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REGULAR ARTICLE

The US consumption function: a new perspective

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Abstract
In the United States, the ratio of consumption to GDP has risen steadily over the past half century. In trying to understand why this ratio has increased so much, it is argued that standard models of the consumption function, built up from the neoclassical theory of constrained optimization, cannot offer a satisfactory answer. An alternative perspective is offered whereby aggregate consumption expenditure is seen as primarily the outcome of the population adopting widely upheld rules ('meso-rules') in a complex economic system. Aggregate consumption is viewed as the outcome of two contrasting historical processes: one mainly involving pre-committed, rule-bound choices and the other involving open-ended choices, made knowingly in the face of uncertainty, to adopt new meso-rules concerning the consumption of novel kinds of goods and services. The former process provides the degree of order that must be present in any complex system and the latter facilitates evolutionary change to occur. Using over half a century of data, the US consumption function is modelled successfully on the presumption that the economy is a complex system. The evidence supports the hypothesis that the ratio of consumption to GDP has risen because of the diffusion of a 'culture of consumerism' in the post-war era and that the limit of this process is now being approached, with important macroeconomic and social implications.

JEL codes E10 · E14 · E21

Keywords Macroeconomics · Consumption · Meso-rules · Economic evolution · Consumerism

1 Introduction

Keynes (1936) argued that aggregate consumption expenditure is important because it transmits multiplier effects to GDP when there are expenditure shocks emanating

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from, for example, business investment. However, he offered a discussion of the determinants of the marginal propensity to consume that was, in the main, qualitative.[1] From 1938 on, researchers began to estimate, econometrically, the quantitative relationship between consumption and income, controlling for other hypothesised causal variables. This was labelled 'the consumption function,' and it became a core component of macroeconomics. It was deemed to be of key importance in assessing the impacts of aggregate expenditure shocks and the efficacy of monetary and fiscal policy.

After the Second World War, there was a growing tendency to construct models of it using neoclassical micro-foundations, following, for example, Friedman (1957). This involved a range of restrictive assumptions and much of the debate in this field became concerned with the implications of relaxing one or more of these assumptions. The original motivation was empirical: why did econometric estimates of the marginal propensity to consume, derived from models using short and long periods of time series data, vary so widely? Answering this research question gave rise to competing hypotheses but a range of difficulties were encountered in obtaining clear-cut econometric evidence that could establish the superiority of any of them. So, more recently, there has been a growing tendency to give up on econometrics and, instead, to simulate and calibrate consumption in a dynamic stochastic general equilibrium (DSGE) model (see Christiano et al. (2018)). This has the advantage of retaining a core of neoclassical micro-foundations but at the cost of introducing the Popperian problem of unfalsifiability since competing simulation models can be calibrated upon a given time series.

This study is motivated by a different empirical observation. It is well known that growth in aggregate consumption has been a key driver of economic growth in the United States. The growth in per capita real consumption has been remarkable – it was 4.5 times higher in 2018, compared to 1947. However, from the early 1960s on, this has been accompanied by a steady increase in the proportion of GDP devoted to consumption, following a temporary post-war consumption surge, as can be seen in Chart 1. Why has this occurred and what are its impacts? Can this secular shift be explained by the operation of economic incentives and constraints set in conventional models of consumption, or are we observing a steady shift in preferences and, if so, why? These are key research questions that are addressed in this article.

Here, it argued that, once we view the economy as a complex system, rather than being, at core, an aggregation of the constrained optimization of a representative individual, we can obtain a historical model of aggregate consumption that can be econometrically estimated. When we presume that the economy is a complex system it alters, in a fundamental way, how we should model aggregate consumption expenditure.[2] First, because a complex system requires order to function, and this yields value to economic decision-makers, we know that much of consumption expenditure will be significantly pre-committed at any point in time. Second, decision-makers are always

[1] See O'Donnell (2018) for careful discussion of Keynes's analysis of the relationship between consumption and income and how it differs from standard representations of the consumption function.

[2] See, for example, Foster (2005), Beinhocker (2006), Arthur (2014), Wilson and Kirman (2016), Foster (2017), Dosi and Roventini (2019) for explanations of why the economy has to be viewed as a complex system and what the key features and functions of a complex economic system are.

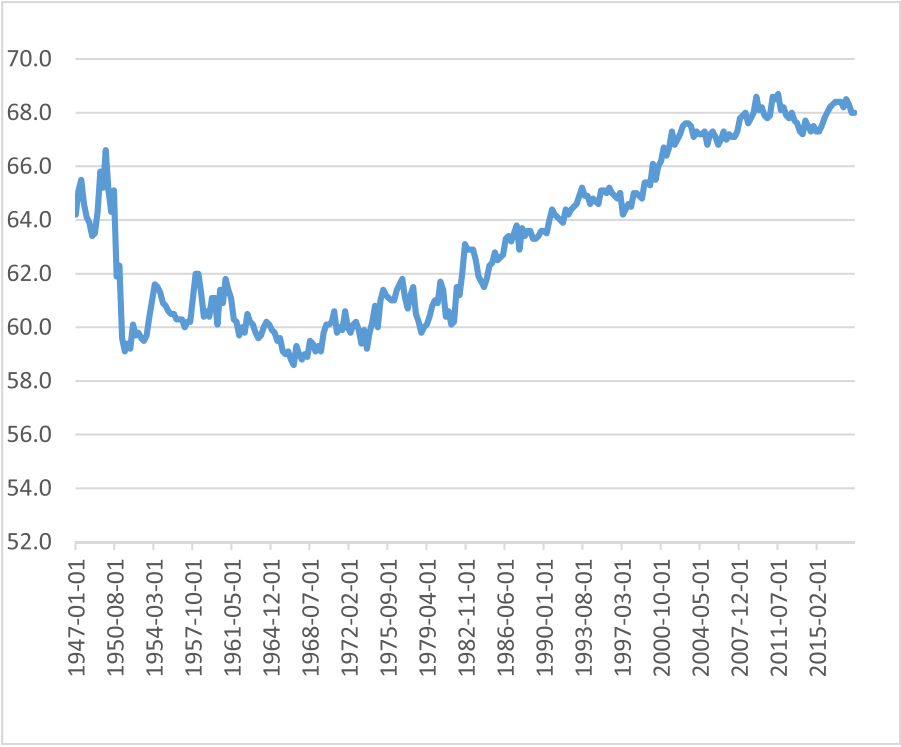

Chart 1 US Share of Consumption in GDP

open to purchasing novel goods and services, even though there may exist uncertainty about their characteristics and value. Here this is labelled as 'positive uncertainty' because it is a domain of opportunities, not threats. Marketing professionals are continually seeking to make new emotional connections between products and consumers in this uncertain domain and they also seek to forge connections between the tastes of different people in the hope that a preference for a product will become widely adopted. This is observed most spectacularly in the domain of fashion goods (Chai et al. (2007)).

The purpose here is to show, using a half century of quarterly US data, that the high degree of order and the slow, diffusional nature of change in this part of a complex economic system enables us to explain a great deal of variation in aggregate consumption expenditure using a very simple econometric model. The key difference with the standard approach is that neoclassical theory is not expected to explain the core functioning of an economic system in historical time. Instead, it is viewed as a body of ahistorical logic which can help us understand how some incentives influence consumption as it moves along historical trajectories that are determined both by adherence to a particular set of facilitating socio-economic rules ('meso-rules') that provide order and by aspiration-driven behaviour in states of positive uncertainty that results in the growth of economic complexity (evolutionary economic change). It is not the purpose here to offer a complete econometric model of consumption: the model

developed and estimated is intended to illustrate how highly ordered behaviour in a complex economic system can yield a simple and stable aggregate trajectory over decades, after and before major structural transitions.[3]

In Section 2 a very selective and brief review of past literature on modelling the consumption function is offered. In Section 3, there is discussion, again rather compressed, of what is meant by a complex economic system and what its key properties are. Section 4 develops a model of aggregate consumption in a complex economic system and offers a testable specification. Section 5 contains the results and related discussion. Section 6 contains concluding remarks.

2 The consumption function in retrospect

In the 1950s, the debate concerning the determinants of aggregate consumption was pivotal to the development of macroeconomics over the following decades. Keynes (1936) had made it of key importance in his discussion of the operation of the multiplier in the application of stabilization policy. The macroeconomic data suggested to him that, over short periods, there is a non-proportional relationship between consumption and income. However, Kuznets (1946) found that a proportional relationship existed when a longer period of US data was used. He found an average, and marginal, propensity to consume out of disposable income that fluctuated in a narrow range between 0.84 and 0.89. The only exception was the Depression period that Keynes had focussed upon. Duesenberry (1949), using standard neoclassical utility theory, argued that the contradiction between short and long period studies arose because past peak consumption is in the preference function of the average consumer. His prediction was that the marginal propensity should rise in downturns and fall back towards a proportional average propensity to consume in upturns.

Despite issues being raised about the clarity of the evidence presented in support of Duesenberry's hypothesis, many Keynesians broadly accepted this kind of explanation until Friedman (1957) pointed out that Duesenberry had not grounded his explanation properly in the neoclassical micro-foundations that he had used. Friedman argued that rational decision-makers, in splitting their income between consumption and saving, should base their consumption decisions on "permanent" income, not current income. Of course, Friedman could not measure permanent income so he used exponential smoothing, applying declining weights to past observations of income, to obtain what he viewed as an approximation of permanent income.[4] Ando and Modigliani (1963) modified Friedman's theory by incorporating the prior insight of Modigliani and Brumberg (1954) that, because consumers are not infinitely lived, the aggregate pattern of consumption over the life cycle has to be taken into account when considering the impact of permanent income on consumption.[5]

[3] Although the goal here is to show that complex economic systems can exhibit quite simple macroeconomic dynamics econometrically, agent-based modeling can provide important insights into the underlying mechanisms. See, for example, Rengs and Scholz-Wackerle (2019) for agent-based simulation modelling that is compatible with the macroeconomic approach to consumption adopted here.

[4] This empirical approximation for an expectation became a cornerstone of his notion of "adaptive expectations" that he applied in other areas of macroeconomics in later years.

[5] See Hynes (1998) for a detailed discussion of the emergence and consolidation of the neoclassical aggregate consumption function.

Gradually, the permanent income hypothesis and the associated life cycle hypothesis became the conventional explanations of aggregate consumption to be found in macroeconomic textbooks. What came to be known, somewhat misleadingly, as the 'absolute income hypothesis' of Keynes became viewed as ad hoc and Duesenberry's 'peak income hypothesis' almost disappeared because of its perceived inconsistent micro-foundations and various problems in interpreting his econometric evidence. Although he was correct to argue that past history has an important role to play, as will be discussed below, Friedman was also correct to argue that past history has no place in a neoclassical exercise in logic. Friedman did also employ history but, crucially, not in the theoretical domain but in attempting to find an approximation for permanent income in testing econometrically the consumption hypothesis that he drew from his theory.

The permanent income hypothesis and its life-cycle cousin came under attack from two distinct directions. First, some Keynesians argued that using weighted observations on past income to approximate permanent income was difficult to distinguish from using the presumption that there is a partial adjustment process involved in going from one equilibrium to another on a non-proportional consumption function. In other words, the problem of observational equivalence was identified and this issue was never fully resolved. But this did involve Keynesians making a concession that the marginal propensity to consume 'in equilibrium' should be higher than a simple regression of consumption on current income would suggest. Second, some economists who shared Friedman's view that the consumption function should be connected to neoclassical micro-foundations, had problems with the way that permanent income is constructed as an adaptive expectation. They argued that, if expectations concerning income are fully rational, in the sense of taking into account all available information about the future, then consumption should not depend on a weighted average of past income but will, instead, follow a random walk (Hall (1978)). Of course, if this is the case, stabilization policy cannot be applied in any systematic way. There is an extensive literature containing variations on these themes that will not be reviewed here.[6]

So, in modern macroeconomics, the neoclassical representation of consumption behaviour is widely accepted.[7] The ardent debates of the past concerning the determinants of aggregate consumption have been largely forgotten and new experimental findings, in the emergent field of behavioural microeconomics, that challenge the validity of neoclassical micro-foundations, have been widely ignored. Furthermore, as Campbell and Deaton (1989) and Deaton (2005) point out, econometric tests using measures of permanent income do not provide support for Friedman's maintained hypothesis, but this has had little impact too. Instead, the difficulty of operationalizing the notion of permanent income in econometric modelling and the formidable challenges posed when trying to aggregate from microeconomic decisions to macroeconomic phenomena led to a widespread decline in interest in undertaking new research on the aggregate consumption function by the 1990s. Many of the key researchers in the field, such as Angus Deaton himself, moved on to other research topics. So the consumption function, even though it lies at the very core of macroeconomics, entered

[6] See Deaton (1992) and Muellbauer (2016).

[7] See Laidler (2010) for an excellent history of postwar macroeconomic thought in which the reasons for the rise of neoclassical general equilibrium theory and its policy-making shortcomings are discussed.

a period of comparative neglect where only variations on old and discredited theories and evidence were offered. However, over the past two decades, there has been increasing interest in examining the role and determinants of consumption in the context of DSGE models that employ a simulation and calibration methodology.[8] These models continue to have a neoclassical, general equilibrium core but cannot be subjected to econometric testing.

So what began as a real world econometric debate in the 1940s concerning a statistical conundrum became a simulation and calibration contest built upon neoclassical micro-foundations. Critics of the DSGE approach often blame its use of neoclassical economic theory. But this is too simplistic: what changed was the context in which neoclassical theory was applied. Alfred Marshall (1890) explained how useful such theory is in helping us understand how incentives influence economic behaviour in the flow of economic history, ceteris paribus. Nothing has changed in this regard. What is more critical is how the basic functioning of an economic system is viewed by a researcher. This is an ontological, not a theoretical, matter (Foster (2005)). But discussion of ontology is not very fashionable in mainstream economics. Most economists want to understand how incentives affect behaviour, not deliberate upon the nature of the system that they are dealing with. But this really does matter because it can determine the clarity with which incentive effects are discovered empirically.

3 Complex economic systems

In its original conception, neoclassical logic was never intended to be viewed as a timeless, general equilibrium core of a whole economy, as promulgated by Arrow and Debreu (1954). Alfred Marshall (1890), a founding father of neoclassical economics, viewed it as a body of theory that could enable us to understand how prices are determined in market settings. It was 'price theory', not a theory of everything.[9] He clearly understood that the core of any economy is its history - economic, social, political and cultural – and, within this historical process, price and cost incentives operate if widely-upheld rules exist that enable markets and contractual arrangements between anonymous individuals to operate securely and effectively.[10] He also argued that an understanding of the logic of price theory is important for the design of rules that can make these arrangements work well. The study of how markets operate within specific historical contexts and how markets and contracting can be introduced in specific contexts was, for Marshall, what neoclassical economics is all about. By introducing neoclassical logic, he revolutionised economics, providing precise mathematical representations of price determination that demonstrated what is and is not possible and, in so doing, he sought to convince governments to introduce and defend rules that facilitated market and contractual activity. Crucially, he gave analytical solidity to the less formal propositions offered by Smith (1776/1904) concerning the rules that are necessary for a free market economy to function

[8] See Christiano, Eichenbaum and Trabandt (2018) for an overview of the relevant literature.

[9] Interestingly, Smith and Wilson (2019) note that the neoclassical utility maximization model works well in experiments involving well-informed demand and supply interactions.

[10] See Foster (1993) for an explanation of how Marshall (1890) embedded price theory in a historical process with intuitive similarities to modern representations of 'self-organization' in complex economic systems.

effectively and fairly. His was an immensely practical agenda, not some quest to provide some optimal representation of a timeless economic system. So how do we build upon Marshall's insights using the modern complex systems perspective?

It was Hayek (1945) who was the most important pioneer in explaining why an economy is a complex economic system. He saw the economy, at core, as functioning because of widespread adherence to rules, such as laws, norms, conventions, etc. The order conferred by these rules enables there to be order which, in turn, allows vastly complex economic behaviour to emerge. So, expanding on Hayek's insights, economic interactions must be governed by 'meso-rules' (Dopfer et al. (2004) and Scholtz-Wackerle (2017)). Any economic system is an incomplete network of connections between decision-makers. It is these 'economic' connections, not the individuals who constitute its elements, which generate value. This involves adherence to a particular set of facilitating meso-rules, both explicit and implicit. Because they are widely, but not completely, upheld, they are neither micro nor macro in nature. For a complex economic system to produce and consume diverse goods and services in predictable ways it must exhibit a high degree of order and this comes from prior commitments to contractual rules and from beliefs that are mutually upheld.[11] The auction market, so central to standard economics, is an arrangement designed to reach an agreed contractual price and, to do so, there must be mutual acceptance of various rules of conduct and, more widely, shared beliefs concerning acceptable human behaviour. Neoclassical economics, because it is a derivative of price theory, emphasises substitutions but, in point of fact, all voluntary trading and contracting connections in an economic system are examples of complementarities due to the existence of mutual interest. But mutual interest will not lead to a contract unless there are mutually accepted rules of conduct and mutual beliefs that engender trust (Smith (1759/1976), Nooteboom (2002)). This is not 'irrational' behaviour because mutual adherence to meso-rules creates a connective order that yields economic value.[12]

A complex economic system and its sub-systems permit the formation of new connections between existing elements, using prevailing rules, and the attachment of new elements via new rules. Because the context is uncertain, the perceived gains from new connectivity are imagined, rather than real, in many instances, and this is why beliefs are so important. Emotions translate into aspirations and the extent to which economic actions are enacted is, in turn, affected by economic incentives. This is how innovation and entrepreneurship come about and these are fundamentally important in determining the development and growth of economic systems. This, of course, was the perspective of Schumpeter (1911/1934) and it implies that a growing economy must always be the outcome of a complex process of novelty diffusion that involves both self-organisation and competitive selection (Foster (2000)). But Schumpeter did not offer an explicit model of this diffusion process: the appropriate methodology was provided later by Kuznets (1930, 1953), using a range of industrial examples of "retardation."[13] The extensive literature on innovation diffusion that followed focussed mainly on the supply side but, in a complex inter-connected economic system, growth

[11] Foster (2005) argues that, when this happens, "4th order complexity" must exist.

[12] Of course, this is well understood by game theorists – economic value is generated in co-operative games that can take place when trust is strong enough. See Smith and Wilson (2019).

[13] See Metcalfe (2003) for a discussion of the emergence of this methodology and a review of the literature that followed.

cannot occur unless there is receptivity to new products on the demand side, as Smith (1776/1904) and, later, Young (1928) stressed. There must always be willingness by consumers to forge new trading and contracting connections by taking up new products that they don't know much about. It is they who orchestrate the selection or rejection of products, aided by the marketing efforts of sellers.

So, complex economic systems contain behaviours that are both conservative and radical. Such systems, therefore, are influenced by history and, at the same time, make history. Within these contrasting historical processes, people do try to optimize in the face of incentives whenever it is feasible to do so. The discipline of economics, at least since the time of Adam Smith, has focussed upon this kind of 'rational' behaviour that, in the twentieth Century, became labelled as 'neo-classical.'[14] So the complex economic system perspective does not reject the predictions of neoclassical economic theory. Instead, it places them in their proper historical context.

4 Consumption behaviour in a complex economic system

The basic problem with modelling aggregate consumption expenditure as if it is the solution of a constrained optimization exercise by a representative micro-agent is that such logic does not relate to the world we actually live in (Kirman (1992)). It is a theory that makes unrealistic assumptions about reversibility of behaviour, availability of knowledge and aggregation. These all disconnect any resultant theoretical model from the historical trajectory of an economy. Also, not being in historical time, it is not possible to ascertain whether movement to a new equilibrium point will take one millisecond or a thousand years. Economists using this theory to derive hypotheses that are tested econometrically often propose adjunct 'translating' mechanisms, such as slow adjustment to equilibrium or learning lags, to promulgate hypotheses with a time dimension that can address historical data, as in Friedman (1957). But, in a timeless body of logic, historical lags cannot exist. The 'future' is known and an error can be instantly corrected by reversing back to a 'previous' equilibrium. So, for example, the random shocks that drive business cycles in RBC theory should never be unanticipated because full reversibility ensures that errors need never be committed because they can be corrected instantly.

In a hypothetical world without history we cannot include a role for past history or make predictions about the history about to unfold in the future. But ahistorical logic is tempting because liberation from the constraints of history frees economic theorists to promulgate a vast array of logical constructions that can be made to calibrate with real historical data. For example, DSGE theorists modelling consumption have introduced limits on the completeness of knowledge, asymmetries in the availability of information, heterogeneity of economic agents and the presumption that quantifiable risk exists but, if timeless constrained optimization is retained at the theoretical core, none of these

[14] But see Smith and Wilson (2019) who argue that it is too simplistic to view Adam Smith's economics as just 'neoclassical.' They argue that his *Theory of Moral Sentiments* and the findings of many recent economic experiments confirm that adherence to socially accepted rules is of primary importance in understanding many aspects of economic behavior discussed by Smith.

get us any closer to the real world in which we actually exist. What we get is a collection of illusions promulgated by those with appropriate mathematical skills.[15]

A realistic macroeconomic model of consumption must be able to capture the presence of two contrasting processes, one embedded in past history and another that creates future history out of systemic incompleteness and openness, i.e., positive uncertainty. First, because a complex system, to function, must exhibit some degree of order, much of consumption expenditure will involve prior commitments to rules of behaviour (Baxter and Moosa (1996), Earl and Potts (2004), Marechal (2010) and Nelson and Consoli (2010)). There is a tendency to re-purchase the same kinds of goods and services and to replace durables with similar models at similar real prices. Also, there will be many contractual obligations that have not expired. So, consumption must, be, in part, historically determined in a complex economic system. This is not a new hypothesis. It was explained and justified by Brown (1952) in the context of habits but not embraced by mainstream macro-economists because of its disconnection with the emerging general equilibrium depiction of an economic system. Muellbauer (1988) found econometric evidence, using US time series data, that habitual behaviour does exist – he argued that it is not 'rational' but, rather myopic, when viewed from an individual optimizing perspective.[16] Second, a component of consumption will be 'entrepreneurial' whereby opportunities available in the presence of positive uncertainty are taken advantage of (El Quaoumi et al. (2018)). We know that all complex systems, although necessarily bound by a structure of rules, continually seek out more energy and knowledge to expand their network structure and increase their ordered complexity. In the case of a complex economic system, this involves the emergence of new types of goods and services, employing new ideas and skills (Foster and Metcalfe (2012)).[17]

When we look at consumption patterns across a whole economy, we witness thousands of products diffusing, hitting saturation limits and declining every year. Although this is an open-ended process that involves vastly complicated micro-interactions, it relies upon the emergence and consolidation of a meso-rule set which is manifest in a combination of fundamental technological, organizational and/or operational innovations (Janssen and Jager (2001)). Provided that consumer demand is continually stimulated by marketing strategies, the result is a system-wide increase in adherence to new meso rules and associated novel goods and services. This offsets the conservative tendency to stick routinely to past consumption patterns. So, aggregate

[15] This is still not widely accepted. There is a significant number of macroeconomists that still hold that clever modifications of the DSGE model can result in a better representation of an actual economic system (Vines and Wills (2018)). See Muellbauer (2016) for a critique of the DSGE model as a theoretical vehicle for understanding consumption. It should be noted that, although heterogeneity of economic decision-makers has been incorporated in some DSGE models the resultant model has similar properties to a representative agent model (Kaplan and Violante (2018)).

[16] More recently, there has been a revival of interest in habit persistence. For example, Carroll et al. (2011) found cross-country evidence that consumption is significantly "sticky" and that their model outperforms that of Hall (1978). But habit persistence in this literature has only been dealt with as an add-on to a conventional neoclassical model (see Fuhrer (2000) and Kaplan and Violante (2018)). Sometimes it is dismissed as an illusion as in, for example, Chetty and Szeidl (2016) who argued that adjustment costs, rather than habit persistence, can better explain the behavior of aggregate consumption.

[17] In contrast, the normal view of uncertainty is negative, as something that is undesirable and to be minimized by learning and appropriate actions. In a complex economic system, this kind of risk, or 'negative uncertainty,' exists but has to be dealt with separately.

consumption data cannot just be the aggregation of the logical optimization choices of individuals, what we observe is a summation of measurable economic connections *between* decision-makers. And the associated streams of value that are generated are, to a large degree, determined by the set of meso-rules adopted.

The meso-rule set that determines aggregate consumption is part of a prevailing 'culture'.[18] The dominating one at the present time in the US we can label 'consumerism' which involves giving a higher priority than in the past to an individualistic goal, driven by a 'positional' motivation, of trying to maximize the quality of goods and services visible to others (Solnicka and Hemenway (1998)). So, for example, instead of buying another Toyota Corolla, a much more expensive Landcruiser SUV might be bought to raise social status. Expensive restaurants may be preferred to fast food outlets, etc. Consumerism has been present for a long time and was identified by, for example, Veblen (1899) as very prevalent amongst the nineteenth century elite.[19] But it only began to spread strongly across the whole population of the US in the post-war era.[20] This socio-economic process has involved, for example: the introduction of modern notions of material 'progress'; an almost universal political preoccupation with maximizing per capita economic growth; a shift towards individualistic priorities; an increase reliance on 'markets'; radical changes in family structure; increased labour mobility; higher female participation in employment; increased availability of credit to consumers; etc. (Ropke (1999) and Sklair (2012)). Personal income taxation rates, particularly for high income groups, has been reduced through the political process. For example, the highest marginal income tax rate was 90% in 1965 and only 40% in 2018. The impact has been to reduce, significantly, the ratio of government spending to GDP from 30% in 1965 to 17% in 2018. This, of course, has led to significant reductions in public services, such as education, defence and the provision and maintenance of infrastructure.

Growth in adoption of this meso rule set has not been rapid, it has occurred over decades. This has resulted in the observed increase in the share of GDP devoted to consumption expenditure (Witt (2001), Shrum et al. (2013), Chai (2017), Xu et al. (2019)). The hypothesis here is that this kind of growth should follow a diffusion curve towards a limit, which is typically what we observe in complex systems when

[18] McCloskey (2010) explains, through detailed study of the economic history of capitalism, how important cultural factors are in determining the extent and nature of economic development and growth. Also, Mokyr (2016) argues that the rise in scientific thought in Europe, with important economic implications, was due to the emergence of a culture, or a network of connections, i.e., a set of meso-rules.

[19] Veblen (1899) argued that the rich purchase expensive goods and services to display their superior wealth. This is, in turn, imitated by lower income individuals. This came to be known as the 'bandwagon' effect by Leibenstein (1950) who also discusses the "snob" effect, whereby the rich seek unique and novel purchases. The latter provides the innovative drive whereby new meso rules emerge and begin to diffuse. Both are essential for the expansion of consumption and its increase in complexity, viewed from an aggregate perspective. Cowan et al. (1997) were pioneers in providing an evolutionary economic model based upon the operation of the Veblen, "bandwagon" and "snob" effects that we would now call meso-rules. Some neoclassical-based models have included related effects. For example, Heffetz (2011) provided some indirect evidence that consumption can be undertaken as a social signal, as well as for its intrinsic benefits

[20] The classic work that identifies consumerism as a growing mass culture in the post-war era is by Baudrillard (1970/1998) who produced his first edition in 1970. There has been an extensive literature on the subject since in sociology and, although consumerism has had many positive benefits, there has been an increasing number of publications, targeted at the general public, focussing on its negative aspects such as, for example, economists Frank (1999) and Hamilton and Denniss (2005).

connective opportunities are taken by elements because of the emergence of an exploitable niche which, in the economic case, involves a facilitating meso-rule set. Following Kuznets (1954) there has been a long tradition, particularly in industrial organization, of modelling diffusional growth as a logistic or a Gompertz trajectory. Using this methodology, and acknowledging the role of prior commitment, an econometrically testable model of aggregate consumption can be constructed. In a sense, we are turning the clock back to the 1950s and adopting Friedman's preference for testing econometrically a precisely specified hypothesis rather than something promulgated from an inductive VECM exercise. However, unlike Friedman, care is taken to model in first differences to avoid spurious correlation problems. This we can do effectively because we have the luxury of selecting fifty years of US quarterly data, from 1965 to 2018.

Following Foster (2017), we can split aggregate consumption expenditure into its two components.

First, we have aggregate expenditure on the consumer goods and services (including durables, as in Bernanke (1985)), that is determined by a pre-commitment to a particular set of interconnected behavioural rules, ranging from meso-rules that are broad and cultural, down to personal commitments to individual routines and habits that are influenced by targeted advertising and marketing.[21] Responsiveness to incentives should exist, but pre-commitments should dominate in the case of consumption:

$$C_{Et} = A[f(\ldots)]^{1-\beta} \tag{1}$$

Expressing in natural logarithms and first differencing:

$$lnC_{Et} = lnC_{Et-1} + (1-\beta)f(\Delta lnx_t, \Delta lnz_t \ldots) + u_t \tag{2}$$

Where:

$\boldsymbol{C_E}$ is aggregate expenditure on goods and services currently consumed.

$\boldsymbol{f(\Delta lnx_t, \Delta lnz_t \ldots)}$ is a function which includes changes in hypothetical explanatory variables, with lags in impact to be discovered empirically.

$\boldsymbol{\beta}$ is the degree of prior commitment to existing consumption expenditure.

$\boldsymbol{u_t}$ includes shocks to the growth in consumption expenditure that are non-systematic.

The higher is pre-commitment ($\boldsymbol{\beta}$) the lower the scope for $\boldsymbol{f(\Delta lnx_t, \Delta lnz_t \ldots)}$ factors to impact on changes in $\boldsymbol{C_E}$. If $\boldsymbol{\beta}$ is unity there is full 'lock-in' to the past and, if $\boldsymbol{u_t}$ is random, we get a random walk in natural logarithms.[22] If $\boldsymbol{\beta} = 0$, which can never be the case in a real world complex economic system that always requires some degree of order, we get:

[21] Interestingly, this seems to constitute an integration of the very different order-inducing perspectives of Hayek (1967) and Veblen (1899). The former stressed the importance of facilitating meso-rules in a complex economic system. The latter saw habitual behaviour at the microeconomic level as vital to the enablement of continuity in an economic system over time. A similar view was expressed by complex systems pioneer, Simon (1947/76).

[22] It should be noted that many macroeconomic time series have been found to approximate random walks, usually with drift. This means that they are historical processes, not mean-reverting trends. However, they are either special cases or misinterpretations from the perspective adopted here.

$$\Delta lnC_{Et} = f(\Delta lnx_t, \Delta lnz_t \ldots) \tag{3}$$

This is consistent with the fully reversible 'general equilibrium neoclassical case,' specified in first differences with only neoclassical economic incentives included. In this fictional world, $\boldsymbol{u_t}$ must be zero with zero variance because there is no uncertainty in a fully reversible system where all errors can be instantly corrected. In the real world, $0 < \beta < 1$, so there is a role for both prior commitment and economic incentives. So, although we are dealing with a historical process, the standard forces of, for example, demand and supply, can still be operative, but restrained by prior commitments.

The second component of aggregate consumption deals with purchases of novel goods and services, mainly for 'positional' reasons, in states of positive uncertainty. This involves new meso-rules, such as fashions. The consumption of novel goods and services yields new commitments on top of existing ones causing a rise in the proportion of GDP devoted to consumption, as observed in Chart 1. It is hypothesised that this rise must follow a diffusion process and not a random walk, although it may roughly approximate one with drift over certain periods. For convenience and simplicity, the Mansfield (1961) logistic diffusion curve is chosen to capture the impact of the diffusion of the culture of consumerism on the share of consumption in GDP, where $\boldsymbol{\alpha}$ is the diffusion rate and $\boldsymbol{K}$ is the limit that uncommitted consumption ($\boldsymbol{C_D}$) can attain. Note that it is *total* consumption relative to the $\boldsymbol{K}$ that limits the growth in $\boldsymbol{C_D}$:

$$C_{Dt} = C_{Dt-1} + \alpha C_{Dt-1}(\mathbf{1} - C_{t-1}/K) \tag{4}$$

Eq. (4) implies that, although not known in advance, there is a finite number of ways that the expansion of trading and contracting connections can increase aggregate consumption expenditure, given a particular set of consumerist meso-rules. However, $\boldsymbol{K}$ is not fixed in a technologically changing and growing economy, so the relevant limit is the proportion of available aggregate income ($\boldsymbol{Y}$) devoted to consumption expenditure.[23] We can specify $\boldsymbol{K = \pi Y}$, where $\boldsymbol{\pi}$ is the limiting fraction of aggregate income devoted to consumption expenditure.

Approximating $[(\boldsymbol{C_{Dt} - C_{Dt-1}})/\boldsymbol{C_{Dt-1}}]$ with $(\boldsymbol{lnC_{Dt} - lnC_{Dt-1}})$, or $\boldsymbol{\Delta lnC_{Dt}}$, we get:

$$\Delta lnC_{Dt} = \alpha - \alpha(C_{t-1}/\pi Y_{t-1}) \tag{5}$$

[23] Ongoing technological change means that productivity growth on the supply side results in existing items of consumption becoming cheaper over time and, thus, greater quantities can be consumed. Also, 'standard models' of consumer durables come with improved features for a similar real price. Thus, expenditure on existing products can stay the same but the service delivered increases. This is important for members of low socio-economic groups with static real incomes. This increase in consumption is not positional and can even result in negative outcomes, such as obesity. What this means is that, in the case of no novel, positional consumption, consumers of existing products can still enjoy increases in quantity demanded. This is the kind of improvement that is implicit in, for example, neoclassical growth theory. Here, neoclassical growth occurs when $\beta = 0$ and the diffusion term, $\boldsymbol{C_{t-1}/\pi Y_{t-1}}$, is zero, resulting in unlimited exponential growth. But this an entirely unrealistic and impossible case.

The limit, π, is fixed for a given meso-rule set but only for a finite period of historical time. Once a limit is reached, a structural transition to a new meso-rule set will commence.[24] This transitional process is not amenable to econometric modelling.

So, in Eq. (2) and (5) we have distinct representations of flows of consumption expenditure, the former relating to the quantities of goods and services already being consumed under an existing set of meso-rules and the latter relating to growth in consumption expenditure on new goods and services, embodying new meso-rules. The first difference of $\boldsymbol{A}$ in Eq. (2) is no longer zero and the total growth in aggregate consumption expenditure can be obtained by summation:

$$\Delta lnC_t = (\mathbf{1}-\beta)f(\Delta lnx_t, \Delta lnz_t\ldots) + \alpha[\mathbf{1}-(C_{t-1}/\pi Y_{t-1})] + u_t \tag{6}$$

However, the diffusion rate need not be fixed and can shifted up and down because of changes in, for example, incentives. So the constant α can be replaced by $\boldsymbol{[(\alpha_0 + f(v_t \ldots)]}$ and it is levels, rather than rates of change, that should be relevant.

$$\Delta lnC_t = (\mathbf{1}-\beta)f(\Delta lnx_t, \Delta lnz_t\ldots) + [\alpha_0 + f(v_t\ldots)][\mathbf{1}-(C_{t-1}/\pi Y_{t-1})] + u_t \tag{7}$$

We can populate both $\boldsymbol{f(\Delta lnx_t, \Delta lnz_t \ldots)}$ and $\boldsymbol{f(v_t \ldots)}$ and, here, the logic of neoclassical economic theory can be of assistance.

First, there is no doubt that individuals are constrained by their income. An aggregate budget constraint operates in two distinct ways in our model. The rate of change of consumption committed to the existing set of meso-rules is affected by the rate of change in aggregate income ($\boldsymbol{\Delta lnY_t}$) while the rate of change of novel consumption is influenced by the level of aggregate income, via the diffusion term ($\boldsymbol{C_{t-1} / \pi Y_{t-1}}$). Second, neoclassical theory predicts that rates of interest should be relevant system-wide incentives, particularly when inflation is high and variable, and they must be real.[25] Using neoclassical economic theory, justifying the inclusion of the short-term real rate of interest is straightforward. It is hypothesised to relate negatively to real consumption because it impacts upon the cost of loans for consumer durables and the rate of return on short-term savings instruments and near-money. However, we must bear in mind that there can be a wealth effect, as well as a substitution effect, in the case of saving. A cut in the short term rate of return can result in a cut in consumption. So the negative hypothesis only holds if this effect is dominated.[26]

However, in a complex systems context, neoclassical theory does not tell us much about the impact of the long-term rate of interest on consumption. Consumers, unlike firms, do not borrow much using long-term debt instruments, so we would not expect to see a strong negative relationship. However, consumers do hold significant amounts of wealth in long-term assets, indirectly via holdings in, for example, pension funds. So

[24] The π-limit should vary significantly across countries and in different historical epochs, depending upon the particular pattern of meso-rules adopted. For example, we know that the consumption to income ratio has tended to be much lower in Japan compared to the US historically because of the adoption of different sets of meso-rules.

[25] The real interest rate is generally defined as the nominal interest rate minus the expected rate of inflation. Here, for simplicity, the actual rate of inflation is used which implies that it is the best estimate of future inflation.

[26] Note that real interest rates are not entered in logarithmic form because of the presence of negative values. So, as the real interest rate rises, so does the interest elasticity, which is consistent with the analysis here.

cuts in the long term rate of interest are likely to lead to cuts in consumption, dominating any positive effect due to cheaper borrowing.[27] In addition, it is also the case that changes in the yield on long-term bonds can affect the dividend payments made by firms (Pericoli (2018)). So, a rise in the bond yield increases the disposable income of shareholders at the expense of investment by firms from retained earnings. This shift involves no change in GDP, only a shift from investment to consumption.

Deaton (1978) argued that, when inflation is rising, there tends to be widespread confusion between actual and relative price increases, leading to a reduction in the average propensity to consume. This was a proposition made in the context of information deficiencies in an otherwise standard neoclassical framework. Here, it can apply to both the diffusion and prior commitment components of our model so, to test the Deaton hypothesis, both the rate of inflation and the rate of change of inflation are added to our test specification. Finally, there is an extensive literature of a non-neoclassical kind that argues that a widening of the distribution of income (and/or wealth) depresses consumption because of the differential savings rates of the rich and poor. To test this hypothesis, the ratio of wages and salaries to GDP was included in our model[28]:

$$\begin{aligned}\Delta lnC_t = (1-\beta)[\lambda_1 \Delta lnY_{t\ldots} - \lambda_2 \Delta R_{St\ldots} + \lambda_3 \Delta R_{Lt\ldots} - \lambda_4 \Delta\Delta lnP_{t\ldots} + \lambda_5 \Delta W_{t\ldots}] \\ + [a_0 - \lambda_5 R_{St\ldots} + \lambda_6 R_{Lt\ldots} - \lambda_7 \Delta lnP_{t\ldots} + \lambda_8 W_{t\ldots}] - a(C_{t-1}/\pi Y_{t-1}) + u_t\end{aligned} \tag{8}$$

Where: $\boldsymbol{C}$ is Real Consumption Expenditure (including durables), $\boldsymbol{Y}$ is Real GDP, $\boldsymbol{R_S}$ is the Real 90 Day Bond Rate, $\boldsymbol{R_L}$ is the 10 Year Bond Rate, $\boldsymbol{\Delta lnP}$ is the inflation rate and $\boldsymbol{W}$ is the ratio of wages and salaries to GDP.[29]

All predicted signs are appended to the variables and, with the exception of $\boldsymbol{C_{t-1}/Y_{t-1}}$, the lags of impact associated with each variable are left open and subject to empirical discovery.[30]

It should be noted that this model is not specified in the usual per capita way because, when we are at the level of the system, rather than the individual or household, population growth is important in expanding the demand and supply of existing products and speeding the adoption of new products.[31] Also, as noted, real GDP is selected, rather than the usual real personal disposable income. The latter makes sense when the analysis starts at the microeconomic level. It is always true that individuals are constrained by disposable income. However, when we conduct analysis at the system level, taxation is transferred back into disposable income via transfers and government expenditure. Provided that government bases its outgoings on expected revenue in the same period, then it will be GDP that is the relevant driver of aggregate

[27] Muellbauer (2016) discusses how wealth and credit influence consumption and he reviewed evidence that supports the hypothesis that lower real interest rates on long-term assets can lower consumption, especially in Germany and Japan. He also finds that the real short-rate has had a strong negative relationship with consumption in the US case.

[28] It should be noted that because this variable includes very high salaries of, for example, CEOs, it understates the inequality of income distribution.

[29] See Appendix 1 for a list of data sources.

[30] $\alpha = [\alpha_0 - \lambda_5 R_{St\ldots} + \lambda_6 R_{Lt\ldots} - \lambda_7 \Delta lnP_{t\ldots}]$ therefore, to obtain an estimate of π, it is necessary to adjust the estimate of α_0 by adding or subtracting the means of the other level variables, weighted by their estimated coefficients.

[31] Estimation using per capita GDP resulted in similar estimates of π.

consumption. Any inequality between receipts and disbursements is covered by a budget deficit or surplus. A deficit adds to consumption expenditure. In the econometric tests conducted, GDP performs significantly better than personal disposable income.

A favoured way of modelling macroeconomic variables such as consumption is to apply the 'error-correction model' (ECM) or the more exhaustive vector error correction model (VECM). There is said to be a 'data generating process' (DGP) with a statistical structure. From it, a long-run equilibrium is deemed to emerge provided that the relevant series are 'co-integrated' (Engle and Granger (1987)). In this methodology, provided that there is co-integration, then the first differences of explanatory variables (integrated at order one) are viewed as disequilibrium values which are set to zero to obtain a long-run equilibrium solution, in line with a hypothesis derived from economic theory.[32] However, co-integration tests, useful as they are in telling us about the co-movement of time series variables, tell us little about a 'long-run equilibrium' state in a chosen economic theory. This is because, if we look at such modelling from such a theoretical perspective, observed co-integration must involve averages of disequilibrium, not the identification of a long run equilibrium state. The problem of combining logic and history is very apparent here – history becomes no more than a disequilibrium process towards an equilibrium solution that is not connected with history.

The complex economic systems perspective adopted here tells us that we should interpret econometric evidence in the opposite way to that prescribed in the popular VECM methodology. History is not relegated to 'short-run disequilibrium dynamics', it is the core, non-equilibrium, process upon which economic behaviour is imposed. In each decision period, responses are made to both economic and non-economic factors and, in the next period, there is a new round of responses, given new historical conditions. There are no 'disequilibrium paths' towards 'long run' analytical equilibrium states that are tractable in subsequent periods.[33]

Also, when we are dealing with aggregate consumption, we must always bear in mind the systemic reality that aggregate income must equal aggregate expenditure as an accounting necessity. This is an aggregate rule in the macro-economy, as conventionally measured. Thus, the issue of endogeneity arises. However, the identity connection from consumption back to income, the 'multiplier,' is just the way the rules of a trading and contracting system operate, it is not driven by exogenous micro-behavioural choices.[34] In a system where consumption is a large component of GDP, it is inevitable that there will be a strong contemporaneous correlation between the rates of change in C and Y – something that has been ignored in much of the literature. The questions of

[32] The pioneering study of consumption using this methodology was by Davidson et al. (1978), reviewed in Hendry (1986)). However, it is worth noting that, in their study, four quarter moving averages are used. This means that the annual average

used in each quarter contains three quarters that are pre-determined. This is prior commitment in disguise.

[33] Samuelson (1972) realised that this historical perspective on economic behaviour is a fundamental challenge to standard equilibrium/disequilibrium analysis: "When the equilibrium of a system depends on (and is dictated by) its path toward equilibrium, the scientist has an uncomfortable feeling." p 441.

[34] Spanos (2012) explains why the existence of an identity cannot be viewed in behavioral terms. It is invalid to use an identity to determine an endogenous variable, for example, using two stage least squares. In the case of the consumption function, it could be argued that there is bi-causality because consumption influences GDP. However, since the latter involves the use of an accounting identity that adjusts passively to other behavioral responses, there is no bi-causality to disentangle, only a systemic connection.

interest that arise are: does the coefficient deviate from unity, i.e., is it a proportional relationship, and does it shift over time?

5 The results

In Table 1, the results of estimating Eq. (8) are reported for the period 1965q1 – 2018q3 using US quarterly data.[35]

In Column A, the results of estimating by OLS are reported. Only significant variables are reported and these are a product of general-to-specific elimination, using up to a three quarter lag. All the reported variables have the predicted signs on their estimated coefficients. In Chart 2, the actual to predicted plots are presented. The fit is excellent, particularly for a model explaining a stationary first-differenced variable. In Chart 3, the Recursive Least Squares (RLS) Coefficient Plots are presented. Once small sample size is exceeded, the coefficients are very stable. In Charts 4 and 5, the RLS N-Step and One-Step Forecast Test results are presented. The performance of the model is excellent with a Chow Forecast Test Likelihood Ratio p value of 0.90.

The DW Statistic in Column A indicates that there is negative first order serial correlation present. This is confirmed by the Breusch-Godfrey Test with an F. Test p value of 0.016. This is, possibly, due the presence of some non-seasonally adjusted independent variables. In order to check the impact of this on our estimated coefficients, the residuals from the OLS result in Column A were entered into the model with a one period lag. We can see from Column B that there is no change in the estimated coefficients except for a small change in $\boldsymbol{W_t}$ which is not seasonally adjusted. The Breusch-Pagan-Godfrey Test also yields evidence of heteroscedasticity with an F. Test p value of 0.002. In order to assess the impact of this, the model was re-estimated by Robust Least Squares. The results are reported in Column C. And, as might be expected, the estimated coefficients are very similar. More importantly, all of the variables remain significant at the 5% level using the z-Test.

Despite the strength of these results, close examination of the residuals in Chart 2 suggests that there is a minor pattern change in the latter part of the sample not picked up by the Chow Forecast Test.[36] Checks were made to see if any breaks could be identified. The Bai-Perron Multiple Breakpoint Test identified one break in 1997q3. Both the Quandt-Andrews Unknown Breakpoint Test and the Chow Breakpoint Test also provided evidence supporting a break in this quarter. The latter reports an F. Test p value of 0.0016. In the light of this evidence, a step dummy, to capture a shift in the diffusion component of the model, and an impulse dummy, to capture any shift in the prior commitment component, were included in the model. The former was significant

[35] The EViews 10 package is used. The sample excluded two quarters of recorded data because they are commonly revised due to measurement errors and lags. The reported results are parsimonious outcomes of general-to-specific modeling that included an initial four quarters of the chosen independent variables.

[36] Although, the residuals pass normal distribution tests in the models estimated, Foster and Wild (1999) showed, using moving window spectral methods, that the pattern of residuals, which capture nonlinear processes in an otherwise specified linear model, changes in predictable ways as we move up a diffusion curve towards a structural transition. This can provide an early warning to policy-makers. However, it would require a study using a long series of monthly data to obtain sufficient data to examine whether there are systematic pattern changes. This would be a useful further research project.

Table 1 OLS Estimates of Eq. (8)

Variable	A 1965q1-2018q3 OLS (t-value)	B 1965q1-2018q3 OLS: With a/c Correction	C 1965q1-2018q3 Robust LS (z-value)	D 1965q1-2018q3 OLS: Including 1997q3 Break	E 1997q3-2018q3 OLS (t-value)
α_0	0.04 (5.34)	0.04 (4.82)	0.04 (4.74)	0.07 (5.88)	0.14 (5.76)
C_{t-1}/Y_{t-1}	−0.05 (−4.88)	−0.05 (−4.39)	−0.05 (−4.31)	−0.10 (−5.46)	−0.20 (−5.66)
ΔlnY_t	0.57 (13.79)	0.59 (14.21)	0.58 (13.74)	0.58 (14.14)	0.51 (9.14)
ΔR_{St-3}	−0.09 (−2.66)	−0.09 (−2.65)	−0.08 (−2.52)	−0.09 (−2.74)	0.20 (2.80)
ΔR_{Lt-3}	0.04 (3.19)	0.04 (3.24)	0.04 (3.06)	0.04 (3.42)	0.04 (3.67)
R_{St-2}	−0.03 (−2.10)	−0.03 (−2.10)	−0.03 (−1.98)	−0.03 (−3.00)	−0.05 (−3.57)
R_{Lt-1}	0.03 (2.34)	0.03 (2.35)	0.03 (2.43)	0.04 (3.15)	0.03 (2.60)
ΔlnP_t	−0.04 (−3.67)	−0.04 (−3.38)	−0.04 (−3.21)	−0.04 (−3.27)	
ΔW_t	0.28 (3.07)	0.30 (3.26)	0.29 (3.06)	0.27 (2.94)	0.21 (2.71)
Residual $_{t-1}$		−0.20 (−2.83)			
Step Dummy 1997q3 to 2018q3				0.0035 (3.04)	
Adj. R^2	0.594	0.600	0.412	0.609	0.740
Prob. F Stat	0.000	0.000	0.000	0.000	0.000
DW	2.37	2.01		2.38	2.15

but not the latter. The results are reported in Column D. The only changes are in the estimated coefficients on a_o and C_{t-1}/Y_{t-1}. Both are raised over the whole period with an increase in the diffusion rate from 1997q3 onwards. This implies that the role of the diffusion component had been understated because of an unexplained shift in real

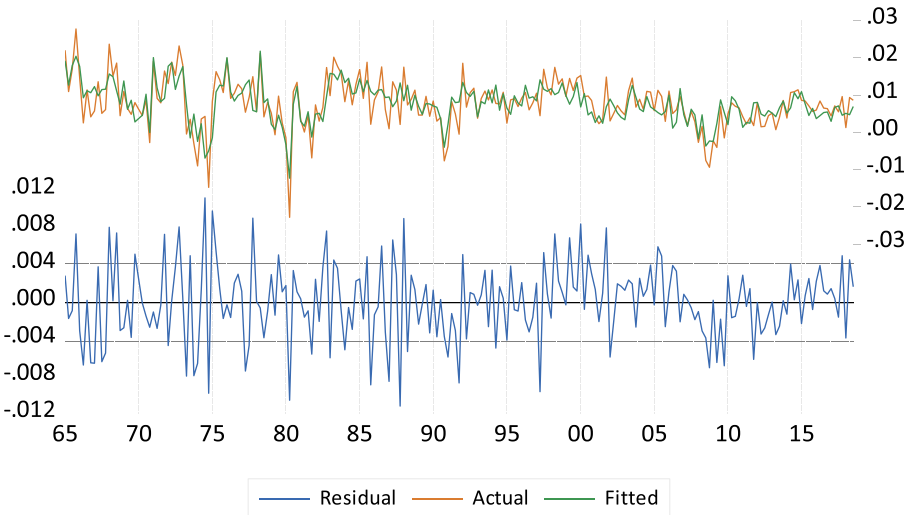

Chart 2 Actual to Predicted Plots (1964Q4-2018Q3)

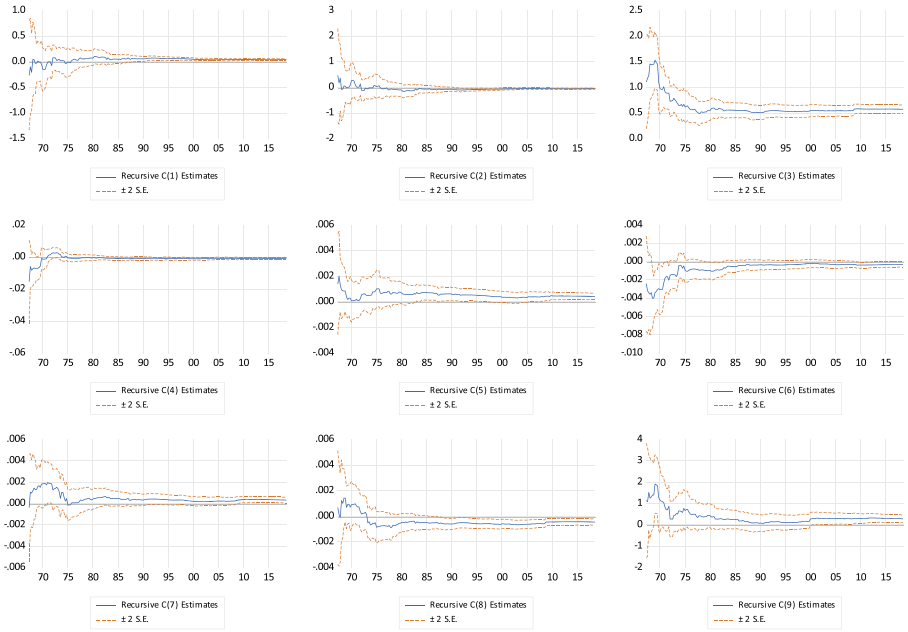

Chart 3 Recursive Least Squares Coefficient Plots: 1964Q4-2018Q3

consumption growth. The impact of negative serial correlation was checked again and there was no evidence of any significant shift in the estimated coefficients.

A further check was conducted by re-estimating the model over the post-break period, 1997q3-2018q3. The results are reported in Column E. The step dummy is now incorporated in the estimated constant, raising the impact of the diffusion rate and

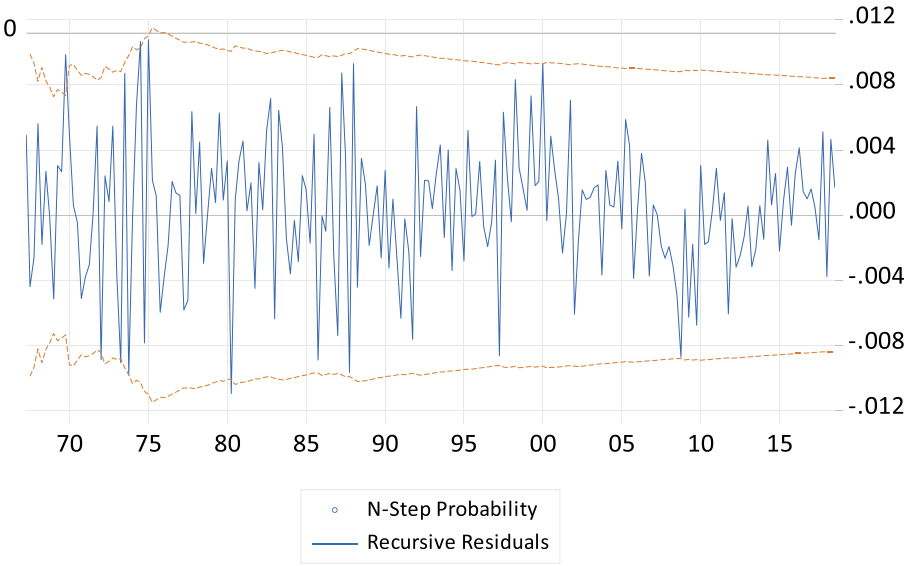

Chart 4 Recursive Least Squares N-Step Forecast Test: 1964Q4-2018Q3

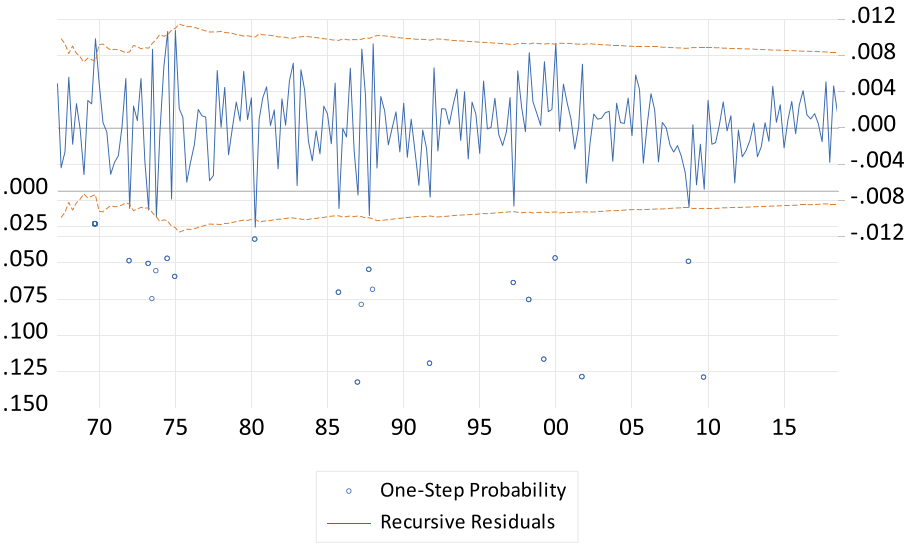

Chart 5 Recursive Least Squares 1-Step Forecast Test: 1964Q4-2018Q3

logistic component even further. The marginal explanatory value of adding this step dummy is small but it may be an indication that the significant loosening of the regulations governing the granting of consumer credit in the mid-1990s, which enabled consumers to borrow more for any given level of creditworthiness, had an impact on diffusion. Also, the level of the short rate exhibits a higher estimated coefficient which may also be due to the freeing up of regulatory restrictions on borrowing. Notably, the rate of change of the short rate records a significant *positive* estimated coefficient. So it would seem that, when the real short rate is at a historical low, the effect of a reduction on committed consumption is dominated by the wealth effect. Also, inflation is no longer significant which is unsurprising given that it is much lower in this recent sub-period.[37] There is no evidence of serial correlation (the *p* value of the Breusch-Godfrey F. Test is 0.75) or of heteroscedasticity (the p value of the Breusch-Pagan-Godfrey F. Test of 0.45).

Overall, these results provide strong support for the model specified in Eq. (8). The hypothesis that aggregate consumption is determined both by prior commitments and a diffusion process, due to the increasing adoption of new products in states of positive uncertainty, resulting in increased spending out of income, is supported. So, although the economy is a complex system, the domination of rule-bound behaviour in the context of consumption makes it a much more stable aggregate than, for example, business investment which, in contrast, is likely to be dominated by behaviour in uncertainty.

The observed rise in the ratio of consumption to GDP over the past half century is consistent with the increasing adoption of a cultural meso-rule set that has been labelled consumerism. But such diffusional shifts do not go on forever. Therefore, the estimates of α_0 and π are of key interest. Across the five estimating equations in Table 1, the

[37] In the different context of the formation of, and action in relation to, inflation expectations, Milton Friedman argued that thresholds are relevant. In the case of inflation his chosen threshold was 8%.

calculated diffusion limit (π) is in the narrow range of 0.69% to 0.70% of GDP, applying the minor adjustment to the estimate of α_0 discussed above. In Chart 1 we can see that the consumption to GDP ratio rose from a low of 0.57% in 1952, after the consumption reversal that occurred following the restrictions in the Second World War, to 0.68% by mid-2018. This means that, in 2018, the US consumption to GDP ratio was close to its limit.[38]

A notable feature of the results is the weak significance of real interest rate variables. The rate of change of the short-term real interest has a significant statistical impact but it is very weak economically. This is consistent with the hypothesis that prior commitment has a strong grip on choice in relation to existing consumption patterns. The level of the short interest rate, included because of hypothesised impact upon the diffusion of new consumption expenditure is well-determined but, again, very weak economically. So, the neoclassical hypothesis, as enunciated by Friedman (1957), that the real interest rate has an important economic impact on consumption is not supported. Keynes (1936) seemed to have had a better intuitive grasp of the actual situation, dismissing the economic importance of interest rate variables in the context of consumption. Also, since the estimated coefficients on the levels of the short and long rates are of very similar magnitude with opposite signs, there is little net impact on consumption expenditure. This suggests that a monetary policy that targets interest rates, but does not alter the term structure, is likely to have little impact on novel consumption. There is a net negative impact in relation to the rates of change over the whole period, but it is low and seems to have become positive in recent decades when inflation and real rates have been relatively low, on average.[39]

The significance of $\Delta \boldsymbol{W}$ supports the hypothesis that rising inequality has depressed expenditure on existing consumption choices with a 1% rise explaining about a 0.2% - 0.3% fall in consumption. Over the estimation period, inequality, by this measure, has risen by about 15% resulting in a reduction in consumption of about 3% - 4% but this seems to have been strongly offset by other variables until recently. The level of $\boldsymbol{W}$ is not significant. This may be because a rise in inequality does not constrain the novel consumption of the upper income groups which tend to dominate when it comes to conspicuous consumption of novel products.[40]

Support is found for the Deaton (1978) hypothesis that there is a widespread inability to distinguish absolute and relative price changes. The level, not the rate of change, of the inflation rate is negative and significant, suggesting that only novel consumption was affected. As can be seen in Chart 6, when inflation surged, real interest rates were depressed. The hypothesis that nominal interest rates adjust to reflect inflation did not hold. So, the three times when inflation accelerated and peaked in the 1970s, would have been when the negative impact on consumption was at its strongest.

[38] This steady rise in the ratio of *C* to *GDP* has important modelling implications. A simple regression of *ln C* on *ln GDP*, plus a constant, that would be used in a cointegration test, yields an estimated coefficient of 1.08. Any long run equilibrium interpretation of this relationship is implausible because consumption 'in equilibrium' would always grow faster than *GDP*. Also, the reported DW statistic is low, at 0.215, calling into question the presence of co-integration and, therefore, a valid error correction representation.

[39] See Fuhrer (2000) for analysis of the implications for monetary policy of consumption stickiness.

[40] Kuhn et al. (2017) confirm that inequality has widened and that this has been associated with strong increases in equity prices and dividend payouts. Also increases in personal debt have been concentrated in the higher income groups which dominate when it comes to conspicuous consumption.

Lower real interest rates did not stimulate business investment much because confidence is negatively affected by downward movements in consumption demand. So the Deaton effect would have contributed to the emergence of the observed three bouts of stagflation.[41] The standard theory of accelerating inflation involves cumulative inflationary expectation effects when unemployment is below its 'natural' rate. However, such theories tell us little as to why the unemployment rate rises in such conditions. So the Deaton effect on consumption would seem to be a part of the story. However, the evidence in Column E in Table 1 suggests that this effect is only operative when inflation is high, since we do not observe any significant effect of inflation on real consumption after the mid-1990s.

6 Conclusion

Any complex system only functions if there is widespread adherence to rules that connect its active elements. In the context of aggregate consumption, if adherence to rules is strong then, despite the vast complexity in behaviour that must exist, the macroeconomic trajectory will be stable and explicable using only a simple model. Support is found for the hypothesis that the rise in the ratio of US consumption to GDP has followed a diffusion curve since the 1960s and it is argued that this can be attributed to the rising adoption of the culture of consumerism. The evidence suggests that, by 2018, a diffusional limit was being approached. Of course, at such a limit, income growth can still increase consumption growth, but non-proportionally because of the lack of an offset due to diffusional growth. If the consumption to GDP ratio rises above the diffusion coefficient because of some exogenous shock, there is a negative effect that pushes consumption back to the limit, much like in an error-correction model. So, expansionary fiscal policy is likely to be much weaker in its impact on growth than in past decades. The corollary is that larger and larger exogenous expansions of money or credit-financed budget deficits and/or business investment are necessary to keep consumption growing at a rate adequate to keep unemployment and underemployment at low levels. So, although there is no lack of technological or organisational innovation on the supply-side, there seems to be a growing lack of collective consumer willingness and/or capacity to increase the consumption to GDP ratio much further.

A higher share of consumption in GDP means a lower share in other parts of the macro-economy. The resultant cuts in services and investment tend to make a government unpopular, especially when the ratio of the budget deficit to government spending still keeps on rising because of an increasing burden of transfers and subsidies. Also, the decline in the proportion of personal savings out of income means that businesses come to rely more heavily on retained earnings and foreign borrowing to finance capital investment. Over the past decade in the US, this has been mitigated by the use of 'quantitative easing' to bolster the reserves of the banking system. Along with low real interest rates, this has meant that credit has been easy and cheap to obtain by businesses that are able to meet the stricter lending criteria operative since the Global Financial Crisis. However, the attractiveness of cheap credit was offset by business investment

[41] Deaton (1992) noted that two of the inflation peaks that we see in Chart 6 followed large oil shocks and he speculated that the effect on consumption may have been related to wider economic concerns.

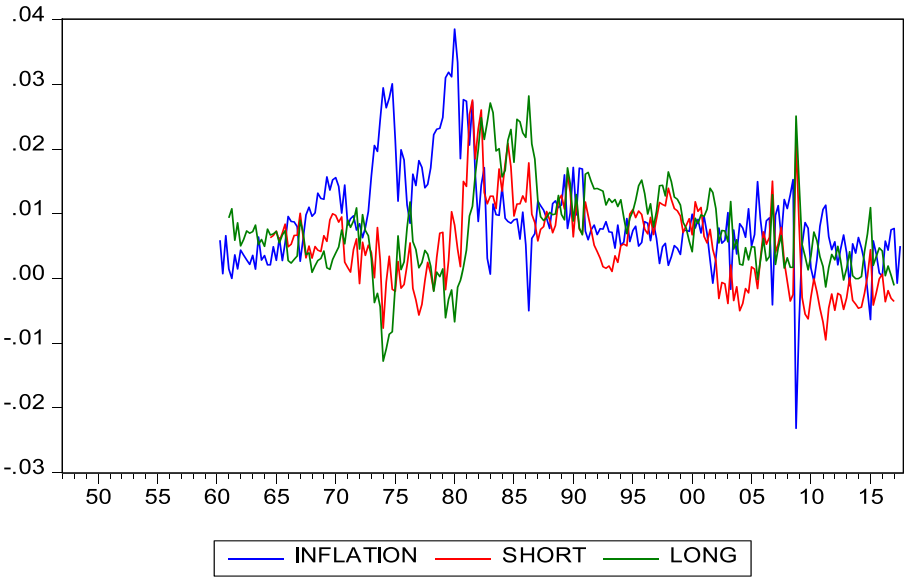

Chart 6 Inflation, US 3 Month (SHORT) and 10 Year (LONG) Real Bond Rates

caution because of the widely observed weakness in consumption expenditure growth.[42] So, quantitative easing only had a slow and weak effect on the economy.

In complex systems, approaching a diffusion limit increases the probability that fundamental structural change will occur.[43] If it is, in fact, the case that the diffusion of consumerism is coming to an end, there are important implications for the US economy. Consumption will no longer be the main engine of growth, as it has been since the Second World War. But this has not occurred suddenly. It has been a tendency that has been present for a long time. For example, Gordon (2014) observed a long-term slowing down of US growth for a range of reasons, mainly on the supply side. Part of his argument was that the slowdown in the expansion of consumption opportunities has contributed to this slowdown.[44] The evidence here suggests that it may be the most important factor. As Adam Smith (1776/1904) emphasised, growth ultimately depends upon the "the extent of the market". Keynes understood this and urged governments to ensure that consumption was continuously stimulated, essentially by having governments engaging in active policies, both to stabilise fluctuations and to facilitate the development of new economy-wide rule based systems, for example, in the public provision of health, education and welfare, that would ensure that effective demand was

[42] This interaction was acknowledged long ago in the classic multiplier-accelerator model of Samuelson (1939).

[43] Rengs and Scholtz-Wackerle (2019) find, in their evolutionary macroeconomic simulation experiments, that the diffusion of "snob" and "bandwagon" meso-rules, similar to what has been proposed here, can eventually cause economic instability.

[44] Hansen (1939) speculated that 'secular stagnation' could occur because of insufficient consumption growth following the Great Depression because of slowing population growth. His prediction was incorrect – population growth accelerated after the Second World War. But the persistent rise in the consumption to GDP ratio, as the culture of consumerism diffused in the postwar era, was a key reason why stagnation was avoided. However, should the diffusion of consumerism come to an end, then the bleak Hansen-Gordon scenario could become a serious possibility, particularly if immigration is controlled.

expanded. There is little doubt that this strategy paid off as long as the consumer culture was gaining new adopters and existing adopters were increasing their consumption to income ratios. But this expansion has had its costs. For example, core social institutions, outside markets – the clubs, churches, etc. – seem to have been weakened while government support for welfare, health and education has been in relative decline because of the rise in the consumption to GDP ratio.

Reaching a diffusion limit, whatever the context, always results in some kind of structural transition that can happen smoothly or, alternatively, be characterised by crisis and conflict. Aggregate consumption is an orderly, slow moving magnitude most of the time, but history tells us that, when consumption ceases to grow much and inequality increases, traumatic political events tend to occur. For example, prior to the share of consumption in GDP peaking at 81% in 1932, inequality in the 1920s had reached a level similar to that prevailing in 2018. What followed was a protracted period of falling real consumption per capita and political trauma, including depression and participation in war. Of course, it is well beyond the scope of this short article to provide any hard evidence concerning the similarity of these two historical episodes of structural transition and political trauma. But we do know that consumption is fundamentally important because people are pre-committed to much of it and, therefore, are often faced with all-or-nothing choices. This is made worse by the fact that, in a consumerist society, much of status and satisfaction with life comes from increases in the quantity and quality of consumption, irrespective of its absolute level. Therefore, relative disadvantage, as well as absolute, can lead to disruption and crisis. But there is nothing inevitable about such processes. What matters is that transitional conditions are recognised and dealt with by policymakers. This is not easy because it demands a change in the prevailing meso-rule set adopted by the population and this is usually resisted by conservative representatives of vested interest. In the domain of macroeconomic policy, they tend to call for austerity measures that defend wealth and power. So, structural transitions in economic systems are predominantly about politics. In such circumstances, it is up to economists to debate constructively and offer practical advice as to how the socio-economic rules that facilitate economic coordination can be modified to cope with new contexts. Simulations of imaginary worlds, so popular in mainstream macroeconomics, are not enough.

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Appendix 1: Data Sources

All data were drawn from the St Louis FED's database at:

https//fred.stlouisfed.org/tags/series?t=quarterly%3Busa&ob=pv&od=desc as follows:

Real Gross Domestic Product, Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted Annual Rate.

Real Personal Consumption Expenditures, Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted Annual Rate.

90-day Rates and Yields: Interbank Rates for the United States, Percent, Quarterly, Not Seasonally Adjusted.

Long-Term Government Bond Yields: 10-year: Main (Including Benchmark) for the United States, Percent, Quarterly, Not Seasonally Adjusted.

Consumer Price Index: Total All Items for the United States, Index 2010 = 1, Quarterly, Seasonally Adjusted.

Compensation of Employees: Wages and Salary Accruals/Gross Domestic Product, Quarterly, Seasonally Adjusted.

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