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Examining the Consumption Behavior of Households Caused by Changing the Utility Function Using the DSGE Model

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Abstract

The utility function and consumption behavior within a society exert a profound influence over both household conduct and broader macroeconomic dynamics, thereby exerting a pivotal role in fostering consumption and economic growth and prosperity. Consequently, the examination and analysis of household consumption behavior stand as a cornerstone in economic inquiry and policy formulation. This paper seeks to investigate the steady state of a small open economy in the presence of imperfect asset markets and proposes three standard and alternative models. Three disparate specifications are presumed: (1) An endogenous discount factor model; (2) A debt-elastic interest-rate premium model; and (3) A portfolio adjustment costs model. This study employs a DSGE model and uses seasonal statistical data from 1977 to 2020 to emulate, scrutinize, and elucidate the intricacies of household macroeconomic variables, particularly delving into the repercussions of economic perturbations while considering shifts in household budget constraints. The empirical findings from our investigation reveal an intriguing outcome: when subjected to alterations in the utility function governing consumption behavior, all three models exhibited remarkably similar responses to the ensuing shock. Notably, the second model demonstrated the least volatility in consumption fluctuations, concurrently displaying the highest degree of serial correlation with the consumption variable. Conversely, the third model exhibited the most pronounced interplay between production and consumption variables, as evidenced by our comparative analysis of consumption variable changes across the trio of models. This study refers to the intricate nexus of utility functions and household consumption behaviour, offering invaluable insights into the macroeconomic underpinnings especially consumption behavior that shape our consumption societies.

Highlights

- In the process of time, the household's utility is subjected to fluctuations and various impulses that lead to a change in its mental pattern and consumption behaviour.
- Knowing how the household reacts to these impulses will be an effective and useful guide for economic planners and policymakers.
- This paper proposes three standard and alternative models for steady-state evaluation.

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1. Introduction

The structure of consumer spending and its modifications over time can reflect the economic well-being of households, social groups and entire societies, Of course, this depends on the structure of the economy, the utility function and the type of economy. Economics, at its core, seeks to elucidate the intricate behaviors and economic decision-making processes of households, which serve as both consumers of final products and proprietors of production factors. Within the economic framework, the household constitutes the fundamental unit, underpinning a myriad of economic choices and actions. Indeed, it stands as a cornerstone alongside government and economic enterprises, collectively forming the quintessential triad of economic activity. The ramifications of household variability reverberate across macroeconomic dimensions, firmly anchoring the study of household consumption behavior as a linchpin in the pursuit of societal economic development and growth.

The evolution of society is inexorably tied to consumption patterns, as shifts in these patterns exert substantial influence over an array of macroeconomic variables, spanning output levels, savings, employment rates, unemployment occurrences, inflation rates, and overall economic expansion. The significance of consumption patterns in shaping a nation's trajectory toward development is unequivocal. The alignment of household consumption and behavior with the prevailing social production framework, as delineated by its utility function, is pivotal for harmonious progress; any divergence may prove counterproductive.

In an economy, the presence of parts such as endogenous discount factor, debt elastic interest rate premium and portfolio holding costs can affect the path of variables and their dynamics. Meanwhile, the direction of movement is an important variable such as consumption, and it is very important to examine its fluctuations and direction as an important variable. Therefore, this article examines the effects of model changes on household consumption behaviour by defining three models to introduce a way for policymakers to control household consumption behaviour. Therefore, for the policymaker to know which sector or model has more effect on consumption behaviour and will lead to more fluctuations in the economy, or which sector or model has less effect, it can be used as a policy tool for the consumption behaviour of the household according to the conditions and adjust for economic goals.

2. A Review of the Related Literature

Over the annals of economic inquiry, scholars and policymakers alike have sought to dissect and classify household consumption across diverse commodities and services. Primarily constituted by families, whose access to requisite goods and services has historically been constrained, these entities grapple with optimizing their limited resources. Consequently, family demands oscillate in consonance with the contours of their utility functions. The examination of household behavior and decision-making under current circumstances unveils a trove of insights into the dynamics of desirability and variables that impinge upon

consumption. Policymakers, in turn, can leverage this knowledge to chart courses and objectives with precision (Izadi,2022).

The research tradition of scrutinizing household expenditure patterns has persisted as a favored domain among economists. Demand equations are typically constructed either individually or systematically. Individual demand functions emerge by extracting item-specific demand functions from the utility function of individual agents.

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Importantly, any perturbation in one market ripples through to affect all other markets. To investigate demand and consumption, economists devised systematic estimation techniques. Noteworthy contributions include the seminal works of Leser (1941), Klein & Rubin (1947), Stone (1954), Houtakker (1960), Barten (1968), Theil (1971), Christensen et al. (1975), Deaton & Muellboure (1980), Zaremohzzabieh et al. (2021), Tian & Liu (2022), Mishra et al. (2023), Wilson and Bellezza (2022), Arya et al. (2022) and Onel(2024).

A global survey of literature underscores the prevalence of studies exploring household consumption, preferences, and bespoke utility models. Economic variables respond diversely to impulses, contingent upon the idiosyncratic utility functions of households. Notable contributions include research by Mencinger et al. (2017), Kandil (2001), Thoma (1994), Bodenstein et al. (2011), Pindyck (1991), Smets & Wouters (2003), Nistico (2012), and Hollander & Liu (2015), Francis & Sarangi (2022), Lim & Weissmann (2023), all of which draw upon DSGE modeling to advance their findings.

Paetz & Gupta (2016), for instance, illuminated the influence of positive momentum on preferences and its subsequent impact on output and consumption, contingent upon the specific household utility function, in their study on economic cycles and pricing dynamics in Africa. Martin Moreno et al. (2016) in Spain found that impulse models engendered augmented preferences, consumption, production, and investment across both tradable and non-tradable goods sectors, albeit with divergent employment outcomes. Razafindrabe (2015), in his study, unearthed shifting consumer purchase habits in response to a positive impulse, leading to alterations in output, consumption, investment, employment, and real interest rates within the UK economy.

Finally, examining several studies like previous studies as Correia et al. (1995), Cardia (1991), Baxter & Crucini (1995) and Kollmann (1996) and others show that most of the studies, consider a small open economy model with incomplete asset markets and state all models provide identical dynamics at business cycle commonnesses, as measured by unconditional second moments and impulse-response functions and only observable difference among the

alternative specifications is that the model with complete asset market yields smoother consumption dynamics.

This paper embarks on a voyage to unravel the contours of household consumption behavior, elucidating its responses to changes in the utility function using the Dynamic Stochastic General Equilibrium (DSGE) model within the context of Iran's economy. To this end, the paper introduces distinct utility functions for households, subsequently unveiling three models. The first model, predicated on an endogenous discount factor, draws inspiration from Uzawa (1968) and subsequent works by Mendoza (1991), Uribe (1997), Obstfeld (1990), Schmitt-Grohe (1998), and Kim & Kose (2003). Our second model embraces a debt-elastic interest-rate premium framework, aligning with Dixit & Stiglitz (1977), Christiano et al. (2005), and Allegret & Benkhodja (2015). The third model, rooted in portfolio holding costs, builds upon Smets & Wouters (2003), Phuong Mai Le et al. (2011), Paetz & Gupta (2016), Martin-Woodhead (2022), Yupal Shukla et al. (2023) and Kumar Prajapati & Uraon (2024).

Within the burgeoning field of new macroeconomics, Dynamic Stochastic General Equilibrium (DSGE) modeling has gained prominence, owing to its capacity to derive decision rules for economic quandaries predicated on preferences and optimization quandaries. This characteristic rendered DSGE models particularly appealing to academics, facilitating exploration into the microeconomic bedrock underpinning macroeconomic phenomena. In constructing a DSGE model, a rudimentary model often serves as a preliminary canvas, before the integration of bespoke research features. Consequently, certain assumptions may be simplified or omitted, and foundational elements may be selectively omitted for expediency.

The DSGE methodology entails the aggregation of disparate economic sectors into a comprehensive model, with parameter selection guided by available field-specific data. Researchers wield the latitude to source parameter values from extant literature and calibrate the model accordingly. Subsequent validation tests assess model fidelity, leveraging estimation techniques and comparisons of simulated data against real-world observations (Izadi,2021).

This study employs the Random Dynamic General Equilibrium model to probe the variable responses of household sector consumption to shifts in household behavior and preferences. Focusing intently on alterations in household desirability, this research constructed a model tailored to the idiosyncrasies of the Iranian economic landscape. The ensuing impacts on household consumption behavior are calibrated using a DSGE model, facilitating the simulation of desired variable responses. Within this purview, the paper endeavors to fashion a household consumption model characterized by a distinctive utility function, one that faithfully mirrors Iran's economic peculiarities. The foundational models advanced by Christiano, Eichenbaum & Evans (2005), and Obstfeld (1982), informed by New Keynesian tenets, serve as the bedrock for our study.

By presenting several scenarios and changes in different parts of the household model in an economy with incomplete markets, this research examines

its effects on the household consumption sector. This paper examined consumer and household behavior by changing parts of the model to show the effect of those changes on the consumer and his behavior to propose programs to make policies more effective and prevent consumption fluctuations.

This paper is organized into four distinctive sections. Following this introduction, the second section introduces the three models in detail and delves into the articulation of the model and associated equations. Subsequently, the third section encompasses calibration, discussion, and the presentation of empirical findings. Finally, the fourth section encapsulates the conclusions drawn from our research.

3. The Study Model[1]

Dynamic stochastic general equilibrium models differ from the static models investigated in applied general equilibrium models and some computable general equilibrium models. DSGE models share a system built around three interrelated partnerships: demand, supply, and monetary policy equations. Formally, the equations that illustrate these blocks are built on micro foundations and make straightforward assumptions about the behaviour of the economy's main economic agents, namely households, firms, and the government. The preferences and objectives of the agents in the economy must be stated. For instance, Households might be assumed to maximize a utility function over consumption and labor effort. Firms have a production function and might be assumed to maximize profits by specifying the number of final goods produced, depending on the capital, labor and other inputs they hire. Firm decisions might include being in the form of the following technological restrictions.

- Adjusting Costs of Capital Stocks.
- Employment relations.
- Products prices.

In the literature on DSGE, these models supply a comprehensive talk about the properties of dynamic stochastic general equilibrium (DSGE) models for the economies and study the complete characterization of the steady state policy of the basic New Keynesian model for opened economies and are generalized for an open economy.

According to the existing economic literature in this field, this article introduces three models to study household behavior by taking the example of Obstfeld's model (1990), Mendoza's model (1991), Izadi's model (2021) and Izadi's model (2022). Note that different scenarios have been modelled here to investigate consumer behaviour, so for simplicity and ease of modelling, parts of the model have been removed and a simple standard model has been used.

[1] Considering that all the equations and relationships are not included in the article due to space limitations, all the extracted equations and relationships related to this modelling are available and can be provided upon request.

Table 1. the Models

Endogenous Discount Factor	Debt Elastic Interest Rate Premium	Portfolio Holding Costs
$E_0\sum_{t=0}^{\infty}\theta_t U(c_t,h_t)$	$E_0\sum_{t=0}^{\infty}\theta_t U(c_t,h_t)$	$E_0\sum_{t=0}^{\infty}\theta_t U(c_t,h_t)$
$\theta_t = 0$ $\theta_{t+1} = \beta(c_t,h_t)\theta_t \;\; t \geq 0$	$\theta_t = \beta^t$	$\theta_t = \beta^t$
$d_t = (1+r_{t-1})d_{t-1} - y_t + c_t + i_t + \Phi(k_{t+1}-k_t)$	$r_t = r + p(\tilde{d})$ $p(d) = \psi_2\left(e^{d-\bar{d}} - 1\right)$	$d_t = (1+r_{t-1})d_{t-1} - y_t + c_t + i_t + \Phi(k_{t+1}-k_t) + \frac{\psi_3}{2}\left(d_t - \bar{d}\right)^2$
The Euler equation		
$\lambda_t = \beta(c_t)(1+r)\lambda_{t+1}$ $\beta(c)(1+r) = 1$	$\beta = \left(1 + r + p(d)\right) = 1$	$\psi'(d_t)) = \beta(1+r)\lambda_{t+1}$ $\left(1 - \psi'(d)\right) = \beta(1+r)$
$\Phi(0) = \Phi'(0) = 0$		
$y_t = A_t F(k_t,h_t)$		
$k_{t+1} = (1-\delta)k_t + i_t$		
$ln\ A_{t+1} = \rho_A lnA_t + \epsilon_{t+1}$		
$U(c,h) = \frac{(c - \frac{h^\omega}{\omega})^{1-\gamma} - 1}{1-\gamma}$		
$F(k_t,h_t) = k^\alpha h^{1-\alpha}$		
$\Phi(x) = x^2 \qquad \Phi > 0$		

According to Table 1, The economy is supposed to be populated by a large representative household with a continuum of members and preferences and technology are parameterized as the same in all models.

Consumption and hours worked are identical across households and where consumption c_t, labor h_t, foreign debt d_t, interest rate r_t which domestic residents can borrow in international markets in period *t*, domestic output y_t, gross investment i_t, physical capital k_t, capital adjustment costs function $\Phi(.)$, an exogenous stochastic productivity shock A_t, rate of depreciation of physical capital δ, a country-specific interest rate premium $p(.)$, the steady-state level of foreign debt $\bar{d}$, the portfolio adjustment cost $\psi(.)$, a constant parameter defining the portfolio adjustment cost function ψ_3, marginal portfolio adjustment cost $\psi_3\left(d_t - \bar{d}\right)$ and the marginal utility of wealth λ_t. According to each model, Households choose processes $\left\{c_t, h_t, y_t, i_t, d_t, k_{t+1}, r_t, k_{t+1}, d_t, \theta_t, \tilde{d}_{t+1}, \lambda_t\right\}_{t=0}^{\infty}$ to maximize the utility function subject to no-Ponzi constraint, and the innovation to this shock is IID normally distributed zero mean innovations.

4. Empirical Results

In the continuation of this research, by solving the model according to the existing equations, calibration and simulation of the model will be done according to the values of the parameters shown in Table 1 .After simulating the model, this part will first display figures of shock's impulse-response functions. In the next step, after presenting the empirical results of the model, the correctness of the model will be checked by validation tests, and the results of these tests will be presented in the last part. It should be noted that Table 4 will show the results of model validation tests and the accuracy of simulation and estimation of the modelling.

Table 2. Calibration Parameters

Parameters	Description	Value	Source
δ	Depreciation Rate	0.0139	Tavakoli (2020)
γ	Risk Aversion	2	Christiano et al. (2005)
Φ	Adjustment Cost of Capital	7.6	Izadi & Marzban (2019)
α	Capital Share	0.44	Izadi (2018)
β	Discount Factor	0.9745	Christiano et al. (2005)
ψ_2	Debt Elastic Interest Rate Premium	0.006	Izadi & Marzban (2016)
ω	Frisch-Elasticity	2.5	Izadi & Sayareh (2019)
ρ_A	TFP Autocorrelation	0.59	Izadi (2018)
ϵ_t	TFP Standard Deviation	0.0164	Izadi & Sayareh (2019)
ψ_3	Portfolio Adjustment Cost	0.006	Marzban et al. (2016)
ψ_1	Elasticity Of the Discount Factor	0.16	Marzban et al. (2018)
$\bar{d}$	Foreign Debt	0.47	Izadi (2021)

The following Figures illustrate the shock function of the response to the positive technology shock in all models. The Circles curve displays the endogenous discount factor model. The stars curve exhibits the debt elastic interest rate premium model. The square curve shows the portfolio holding costs model. Because technology is one of the fundamental foundations of production, many developing and advanced nations have designed their production and development structures based on scientific and technological advancement. Considering the significance of production goals, job creation, and prosperity, as well as the influence and changes of this market on other markets and economic variables, is undoubtedly crucial when examining the effects of technology-related fluctuations on the economy, the labor market, and the state of production and its future prospects. The figures below show that if technology advances, the household will create more and earn more money without cutting back on their spare time or altering their working hours. Household consumption has increased due to this rise in production, which is also having an increasingly negative impact on utility function and consumption. This incremental impact of the positive technological shock on the aforementioned economic variables has begun to diminish throughout the succeeding periods, eventually returning to its prior level once it reaches its stable level.

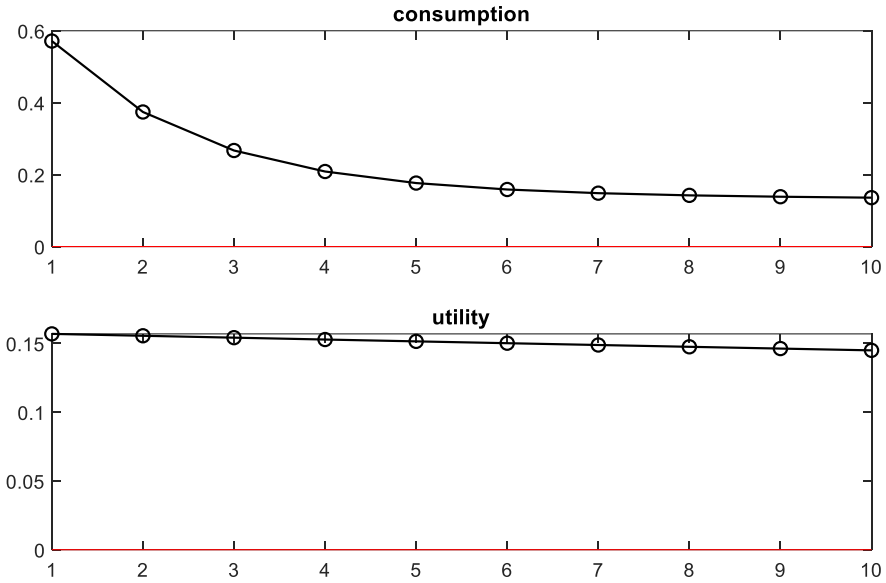

Figure 1. Impulse-Response to Technology Shock in Endogenous Discount Factor Model (Circles).

***Source**: Research Calculations*

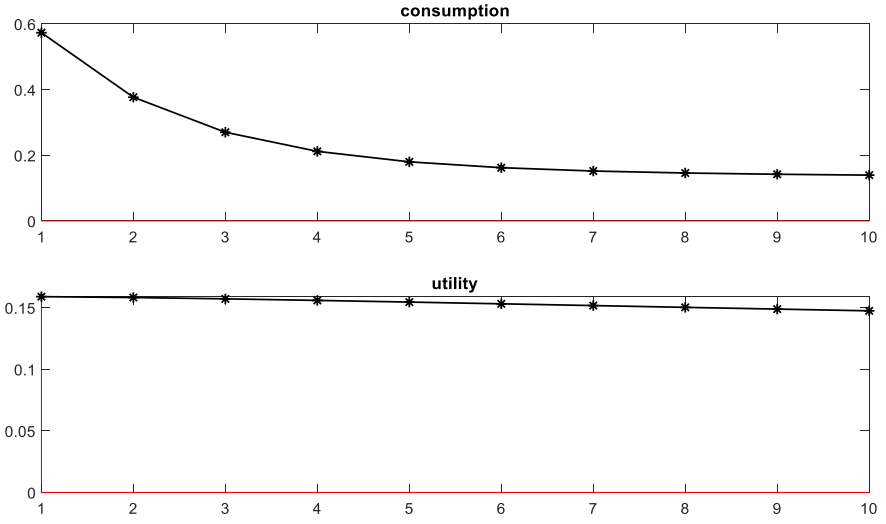

Figure 2. Impulse-Response to Technology Shock in Debt Elastic Interest Rate Premium Model (Stars).

***Source**: Research Calculations*

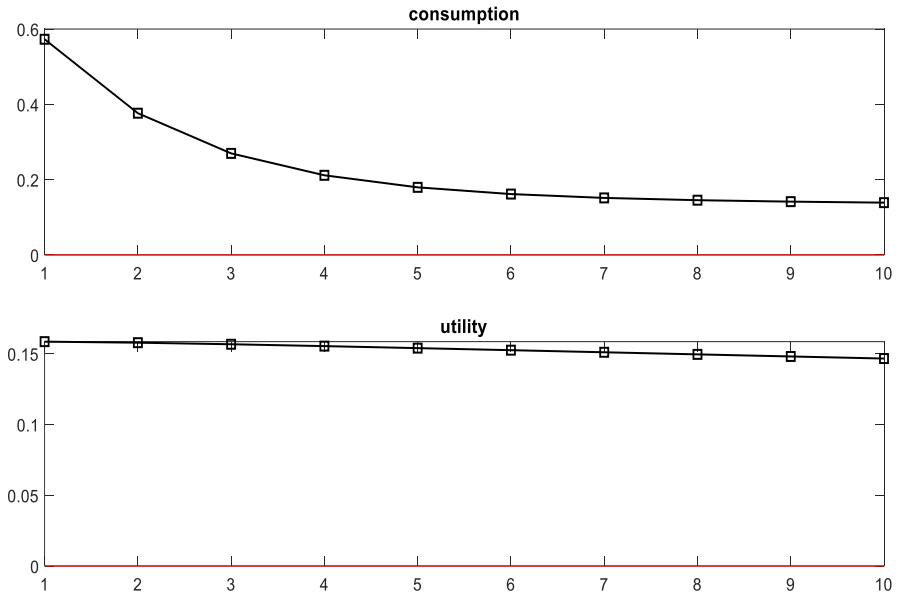

Figure 3. Impulse-Response to Technology Shock in Portfolio Holding Costs Model (Square).

Source: *Research Calculations*

Table 2 shows the serial correlations and volatilities of the variables and correlations with output variables with other variables of the three models. From the first part of the table and the results of Table 2, it is clear that the endogenous discount factor model and portfolio holding costs model indicate the same volatilities in consumption and the debt elastic interest rate premium model has fewer volatilities in consumption.

From the second part of the table, it can be said that the portfolio holding costs model and the endogenous discount factor model display the same serial correlations of the consumption and the debt elastic interest rate premium model displays more changes in the serial correlation of the consumption variable. The third part of the table and results illustrate that consumption has a higher correlation with output in a portfolio holding costs model, and consumption has a lower correlation with output in the model of the endogenous discount factor.

Table 3. Implied Unconditional Second Moments

	Endogenous Discount Factor	Debt Elastic Interest Rate Premium	Portfolio Holding Costs
	Volatilities		
$std(Y_t)$	2.5	2.5	2.5
$std(C_t)$	2.2	2.0	2.2
$std(I_t)$	0.1	0.6	0.6

$\mathrm{std}(H_t)$	1.0	1.0	1.0
$\mathrm{std}(\frac{TB_t}{Y_t})$	2.0	2.0	1.9
$\mathrm{std}(\frac{CA_t}{Y_t})$	1.7	1.7	1.7
Serial Correlations			
$\mathrm{corr}(Y_t, Y_{t-1})$	0.54	0.55	0.55
$\mathrm{corr}(C_t, C_{t-1})$	0.89	0.90	0.89
$\mathrm{corr}(I_t, I_{t-1})$	0.787	0.995	0.995
$\mathrm{corr}(H_t, H_{t-1})$	0.54	0.55	0.55
$\mathrm{corr}(\frac{TB_t}{Y_t}, \frac{TB_{t-1}}{Y_{t-1}})$	0.64	0.63	0.63
$\mathrm{corr}(\frac{CA_t}{y_t}, \frac{CA_{t-1}}{Y_{t-1}})$	0.53	0.53	0.53
Correlations with Output			
$\mathrm{corr}(C_t, Y_t)$	0.59	0.66	0.67
$\mathrm{corr}(I_t, Y_t)$	0.79	0.27	0.27
$\mathrm{corr}(H_t, Y_t)$	1.0	1.0	1.0
$\mathrm{corr}(\frac{TB_t}{Y_t}, Y_t)$	0.805	0.749	0.756
$\mathrm{corr}(\frac{CA_t}{Y_t}, Y_t)$	0.991	0.969	0.968

***Source**: Research Calculations*

Suppose economic policymakers are seeking more linkages and interconnections between the production and consumption markets; targeting and making decisions based on the third model (3) will be more rational. In that case, it can be shown by comparing the outcomes of the above table based on the three models created. Using the second and third methods to accomplish their objectives will be more appropriate and better if they want to produce the greatest swings in the consumer market. As a result, the outcomes assist the planner in selecting the appropriate model to offer a proper framework for household decision-making and the best distribution of resources.

As a result, compared to the results of other studies, it can be said other models provide identical dynamics at business cycle commonnesses, as measured by impulse-response functions and unconditional second moments. The only observable difference among the alternative specifications is the model of the complete asset market yields smoother consumption dynamics.

In the modelling of dynamic stochastic general equilibrium models, to check the accuracy and validity of the built model, the moments of the simulated data are compared and checked with the moments of the real data of the model. The smaller the difference between these moments, the more accurate and valid the model will be. Table 4 compares the moments obtained from some of the model's endogenous variables with the real data moments. The table below shows the results of autocorrelation and standard deviation of variables. This Table shows

the data's business cycle moments compared with the model's filtered moments by the time series path of simulated and data empirical.

The table lists the results in terms of the first-order autocorrelation and volatility of the time series. According to model fitting, the model does a fine matching of the data's business cycle moments, particularly of output, investment, consumption, and debt. Finally, according to the results in the below Table, A comparison of software-derived moments and real data moments shows that the research model has been able to simulate the periodic behavior and fluctuations of variables nicely.

Table 4. Implied and Observed Second Moments

	Theoretical Moments		Autocorrelation Coefficients	
Variable	Model	Data	Model	Data
C	0.0236	0.0376	0.8942	0.9210
I	0.0015	0.0040	0.8285	0.8121
D	0.5051	0.4348	0.9971	0.9767
Y	0.0263	0.0248	0.5949	0.5966
K	0.0012	0.0053	0.9929	0.9662

***Source**: Research Calculations*

5. Concluding Remarks

In the process of time, the household's utility is subjected to fluctuations and various impulses that lead to a change in its mental pattern and consumption behaviour. Knowing how the household reacts to these impulses will be an effective and useful guide for economic planners and policymakers. In this paper, we present three alternative ways of making the small open economy real business cycle model stationary: one version of an endogenous discount factor, a debt-contingent interest rate premium, and portfolio adjustment costs.

This study developed three models in the framework of stochastic dynamic general equilibrium models to study household consumption behavior and has demonstrated the impact of economic shock on consumption and utility variables. When examining the impact-reaction diagrams of a technology shock, it can be concluded that as technology has advanced, household consumption has gone up until it reached its pre-advanced level.

The study's findings also demonstrate that policymakers may select suitable planning models based on their objectives and plans for production and consumption, and by those objectives, they can alter household behavior in terms of decision-making and the best use of available resources. By affecting the macro level of demand for products, politicians may utilize the findings of this research to formulate policies and manage their economic plans, including the best distribution of resources, growth, and economic stability. When financial instruments do not produce the full and desired effects and the implementation policies have unexpected results, these goals can be used by combining the aforementioned models to fit the conditions and context of allocation, distribution, growth, and economic stability. According to the research's projected findings,

policymakers may impact demand for many categories of home products and better monitor household consumption.

They may look at consumer behavior across all product categories and factor in their consumption patterns when making judgments, influencing customers in the desired direction. This is because a society's consumption pattern greatly impacts whether or not it will grow and develop. As a result, the category of changing the consumption pattern and consuming behavior should receive considerable attention from the social and cultural elements of human behavior within the society and the culture that results from it, and the required regulations should be developed.

The conclusions of this research are employed for constructing, implementing, watching and analyzing:

The effects of economic and social policy, including, for example:

- The planning of fiscal changes and making policy.
- The analysis of the results of government activities in the support of certain groups and finding destroying factors.
- The evaluation of programs to decrease disparities between regions and groups.

Investigation of utility function and Expenditure statistics also supply a rich source of data for examinations of the consumption of and demand for various categories of products and services and different social groups.

Author Contributions:

Conceptualization, methodology, validation, formal analysis, resources, writing— original draft preparation, writing—review and editing, supervision by H.R. Izadi.

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The authors declare no conflict of interest.

Data Availability Statement:

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