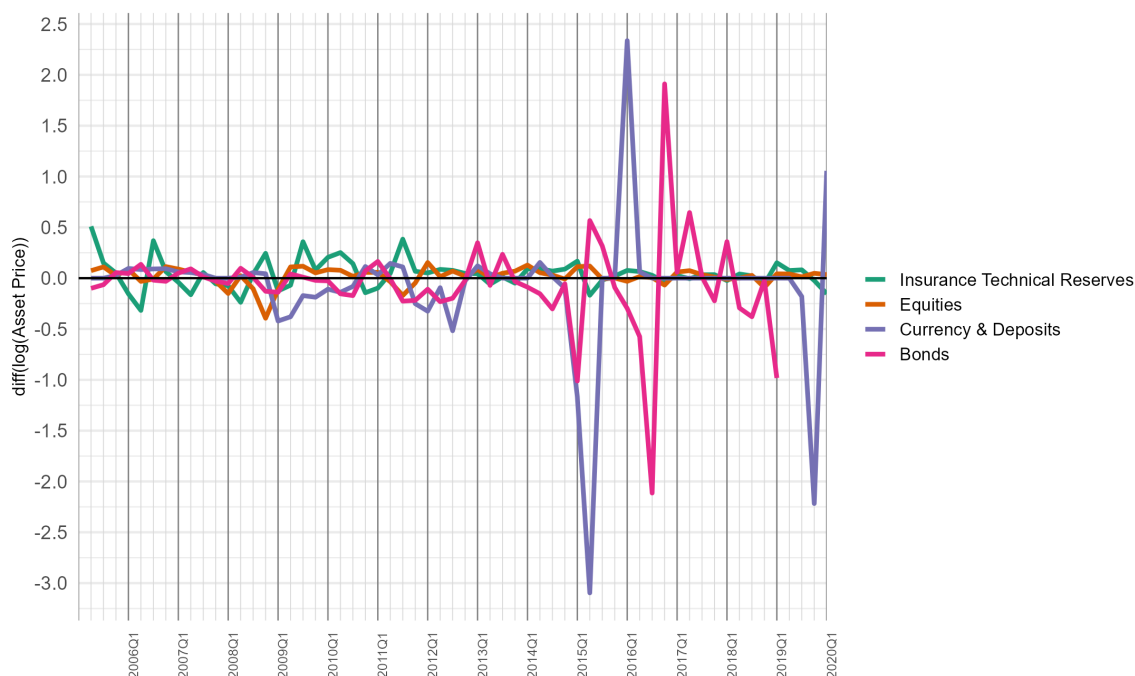
Note: Critical values: -2.60 (1%), -1.95 (5%), -1.61 (10%). The null hypothesis of this unit root is rejected if the test statistic is *less than* the critical value. All tests are conducted without constant or trend using four lags.

Price definitions: Revaluations for Insurance Technical Reserves, Share Prices for Denmark for Equities, Certificate of Deposit rate for Currency and Deposits, and 10-year government bond yield for Denmark for Bonds.

To provide an overview of the transformed data used in the estimation, Figure 5.5 presents the first differences of the logarithmic transformation of all price series. These transformed series represent the approximate quarterly growth rates of the indexed price series. That is, each observation shows the relative change in price from one period to the next, expressed in approximate percentage terms. As the figure shows, all four series fluctuate around zero without a clear trend, indicating that the price growth rates are stationary over time. This visual impression is consistent with the results from the ADF tests, which confirm the stationarity of the transformed price series. The use of these growth rate series in the AIDS model is, therefore, both statistically appropriate and theoretically consistent.

This transformation of the employed price proxies means that, as shown in Figure 5.5, the first observation of the price series now appears in 2005 Q2. Furthermore, it can be observed that the last valid observation for the Bonds series is in 2019 Q1. As discussed in the analysis of Figure 5.4, the final part of the Bonds price series includes negative values, rendering the last observations invalid after transformation. These data points are, accordingly, excluded from the log-differenced series. As a result, the final AIDS model is only estimated on the dataset up to 2019 Q1. For now, the figure serves to illustrate the transformed price dynamics and the observable characteristics of the data that go into the final AIDS model.

Figur 5.5: Log-Transformed and Differenced Household Asset Prices



Source: Own presentation of data obtained from (Danmarks Nationalbank, Statistikbanken, 2020), (Federal Reserve Bank of St. Louis, 2025a), (Danmarks Nationalbank, Statistikbanken, 2025) and (Federal Reserve Bank of St. Louis, 2025b) compiled as stated on 2025-03-20

Note: The figure shows log-differenced price series where prices are: Revaluations for Insurance Technical Reserves, Share Prices for Denmark for Equities, Certificate of Deposit rate for Currency and Deposits, and 10-year government bond yield for Denmark for Bonds.

Figure 5.5 reveals some notable differences across the prices. While the price of Insurance Technical Reserves and Equities display relatively stable growth rates over time, the price of Bonds and Currency and Deposits exhibit noticeable spikes, especially toward the end of the period. This might seem surprising given their stable appearance in Figure 5.4. However, it is consistent with the transformation: when price levels are low, even small absolute changes generate large relative changes. These amplified movements are expected in log-differenced data and do not indicate a data error.

Consequently, the final AIDS model is estimated using the first difference of the logarithmic transformation of all price series, which are stationary and specified according to the model's assumptions.

5.3. Validity and Reliability

This section addresses the measurement validity and reliability of the selected variables. The purpose is to identify potential sources of error in the empirical analysis.

Measurement validity concerns the alignment between the theoretical and operational definitions of a given concept. This involves assessing the extent to which the chosen variables measure what is specified in the theoretical definition (Andersen et al., 2010, p. 100).

In this study, measurement validity is supported through the careful selection of asset and price proxies that reflect the theoretical concepts underlying household investment behavior. The four asset categories, Insurance Technical Reserves, Equities, Currency and Deposits, and Bonds, are well-established components of household portfolios and represent distinct aspects of financial decision-making. Although the prices associated with these assets have been operationalized using proxies, the choices are grounded in sound economic reasoning and supported by existing literature and institutional data practices.

Although the Almost Ideal Demand System (AIDS) was originally developed to model household consumption of consumer goods, its application to financial asset allocation in this study represents a novel use of the framework. This deviation from traditional use raises some concerns regarding measurement validity. However, the theoretical assumptions of the AIDS model, such as expenditure shares responding to relative prices and income, can be meaningfully translated to portfolio shares and asset prices, assuming that households make trade-offs between financial assets analogous to consumption decisions. In this context, the AIDS model offers a flexible and well-established structure for analyzing substitution patterns in response to changing relative prices, thereby supporting its validity even in a financial setting.

Additionally, the price series have been consistently transformed, for example, converted to indices, log-transformed, and differenced to conform with the econometric requirement of stationarity. Even in cases where proxies had

to be constructed, the operationalization is grounded in established financial theory and reflects economically meaningful relationships between prices and portfolio shares. It is important to emphasize that conclusions regarding measurement validity apply specifically within the context of this thesis.

Reliability refers to the consistency of results when the same variable is measured repeatedly (Andersen et al., 2010, s. 101).

The reliability of the variables is therefore considered high, assuming that all relevant data are available and the same modeling approach is consistently applied. In this analysis, all variables are derived from official and methodologically stable and reliable data sources such as Denmark's Nationalbank and the Federal Reserve Bank of St. Louis (FRED). These sources ensure high-quality data collection and reporting standards. Since the variables are observable and quantifiable, and the same transformation procedures are systematically applied throughout the dataset, repeated measurements using the same definitions and methods are expected to yield consistent results. This indicates a high level of reliability in the empirical foundation of the AIDS model.

In summary, the applied data exhibits both measurement validity and reliability. The variables are constructed using standardized methods, the proxy selections are economically justified, and the data transformations align with the theoretical structure of the model. This ensures that the resulting empirical analysis rests on a robust and credible measurement framework. How data transformation affects the model specification and estimation will be discussed later in section 8.5.

6. Setting Up The Model

This section introduces the empirical model used to capture the dynamic relationship between household portfolio composition and asset price movements. It sets out the econometric strategy underlying the impulse response analysis, which serves as the basis for the results presented in the following section.

To model household portfolio responses to price changes, the analysis employs a dynamic version of the Almost Ideal Demand System (AIDS), estimated using Local Projections (LP) and Seemingly Unrelated Regressions (SUR). This hybrid approach enables flexible, horizon-specific estimation of impulse responses. The underlying theoretical and econometric framework is detailed in Section 4.2.

In accordance with the AIDS framework and the adding-up condition defined in Section 4.2.1 (Equation 4.4), the budget shares must sum to one in every period. This theoretical restriction plays a key role in how the system of equations is specified and estimated.

For each horizon $h = 0, 1, \dots, 8$, a separate regression is estimated where the dependent variable is the budget share $w_{i,t+h}$. Each regression includes two lags of the dependent variable and four lags of price changes. The general form of the estimated dynamic LP equations is:

$$w_{i,t+h} = \sum_{k=1}^K \phi_{ik}^{(h)} w_{i,t-k} + \sum_{j=0}^L \sum_{n=1}^N \gamma_{ijn}^{(h)} \Delta p_{n,t-j} + \varepsilon_{i,t+h}^{(h)} \quad (6.1)$$

Where $w_{i,t+h}$ is the budget share for good i at horizon h , $\phi_{ik}^{(h)}$ is the coefficient on lag k of the budget share for good i , $\gamma_{ijn}^{(h)}$ is the coefficient on lag j of the price change for good n , $\Delta p_{n,t-j}$ is the price change for good n at lag j , and $\varepsilon_{i,t+h}^{(h)}$ is the error term for good i at horizon h . Here, n indexes the asset whose price change is being considered, j denotes the lag of the price change, and i refers to the asset whose budget share is affected. The price changes $\Delta p_{n,t-j}$ are defined as log-differences, $\Delta \log(p_{n,t-j})$, which allows the estimated coefficients to be interpreted as the response of budget shares to percentage changes in prices. This notation separates the asset index n from the lag index j , ensuring clarity in the model's dynamic structure ⁸.

As an illustration, the equation for asset 1 at $h = 1$ is specified as:

⁸Note that the notation differs slightly from the static AIDS specification: in the dynamic Local Projection model, n indexes the asset whose price change is considered, while j denotes the lag order. In contrast, the static AIDS model uses j to index the price of asset j .

$$\begin{aligned}
w_{1,t+1} &= \phi_1^{(1)} w_{1,t-1} + \phi_2^{(1)} w_{1,t-2} \\
&+ \gamma_{10}^{(1)} \Delta p_{1,t} + \gamma_{11}^{(1)} \Delta p_{1,t-1} + \gamma_{12}^{(1)} \Delta p_{1,t-2} + \gamma_{13}^{(1)} \Delta p_{1,t-3} + \gamma_{14}^{(1)} \Delta p_{1,t-4} \\
&+ \gamma_{20}^{(1)} \Delta p_{2,t} + \gamma_{21}^{(1)} \Delta p_{2,t-1} + \gamma_{22}^{(1)} \Delta p_{2,t-2} + \gamma_{23}^{(1)} \Delta p_{2,t-3} + \gamma_{24}^{(1)} \Delta p_{2,t-4} \\
&+ \gamma_{30}^{(1)} \Delta p_{3,t} + \gamma_{31}^{(1)} \Delta p_{3,t-1} + \gamma_{32}^{(1)} \Delta p_{3,t-2} + \gamma_{33}^{(1)} \Delta p_{3,t-3} + \gamma_{34}^{(1)} \Delta p_{3,t-4} \\
&+ \gamma_{40}^{(1)} \Delta p_{4,t} + \gamma_{41}^{(1)} \Delta p_{4,t-1} + \gamma_{42}^{(1)} \Delta p_{4,t-2} + \gamma_{43}^{(1)} \Delta p_{4,t-3} + \gamma_{44}^{(1)} \Delta p_{4,t-4} \\
&+ \varepsilon_{1,t+1}^{(1)}
\end{aligned} \tag{6.2}$$

In this specification, the impulse response of budget share w_1 at horizon $h = 1$ to a contemporaneous price change in good n is given by the coefficient $\gamma_{n0}^{(1)}$. That is, $\gamma_{10}^{(1)}$, $\gamma_{20}^{(1)}$, $\gamma_{30}^{(1)}$, and $\gamma_{40}^{(1)}$ represent the IRFs of w_1 at $h = 1$ in response to changes in p 1 to 4, respectively.

Similarly, for $h = 2$:

$$\begin{aligned}
w_{1,t+2} &= \phi_1^{(2)} w_{1,t-1} + \phi_2^{(2)} w_{1,t-2} \\
&+ \gamma_{10}^{(2)} \Delta p_{1,t} + \gamma_{11}^{(2)} \Delta p_{1,t-1} + \gamma_{12}^{(2)} \Delta p_{1,t-2} + \gamma_{13}^{(2)} \Delta p_{1,t-3} + \gamma_{14}^{(2)} \Delta p_{1,t-4} \\
&+ \gamma_{20}^{(2)} \Delta p_{2,t} + \gamma_{21}^{(2)} \Delta p_{2,t-1} + \gamma_{22}^{(2)} \Delta p_{2,t-2} + \gamma_{23}^{(2)} \Delta p_{2,t-3} + \gamma_{24}^{(2)} \Delta p_{2,t-4} \\
&+ \gamma_{30}^{(2)} \Delta p_{3,t} + \gamma_{31}^{(2)} \Delta p_{3,t-1} + \gamma_{32}^{(2)} \Delta p_{3,t-2} + \gamma_{33}^{(2)} \Delta p_{3,t-3} + \gamma_{34}^{(2)} \Delta p_{3,t-4} \\
&+ \gamma_{40}^{(2)} \Delta p_{4,t} + \gamma_{41}^{(2)} \Delta p_{4,t-1} + \gamma_{42}^{(2)} \Delta p_{4,t-2} + \gamma_{43}^{(2)} \Delta p_{4,t-3} + \gamma_{44}^{(2)} \Delta p_{4,t-4} \\
&+ \varepsilon_{1,t+2}^{(2)}
\end{aligned} \tag{6.3}$$

In this specification for $h=2$, the impulse response of budget share w_1 at horizon $h = 2$ to a contemporaneous price change in good n is given by the coefficient $\gamma_{n0}^{(2)}$. That is, $\gamma_{10}^{(2)}$, $\gamma_{20}^{(2)}$, $\gamma_{30}^{(2)}$, and $\gamma_{40}^{(2)}$ represent the IRFs of w_1 at $h = 2$ in response to a changes in p 1 to 4, respectively.

Furthermore, to ensure theoretical consistency with the AIDS framework, only three of the four budget share equations are estimated directly. Specifically those for $i = 1, 2, 3$. The fourth share, w_4 , is then recovered using the identity:

$$w_{4,t+h} = 1 - \sum_{i=1}^3 w_{i,t+h} \tag{6.4}$$

This setup guarantees that the budget constraint is satisfied for every horizon, while avoiding perfect multicollinearity and preserving degrees of freedom. Likewise, the IRFs for w_4 are not estimated directly, but computed as the negative sum of the IRFs for the other goods:

$$\text{IRF}_{w_4}^{(h)} = - \left(\text{IRF}_{w_1}^{(h)} + \text{IRF}_{w_2}^{(h)} + \text{IRF}_{w_3}^{(h)} \right) \tag{6.5}$$

This means that w_4 is fully derived for every horizon as a series of budget shares and impulse responses without requiring direct estimation. The approach, therefore, satisfies the theoretical constraints while allowing full recovery of portfolio dynamics across all asset categories.

Each model is estimated jointly using a Seemingly Unrelated Regressions (SUR) framework to allow for contemporaneous correlation in the residuals across assets, reflecting the interdependence of household consumption decisions. This framework improves estimation efficiency by exploiting the covariance structure of the error terms across equations, compared to separate OLS regressions.

At each horizon h , the following system of equations is estimated jointly. In matrix form, each LP regression can be expressed using a compact notation, where $\beta_i^{(h)}$ collects all coefficients, including both lagged dependent variables $\phi_{ik}^{(h)}$ and price change terms $\gamma_{ijn}^{(h)}$, for asset i at horizon h . This allows the complete SUR system to be written as:

$$\begin{bmatrix} w_{1,t+h} \\ w_{2,t+h} \\ w_{3,t+h} \end{bmatrix} = \begin{bmatrix} X_{1,t} & 0 & 0 \\ 0 & X_{2,t} & 0 \\ 0 & 0 & X_{3,t} \end{bmatrix} \begin{bmatrix} \beta_1^{(h)} \\ \beta_2^{(h)} \\ \beta_3^{(h)} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t+h} \\ \varepsilon_{2,t+h} \\ \varepsilon_{3,t+h} \end{bmatrix} \quad (6.6)$$

Where the error terms ε_i and ε_j are allowed to be contemporaneously correlated across equations, as shown in equation 4.9.

To ensure consistency with the AIDS framework, symmetry, and homogeneity restrictions are explicitly imposed at each horizon by estimating each system of equations using the *systemfit* package in R.⁹ The dynamic AIDS model is estimated horizon by horizon using a Local Projection (LP) approach, where each horizon h corresponds to a separate system of equations. Within each system, symmetry and homogeneity restrictions are forced through parameter constraints in the SUR estimation. This ensures that the theoretical properties of the AIDS model are respected at every point in the impulse response horizon. Post-estimation checks confirm that the homogeneity and symmetry conditions are satisfied across all horizons. These results are documented in Appendix B.1, which provides empirical verification of the model's theoretical coherence.

Once the models are estimated for each horizon, the estimated coefficients trace the dynamic response of budget share w_i to a 1% price change in asset n . Collecting these estimates across horizons produces 16 impulse response plots, one for each combination of four budget shares and four price series, traced across eight horizons. These plots illustrate the dynamic adjustment of asset shares in response to price changes. This structure ensures that the model is theoretically grounded and empirically tractable, enabling a clear interpretation of household portfolio dynamics in response to change in relative asset prices.

With the model setup and estimation strategy established, the following section presents the empirical results based on the derived impulse response functions, linking observed substitution patterns to theoretical expectations.

⁹See Henningsen & Hamann (2007) for details on the *systemfit* package.

7. Empirical Results

This section presents the empirical results based on the impulse response functions derived from the AIDS-LP-SUR model setup described in Section 6 to address the thesis's research question. Throughout the analysis, the results are interpreted in light of Tobin's portfolio theory, as outlined in Section 4.1.1. The section concludes with a summary of the main findings.

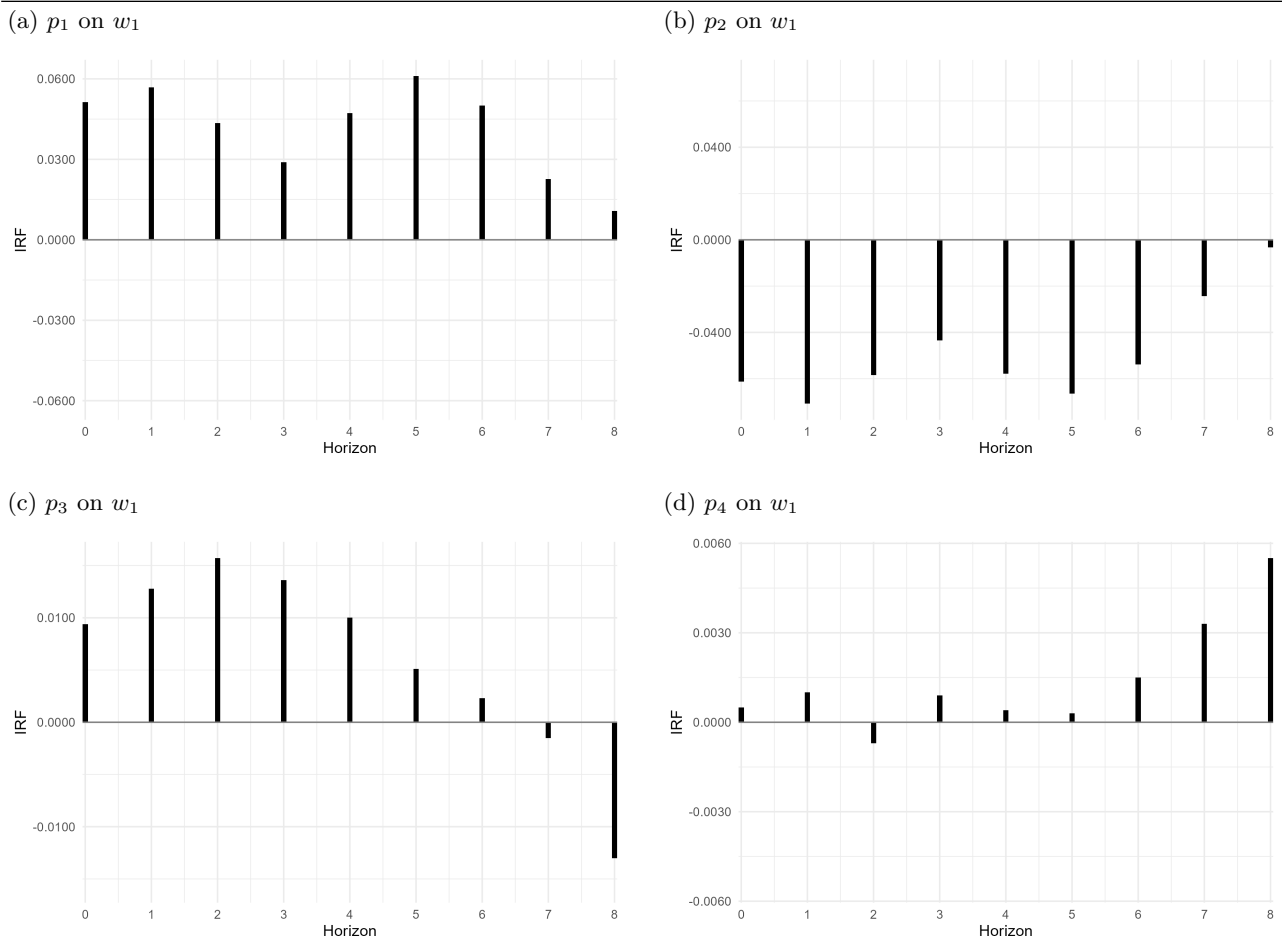
7.1. Model Results

The model results provide empirical evidence on how changes in relative asset prices affect Danish households' allocation of financial assets, thereby addressing the thesis's research question. Although the prices are represented as differenced logarithms in the data and model setup, corresponding to percentage changes or returns, they can still be interpreted as proxies for relative asset prices. This is because changes in asset returns reflect shifts in the opportunity cost of holding one asset relative to others, thereby influencing household portfolio allocation. The presented impulse response functions trace how households adjust their portfolio shares over time in response to these relative price signals, offering insights into substitution patterns and the dynamics of portfolio rebalancing across different financial asset categories.

The results reveal distinct patterns of substitution and adjustment that vary across asset classes. Some asset categories exhibit immediate and significant responses to changes in their own prices, while others adjust in response to changes in the prices of other assets. Due to time constraints and the manual nature of the estimation procedure (as described in Section 6), confidence interval bands have not been computed for the impulse response functions. However, the statistical significance of the responses is evaluated throughout the analysis. The exact estimated values and p-values of the impulse response functions for horizons 0 to 8 are provided in Appendix B.1 and B.2.

As illustrated in Figure 7.1, the portfolio share allocated to Insurance Technical Reserves w_1 responds clearly to changes in the relative prices of other assets. According to Figure 7.1a, when the price of Insurance Technical Reserves itself increases, households tend to increase their allocation to this asset category. This response is both statistically significant and temporally consistent across the early horizons. The response is statistically significant at all horizons from 0 to 6, except horizon 3,¹⁰ indicating a broadly persistent adjustment over more than half of the observed period. At its highest point, the effect reaches approximately 0.0610 at horizon 5, underscoring its economic relevance. Since these revaluations reflect accrued gains rather than direct cost increases, the observed increase in the Insurance Technical Reserves share likely reflects households responding to improved performance and viewing Insurance Technical Reserves as a stable store of long-term value.

¹⁰See detailed estimates in Appendix B.1 and B.2.

Figure 7.1: IRFs – Effect of Price Changes on Budget Share Allocated to w_1 

Note: The figure shows the estimated impulse response functions for the budget share of w_1 in response to relative price changes. Note that the y-axes have different intervals for Figures a, b, c, and d. Exact estimated values and corresponding p-values can be found in Appendix B.

Source: Own illustration based on own calculations, using data described in Section 5

As shown in Figure 7.1b, households reduce their allocation to Insurance Technical Reserves when the Equity price rises. This inverse relationship suggests that households reallocate capital away from Insurance Technical Reserves to capitalize on expected Equity returns, treating the two categories as partial substitutes. The response is statistically significant up to horizon 6 and emerges immediately, with an estimated effect of -0.0613 at horizon 0 and -0.0707 at horizon 1.¹⁰ The immediacy and persistence of this response support the interpretation of a rebalancing mechanism, whereby shares allocated to Insurance Technical Reserves decline when Equity price increases.

Figure 7.1c shows that changes in the price of Currency and Deposits result in a modest increase in the Insurance Technical Reserves share. The effect is most noticeable in the early horizons, with the largest estimated response being 0.0157 at horizon 2. However, the modest magnitude of the response, combined with the lack of statistical significance beyond horizon 2,¹⁰ suggests that the relationship is weak and likely driven by tem-

porary factors rather than a robust, stable complementarity dynamic.

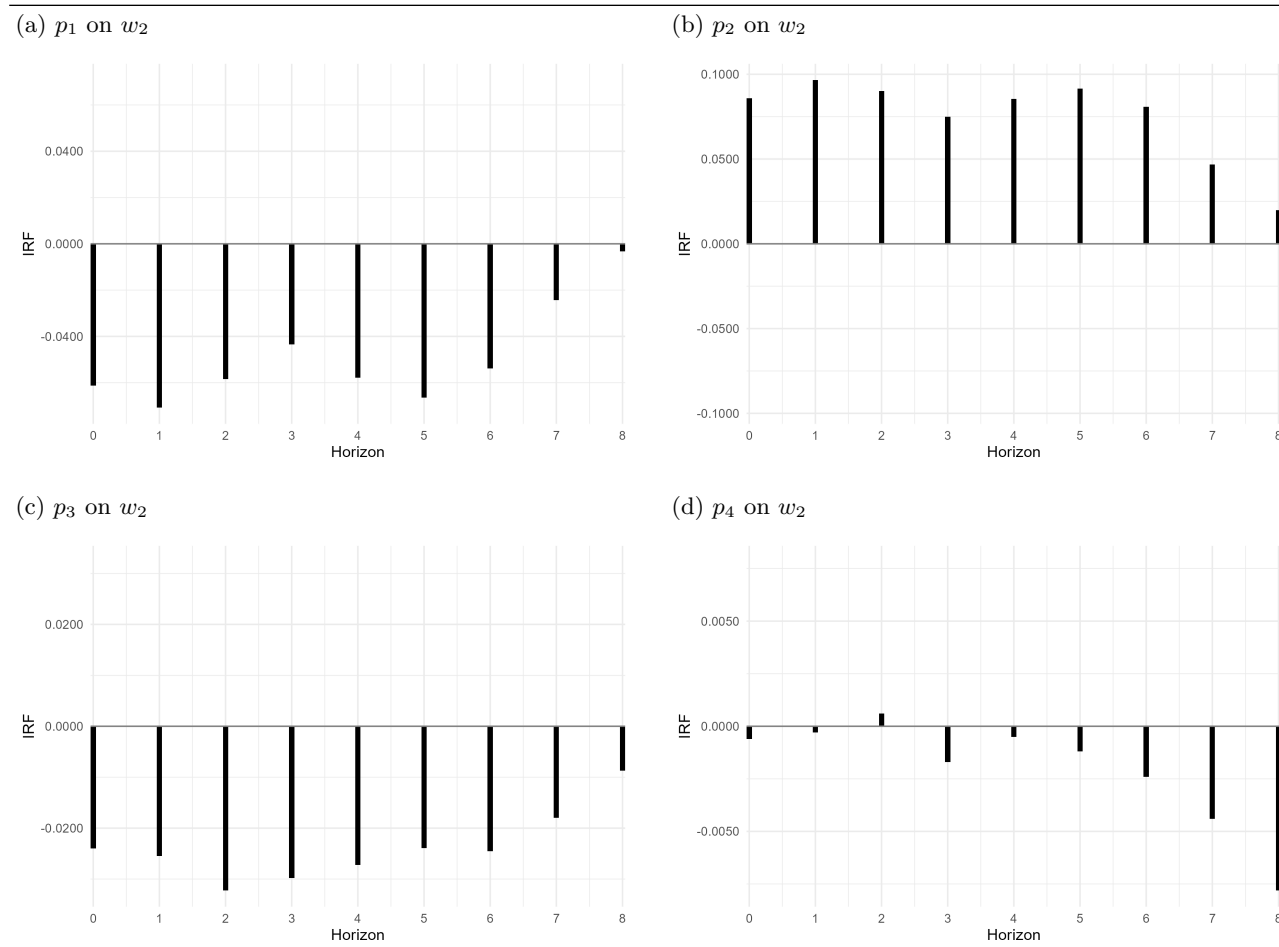
Finally, Figure 7.1d shows that price changes in Bonds have no meaningful effect on the allocation to Insurance Technical Reserves. Although some positive responses appear visually at horizons 6 to 8, the estimated effects fluctuate close to zero and remain statistically insignificant across all horizons.¹⁰ These late and insignificant responses are, therefore, most likely attributable to noise rather than genuine substitution behavior.

The observed behavior is consistent with Tobin's portfolio theory, which posits that households diversify their holdings in response to changing return-risk profiles, rather than reallocating their entire wealth from one asset to another. The positive, yet gradual and incomplete, adjustment in Insurance Technical Reserves allocation supports the idea that households do not view financial assets as perfect substitutes but instead engage in partial rebalancing to optimize expected utility.

In Figure 7.2, the portfolio share allocated to Equity responds clearly and consistently to changes in relative asset prices. Figure 7.2b shows that when the price of Equity itself increases, households' portfolio share in Equities also increases. This relationship may partly reflect mechanical revaluation effects: as stock prices rise, the relative value of existing Equity holdings increases, thereby raising their share in household portfolios even in the absence of active reallocation. However, the observed pattern may also be consistent with momentum-based behavior, where households respond to rising prices by further increasing their Equity exposure. The response is statistically significant at all horizons from 0 to 6 and peaks at horizon 1, with an estimated effect of 0.0965.¹⁰

In contrast, Figure 7.2a shows that when the price of Insurance Technical Reserves rises, the share of wealth allocated to Equity declines. The response is negative from the outset and remains consistent across the subsequent horizons, with several periods showing significant effects, particularly between horizons 0 and 6. The strongest decline occurs at horizon 1, with an estimated effect of -0.0707.¹⁰ This suggests that Insurance Technical Reserves and Equities act as substitutes in household portfolios. For example, when the value of Insurance Technical Reserves increases through revaluation gains, households may reduce their Equity exposure in relative terms. This finding supports the interpretation that both assets serve long-term investment purposes, albeit with different risk profiles.

According to Figure 7.2c, a rise in the price of Currency and Deposits results in a modest decline in the Equity share. The estimated response is negative throughout the period and statistically significant from horizon 0 to horizon 5, with a maximum effect of -0.0322 observed at horizon 2.¹⁰ This pattern indicates that increases in certificate of deposit rate are associated with a gradual reallocation away from Equities, suggesting a limited but measurable degree of substitution between these two asset classes.

Figure 7.2: IRFs – Effect of Price Changes on Budget Share Allocated to w_2 

Note: The figure shows the estimated impulse response functions for the budget share of w_2 in response to relative price changes. Note that the y-axes have different intervals for Figures a, b, c, and d. Exact estimated values and corresponding p-values can be found in Appendix B.

Source: Own illustration based on own calculations, using data described in Section 5

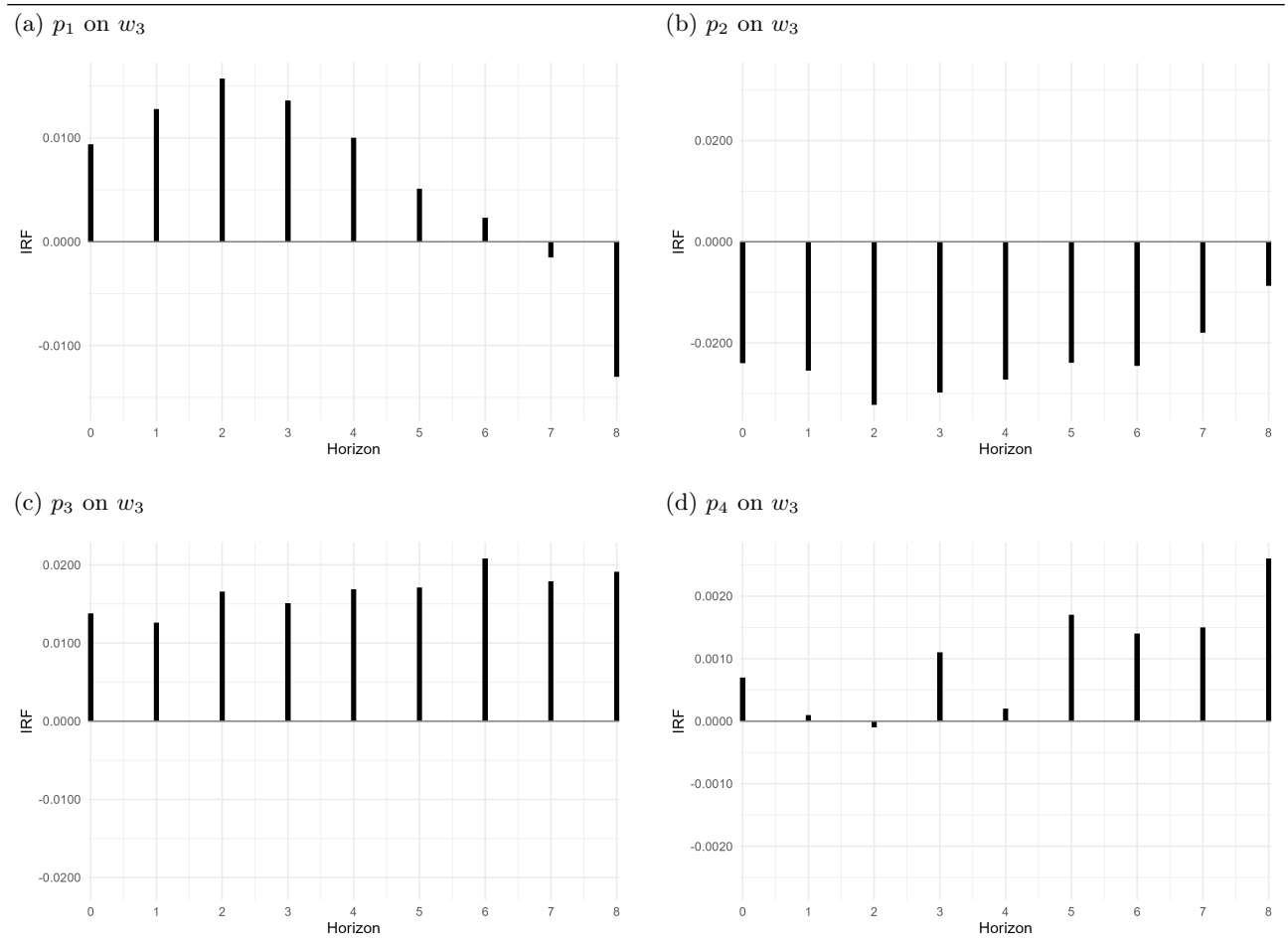
Finally, Figure 7.2d shows that increases in the price of Bonds lead to small and generally negative responses in Equity holdings. While the response briefly turns positive at horizon 3, the effects remain close to zero and are statistically insignificant across all horizons.¹⁰ This lack of significance limits the ability to draw robust conclusions. However, the observed pattern suggests that Danish households do not systematically adjust their Equity exposure in response to changes in Bond prices. This may reflect the lower perceived return potential of Bonds relative to Equities, or institutional characteristics of Bond ownership that limit household-level portfolio adjustments.

Overall, the results align with Tobin's portfolio theory, suggesting that households adjust their asset allocations gradually in response to changes in relative prices and perceived return-risk profiles. The observed substitution patterns between Equity, Insurance Technical Reserves, and Currency and Deposits indicate that households rebalance their portfolios in a manner consistent with utility maximization under risk and return

considerations. The findings further underscore that financial assets are not treated as perfect substitutes, but rather as distinct investment instruments within a diversified portfolio.

According to Figure 7.3, Currency and Deposits display moderate yet statistically significant responses to changes in their own price and the price of the other assets. Figure 7.3c shows that when the price of Currency and Deposits increases, as proxied by changes in the Certificate of Deposit rate, the portfolio share allocated to this category also rises. The adjustment begins immediately, peaks at approximately 0.0208 at horizon 6, and remains statistically significant from horizon 0 to horizon 7.¹⁰ This indicates that households respond positively to improved returns on liquid, low-risk assets by allocating more wealth accordingly.

Figur 7.3: IRFs – Effect of Price Changes on Budget Share Allocated to w_3



Note: The figure shows the estimated impulse response functions for the budget share of w_3 in response to relative price changes. Note that the y-axes have different intervals for Figures a, b, c, and d. Exact estimated values and corresponding p-values can be found in Appendix B.

Source: Own illustration based on own calculations, using data described in Section 5

As seen in Figure 7.3b, the allocation to Currency and Deposits declines when the price of Equity rises. This negative response appears immediately and remains statistically significant from horizon 0 through horizon 5. The largest estimated effect is -0.0322 at horizon 2.¹⁰ This pattern suggests that when Equity prices in-

crease, households reallocate away from deposits, possibly to maintain exposure to higher-return investments. This behavior reflects a calculated trade-off between liquidity and risk, which is consistent with household preference structures.

Figure 7.3a also reveals a small, short-lived increase in the Currency and Deposits share in response to higher Insurance Technical Reserves prices. The response reaches up to 0.0157 at horizon 2, but the effect is statistically significant only at the earliest horizons and fades thereafter.¹⁰ This suggests a weak and short-lived complementary relationship between Insurance Technical Reserves and Currency and Deposits, possibly driven by temporary shifts in household preferences for lower-risk assets.

Meanwhile, Figure 7.3d shows that price changes in Bonds have no meaningful impact on this category. The estimated effects remain statistically insignificant across all horizons.¹⁰ Given the lack of statistical significance, the model does not provide sufficient evidence to determine whether Bonds and Currency and Deposits act as substitutes or complements in household portfolios.

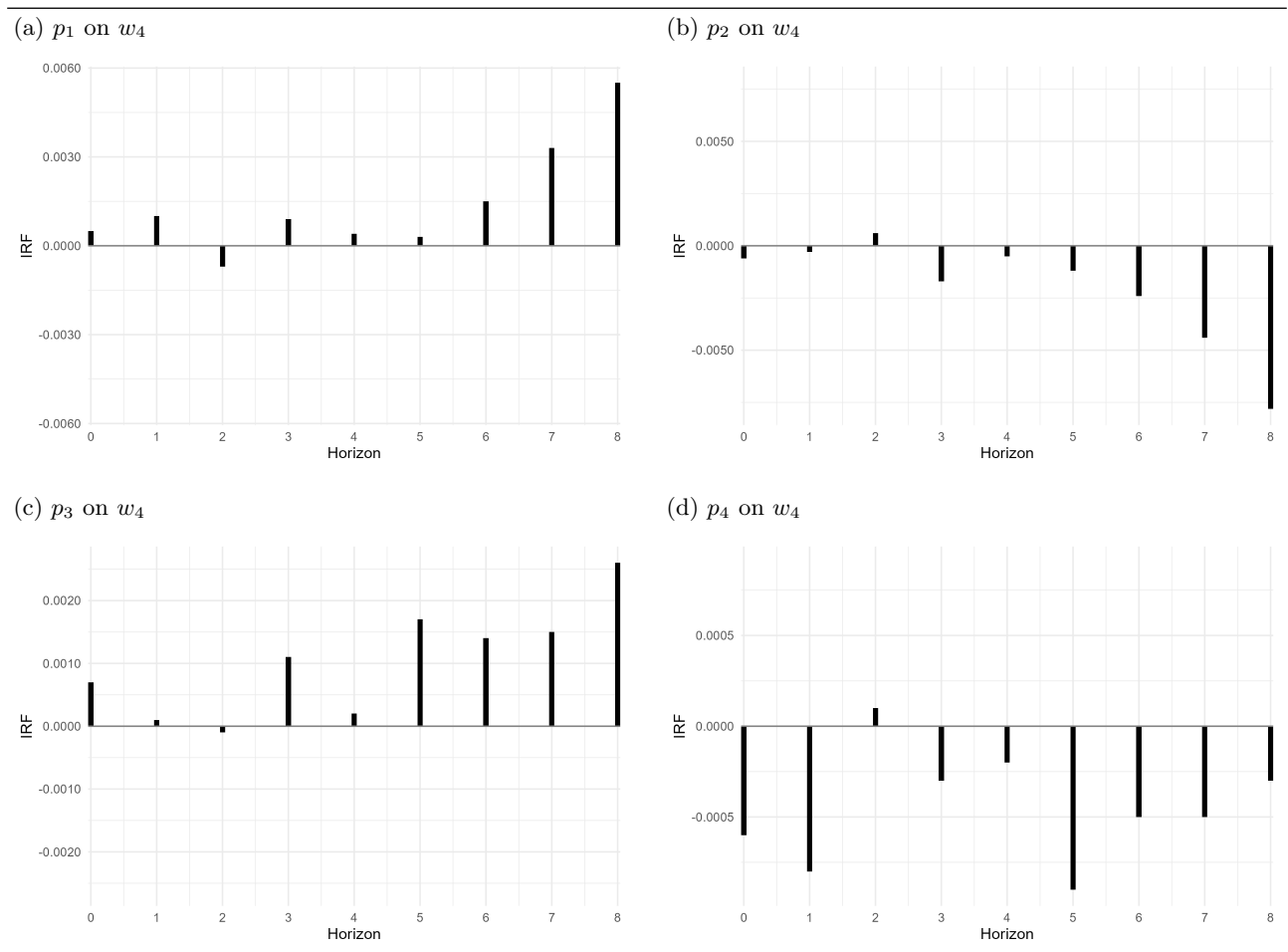
This adjustment pattern is consistent with Tobin's portfolio theory, which proposes that households adjust their asset allocations gradually in response to changes in expected returns, while also considering the liquidity and relative safety offered by deposit-based instruments. The observed substitution patterns, including the reallocation away from Currency and Deposits in response to rising Equity prices and the small, short-lived increase in Currency and Deposits following higher Insurance Technical Reserves prices, support the view that financial assets are not treated as perfect substitutes. Instead, household portfolio decisions may reflect a utility-maximizing trade-off between return, risk, and liquidity preferences, in line with Tobin's theoretical framework.

Figure 7.4 shows that Bonds remain unaffected by changes in the prices of all four asset categories. Across all horizons, the estimated responses are minimal, fluctuate close to zero, and none of the estimates are statistically significant, regardless of whether the price change occurs in Bonds themselves or in the other assets. All estimated responses to changes in the Bonds price range between -0.0009 and 0.0001 .¹⁰

These small responses suggest that Bonds do not play an active role in portfolio reallocation. One possible explanation is that Danish households often hold Bonds indirectly through pension funds or structured products, where holdings are managed over longer time horizons and are not typically adjusted in response to short-term price fluctuations. Bonds may also be perceived as low-yield, low-flexibility instruments, making them a less relevant margin of adjustment when households respond to shifts in relative returns elsewhere in the portfolio.

Although the estimated coefficients for Bonds are small and consistently close to zero, the absence of statistical significance means that the thesis cannot draw firm conclusions about the role of Bonds in household portfolio decisions. The observed pattern is, however, consistent with the idea that households focus their portfolio adjustments on assets where trade-offs between risk, return, and liquidity are more important, as emphasized in Tobin’s framework.

Figur 7.4: IRFs – Effect of Price Changes on Budget Share Allocated to w_4



Note: The figure shows the estimated impulse response functions for the budget share of w_4 in response to relative price changes. Note that the y-axes have different intervals for Figures a, b, c, and d. Exact estimated values and corresponding p-values can be found in Appendix B.

Source: Own illustration based on own calculations, using data described in Section 5

7.2. Empirical Summary

In summary, the analysis shows that Danish households adjust their financial portfolios in response to changes in relative asset prices. The extent, direction, and significance of these adjustments vary across asset classes. The strongest and most consistent responses are observed for Equity and Insurance Technical Reserves, where households reallocate capital in response to changes in expected returns on Equity and Revaluations of Insurance Technical Reserves. These asset categories appear to be substitutes to some extent, with hou-

holds balancing risk, return, and liquidity considerations in their portfolio choices. Currency and Deposits exhibit a modest, short-lived positive response to changes in Insurance Technical Reserves prices, suggesting a limited and temporary complementary relationship. The relationship between Currency and Deposits and Equity indicates a small degree of substitution.

In contrast, Bonds exhibit no statistically significant responses to price changes at any horizon. The estimated coefficients for Bonds are consistently small and close to zero, suggesting that this asset category plays a limited role in portfolio reallocation. This may reflect the fact that Bonds are often held indirectly through pensions or funds, making them less responsive to short-term price changes.

Most portfolio adjustments typically occur between horizon 0 and horizon 6, indicating that households respond relatively quickly to changes in asset prices. However, it is important to note that the analysis cannot fully distinguish between active rebalancing and revaluation effects. Increases in any asset share following price rises may partly reflect valuation gains on existing holdings rather than new transactions. This distinction is particularly relevant in a financial accounts framework, where observed portfolio changes may arise from both flows and valuation effects.

While the LP-SUR approach represents an unconventional application of the AIDS model, the results indicate that the framework provides a valid and internally consistent structure for analyzing household asset allocation. The homogeneity and symmetry restrictions hold across all horizons, ensuring theoretical coherence in the estimates. The statistically significant impulse response functions, particularly for Equity, Insurance Technical Reserves, and Currency and Deposits, further support the model's robustness. Additionally, the observed substitution patterns align with findings from related empirical studies, reinforcing the external validity of the results.

Together these findings provide confidence that the model captures meaningful economic relationships and that the results are reliable within the scope of the analysis. Overall, the results are consistent with Tobin's portfolio theory, suggesting that households adjust their asset allocations gradually in response to relative asset prices, while balancing risk, return, and liquidity. However, the limited evidence of substitution effects for Bonds highlights the need for cautious interpretation and suggests that not all assets serve as meaningful margins of adjustment in household portfolios.

8. Discussion and Critical Reflection

This discussion is structured around the main delimitations of the thesis, which have shaped the design, execution, and interpretation of the empirical analysis. Each delimitation is examined individually to assess its implications, limitations, and justification. The discussion then compares the empirical findings with existing literature, followed by a consideration of behavioral factors in household portfolio choices. Finally, the empirical methodology and chosen data are evaluated in light of both the results and alternative modeling approaches. While the delimitations are initially treated separately, several more influential ones are further explored in the subsequent sections, particularly where they intersect with behavioral theory and empirical modeling choices.

8.1. Delimitations and Their Impact

This thesis is shaped by a number of clearly defined delimitations that contribute to analytical focus while simultaneously constraining the interpretation and scope of the findings. On the one hand, the geographical focus on Danish households confers distinct analytical advantages. It ensures homogeneity and enables the use of high-quality data, facilitating an internally consistent and contextually coherent empirical analysis. This internal validity is crucial, especially in studies of financial behavior where national differences in taxation, regulation, and social safety nets can profoundly affect household choices, as Guiso & Paiella (2008) showed in their study. On the other hand, this focus necessarily limits the broader applicability of the findings. It is not self-evident that the substitution patterns identified in this study, such as the negative relationship between Equity prices and the allocation to Insurance Technical Reserves, would necessarily occur in countries with different pension systems, capital gains tax regimes, or cultural risk preferences.

As stated above, the analysis reveals that Danish households significantly reduce their allocation to Insurance Technical Reserves when the price of Equity rises. The impulse response analysis shows an immediate effect, supporting the view that these categories are, to some extent, substitutable in the Danish context. Suppose the analysis had included multiple countries, as in comparative studies like Bashar Al-Zu'bi and Khalid Al-Zu'bi (2014), it might have revealed whether this substitution pattern is specific to Denmark or more widely observed. For example, the role of Insurance Technical Reserves in household portfolios may differ significantly in countries with alternative public pension arrangements, and equity investments may be more or less sensitive to price shifts depending on local market conditions. Studies such as Petropoulou & Murinde (2024) also indicate that technological and institutional differences across countries lead to different asset allocation patterns, emphasizing the importance of contextual interpretation when relating these findings to the international literature.

Similarly, restricting the analysis to the asset side of the household balance sheet simplifies the empirical approach. It helps avoid the simultaneity problems arising when assets and liabilities are modeled together. This approach is methodologically justified because it allows the analysis to focus on portfolio allocation choices without interference from the effects of debt and loan dynamics. At the same time, existing literature has shown that household debt, liquidity constraints, and leverage ratios can significantly impact how households respond to price changes, as demonstrated by Mian & Sufi (2010). For instance, if indebted households cannot reallocate their portfolios because of collateral or liquidity requirements, the aggregate responses observed in this study may conceal important distributional effects. The substitution effects identified in the analysis, such as the responsiveness of Insurance Technical Reserves and Equity, are significant at the household sector level. However, including liabilities might reveal that these effects are either weaker or distributed differently across households. Studies by Adam (1999) and Benhabib & Bisin (2018) have shown that the interaction between assets and liabilities is essential for understanding wealth dynamics and inequality, which suggests that a more comprehensive approach could offer more profound insights.

Furthermore, since this thesis focuses exclusively on the household sector, it does not capture the interconnectedness between household portfolios and the balance sheets of other sectors, such as financial corporations, non-financial corporations, the public sector, and the foreign sector. As illustrated in Table 4.1 in the theory section, each asset on the household balance sheet is mirrored by a corresponding liability in another sector. This interdependence means that changes in household asset allocation inevitably affect and are affected by developments in other parts of the economy. Therefore, an analysis that also considers these cross-sector linkages could have provided a more complete and nuanced understanding of how the broader financial system reacts to relative asset price changes.

The choice to use aggregate sector-level data represents another important delimitation. Using this level of aggregation enables the application of the dynamic AIDS-LP-SUR framework in a statistically efficient way that aligns with macro-empirical studies such as the German FAIDS study by Scharnagl & Ramb (2010). However, working with aggregated data also means that substantial heterogeneity between households is masked. The literature reviewed in Section 3 documents that portfolio allocations differ across dimensions such as wealth, age, and financial literacy. If suitable data had been available, it would have been possible to assess whether the observed substitution patterns between Insurance Technical Reserves and Equity are primarily driven by households with high socioeconomic status and wealth, while others remain passive or less responsive. Consequently, aggregate analysis is well suited to identifying some patterns, but it may understate behavioral diversity and obscure important distributional or policy-relevant effects. In addition, studies such as the one by Bohlin & Rosvall (2014) point out that peer effects and social dynamics can lead to correlated re-

sponses within certain groups. Such effects remain invisible in sector-level data but may play a central role in shaping portfolio dynamics.

The temporal scope of the study also introduces limitations. By excluding data after the first quarter of 2020, the analysis avoids the structural disruptions caused by the COVID-19 pandemic. On the one hand, this choice increases the internal consistency and stability of the estimated models, as crisis periods often introduce structural breaks and increased volatility. On the other hand, the pandemic represents an exogenous shock with the potential to alter household financial behaviour fundamentally. Excluding it means that the analysis is silent on how robust the observed dynamics are to this kind of uncertainty. Had the pandemic period been included, it is conceivable that the impulse response functions would display larger or more volatile responses, especially in more risky asset classes such as Equity. This exclusion reduces external validity, especially regarding how households behave under uncertainty. Moreover, leaving out crisis periods could bias estimates toward "normal times", potentially underestimating risk aversion or the importance of "buffer assets". Previous studies, including the French FAIDS study by Avouyi-Dovi et al. (2019), have shown that uncertainty and policy changes can significantly and persistently impact asset allocation.

The selection of the empirical modeling framework, specifically the dynamic AIDS-LP-SUR approach, also constitutes both a strength and a limitation. On the one hand, it allows for a nuanced analysis of the dynamic adjustment effects, going beyond the static analysis common in many of the earlier (F)AIDS studies. On the other hand, while theoretically attractive, the imposed symmetry, homogeneity, and adding-up restrictions may not fit the behavioral realities of actual households. Alternative models, such as those allowing for non-symmetric cross-price effects or structural breaks, could maybe have produced richer or more behaviorally plausible estimates.

These delimitations emphasize central challenges in empirical research, namely the balance between analytical focus and the complexity of real-world behavior. On one side, clear delimitations are necessary to define the research question and keep the analysis within feasible methodological and data boundaries. On the other side, they inevitably restrict the scope of interpretation and may introduce subtle biases in the results. Therefore, it is important to acknowledge and reflect on these choices and their implications for the analysis and its conclusions. If these delimitations had been addressed differently, for example, by including both assets and liabilities, using more detailed data, adopting a broader time frame, including other sectors, or employing alternative modeling strategies, the analysis could possibly have uncovered more nuanced or complex patterns. This might include distributional effects or behavioral asymmetries.

While these delimitations significantly shape both the results and the ability to answer the research question, they provide a basis for several nuanced and critical discussions throughout the following sections. These di-

scussions will not only engage with the existing literature in relation to this thesis's findings but will also consider relevant perspectives from behavioral economics as well as the methodological choices and decisions made in designing and conducting the study. Accordingly, the following discussion evaluates the results of the thesis in light of the findings and methods presented in Section 3. However, some reviewed studies will also be referenced in other sections of the discussion.

8.2. Comparing Results with Existing Literature

The results of this thesis broadly align with earlier studies applying the AIDS or FAIDS framework to household portfolio allocation. As demonstrated in previous research, relative prices are confirmed as key determinants of how households allocate financial wealth, and the most pronounced substitution effects are found between Insurance Technical Reserves and Equity. This is precisely what is found in the studies by Blake (2004), Scharnagl & Ramb (2010), and Avouyi-Dovi et al. (2019), who all report significant own- and cross-price elasticities for these asset categories. Moreover, the limited responsiveness of Bonds found in this thesis is also consistent with the existing literature, as these studies also show that households tend not to adjust their bond holdings much in response to changes in relative prices.

The observed substitution patterns between Insurance Technical Reserves and Equity in Danish household portfolios are likely influenced by the specific institutional context of Denmark's pension system. Denmark has a highly developed pension system, where a significant portion of household financial wealth is automatically allocated to pension products and life insurance through mandatory occupational schemes and widespread private pension savings. As emphasized by Byrialsen et al. (2022), pension wealth constitutes a substantial share of the typical Danish household's financial assets, and this institutional framework shapes both preferences and constraints when market conditions change. In this light, the substitution effects identified in the empirical results may not solely reflect households' active decisions but also the outcome of how pension contributions are invested by fund managers across asset classes such as equities and bonds.

This raises important questions about the extent to which the observed behavior in Denmark can be generalized to other countries. The findings suggest that institutional design, and specifically the role of mandatory pension schemes, can play a significant role in shaping portfolio dynamics. For example, the similarities between the Danish and German results, as seen in the study by Scharnagl & Ramb (2010), indicate that strong collective pension arrangements may produce similar substitution patterns across different countries with comparable systems. However, in countries with less developed pension systems or greater reliance on voluntary savings, household behavior may differ considerably, as households might exercise more direct control over their asset allocation and exhibit different sensitivities to relative price changes.

It is also important to acknowledge that the data and model used in this thesis do not allow for a detailed

separation between different types of pension products or a decomposition of how specific institutional mechanisms, such as regulatory changes or the investment strategies of pension funds, contribute to the substitution patterns observed. This limitation suggests that while the empirical findings provide valuable insights into the aggregate behavior of Danish households, they should be interpreted in the context of the Danish system, where a large part of household financial wealth is shaped by institutional frameworks rather than individual investment decisions. Future research could explore this dimension in more detail, perhaps by combining sector-level analyses with micro-level data that capture household-level variation in pension contributions and preferences.

On the one hand, the finding that liquidity assets like Currency and Deposits mainly serve as buffers rather than as active tools for changing portfolio allocation aligns with Tobin's portfolio theory and previous empirical studies. This supports the theoretical perspective that households hold liquid assets to manage risk and maintain a safety margin during periods of uncertainty. Furthermore, the positive own-price responses observed for all asset categories except Bonds also align with Tobin's framework in a financial context, as households may interpret rising prices as signals of higher expected returns rather than merely as increased costs. Consequently, households may increase their allocation to these assets, reflecting adjustments based on changes in perceived risk and return rather than simply reacting to price movements. The observed partial and dynamic adjustment patterns also fit Tobin's theory that financial assets are imperfect substitutes and that households typically rebalance portfolios incrementally rather than through complete shifts, which is captured through the dynamic feature in the model.

On the other hand, the study indirectly highlights the relevance of household heterogeneity, even though such effects are not directly estimated. The responsiveness across asset types in and changes in the relative prices suggest that households may have distinct preferences, constraints, or levels of market access. This view is supported by the broader literature on household finance, presented in 3.

Previous studies using the AIDS and FAIDS frameworks, including this thesis, demonstrate that these models are effective for analyzing how households adjust their asset allocation in response to changes in relative prices. However, as noted above, other research indicates that portfolio choices are also shaped by factors such as behavioral biases, institutional context, tax regulations, and differences in financial literacy. This suggests that while the AIDS model provides valuable insights, it does not fully capture the range of influences affecting household financial decisions. Therefore, future studies could benefit from combining demand system models with approaches that consider household heterogeneity and institutional variation.

Based on this recognition, the following section will discuss relevant insights from behavioral economics in light of the empirical results presented in this study.

8.3. Perspectives on Behavioral Economic

While the empirical analysis presented in this thesis identifies substitution dynamics across asset categories in response to price changes, it does not explicitly incorporate behavioral aspects of household decision-making. This delimitation invites reflection on how behavioral economics insights could influence the interpretation of the findings.

Traditional economic models, such as the AIDS framework, typically operate under the assumption of fully informed, rational agents who optimize utility subject to constraints. This logic is also central to Tobin's portfolio theory, which similarly posits that households aim to maximize expected utility by distributing wealth across assets with varying degrees of return and risk. In both frameworks, households are expected to adjust their portfolios systematically in response to changes in relative prices, gradually reallocating wealth in accordance with shifting opportunity costs. A central assumption is that financial assets are imperfect substitutes, implying that adjustments occur incrementally rather than through abrupt or complete reallocation. This theoretical foundation helps explain the partial and persistent effects observed in several of the impulse response functions. However, the empirical results from this study and a growing body of behavioral economics research suggest that household behavior often departs from these rational benchmarks.

Whether the observed positive own-price responses for all asset categories, except Bonds, fully align with classical economic theory is open to discussion. On the one hand, this pattern may indicate that households interpret rising prices as signals of improved expected returns, encouraging households to increase their allocations. This view is consistent with the idea of utility-maximizing agents who adjust portfolios based on changing risk and return expectations. On the other hand, classical theory could also suggest it is rational to reduce exposure to assets with rising prices, as higher prices typically lower marginal expected returns and increase the opportunity cost of further investment. Therefore, rational behavior does not necessarily imply a single response in this setting; reallocating either towards or away from an asset with a price increase can be justified, depending on household preferences, forward looking expectations, and available information.

This ambiguity complicates the interpretation of the empirical findings. The observed responses could reflect either forward-looking optimization or alternative behavioral mechanisms. In this context, behavioral economics offers a valuable complementary perspective. It emphasizes that households are not entirely rational but instead exhibit bounded rationality, relying on heuristics, cognitive biases, and emotional reactions rather than complete and deliberative analysis when making financial decisions (Kumar & Goyal, 2015). From this viewpoint, price changes may not merely represent shifts in opportunity cost but also serve as psychological cues that influence household behavior through perceived momentum, fear of loss, or herd dynamics.

Behavioral finance literature suggests that rising prices can lead to herding behavior, where households follow the actions of others instead of making independent assessments (Kumar & Goyal, 2015). In this context, price increases are not necessarily viewed as indicators of intrinsic value but as cues that other investors possess superior information or are profiting from market momentum. This can lead to fear of missing out, prompting households to reallocate capital toward, for example, Equities to avoid being left behind.

Overall, the discussion above suggests that several factors shape household portfolio choices. While some patterns are in line with Tobin's theory of gradual rebalancing in response to changes in risk and return, other findings point to cognitive or psychological influences beyond standard portfolio theory. The analysis cannot determine which explanation dominates, but recognizing both perspectives gives a more nuanced view of the results. Some portfolio adjustments happen quickly and then fade or move in unexpected directions. This indicates that household behavior does not always follow purely rational models and may be influenced by additional behavioral or informational factors.

Likewise, the finding that most significant portfolio adjustments occur within the first few horizons and fade thereafter may reflect the influence of present bias. Behavioral economics suggests that households tend to overvalue immediate gains relative to delayed benefits, prioritizing short-term returns over long-term optimization (Samson et al., 2019). This could help explain the immediate but transitory reaction to price changes observed in the impulse response functions. Such a temporal pattern challenges the gradual adjustment mechanisms assumed in Tobin's model and goes beyond the static structure of the classical AIDS framework.

Another important consideration is imperfect information. Households may not completely understand financial markets or face cognitive limitations when assessing complex return-risk trade-offs. As a result, their responses to price movements can be partial, delayed, or inconsistent (Samson et al., 2019). This could help explain why some of the estimated responses in the analysis are statistically insignificant or economically modest over time. It is also possible that certain price increases, such as Revaluations in Insurance Technical Reserves, are not perceived as costs but rather as signals of strong past performance, leading households to maintain or even increase their investment in these assets.

Information frictions and limited financial literacy also play a significant role. Many households may not fully understand the risk-return profiles of financial products, or they may be influenced by prominent but incomplete information from the media or their peers. This can lead to portfolio choices that deviate from model predictions. The lack of significant or persistent responses for specific asset categories, along with the statistical insignificance of some estimated impulse response functions, suggests that households only partially perceive or respond to relevant price signals. Studies such as Calvet & Sodini (2014) highlight the importance of financial literacy for effective diversification and optimal asset allocation. Furthermore, peer effects and social

influence, as documented by Bohlin & Rosvall (2014), can lead households within certain networks or communities to make correlated investment decisions, amplifying trends and producing behavior that diverges from purely individual risk-return assessments.

These behavioral considerations raise important questions about how empirical results should be interpreted. While the AIDS-LP-SUR approach remains an intriguing tool for identifying systematic patterns in portfolio behavior, it does not explicitly include variables that measure fear of loss, risk preferences, or market sentiment. As a result, it is not possible to distinguish cleanly between rational adjustments to price changes and adjustments driven by psychological or informational frictions. Incorporating survey data, experimental evidence, or direct measures of behavioral traits in future research could help produce more nuanced, behaviorally informed estimates.

Incorporating behavioral insights into portfolio analysis may offer a more comprehensive understanding of household financial decision-making. While Tobin's theory provides a valuable benchmark by modeling rational, utility-maximizing behavior under constraints, behavioral economics highlights the psychological and informational frictions that can lead to deviations from this ideal. Rather than assuming full rationality, future research may benefit from exploring frameworks that integrate bounded rationality, adaptive expectations, and emotionally driven responses to financial signals. These perspectives can help bridge the gap between theoretical predictions and empirically observed household behavior, thereby enhancing the explanatory power and realism of asset allocation models.

8.4. Theoretical and Methodological Discussion

While this thesis's theoretical and empirical framework offers a structured foundation for analyzing household asset allocation in response to relative price changes, it also raises important questions that should be further discussed.

On the one hand, Tobin's portfolio theory provides a clear and intuitive basis for understanding household portfolio choices, emphasizing trade-offs between return, risk, and liquidity. Its assumption of imperfect substitutability aligns with the gradual adjustment patterns observed in the empirical results in Section 7.1. It supports the notion that households adjust their portfolios gradually rather than through complete reallocations. On the other hand, it is worth questioning whether this classical framework fully captures the complexities of real-world household finance. Alternative theoretical approaches, such as life-cycle models or behavioral models that account for bounded rationality and biases, could potentially have provided richer insights into household decision-making. This behavioral aspect was discussed in more detail in the previous section as well (Section 8.3). This raises questions about whether the substitution effects identified in the empirical

results reflect purely rational optimization or whether other factors, such as behavioral tendencies or life-stage considerations, might also be at play. While the focus on price-based substitution offers clarity, it also narrows the lens through which household behavior is viewed. Including alternative theories could have introduced competing expectations and potentially reshaped the interpretation of the results.

The sectoral balance sheet framework presented in Section 4.1.2 adds an important macroeconomic dimension by situating household asset choices within the broader financial system. The inclusion of the balance sheet table 4.1 illustrates the fundamental interconnectedness between household assets and the liabilities held across other sectors. However, the analysis remains delimited to the asset side of the household balance sheet. It excludes liabilities such as mortgages and loans and the broader interconnections between the other sectors. On the one hand, this simplification enhances the model's tractability and focuses the analysis on substitution patterns for the household assets side. On the other hand, it risks omitting key mechanisms that shape real-world portfolio behavior. Liabilities can impose liquidity constraints, amplify risk exposures, or create collateral effects that fundamentally influence how households respond to price changes, as suggested in the literary review in Section 3.1. By leaving out the feedback between sectors, the analysis does not show how changes in one sector can spread to the whole financial system. Including liabilities and additional sectors in the analysis could have uncovered different dynamics and revealed how cross-sectoral balance sheet adjustments influence household asset allocation choices. However, expanding the scope in this way would have required a much more complex modeling framework, which may not have been feasible given the scope and objectives of this thesis. This trade-off highlights the tension between analytical simplicity and the richness of real-world interdependencies.

The empirical strategy combines the AIDS model, LP, and SUR estimation, reflecting a novel and intriguing integration of theory and econometric techniques. As mentioned earlier, this approach provides a theoretically consistent and flexible structure for analyzing dynamic substitution patterns and ensures that the adding-up, homogeneity, and symmetry conditions from demand theory are respected.

However, while the restrictions from demand theory are important for maintaining internal consistency, they are imposed at every forecast horizon without explicitly testing whether they hold in practice. This raises the question of whether households would actually allocate wealth across the available assets in the way the model predicts. It is also unknown whether households, in practice, would allocate towards other assets not included in the model. Therefore, it cannot be ruled out that the theoretical restrictions, combined with the exclusion of certain asset classes, may also affect the model's results in a less precise direction. This important consideration reflects a deliberate choice made in the model setup. The aim has been to prioritize theoretical consistency, while acknowledging that this may come at the cost of flexibility in fully capturing how house-

holds actually behave.

Another relevant reflection concerns the potential for using the model to simulate policy shocks, such as changes in interest rates. In many macro-financial models, interest rates are a central driver of portfolio reallocation, and interest rate shocks are often used as a standard approach for analyzing how households adjust their asset holdings in response to changes in the macroeconomic environment. While this thesis does not include or investigate interest rate shocks, the dynamic AIDS-LP-SUR framework developed here could have been well-suited for such an analysis.

The dynamic structure of the model allows for tracing adjustment paths over time, which makes it particularly relevant for studying the transmission of policy shocks through household portfolios. Simulating, for example, the effects of an interest rate shock could have provided valuable insights into how households rebalance between Equities, Bonds, Currency and Deposits, and other assets in response to changes in the monetary policy stance.

The omission of policy shock analysis is not a direct delimitation of the thesis, but rather a modeling choice aimed at focusing on the effects of relative price changes across asset categories. Nonetheless, the potential for using the model in a policy simulation context remains an important avenue for future research. Extending the current analysis to include interest rate shocks could deepen the understanding of how macroeconomic policies influence household financial assets and reveal nuanced responses under different policy scenarios.

Other specific modeling choices, such as including two lags of the dependent variable and four lags of price changes to cover a fiscal year, are reasonable approximations of household adjustment processes. However, with only 61 observations for the whole period, the risk of overfitting can be a concern, and the large number of estimated coefficients increases estimation uncertainty. The decision to impose AIDS restrictions across all horizons while omitting certain asset categories also raises questions about theoretical coherence, as the absence of key assets could distort substitution patterns or bias results. These choices highlight the tension between theoretical rigor and the practical constraints of data availability and model complexity.

In sum, the theoretical and methodological framework and the model setup of this thesis provide a coherent and theoretically grounded approach to studying household portfolio allocation in response to relative price changes. However, it also reflects trade-offs between tractability and realism, between generalizability and specificity, and between theoretical structure and empirical flexibility. These choices shape the insights generated but also limit the conclusions that can be drawn. Future research could address these limitations by accounting for liabilities, incorporating inter-sectoral linkages, and exploring alternative estimation strategies to deepen our understanding of household financial behavior in complex economic environments.

8.5. Data Discussion

This section reflects on the data choices made in this thesis and discusses their implications for the analysis and interpretation of results.

One central aspect for the data is the limited number of observations as mentioned earlier. The dataset covers 61 quarterly periods, which, while sufficient for estimation, introduces some challenges. Quarterly data offers a practical compromise between granularity and feasibility, as higher-frequency data are often unavailable or prone to excessive noise. This allows for the analysis of medium-term portfolio dynamics without overwhelming the model with short-term fluctuations. However, quarterly data may also smooth out rapid adjustments and dampen short-lived shocks, potentially masking more immediate substitution effects that could emerge in higher-frequency data. For example, if households reallocate their portfolios quickly in response to shocks, the model may not fully capture these short-term dynamics.

Moreover, the relatively small sample size raises concerns about overfitting. This is especially relevant because the model is complex and requires estimating many parameters. Using a theoretically grounded AIDS-LP-SUR model improves efficiency. The SUR estimation imposes economic structure and uses cross-equation correlations. However, the limited number of observations, with only 61 quarterly data points, may still affect the precision and generalizability of the results. Alternative estimation strategies could potentially have addressed some of these challenges. For instance, Vector Autoregressions (VAR) allow for richer dynamic interdependencies across variables, which may have been beneficial in this context. However, standard VAR models often require a substantial number of observations to avoid problems such as overparameterization and instability. Given the limited availability of only 61 quarterly periods, applying a standard VAR could risk unreliable and unstable estimates. Bayesian VARs (BVAR), by introducing prior information, present a potentially more robust alternative in small-sample settings, as they help stabilize parameter estimates and mitigate the biases typically associated with small datasets (Jarociński & Marcet, 2010). Nevertheless, it is important to note that while VAR and BVAR models can improve empirical fit, they are generally less theory-driven than structural approaches such as the AIDS model.

The choice of asset categories also raises important questions. The inclusion of Insurance Technical Reserves, Equities, Currency and Deposits, and Bonds is primarily motivated by the size and relevance of these assets in household portfolios, as well as the availability of consistent, high-quality data. This selection provides a balanced view of different investment motives, such as liquidity, risk-taking, and long-term savings. The exclusion of smaller asset classes such as Trade Credits, Derivatives, and Stock Options is methodologically justified, but it introduces potential biases. For example, Bonds, which are included in the model, represent a

relatively small share of household assets, and their size is comparable to that of the excluded Trade Credits. This raises the question of whether the inclusion of Bonds is meaningful or if they should have been omitted alongside other small categories. The empirical results, where Bonds exhibit insignificant substitution effects, further underline this issue. On one hand, including Bonds offers a theoretically complete portfolio representation. On the other hand, the weak results suggest that much of the meaningful substitution occurs between Insurance, Equities, and Deposits. This raises the possibility that the analysis primarily captures reallocation among these larger, more salient categories, while the inclusion of Bonds may add complexity without contributing much explanatory power.

There could also be an argument for including Trade Credits in the model, given that their size is comparable to Bonds. However, Trade Credits are more difficult to price consistently, and this challenge ultimately led to their exclusion. The decision to focus on assets with clearer pricing structures reflects a trade-off in the model design that prioritizes theoretical consistency and data quality but may exclude assets that could play a meaningful role in household portfolios. This choice underscores the importance of considering both theoretical motivations and practical constraints in empirical modeling.

The limited fluctuation in asset weights, as shown in the descriptive plots in section 5.1.2, also call further discussion. Although the weights are not formally tested for stationarity, their visual presentation indicates a degree of stability. However, this does not imply that the weights are necessarily stationary, and it cannot be ruled out that non-stationarity may affect the model's results. At the same time, it would not have been appropriate to apply standard techniques such as differencing to address potential non-stationarity, since the weights are by definition constrained to sum to one in the AIDS model framework. Modifying the weights in this way would break the internal logic of the model and undermine its theoretical consistency. Therefore, the decision to proceed without transformations reflects a trade-off between preserving the model's theoretical foundations and acknowledging the potential limitations introduced by the non-stationarity of the data.

Turning to the price proxies, each was selected to reflect theoretically meaningful signals for household investment decisions. The use of the Share Prices for Denmark index for Equities and the 10-year government bond yield for Bonds is well-founded, as these series capture the core economic forces driving returns in these asset classes.

For Currency and Deposits, the Certificate of Deposit rate was chosen, as it represents the opportunity cost of holding liquid assets. However, this selection needs further discussion. While the rate is conceptually relevant, it exhibits limited variation over parts of the sample period. This lack of variation potentially affects the model's ability to capture household responses to changes in the price of Currency and Deposits. At times, the Certificate of Deposit rate remains flat across several consecutive observations, providing little in-

formation on how households adjust their portfolios in response to changing incentives. On the one hand, the Certificate of Deposit rate is theoretically consistent with the notion of a return on liquid assets, and its use maintains internal coherence within the model framework. On the other hand, its limited variation over parts of the data period reduces its potential for identifying meaningful substitution patterns. The initial approach of using the short-term interest rate faced an even greater challenge, as this rate exhibited even less variation and was completely constant for most of the period. Consequently, the Certificate of Deposit rate was chosen because it offered some degree of fluctuation, unlike the short-term rate.

For Insurance Technical Reserves, the constructed price proxy based on Revaluations represents a pragmatic solution in the absence of a market price. While this measure approximates shifts in the value of insurance entitlements, it is subject to idiosyncratic influences, such as actuarial revisions and regulatory changes, which may not reflect pure market valuation dynamics.

Moreover, the log-differencing of prices to achieve stationarity, as confirmed by ADF tests, is a standard and appropriate transformation. However, the presence of negative bond yields in the final four quarters introduces complications, as log transformations are undefined for negative values. This issue led to the exclusion of four observations in the estimation stage. One could argue that the series should have been shifted or transformed differently to retain these observations.

Overall, the data choices in this thesis reflect a series of informed compromises. On one side, the selected proxies and asset categories align with theoretical considerations and data availability. On the other side, these choices inevitably impose constraints that limit the model's ability to fully capture the complexity of household financial behavior. This balance between theoretical soundness, empirical feasibility, and data reliability underscores the importance of cautious interpretation and highlights opportunities for future research to extend and refine the analysis.

An additional concern is the distinction between revaluations and actual transactions in the data. Since the dataset used in this thesis is based on aggregated sector-level balance sheet data, it is not possible to separate how much of the observed changes in household asset holdings stem from active portfolio choices and how much is due to market-driven revaluations of existing assets. For example, an increase in Equity prices will automatically lead to a higher market value of Equity holdings, even if households do not make any transactions. This raises a concern that the observed substitution effects between asset categories, may partly reflect accounting effects rather than deliberate reallocation decisions by households.

This issue is a common challenge in macro-level portfolio analyses, where national accounts data often conflate price effects and flow effects. The inability to distinguish these components means that the estimated substitution effect could potentially overestimate households' true responsiveness to price changes. It is therefore important to interpret the results cautiously and acknowledge that some of the substitution patterns identi-

fied may reflect revaluation effects rather than active portfolio rebalancing. However, while some of the effects may originate from revaluations, they still capture how relative price movements influence households' asset allocation, even though they do not reflect active transaction choices.

Future research could address this limitation by estimating the model using transaction-level data. Such data could help disentangle whether the patterns observed in this thesis primarily result from passive price effects or actual behavioral responses in the form of transactions.

8.6. Conclusion and Directions for Future Research

In summary, this thesis provides new evidence on the dynamic substitution patterns in Danish household portfolios, showing how relative asset prices, particularly for Equity and Insurance Technical Reserves, influence household asset allocation. The results indicate that substitution effects are strongest in the initial horizons, which aligns with economic theory and previous empirical studies. However, these findings should be interpreted with care due to certain limitations. The reliance on Danish sector-level balance sheet data, the exclusion of liabilities, the omission of crisis periods such as the COVID-19 pandemic, and the use of aggregated data all constrain the generalizability and depth of the analysis. In particular, the aggregated data structure means that differences between households in terms of wealth, age, and risk preferences remain unobserved, and the inability to distinguish between revaluations and active transactions calls for caution when interpreting the substitution effects.

Future research could address these limitations by using transaction-level data to distinguish between passive price effects and active portfolio adjustments. Incorporating household-level microdata would allow for a deeper understanding of how demographic factors such as age, education, financial literacy, and wealth influence portfolio choices. Comparative studies across countries could further clarify which substitution patterns are universal and which are shaped by specific institutional frameworks. Another important avenue for future research is to integrate behavioral perspectives, for example through surveys, experiments, or sentiment analysis, to explore how psychological factors such as risk aversion, fear of loss, and herd behavior shape household responses to asset price changes. Including periods of economic uncertainty or crises, accounting for liabilities, and analyzing cross-sectoral balance sheet linkages could also provide a more comprehensive picture of household portfolio dynamics. Additionally, alternative modeling strategies may offer further insights into the mechanisms behind the observed substitution patterns.

Overall, this thesis offers an insightful analysis within its chosen scope, but it also acknowledges that methodological choices, data constraints, and theoretical assumptions shape empirical findings. Recognizing these factors is essential for scientific progress and lays the foundation for future research that can extend and deepen the understanding of how relative asset prices affect Danish households' allocation of financial assets.

9. Conclusion

This final section addresses the research question:

How do relative asset prices affect Danish households' allocation of financial assets?

Based on a dynamic adaptation of the Almost Ideal Demand System (AIDS) model, estimated using Local Projections (LP) and Seemingly Unrelated Regressions (SUR) on Danish household sector national accounts data, the analysis provides new insights into how Danish households adjust their portfolios in response to changes in relative asset prices.

The empirical analysis shows that Danish households adjust their portfolios in response to changes in relative asset prices, although the magnitude, direction, and persistence of these responses vary across asset categories. The strongest and most consistent adjustments are observed in Equity and Insurance Technical Reserves. These two categories appear to function as imperfect substitutes, with households reallocating capital between them in response to changes in expected returns or revaluations. Specifically, when Equity prices increase, households reduce their allocation to Insurance Technical Reserves. Conversely, when the price of Insurance Technical Reserves rises, households increase their allocation to this asset. The substitution effects are statistically significant and most evident within the first six horizons following a price change, suggesting that adjustments in portfolio weights occur relatively quickly.

Currency and Deposits exhibit more moderate, but economically meaningful, responses. The allocation to this category tends to decrease when Equity prices rise, indicating some degree of substitution. In contrast, the response to changes in the price of Currency and Deposits itself is positive and significant during the initial horizons. This suggests increased allocation when the Certificates of Deposits Rate rises. There is also limited evidence of a temporary complementary relationship between Currency and Deposits and Insurance Technical Reserves.

For Bonds, the estimated coefficients are consistently small and statistically insignificant across all horizons and price combinations. This pattern indicates that Bonds are not actively adjusted in response to changes in relative prices. While no firm conclusions can be drawn from the insignificance of the estimates, a possible explanation is that Bonds are often held indirectly, for example through pension schemes or investment products, where households have limited discretion over asset composition and rebalancing decisions.

Across all asset categories, the results show that most portfolio adjustments occur within the first few horizons following a change in relative prices, with the effects gradually declining thereafter. This dynamic pattern indicates a process of gradual rebalancing rather than abrupt shifts, which is consistent with Tobin's po-

portfolio theory. The findings confirm that Danish households do not treat financial assets as perfect substitutes. Instead, they respond selectively to price signals, adjusting their holdings in a manner that reflects a utility-maximizing trade-off between return, risk, and liquidity considerations.

In sum, this thesis concludes that relative asset prices affect how Danish households allocate their financial assets. By applying a dynamic AIDS-LP-SUR framework to household financial data, the analysis provides a novel perspective on portfolio adjustment behavior. The study focuses specifically on the effects of relative price changes, while acknowledging that other factors such as behavioural preferences, macroeconomic conditions, and institutional settings also shape household portfolio decisions. These broader determinants are important but fall outside the scope of this thesis.

The empirical results suggest that Danish households adjust their portfolios in response to changes in relative asset prices, particularly through notable and timely reallocations between Equity and Insurance Technical Reserves. These adjustments indicate meaningful substitution effects and are consistent with a utility-maximizing approach to balancing return, risk, and liquidity.

Future research could build on this work by incorporating additional factors such as household heterogeneity, behavioural elements, and macroeconomic shocks to develop a more comprehensive understanding of how relative asset prices affect Danish households allocation of financial assets.

10. References

- Aarhus Universitet. (2023a). *Ekstern validitet*. metodeguiden.au.dk. Retrieved from <https://metodeguiden.au.dk/ekstern-validitet>
- Aarhus Universitet. (2023b). *Kvantitativ metode*. metodeguiden.au.dk. Retrieved from <https://metodeguiden.au.dk/kvantitativ-metode>
- Adam, C. S. (1999). Asset portfolios and credit rationing: Evidence from kenya. *Economica*, 66(261), 97–117. Retrieved from <https://www.jstor.org/stable/2555204>
- Adämmer, P. (2019). An r package to estimate impulse response functions by local projectios. *Contributed research article*, 11/2, 423.
- Altayeb, S., & Daoud, H.-E. (2022). Application of the almost ideal demand system (aids) model in the demand of the household commodity group in jordan. *Jordan Journal of Economic Sciences*, 9(1), 1–15. Retrieved from <https://jjournals.ju.edu.jo/index.php/jjes/article/view/250> doi: 10.35516/jjes.v9i1.250
- Ameriks, J., & Zeldes, S. P. (2004). *How do household portfolio shares vary with age?* (Tech. Rep.). Columbia Business School. Retrieved from <https://business.columbia.edu/faculty/research/how-do-household-portfolio-shares-vary-age>
- Andersen, L. B., Hansen, K. M., & Klemmensen, R. (2010). *Metoder i statskundskab*. København K: Hans Reitzels Forlag.
- Arrondel, L., Bartiloro, L., Fessler, P., Lindner, P., Mathä, T. Y., Rampazzi, C., ... Vermeulen, P. (2014, August). *HOW DO HOUSEHOLDS ALLOCATE THEIR ASSETS? STYLISED FACTS FROM THE EUROSISTEM HOUSEHOLD FINANCE AND CONSUMPTION SURVEYI* (Working Paper No. 1722). Frankfurt am Main: European Central Bank.
- Arrondel, L., & Coffinet, J. (2021). *Preparing for the tax reform: the risky french households' portfolio in 2018*. <https://halshs.archives-ouvertes.fr/halshs-03322577>. (halshs-03322577)
- Avouyi-Dovi, S., Pfister, C., & Sédillot, F. (2019, September). *French Households' Portfolio: The Financial Almost Ideal Demand System Appraisal* (Working Paper No. 728). Paris: Banque de France.
- Bach, L., Calvet, L. E., & Sodini, P. (2020). Rich pickings? risk, return, and skill in household wealth. *American Economic Review*, 110(9), 2703–2747. doi: 10.1257/aer.20170666

- Balestra, C., & Tonkin, R. (2018, June 20). *Inequalities in household wealth across OECD countries: Evidence from the OECD Wealth Distribution Database* (Working Paper No. 88). Paris: OECD Statistics and Data Directorate.
- Barr, D., & Cuthbertson, K. (1991). Neoclassical consumer demand theory and the demand for money. *The Economic Journal*, 101(407), 855–876. Retrieved from <https://www.jstor.org/stable/2233859>
- Bashar Al-Zu'bi and Khalid Al-Zu'bi. (2014). Portfolio behavior in a flow of funds: Extended model for the household sector in the me countries. *International Journal of Economic Perspectives*, 8(4), 39–50.
- Benhabib, J., & Bisin, A. (2018, December). Skewed wealth distributions: Theory and empirics. *Journal of Economic Literature*, 56(4), 1261–1291. doi: 10.1257/jel.20161390
- Blake, D. (2004). Modelling the composition of personal sector wealth in the uk. *Applied Financial Economics*, 14(9), 611–630. Retrieved from <https://doi.org/10.1080/0960310042000233395> doi: 10.1080/0960310042000233395
- Bohlin, L., & Rosvall, M. (2014, July). Stock Portfolio Structure of Individual Investors Infers Future Trading Behavior. *PLOS ONE*, 9, 1-8.
- Byrialsen, M. R., Smith, R. A. B., & Olesen, F. (2022, April). *Sektorbalancer i danmark i et historisk perspektiv 1950-2020*. Retrieved from <https://tidsskrift.dk/ea/article/view/133415>
- Calvet, L. E., & Sodini, P. (2014). Twin picks: Disentangling the determinants of risk-taking in household portfolios. *The Journal of Finance*, 69(2), 867–906. doi: 10.1111/jofi.12125
- Campbell, J. Y. (2006). Household finance. *The Journal of Finance*, 61(4), 1553–1604. doi: 10.1111/j.1540-6261.2006.00883.x
- Danmarks Nationalbank. (2021, December). *Danskerne investerer selv en større del af formuen*. Retrieved from <https://www.nationalbanken.dk/da/viden-og-nyheder/data-og-statistik/finansielle-konti/20211223-danskerne-investerer-selv-en-stoerre-del-af-formuen> (Publiseret 23. december 2021)
- Danmarks Nationalbank, Statistikbanken. (2020). *DNFIK: Quarterly financial accounts by sector, data type, account entry, financial instrument and counterpart sector (DISCONTINUED)*. Retrieved 2025-03-20, from <https://www.statbank.dk/DNFIK>
- Danmarks Nationalbank, Statistikbanken. (2024). *NAN1: Demand and supply by transaction and price unit*. Retrieved 2025-03-20, from <https://www.statistikbanken.dk/NAN1>

- Danmarks Nationalbank, Statistikbanken. (2025). *DNRENTD: Danmarks Nationalbank's official interest rates and money and capital market interest rates by item, country and methodology (daily observations)*. Retrieved 2025-03-20, from <https://www.statbank.dk/DNRENTD>
- Deaton, A., & Muellbauer, J. (1980). An Almost Ideal Demand System. *The American Economic Review*, *70*(3), 312-326.
- Delbecque, B. (2024, January). *Household Participation in Capital Markets* (Tech. Rep.). Belgium: European Fund and Asset Management Association (EFAMA).
- Dinenis, E., & Scott, A. (1993). What determines institutional investment? an examination of uk pension funds in the 1980s. *Oxford Economic Papers*, *45*(2), 292–310. Retrieved from <https://www.jstor.org/stable/2663640>
- Enders, W. (2015). *Applied Econometric Time Series* (4th ed.). Hoboken: John Wiley & Sons, Inc.
- Federal Reserve Bank of St. Louis. (2025a). *Financial market: Share prices for denmark (spastt01dkm661n)*. Retrieved 2025-03-20, from <https://fred.stlouisfed.org/series/SPASTT01DKM661N#>
- Federal Reserve Bank of St. Louis. (2025b). *Interest rates: Long-term government bond yields: 10-year: Main (including benchmark) for denmark (irltlt01dkq156n)*. Retrieved 2025-03-20, from <https://fred.stlouisfed.org/series/IRLTLT01DKQ156N#>
- Godley, W., & Lavoie, M. (2007). *Monetary economics: An integrated approach to credit, money, income, production and wealth*. Palgrave Macmillan.
- Guiso, L., Jappelli, T., & Terlizzese, D. (1996, March). Income risk, borrowing constraints, and portfolio choice. *The American Economic Review*, *86*(1), 158–172. Retrieved from <http://www.jstor.org/stable/2118260>
- Guiso, L., & Paiella, M. (2008). Risk aversion, wealth, and background risk. *Journal of the European Economic Association*, *6*(6), 1109-1150. doi: 10.1162/JEEA.2008.6.6.1109
- Guiso, L., Sapienza, P., & Zingales, L. (2003). People's opium? religion and economic attitudes. *Journal of Monetary Economics*, *50*(1), 225-282. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0304393202002027> doi: [https://doi.org/10.1016/S0304-3932\(02\)00202-7](https://doi.org/10.1016/S0304-3932(02)00202-7)
- Henningsen, A., & Hamann, J. D. (2007). systemfit: A package for estimating systems of simultaneous equations in r. *Journal of Statistical Software*, *23*(4), 1–40. Retrieved from <https://www.jstatsoft.org/v23/i04/>

- Jarociński, M., & Marcet, A. (2010). *Autoregressions in small samples, priors about observables and initial conditions* (ECB Working Paper No. 1263). Frankfurt am Main: European Central Bank. Retrieved from <https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1263.pdf>
- Kumar, S., & Goyal, N. (2015). *Behavioural biases in investment decision making – a systematic literature review*. Emerald Group Publishing Limited. Retrieved from <https://www.emerald.com/insight/content/doi/10.1108/QRFM-07-2014-0022/full/html>
- Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, 7(1), 77–91. Retrieved 2025-05-22, from <http://www.jstor.org/stable/2975974>
- Mian, A., & Sufi, A. (2010). Household leverage and the recession of 2007–09. *IMF Economic Review*, 58, 74–117.
- Mishkin, F. S., & Eakins, S. G. (2018). *Financial markets and institutions* (9th ed.). Pearson.
- OECD. (n.d.). *Long-term interest rates (indicator)*. Retrieved from <https://www.oecd.org/en/data/indicators/long-term-interest-rates.html> (Accessed: 2025-05-12)
- OECD. (n.d.). *Share prices*. <https://www.oecd.org/en/data/indicators/share-prices.html>. (Accessed on 12 May 2025)
- OECD. (2017). *Understanding financial accounts*. Paris: OECD Publishing. (Accessed: 2025-05-12) doi: 10.1787/9789264281288-en
- Petropoulou, A., & Murinde, V. (2024). *How is fintech shaping household portfolio behaviour?* <https://ssrn.com/abstract=5023074>. (Available at SSRN. DOI: <http://dx.doi.org/10.2139/ssrn.5023074>)
- Poterba, J. M., & Samwick, A. A. (2001). Household portfolio allocation over the life cycle. In S. Ogura, T. Tachibanaki, & D. A. Wise (Eds.), *Aging issues in the united states and japan* (pp. 65–104). University of Chicago Press.
- Ravikumar, B., & Karson, E. (2018, April 9). *How has stock ownership trended in the past few decades?* Retrieved from <https://www.stlouisfed.org/on-the-economy/2018/april/stock-ownership-trended-past-few-decades#:~:text=However%2C%20the%20share%20of%20household,asset%20holdings%20remained%20essentially%20unchanged>
- Samson, A., Gneezy, U., & Mazar, N. (2019). *The behavioural economics guide 2019*. Behavioral Science Solutions Ltd. Retrieved from <https://www.%20behavioraleconomics.com/>

- Samuelson, P. A. (1969). Lifetime portfolio selection by dynamic stochastic programming. *The Review of Economics and Statistics*, 51(3), 239–246. Retrieved 2025-05-10, from <http://www.jstor.org/stable/1926559>
- Scharnagl, M., & Ramb, F. (2010, July). *Households' portfolio structure in germany – analysis of financial accounts data 1959–2009*. <https://ssrn.com/abstract=1646344>. (Available at SSRN. DOI: <http://dx.doi.org/10.2139/ssrn.1646344>)
- Sonne-Ragans, V. (2019). *Anvendt videnskabsteori – refleksion over uretigheder i husholdningsrigdom over OECD-landene: Evidens fra OECD Wealth Distribution Database og retning i videnskabelige opgaver* (2. udgave ed.). Frederiksberg C: Samfundslitteratur.
- Statistics Department - International Monetary Fund. (2007). *The system of macroeconomic accounts statistics - an overview*. Washington, D.C.: International Monetary Fund, Publication Services.
- Statistics Eurostat. (2024). *Financial balance sheets - quarterly data*. Retrieved 2025-03-20, from https://ec.europa.eu/eurostat/databrowser/view/nasq_10_f_bs__custom_9154040/default/table?lang=en
- Thomas, R., & Nolan, L. (2016, January 12). *Economic statistics transformation programme: Historical estimates of financial accounts and balance sheets*. Retrieved 2025-04-19, from <https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/articles/nationalaccountsarticles/historicalestimatesoffinancialaccountsandbalancesheets>
- Tobin, J. (1958, February). Liquidity preference as behavior towards risk. *The Review of Economic Studies*, 25(2), 65–86.
- Waldenström, D. (2021, November 17). *Wealth and history: A reappraisal*. Retrieved from <https://cepr.org/voxeu/columns/wealth-and-history-reappraisal#:~:text=The%20main%20result%20is%20that,trend%20had%20important%20distributional%20implications>
- Wooldridge, J. M. (2016). *Introductory Econometrics: A Modern Approach* (6. ed.). Boston: Cengage Learning.
- Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association*, 57(298), 348–368. Retrieved 2025-05-26, from <http://www.jstor.org/stable/2281644>

A. Stationarity Test - Augmented Dickey-Fuller test

This appendix A presents the econometric approach used to assess whether the price variables are suitable for model specification by testing for stationarity. Specifically, it briefly outlines the theoretical foundation of the Augmented Dickey-Fuller (ADF) test, which is applied to all price-related variables in the thesis. The results of the tests are shown in Table 5.2 in Section 5.2.3.

In this thesis, stationarity is defined as weak stationarity, implying that the mean, variance, and autocovariance of the time series are constant over time (Wooldridge, 2016, pp. 345–346):

$$E[y_t] = \mu < \infty \quad (\text{A.1})$$

$$Var[y_t] = E[(y_t - \mu)^2] = \gamma_0 < \infty \quad (\text{A.2})$$

$$Cov[y_t, y_{t-i}] = E[(y_t - \mu)(y_{t-i} - \mu)] = \gamma_i, \quad i = 1, 2, 3, \dots \quad (\text{A.3})$$

The ADF test controls for serial correlation by including p lagged differences of the dependent variable in the following model:

$$\Delta y_t = \alpha + \beta t + \pi y_{t-1} + \sum_{i=1}^p \delta_i \Delta y_{t-i} + \varepsilon_t \quad (\text{A.4})$$

where α is a constant, β is a trend coefficient, and p is the number of lags chosen to eliminate serial correlation.

The ADF test evaluates the following hypotheses:

$$H_0 : \pi = 0 \quad (\text{unit root present}) \quad (\text{A.5})$$

$$H_1 : \pi < 0 \quad (\text{stationarity}) \quad (\text{A.6})$$

If the null hypothesis cannot be rejected, the series is considered non-stationary, and its first difference is taken. The test is repeated until stationarity is achieved. The number of differencing steps corresponds to the integration order.

The ADF test can be estimated in three variations, depending on whether a constant and/or a trend is included (by setting $\alpha = 0$ and/or $\beta = 0$). Since the test statistic does not follow a standard t-distribution, it must be compared to critical values from the Dickey-Fuller distribution, which depend on the test specification and sample size (Enders, 2015, pp. 215–218).

In this thesis all tests are conducted without a constant or trend, using four lags.

B. Model Results

This appendix B presents the estimated impulse response functions (IRFs) in matrix form for each horizon. The results are divided into two subsections: Appendix B.1 reports the IRF values, while Appendix B.2 contains the corresponding p-values.

All matrices presented in Appendix B follow the notation provided in Table B.1 below, which is also introduced in Section 5.2.2 as Table 5.1.

Table B.1: Overview of Each Asset and corresponding Price Data Used in the AIDS Model

Asset Category (w_i)	Price of that Asset (p_j)
Insurance Technical Reserves (w_1)	Revaluations of Insurance Technical Reserves (p_1)
Equities (w_2)	Share Price Index for Denmark (p_2)
Currency & Deposits (w_3)	Certificates of Deposit Rate (p_3)
Bonds (w_4)	10-Year Government Bond Yield for Denmark (p_4)

Note: The notation in parentheses illustrates how each asset and price is noted.

B.1. Impulse Response Function Matrices

This section presents the estimated impulse response functions (IRFs) in matrix form for each horizon from $h = 0$ to $h = 8$. In each matrix, the rows correspond to budget shares w_i , and the columns represent asset prices p_j . Each cell shows the estimated effect of a price change in asset j on the budget share w_i at the given horizon. These values correspond to the coefficients analyzed in Section 7.1.

The AIDS model imposes two key theoretical restrictions: homogeneity and symmetry. These can be evaluated directly from the estimated IRF matrices. Homogeneity requires that each row sums to zero, ensuring that budget shares are unaffected by proportional changes in all prices. Symmetry implies that the cross-price effects are equal across the diagonal, meaning the effect of price j on share i equals the effect of price i on share j . Both restrictions are satisfied across all horizons, confirming that the estimated model aligns with the theoretical structure of the AIDS framework.

Tabel B.2: IRF matrix at h=0

	p_1	p_2	p_3	p_4
w_1	0.0513	-0.0613	0.0094	0.0005
w_2	-0.0613	0.0858	-0.0240	-0.0006
w_3	0.0094	-0.0240	0.0138	0.0007
w_4	0.0005	-0.0006	0.0007	-0.0006

Tabel B.3: IRF matrix at h=1

	p_1	p_2	p_3	p_4
w_1	0.0569	-0.0707	0.0128	0.0010
w_2	-0.0707	0.0965	-0.0255	-0.0003
w_3	0.0128	-0.0255	0.0126	0.0001
w_4	0.0010	-0.0003	0.0001	-0.0008

Tabel B.4: IRF matrix at h=2

	p_1	p_2	p_3	p_4
w_1	0.0435	-0.0585	0.0157	-0.0007
w_2	-0.0585	0.0901	-0.0322	0.0006
w_3	0.0157	-0.0322	0.0166	-0.0001
w_4	-0.0007	0.0006	-0.0001	0.0001

Tabel B.5: IRF matrix at h=3

	p_1	p_2	p_3	p_4
w_1	0.0289	-0.0434	0.0136	0.0009
w_2	-0.0434	0.0749	-0.0298	-0.0017
w_3	0.0136	-0.0298	0.0151	0.0011
w_4	0.0009	-0.0017	0.0011	-0.0003

Tabel B.6: IRF matrix at h=4

	p_1	p_2	p_3	p_4
w_1	0.0473	-0.0578	0.0100	0.0004
w_2	-0.0578	0.0855	-0.0272	-0.0005
w_3	0.0100	-0.0272	0.0169	0.0002
w_4	0.0004	-0.0005	0.0002	-0.0002

Tabel B.7: IRF matrix at h=5

	p_1	p_2	p_3	p_4
w_1	0.0610	-0.0664	0.0051	0.0003
w_2	-0.0664	0.0915	-0.0239	-0.0012
w_3	0.0051	-0.0239	0.0171	0.0017
w_4	0.0003	-0.0012	0.0017	-0.0009

Tabel B.8: IRF matrix at h=6

	p_1	p_2	p_3	p_4
w_1	0.0500	-0.0539	0.0023	0.0015
w_2	-0.0539	0.0808	-0.0245	-0.0024
w_3	0.0023	-0.0245	0.0208	0.0014
w_4	0.0015	-0.0024	0.0014	-0.0005

Tabel B.9: IRF matrix at h=7

	p_1	p_2	p_3	p_4
w_1	0.0226	-0.0244	-0.0015	0.0033
w_2	-0.0244	0.0467	-0.0180	-0.0044
w_3	-0.0015	-0.0180	0.0179	0.0015
w_4	0.0033	-0.0044	0.0015	-0.0005

Tabel B.10: IRF matrix at h=8

	p_1	p_2	p_3	p_4
w_1	0.0107	-0.0032	-0.0130	0.0055
w_2	-0.0032	0.0198	-0.0087	-0.0078
w_3	-0.0130	-0.0087	0.0191	0.0026
w_4	0.0055	-0.0078	0.0026	-0.0003

B.2. P-Value Matrices for IRFs

This section reports the p-values corresponding to the IRF coefficients presented in Appendix B.1. The structure of each matrix is the same: rows represent budget shares w_i , and columns indicate asset prices p_j . Each cell displays the significance level of the estimated effect of a price change in asset j on the budget share w_i at the given horizon.

Tabel B.11: P-value at h=0

	p_1	p_2	p_3	p_4
w_1	0.0000***	0.0000***	0.0046***	0.8184
w_2	0.0000***	0.0000***	0.0000***	0.8268
w_3	0.0046***	0.0000***	0.0000***	0.5318
w_4	0.8181	0.8265	0.5307	0.5643
***p<0.01	**p<0.05	*p<0.1		

Tabel B.12: P-value at h=1

	p_1	p_2	p_3	p_4
w_1	0.0001***	0.0001***	0.0231**	0.7888
w_2	0.0001***	0.0000***	0.0007***	0.9481
w_3	0.0231**	0.0007***	0.0015***	0.9579
w_4	0.7884	0.9480	0.9578	0.6765
***p<0.01	**p<0.05	*p<0.1		

Tabel B.13: P-value at h=2

	p_1	p_2	p_3	p_4
w_1	0.0204**	0.0078***	0.0293**	0.8842
w_2	0.0078***	0.0016***	0.0009***	0.9100
w_3	0.0293**	0.0009***	0.0011***	0.9753
w_4	0.8840	0.9098	0.9753	0.9610
***p<0.01	**p<0.05	*p<0.1		

Tabel B.14: P-value at h=3

	p_1	p_2	p_3	p_4
w_1	0.1660	0.0789*	0.1036	0.8769
w_2	0.0789*	0.0205**	0.0087***	0.0819
w_3	0.1036	0.0087***	0.0141**	0.7333
w_4	0.8766	0.8015	0.7328	0.9343
*** $p < 0.01$	** $p < 0.05$	* $p < 0.1$		

Tabel B.15: P-value at h=4

	p_1	p_2	p_3	p_4
w_1	0.0276**	0.0259**	0.2730	0.9397
w_2	0.0259**	0.0139**	0.0344**	0.9461
w_3	0.2730	0.0344**	0.0231**	0.9574
w_4	0.9396	0.9460	0.9573	0.9730
*** $p < 0.01$	** $p < 0.05$	* $p < 0.1$		

Tabel B.16: P-value at h=5

	p_1	p_2	p_3	p_4
w_1	0.0066***	0.0157**	0.6035	0.9572
w_2	0.0157**	0.0150**	0.0934*	0.8884
w_3	0.6035	0.0934*	0.0446**	0.7130
w_4	0.9571	0.8882	0.7125	0.8809
*** $p < 0.01$	** $p < 0.05$	* $p < 0.1$		

Tabel B.17: P-value at h=6

	p_1	p_2	p_3	p_4
w_1	0.0280**	0.0576*	0.8251	0.8143
w_2	0.0576*	0.0411**	0.1160	0.7894
w_3	0.8251	0.1160	0.0333**	0.7985
w_4	0.8139	0.7890	0.7981	0.9370
*** $p < 0.01$	** $p < 0.05$	* $p < 0.1$		

Tabel B.18: P-value at h=7

	p_1	p_2	p_3	p_4
w_1	0.3223	0.3901	0.8926	0.6216
w_2	0.3901	0.2389	0.2632	0.6387
w_3	0.8926	0.2632	0.0976*	0.7965
w_4	0.6208	0.6379	0.7961	0.9497
*** $p < 0.01$	** $p < 0.05$	* $p < 0.1$		

Tabel B.19: P-value at h=8

	p_1	p_2	p_3	p_4
w_1	0.6111	0.9039	0.2212	0.3817
w_2	0.9039	0.5982	0.5816	0.4070
w_3	0.2212	0.5816	0.1030	0.6744
w_4	0.3800	0.4054	0.6737	0.9696
*** $p < 0.01$	** $p < 0.05$	* $p < 0.1$		