The Consumption Function: A New Perspective

Foster, John

School of Economics, University of Queensland

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A New Perspective

John Foster[1]

The School of Economics

The University of Queensland

Brisbane

Queensland 4072

Australia

j.foster@uq.edu.au

Abstract

The behaviour of aggregate consumption is conventionally understood from the perspective of the permanent income and life cycle hypotheses. Both of these hypotheses are deduced from the theory of constrained optimization as applied to a 'representative agent' that consumes and saves. An alternative way of understanding aggregate consumption expenditure is to see it as primarily a systemic outcome of the adoption of widely upheld rules ('meso-rules') that enable trading and contracting in a complex economic system. Such systems require order to function but they must also adapt and evolve. Correspondingly, aggregate consumption can be viewed as being determined by two contrasting historical processes: one involves an aggregation of pre-committed, rule-bound choices and the other open-ended aspirational choices of novel products. Both of these processes are influenced by economic incentives. This is the domain of neoclassical economic theory and it is found that such theorising can tell us a great deal once it is set in its proper historical context. Although a modern complex system perspective derived from the natural sciences is adopted, it is embedded in economic thinking. For example, connections are made to the insights and intuitions of Alfred Marshall, Joseph Schumpeter, Simon Kuznets, Friedrich Hayek and John Maynard Keynes. What we understand from them, along with modern complex system analysis, is that, although it is individual decisions that are fundamental in any economic system, it cannot be the case that what we observe at the aggregate level just reflects the optimization decision of a representative agent. As Hayek observed, the role of individual is much more complex and important than this. Using half a century of data, the US consumption function is modelled successfully on the presumption that the economy is a complex system in which there has been the diffusion of a 'culture of consumerism' in the post-war era. This has involved the increasing adoption of a particular bundle of meso rules and this has resulted in a steadily increasing ratio of consumption to GDP that has been tending towards a limit. However, variables and perspectives drawn from neoclassical economic theory remain important in explaining variations in the growth of aggregate consumption.

In framing an ideal we may assume what we wish, but should avoid impossibilities.

ARISTOTLE

1. Introduction

Modern macroeconomics analysis is built upon theoretical foundations that involve a representative agent engaging in constrained optimisation. If appropriate assumptions are made, a general equilibrium can exist and deduction can proceed. Variations in these assumptions yield different macroeconomic characterisations, the most popular in recent years being the dynamic stochastic general equilibrium (DSGE) model. However, there is a radically different way of viewing the structure and behaviour of an economy - as a complex system governed by rules. From this perspective, the economy is a system containing elements - economic decision-makers - connected by widely accepted rules ('meso-rules') concerning, for example, trading and contracting arrangements. If the resultant complex, but incomplete, network is stable and predictable, i.e., it produces low risk, it yields value to those who adhere to these rules. But such systems, although necessarily ordered, are far from static. Since the rule network is incompletely connected, there is always scope for new connections to form between existing elements and, also, for new elements to connect via the adoption of existing or novel rules. In this way, a complex economic system can evolve.

So, complex economic systems contain both conservative and radical dimensions. Such systems, therefore, are influenced by history and, at the same time, make history. Within these contrasting historical processes, people try to optimize in the face of incentives whenever it is feasible to do so. So the complex economic system perspective does not reject the predictions of neoclassical economic theory, instead, it places them in their proper historical context. Not only does such neoclassical theorising help us to understand observed economic decision-making in the flow of history, but it also helps us identify, and design, rule structures that facilitate trading and contracting within the prevailing architecture of the socio-economic system.[2]

When we presume that the economy is a complex system it alters, in a fundamental way, how we should model aggregate consumption expenditure. 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 pre-committed at any point in time. Second, decision-makers are always open to considering the purchase of novel goods and services, driven by aspirational goals that form in states of uncertainty. We know that marketing professionals are continually seeking to make emotional connections between products and consumers and to also forge connections between the tastes of different people in the hope that a preference for a product will become a widely adopted rule. This is observed most spectacularly in the domain of fashion goods.

The purpose here is not to build a complex economic system model but, rather, to build a simple model of consumption expenditure that takes account of the fact that decision-making takes place in the context of an evolving complex economic system. Only very basic features of complex economic systems are introduced. The key difference to the standard economic approach is that neoclassical theory is not expected to explain the core functioning of an economic system but, instead, offers us

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[2] See Foster (2017) for a fuller discussion than there is space for here about the implications for economics of presuming that we are dealing with a complex system.

a body of logic which can help us understand how incentives influence behaviour along historical trajectories that are determined by adherence to prevailing socio-economic rules and aspirations formed in states of uncertainty, given prevailing beliefs. It is shown that, in the case of aggregate consumption, some predictions derived from neoclassical economic theory, concerning rational responses to incentives, are confirmed once we accept that we are dealing behaviour in a complex economic system.

A very simple model is tested econometrically to demonstrate the usefulness of neoclassical economic theory once we accept that we are dealing with a complex system. The variables chosen are a sub-set of those suggested by, for example, Friedman (1957) using a very different ontology. Of course, confining ourselves to neoclassical explanatory variables is very restrictive – other non-neoclassical variables are likely to be relevant too. However, it is not the purpose here to offer a complete model of consumption, just to demonstrate that a complex system perspective does not diminish the importance of neoclassical economic logic, when properly contextualised. Given that the context is a complex system bequeathed by history, any modeller of economic behaviour needs to know what dominant rules hold such a system together. Only careful historical study, rather than just econometric modelling, is required to understand the role and importance of different rules.[3] Here, discussion of the meso-rule structure impacting aggregate consumption in the case of the United States is kept very simple and intended to be only a starting point for further research.

In a sense, what is being proposed is not new. The use of neoclassical theory advocated here aligns with the recommendations of one of its founding fathers, Marshall (1890), not the 'general equilibrium' approach that is currently popular in macroeconomics. The latter is not neoclassical theory but, rather, an abstract theoretical construction that builds upon such theory. The complex systems perspective offers the bonus of being able to take on board the insights of Schumpeter (1934/ 1911) concerning the key roles of innovation and entrepreneurship in generating economic growth, operationalized in the diffusion methodology initiated by Kuznets (1930, 1954). Of course, these pioneers had only an intuitive understanding of how complex economic systems function. It was Keynes (1936) who, in a fragmentary way, introduced a form of macroeconomic analysis that acknowledged that the economy has to be understood as a complex system. However, it was his nemesis, Hayek (1945), who was the most important pioneer in arguing that the economy is a rule-based complex system; but he tended to deny that the macroeconomic level of inquiry is a valid or useful one. To him, it only opened the door for government intervention and the introduction of politically motivated statutory rules that damaged enterprise. But, politics aside, it is difficult to deny that a rule-based system, ordered by laws, norms, and other widely upheld meso-rules that emerge from Hayek's process of "spontaneous order," can form the rock upon which macroeconomic modelling, using historical data, can be built.

In Section 2 a very selective 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 consumption in a

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[3] A fine example of this approach, in the context of monetary theory and policy, is the study by Friedman and Schwartz (1963). Indeed, their insistence that careful historical research reveals that money is fundamentally important, and not simply a 'veil', fits well with the perspective that an economy is, necessarily, a complex system.

complex economic system and offers a testable specification that includes variables suggested by neoclassical theory. 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 is 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. So 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 has 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. He justified this hypothesis by engaging in a logical exercise that involved a representative agent making an allocation decision over two hypothetical periods. This rational consumer is presumed to take into account his or her expectation concerning income in the future. This theory suggested that consumption should be proportional to permanent income, subject to variations in other incentives, such as the real interest rate. Friedman then suggested that the non-proportionality observed in short periods is due to the existence of 'transitory' variations in income that cannot be anticipated. These, he argued, should be relatively larger in their impact over a short period. So, if the 'true' relationship is between consumption and permanent income, using only current income will result in measurement errors that downwardly bias the estimated marginal propensity to consume. Of course, Friedman could not measure permanent income so he used exponential smoothing, applying declining weights to current and 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 (1955) 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]

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[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 as the 'absolute income hypothesis' of Keynes became viewed as *ad hoc* and Duesenberry's 'peak income hypothesis' gradually disappeared because of its perceived inconsistent micro-foundations and various problems in interpreting his empirical 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 is 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, a 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, of course, a lively and extensive literature containing variations on these themes that will not be reviewed here.[6] However, over the last decade or so, there has not been much in the way of significant new developments. An uneasy compromise was reached in macroeconomic textbooks - the permanent income and life cycle hypotheses dominate the consumption chapter while, in most cases, standard Keynesian income-expenditure analysis, complete with a short-run non-proportional consumption function and the multiplier, is retained. This has always been something of a contradiction and, when push came to shove in the Global Financial Crisis, the US Federal Government relied on the basic Keynesian story in deciding to enact a stabilization policy to counter the collapse in business investment that occurred because of a loss in confidence. So it would appear that policymakers have not paid too much attention to 'general equilibrium' representations of macroeconomic behaviour that presume rational expectations.[7] Why is this? Put quite simply, policymakers have to make decisions 'in history' not in the ahistorical world of abstract macroeconomic theory.

When Keynes presented the income-expenditure flow model of a macro-economy, based upon historical national income accounts, it was a major challenge to adherents of the view, emerging in his time, that the core behaviour of the economic system and its sub-systems, should be

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[6] See Deaton (1992) for an authoritative review and Muellbauer (2016) for a more recent critical review

[7] However, some central banks have persisted with DSGE models. Hendry and Muellbauer (2018) discuss the case of the Bank of England.

represented by constrained optimization theory, suitably qualified by 'imperfections' of various kinds. Keynes rejected this view. He had followed Alfred Marshall in fully accepting that neoclassical theory is useful in understanding how incentives influence economic behaviour. But, like Marshall, he viewed such decision-making as embedded in a more fundamental process that is historical in nature. For example, he accepted a modified version of the neoclassical representation of the relationship between capital investment and the interest rate, but assigned much more importance to the impact of "animal spirits" that affected investor confidence. So he doubted that the relationship between business investment and the real interest rate is stable and reliable enough to justify using monetary policy, in preference to fiscal policy, to stabilize the impacts of macroeconomic shocks.

So Keynes used neoclassical theory to understand the role of incentives in an economy that is, at its core, a historical process governed by, for example, beliefs formed out of the emotional dispositions of business decision-makers. To some, later identified as 'post-Keynesians', this was hailed as a 'revolution' in economics but to the main body of economists trained in neoclassical economics, it just seemed to be muddled logic. To them, using neoclassical constrained optimization to construct a 'general equilibrium' representation of the macroeconomy was seen as a logical way of representing the core functioning of an economic system. As time passed, this view prevailed. It became widely accepted that macroeconomics must be built up from neoclassical microeconomic foundations. But the only way that this could be coherent is to make very restrictive assumptions concerning aggregation. So a 'representative' neoclassical optimizing agent became the bedrock of macroeconomic analysis. From then on, it was inevitable that we would see 'rational expectations' play an increasing role and growing demands that the economy be represented as a general equilibrium system.[8] Post-Keynesians went in the opposite direction and were severely marginalised for doing so – their macroeconomic analysis became based upon an expansive accounting exercise (see Godley and Lavoie (2007)). In other words, it is very historical in content, relying heavily upon identities.[9]

There remained a mainstream 'New Keynesian' perspective on economic policy but, with the almost total victory of the neoclassical micro-foundations perspective on macroeconomics, this was eventually based upon what came to be known as the dynamic stochastic general equilibrium (DSGE) model pioneered by Woodford (2003). Such models are entirely theoretical but, with a series of carefully selected assumptions, they can be made to calibrate in an approximate way on historical stylised facts. However, being non-empirical models, they cannot be used to provide any precise guide to macroeconomic policy-making and, indeed, prior to the Global Financial Crisis, they offered little warning of what was to come. We can classify DSGE models as 'false Keynesianism' because they lack a proper treatment the historical process which Keynes' felt was so important.[10]

Many neoclassical economists and, of course, neo-Austrian economists, argue that macroeconomics is not a valid level of inquiry. So was Keynes just theoretically incompetent or playing political games? He has been accused of being both of these and worse. His main concern was not

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

[9] The most interesting contribution in the Post Keynesian literature, in relation to the focus here, is the distinction made between ergodic and non-ergodic systems when dealing with uncertainty. See Rosser (2015) for a critical assessment. .

[10] See Muellbauer (2016) for a critique of the DSGE model as a theoretical vehicle for understanding consumption.

theoretical but, instead, he offered a representation of the economy that he hoped would persuade governments that explicit policies had to be enacted to mitigate involuntary unemployment. So he did not bring about a theoretical revolution in economics, as Post-Keynesians assert, otherwise it would not have been so easy for the bulk of the profession to overturn and reject his analysis. Keynes struggled to know how to deal with the integration of history and neoclassical logic. Marshall had also set out to do this in Volume II of his *Principles* which he never completed (Foster (1993)). We can see now that both understood that they were dealing with what we would later recognise as a complex economic system that had coherent historical features. But, apart from fragmentary insights, neither knew how to provide a general representation of such a system, either at the microeconomic or macroeconomic level of inquiry. So we have to conclude that Keynes' *General Theory* is not general and, in the remainder of his life, he was less interested in gaining an enhanced understanding of how a complex economic system functions and more interested in, for example, promoting fiscal, rather than monetary, policy as a tool to stabilize business cycle fluctuations. Almost immediately after the publication of *The General Theory,* he even tolerated the general equilibrium representation of his macroeconomics offered by Hicks (1937). A theoretical revolution was not his primary goal.

Others would try to develop a general Keynesian theory as an alternative to the popular 'IS-LM' model derived from Hicks' model and the added contribution of Hansen (1953). For example, Leijonhufvud (1968), tried to conceptualize Keynes' model as one that acknowledges that the economy is in a continual a state of market disequilibrium in which people respond to quantity as well as price constraints. The general equilibrium structure is retained but with the Arrow-Debreu equilibrium outcome demoted to a special case. Barro and Grossman (1971), in an article that was very highly cited in the 1970s, expanded upon this theme. But these attempts to offer general theories with Keynesian features were very difficult to understand and teach and not amenable to econometric modelling. So they slipped into relative obscurity in mainstream macroeconomics, particularly after Barro (1976) abandoned the project in favour of a focus upon the role of rational expectations. Research of this kind did continue. Most notably, Negishi (1979) offered a modified general equilibrium representation that yielded Keynesian features by presuming existence of imperfect competition. But it had little impact. By then, mainstream macroeconomics in the US was becoming dominated by 'New Classical Economics' from which 'Real Business Cycle Theory' and its DSGE derivative evolved. Nobel Memorial Prizes would be won separately by macro-theorists, Robert Lucas and Edward Prescott, for their contributions in transforming macroeconomics into a body of consistent logic rather than the looser 'policy science' that Keynes had envisaged it to become.

So what happened to the consumption function? In modern macroeconomics, the neoclassical representation of consumption behaviour is largely uncontested. 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 behavioral microeconomics that challenged the validity of neoclassical micro-foundations have been widely ignored. Furthermore, as Deaton (2005) points out, it had been established that econometric tests using measures of permanent income did not provide support for Friedman's maintained hypothesis but this had little impact. 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 loss of 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 a period of comparative neglect where only variations on old and discredited theories and evidence were offered.

It could be argued that use of the logic of neoclassical economic theory caused the decline of interest in modelling aggregate consumption. But this is not necessarily the case: what changed was the context in which neoclassical theory is applied. Alfred Marshall explained to us 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 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 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. As we shall see below, getting ontology right can strengthen, rather than weaken, neoclassical economics.

3. Complex economic systems

The basic problem with modelling aggregate consumption expenditure as the outcome of a neoclassical constrained optimization problem by a 'representative' micro-agent is that such logic does not relate to the world we actually live in. It is a theory that makes 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 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. This is because timelessness permits an infinite choice of theories and associated hypotheses. For example, DSGE theorists have introduced limits on the completeness of knowledge, asymmetries in the availability of information and the presumption that quantifiable risk exists but, if timeless constrained optimization is retained at the theoretical core, none of these 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. [11]

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[11] This is still not widely accepted. There are significant numbers of macroeconomists who still hold that clever modifications of the DSGE model can result in a better representation of an actual economic system (Vines and Wills (2018)).

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, 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. 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 meso-rules exist that enable markets and contractual arrangements to operate securely and effectively. 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.

Marshall rejected, explicitly, the notion that neoclassical economics is about viewing the economy as the general equilibrium outcome of the optimizing decisions of identical individuals. In his day, this was associated with the logical structure devised by Leon Walras but he would have equally rejected the modern RBC and DSGE analytical representations of a macro-economy. He knew that neoclassical logic is timeless but viewed it as a useful approximation particularly when the time period is short, the knowledge set involved is narrow and the market arrangements are efficient and low cost. 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, convinced 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) concerning the functioning of a free market economy. 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?

Any economic system is an incomplete network of a particular class of connections between decision-makers. It is these 'economic' connections, not the individuals who constitute its elements, which generate value. This involves adherence to rules, both explicit and implicit and, because they are widely, but not completely, upheld, they are neither micro nor macro in nature. These are 'meso-rules' governing economic interactions (Dopfer, Foster and Potts (2004)). For a complex economic system to produce and consume diverse goods and services in highly predictable ways, it must exhibit order and this comes from prior commitments to explicit contractual rules and to beliefs that are mutually upheld. The auction market, so central to standard economics, is an arrangement to settle a contractual price subject to a set of accepted rules of conduct and, more widely, shared beliefs concerning acceptable human behaviour. Standard neoclassical economics, because it is a derivative of price theory, emphasises substitutions but, in point of fact, all the 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), Nooteboom (2002)). The order that exists in an economic system involves many economic habits and routines that do not involve ongoing optimization exercises in relation to movements in incentives. This is not 'irrational' because mutual adherence to meso-rules creates a connective order that yields economic value. What this means is that prior commitments bequeathed from history are important in economic decision-making.

But, as noted, a second key feature of a complex economic system and its sub-systems is openness to forging 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. 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 (1934/1911) 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"[12]. The extensive literature on innovation diffusion that followed focussed mainly on the supply side but, in a complex inter-connected economic system, growth cannot occur unless there is receptivity to new products on the demand side, as Smith (1776) 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.

4. Consumption behaviour in a complex economic system

So, any macroeconomic model of consumption must reflect 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., uncertainty. Within this dual historical process, the kinds of responses to incentives that economists commonly deal with are relevant. If these are strong, as is asserted in neoclassical economics, we should find supportive empirical evidence. But macroeconomic analysis that only involves aggregation of the behaviour of a neoclassical 'representative agent' (only a representative 'element' from a complex systems perspective) is unhelpful because the historical context in which decisions are being made is missing. In contrast, neoclassical theory can be very usefully applied if careful historical study, involving detailed investigations of the rules operative in any economy and how these have changed historically, has been undertaken (North (2005)).

So, we can provide a different way of modelling consumption expenditure. 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. So, consumption must, by definition, be, in part, historically determined in a complex economic system. This is not a new hypothesis. It was explained and justified by Brown (1952) but not embraced by mainstream macro-economists because of its disconnection with the emerging general equilibrium depiction of an economic system. Second, a component of consumption will be 'entrepreneurial' in states of uncertainty. 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 modern economic systems, this involves increasing the production and consumption of new types of goods and services, employing new ideas and skills (Foster and Metcalfe (2012)). When we look at consumption patterns across a whole economy, we witness thousands of products

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

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 core meso-rule set which is manifest in a combination of fundamental technological, organizational and/or operational innovations. Provided that demand is stimulated by marketing strategies, the result is a system-wide increase in novel consumption that offsets the tendency to stick routinely to past consumption patterns.

When we look at aggregate consumption in this way, what we observe cannot be just the outcome of the logical behaviour of a 'representative', or average decision-maker. Using historical data, we must be dealing with behaviour that is systemic – what we observe is a summation of measurable economic connections between decision-makers. These are determined by the set of meso-rules adopted. So, what we observe will be very different in, for example, a modern capitalist system and a medieval feudal one because the meso-rule sets are not the same.[13] The meso-rule set determining aggregate consumption is part of a prevailing 'culture'. The dominating one at the present time in the US we can label 'consumerism' which involves giving priority to the goal of maximizing both the quantity and quality of goods and services consumed. Consumerism has been present for a long time and was identified by, for example, Veblen (1898) amongst the 19th century elite. But it only began to diffuse strongly across the whole population of the US in the post-war era.[14] This diffusion has involved, for example: the introduction of modern notions of material 'progress'; an almost universal political preoccupation with maximizing economic growth; a shift towards individualism; 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. (Sklair (2012)). The diffusion of this meso rule set has not been rapid, it has unfolded over decades, and what it has done is not only increase consumption per capita but it has also increased the share of GDP devoted to consumption expenditure (Witt (2001)).

Now, a recurrent feature of any diffusion process is that it eventually reaches a limit. In the case of consumption, there is likely to be a maximum share of GDP that can be sustained by an economic system, given its particular meso-rule structure. Following Kuznets (1953) there has been a long tradition, particularly in industrial and evolutionary economics, 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. Here the goal is to see how much can be explained by variables derived from neoclassical economic theory in such a context, even though other non-neoclassical factors are likely to be important in determining consumption. In a sense, we are turning the clock back to the 1950s and adopting Friedman's preference for testing a precisely specified hypothesis rather than something promulgated from an inductive VECM exercise.[15] However, unlike Friedman, care is taken to model

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[13] 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. 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.

[14] The classic work that identifies consumerism as a growing mass culture in the post-war era is by Baudrillard (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 Hamilton and Denniss (2005).

[15] The pioneering study that relates to the approach here is Brown (1952) who analysed the impact of 'habit persistence' on consumption but not from a complex systems perspective. Muellbauer (1988) found econometric evidence, using US

in first differences to avoid spurious correlation problems. This we can do effectively because we have the luxury of fifty years of US quarterly data, from 1964-2016, at hand.

Following Foster (2017), we can represent aggregate consumption expenditure in the following way:

Expressing in natural logarithms:

$$lnC_t = lnC_{t-1} + (1-β) f(Δ_t...) + u_t \tag{1}$$

Where:

C is aggregate consumption expenditure (including durables)

f(Δ_t...) is a function which includes changes in hypothetical variables chosen using economic theory with lags in impact discovered empirically.

β is the degree of prior commitment to consumption expenditure.

u_t includes shocks to consumption expenditure that are non-systematic.

The higher is pre-commitment (**β**) the lower the scope for **f(Δ...)** factors to impact on changes in **C**. If **β** is unity there is full 'lock-in' to the past and, if u_t is random, we get a random walk in natural logarithms.[16] If **β** = 0, which can never be the case in a real world complex economic system because of the Second Law of Thermodynamics, we get:

$$ΔlnC_t = f(Δ_t...)] \tag{2}$$

This is the fully reversible, but non-existent, 'general equilibrium' case, specified in first differences. This special function **f(Δ_t...)]** includes only a set of neoclassical economic incentives and u_t drops to zero because there is no uncertainty in a fully reversible system where all errors can be instantly corrected. In the real world, 0<**β**<1, so there is a role for both prior commitment and neoclassical economic incentives that can modify consumption expenditure that, otherwise, would be the same as in the past. So, although we are dealing with a historical process operative over the past and into the future, the standard forces of, for example, demand and supply can still be operative, but restrained by prior commitments. As noted, only incentives that are system-wide will be operative and visible at the macroeconomic level of inquiry. The usually positive component of **Δ_t...** is growth in income, but if 0<**β**<1, its impact is moderated by prior commitments yielding a non-proportional relationship.

But, as has been argued, Eq. (1) is only part of the story. For convenience and simplicity, the simple Mansfield (1961) logistic diffusion curve is chosen to capture the diffusion of the culture of consumerism, where **α** is the diffusion rate and **K** is the limit that **C** can attain:

$$C_t = C_{t-1} + α C_{t-1}(1 - C_{t-1}/K) \tag{3}$$

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time series data, that habitual behaviour does exist - it is not 'rational' but, rather myopic, when viewed from an individual optimizing perspective.

[16] 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.

This implies that, although not known in advance, there is a finite number of ways that the expansion of trading and contracting connections due to the emergence of a core cultural shift can increase aggregate consumption expenditure.

Approximating $[(C_t - C_{t-1})/C_{t-1}]$ by $(lnC_t - lnC_{t-1})$ or ΔlnC_t, we get:

$$\Delta lnC_t = \alpha - \alpha(C_{t-1}/K_{t-1}) \tag{4}$$

K is given a time dimension in Eq. (4) because, although it can be stable over significant periods of time, it can change abruptly when a diffusion limit is reached and an old rule set is abandoned for a new one. This is dramatic, for example, in cases of fashion goods at the micro level of inquiry. Also, the K-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 with the US historically because of the adoption of a different set of meso-rules. Correspondingly, we would expect the diffusion limit to be higher in the latter.

So, in Eq. (1) and (4) we have distinct representations of flows of consumption expenditure, the former relating to the quantities of goods and services already being consumed and the latter relating to net growth when consumption expenditure on new goods exceeds the decline in consumption of old goods and services because of obsolescence and failure. Total growth in consumption expenditure now has two components with the Eq. (4) component multiplied by β to ensure that the two special cases can be derived:

$$\Delta lnC_t = (1-\beta)f(\Delta_t...) + \beta\alpha[1 - (C_{t-1}/K_{t-1})] + u_t \tag{5}$$

In Eq. (6) it is also acknowledged that the diffusion rate is not fixed and can be shifted up and down by responses to incentives, some usefully suggested by neoclassical theory. In this case, it is levels, rather than rates of change, that are relevant for inclusion in $f(z_t...)$. For example, if a fall in the real interest rate increases the rate of diffusion it will remain higher in subsequent periods.

$$\Delta lnC_t = (1-\beta)f(\Delta_t...) + \beta[\alpha_0 + f(z_t...)][1 - (C_{t-1}/K_{t-1})] + u_t \tag{6}$$

There is a fundamental difference here with the permanent income hypothesis. If proportionality is observed over long periods is not just because of neoclassical optimising behaviour into the future but because the positive effect of cultural diffusion on consumption offsets the non-proportional effect of prior commitment. As consumption grows towards its diffusion limit, non-proportionality becomes more pervasive. We can specify $K = \pi Y$ where π is the limiting fraction of aggregate income devoted to consumption expenditure. So we can rewrite Eq. (6) as follows:

$$\Delta lnC_t = (1-\beta)f(\Delta_t...) + \beta[\alpha_0 + f(z_t...)][1 - (C_{t-1}/\pi Y_{t-1})] + u_t \tag{7}$$

In order to populate $f(\Delta_t...)$ and $f(z_t...)]$ we can apply the logic of neoclassical economic theory.

First, there is an aggregate budget constraint (ΔlnY_t). The measure of income chosen here is not disposable income, as is normal in consumption studies. Although this makes sense when starting from individual decision-making, at the aggregate it is less so. From a systemic perspective, we are interested in the share of consumption in aggregate income, i.e., in GDP. National income accounting tells us that personal taxes are recycled immediately into the incomes of those employed

by government and the organizations from which government purchases products. The same applies to taxes on income from profits, interest and rents. Although the net effect is generally positive, GDP then moves very similarly to disposable income. However, it is less prone to measurement errors when estimated as aggregate expenditure. The modelling conducted in this study here confirmed that GDP explains much more than disposable income.

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.[17] However, we must distinguish between short and long term interest rates. Using neoclassical economic theory, the short-term real rate of interest 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. In this study, the real three month US bond rate is selected.

In contrast, neoclassical economic theory tells us that the long-term real rate of interest may impact positively on real consumption because, for example, when the rate of return on wealth rises, the income effect is likely to dominate the substitution effect in relation to saving, causing consumption expenditure to increase, either directly or because more credit can be secured against it. Here, the real ten year US bond rate is used in modelling. Of course, this is a very limited way of capturing wealth effects on consumption. A more comprehensive study would include, in particular, rates of return on equity and real estate.[18]

We can now expand Eq. (7) to take account of the key neoclassical variables that have been discussed. It should be noted that this 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:[19] All signs predicted by neoclassical theory are appended to the chosen variables and, with the exception of C_{t-1}/Y_{t-1} , the lags of impact associated with each variable are left open and subject to empirical discovery:[20]

$$\Delta lnC_t \;=\; (1\text{-}\beta)[\lambda_1\Delta lnY_{t...}\text{-}\lambda_2\Delta R_{Lt...}+\lambda_3\,\Delta R_{St...}] + \beta[\alpha_0 + \lambda_4 R_{Lt...}\text{-}\lambda_5\,R_{St}] \text{-} \beta\alpha(C_{t-1}/\pi Y_{t-1}) \;+ u_t \qquad (8)$$

Where: C is Real Consumption Expenditure (including durables), Y is Real Gross Domestic Product (GDP). R_S is the Real 3 Month Bond Rate and R_L is the Real 10 Year Bond Rate.[21]

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

[18] See Cooper and Dynan (2016) for a comprehensive review of how wealth effects have been modelled in macroeconomics. Also, Muellbauer (2016) provides a detailed explanation of how wealth and credit influence consumption, with evidence reviewed that supports the hypothesis that lower interest rates on long-term assets have lowered consumption, especially in Germany and Japan. He also found that the real short-rate has a strong negative relationship to consumption in the US case.

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

[20] $\alpha = [\alpha_0 - \lambda_4 R_{Lt...} + \lambda_5\,R_{St}]$ 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 stationary variables, weighted by their estimated coefficients.

[21] All data were drawn from 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
3-Month or 90-day Rates and Yields: Interbank Rates for the United States, Percent, Quarterly, Not Seasonally Adjusted

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 the long-run equilibrium solution.[22] 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 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 precisely 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.[23] However, this does not preclude short-term homeostasis operating along historical paths. For example, in markets with facilitating rules, we shall always see price movements rebalancing demand and supply.

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 economic system, as measured. Consumption is a component of GDP and, therefore, these variables are, necessarily, correlated. For example, since **Y = C + I + G + (X-M)** is a national income accounting identity, when the share of each component stays the same as Y grows, i.e., nothing happens, then we should observe **ΔlnY** = **ΔlnC**, i.e., if we regress them we should find an estimated coefficient of unity. From a systemic point of view, what we are interested in are the behavioural reasons why this estimate should deviate from unity, not zero. Direction of causality is not an issue since GDP and consumption are systemically linked.[24] What we are interested in is what causes the ratio of consumption to GDP to change. This is the relevant behavioural question.

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

[22] The pioneering study of consumption using this methodology is 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.

[23] 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.

[24] Spanos (2012) explains why the existence of an identity cannot be viewed in behavioural 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

5. The Results

In Table 1, the results of estimating Eq. (8) are reported over the period 1964q4 – 2016q3 using US quarterly data.[25] All the variables are significant, except for the real 3 month interest rate ($\Delta R_{St...}$), with the predicted signs on their estimated coefficients. The Durbin-Watson and LM tests indicate no evidence of serial correlation. In Chart 1, the actual to predicted plots are presented. The fit is excellent, particularly for a model explaining a stationary first-differenced variable.

Table 1

OLS Test of Eq. (8): 1964Q-2016Q3

Dependent Variable: ΔlnC_t

Variable	Coefficient	Std. Error	t-Statistic
Constant ($\beta\alpha_0$)	0.039	0.010	3.967
C_{t-1}/Y_{t-1}	-0.057	0.015	-3.369
ΔlnY_t	0.475	0.043	10.984
ΔR_{Lt-3}	0.214	0.089	2.413
R_{Lt-1}	0.451	0.106	4.270
R_{St-1}	-0.368	0.107	-3.428

Adjusted R^2: 0.52, F-statistic: 46.15, Durbin-Watson: 2.15 (Breusch-Godfrey LM prob. F(2,200) = 0.48)
Heteroskedasticity Test: Breusch-Pagan-Godfrey Prob. F(7,199) = 0.0004. Ramsey RESET Test t-statistic: 1.69.

Chart 1

Actual to Predicted Plots (1964Q4-2016Q3)

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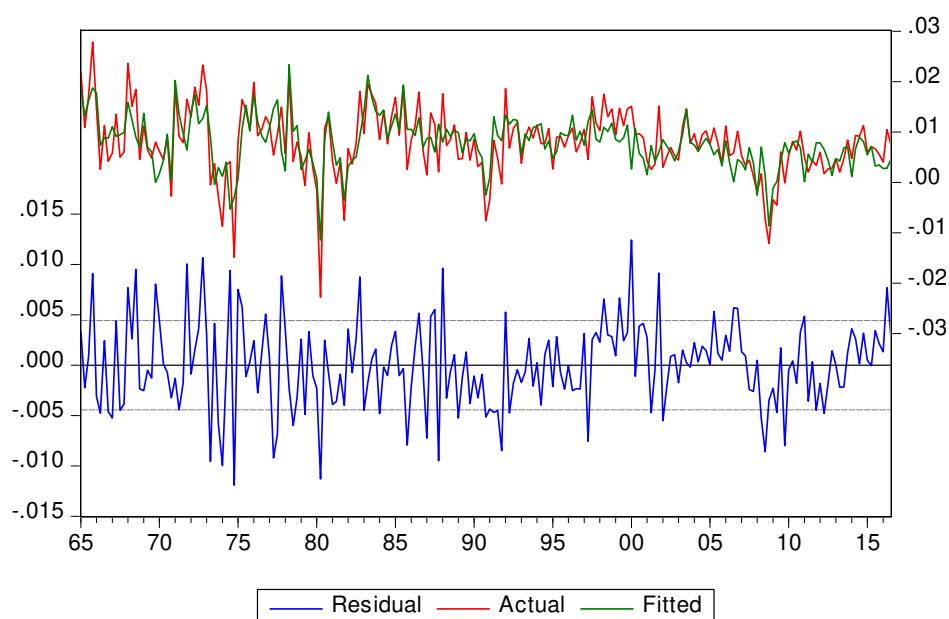
involves the use of an accounting identity that adjusts passively to other behavioural responses, there is no bi-causality to disentangle, only a systemic connection.

[25] The EViews 9.5 package was used in model estimation. Also, It should be noted that the sample excluded the last year of recorded data because it is commonly revised due to measurement errors and lags.

Chart 2

Recursive Least Squares Coefficient Plots: 1964Q4-2016Q3
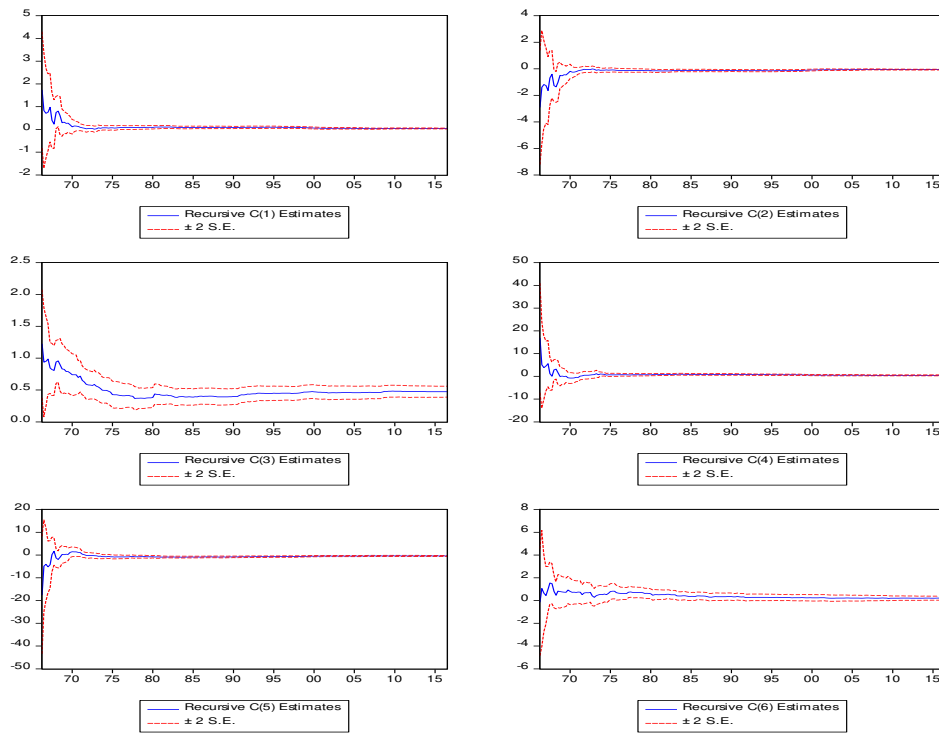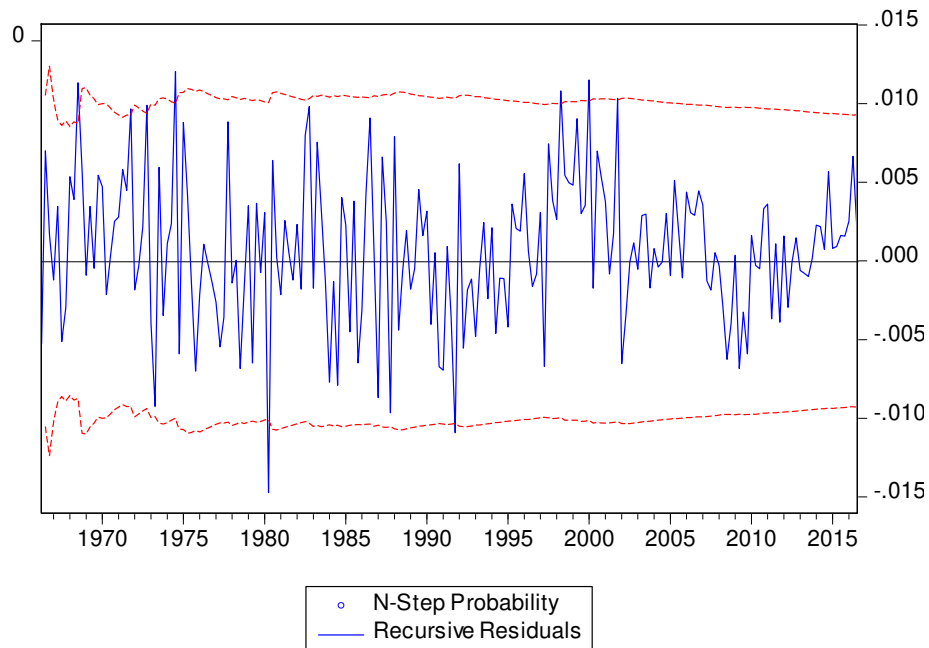

Chart 3

Recursive Least Squares N-Step

Forecast Test: 1964Q4-2016Q3

In Chart 2, the Recursive Least Squares (RLS) Coefficient Plots are presented. Once small sample size is exceeded, the coefficients are very stable. In Chart 3, the RLS N-Step Forecast Test results are presented.[26] These results further confirm stability although the observed long oscillations in the recursive residuals after the late 1980s suggest that other variables, in addition to the neoclassical ones selected, may be relevant. There is evidence for heteroskedasticity but this problem does not the bias estimated coefficients in the model. The Ramsay RESET test fails, but only marginally.

As specified, Eq. 2 allows for the impact of inflation via movements in variables that are specified in real terms. However, 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. In Table 2 the results of including both the inflation rate (ΔlnP_t) and its rate of change ($\Delta\Delta lnP_{t-1}$) are reported. The former relates to the diffusion component of Eq.8 and the latter to the existing consumption component. Both are significant and alter the other coefficient estimates somewhat. Most notably, inclusion of inflation effects lowers the estimated coefficients on both of the real interest rates, bringing them very close to each other with opposite signs. The other diagnostics reported above are very similar, but the Ramsey RESET Test now passed.[27]

Table 2

OLS Test of Eq. (8) plus inflation effects: 1965Q1-2016Q3

Dependent Variable: ΔlnC_t

Variable	Coefficient	Std. Error	t-Statistic
Constant ($\beta\alpha_0$)	0.057	0.010	5.335
C_{t-1}/Y_{t-1}	-0.080	0.016	-4.985
ΔlnY_t	0.478	0.042	11.409
ΔR_{Lt-3}	0.238	0.087	2.713
R_{Lt-1}	0.304	0.111	2.745
R_{St-1}	-0.324	0.108	-2.994
$\Delta\Delta lnP_{t-1}$	-0.206	0.092	-2.244
ΔlnP_t	-0.187	0.061	-3.052

Adjusted R^2: 0.553, F-statistic: 37.48, Durbin-Watson: 2.19 Breusch-Godfrey LM Prob. F(2,197) = 0.33. Heteroskedasticity Test: Breusch-Pagan-Godfrey Prob. F(7,199) = 0.0009. Ramsey RESET Test t-statistic: 1.57.

Although variables suggested by neoclassical economic theory are important, this model, at its core, is about prior commitments to existing patterns of consumption and the emerging adoption of novel spending in states of uncertainty. Thus, β and π are of key interest. If we make the neoclassical assumption that, in the ideal world of full reversibility (Eq. 2), consumption is proportional to income (λ_1=1), as in Friedman (1957), then we can infer an estimate of β = 0.522. This, in turn, enables us to estimate the diffusion rate, α_0 = 0.109. The calculated diffusion limit (π) is 71% of GDP, applying the

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[26] The only significant outlier is in 1980q2 when the rapid onset of a recession dropped growth to -8% (annualized).
[27] When inflation effects are included, 2008q4, a quarter when annualised economic growth was -8%, becomes an additional outlier in the N-Step RLS Plots.

minor adjustment to α_0 discussed above.[28] In Chart 4 we can see that the consumption to GDP ratio rose from a low of 0.57 in 1952, after the positive consumption reversal that occurred following the Second World War, to 0.69 by the end of 2016. So our estimate of π suggests that the ratio is now close to its diffusion limit.[29]

Chart 4

US Consumption to GDP Ratio 1965 – 2016
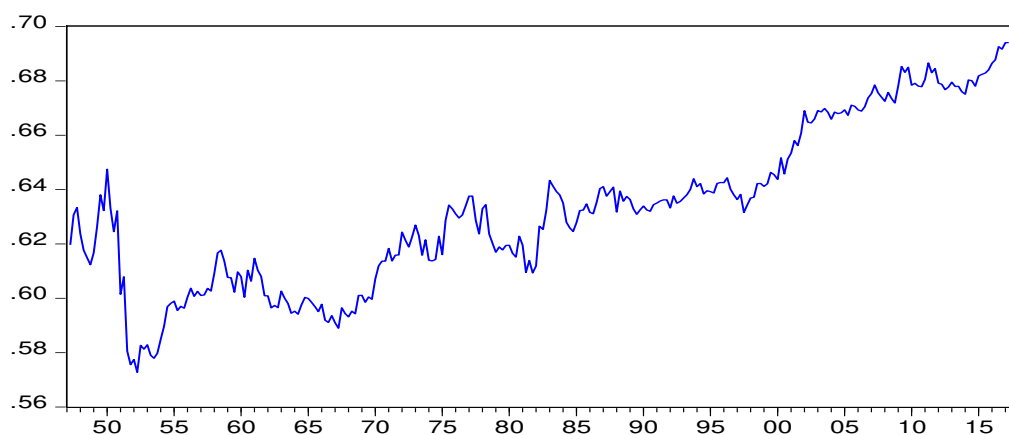
A notable feature of the results is the significance of real interest rate variables. The hypothesised interest rate level effects, included because of the diffusion of new consumption expenditure, are well determined. However, as noted, they have estimated coefficients of very similar magnitude with opposite signs. What this means is that, if they move together, there is little negative 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 a greater impact upon new business investment than on consumption, broadly in line with Keynes' thinking. The impacts of the rates of change of real interest rates are much weaker, with the real short rate insignificant and the real long rate only impacting after three quarters. This is consistent with the hypothesis that prior commitment has a strong grip on choice. However, the significance of the long rate and its rate of change does support, indirectly, the neoclassical view that wealth, and its capacity to be used as collateral, are important in consumption decisions, particularly those made with regard to expenditures on novel forms of consumption. Support is found for the Deaton (1978) hypothesis that neoclassical predictions concerning real decision-making have to be modified because of widespread inability to distinguish absolute and relative price changes. The estimated coefficients on inflation rate and its rate of

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[28] When the model is estimated using per capita data, the results are very similar. The explanatory power is only slightly lower and π is also slightly lower at 70%.

[29] This steady rise in the ratio of C to GDP has important modelling implications. A simple regression of lnC on lnGDP, 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.

change are negative and significant, suggesting that both pre-existing consumption patterns and novel consumption are affected. So, when inflation accelerated and peaked in the 1970s, the negative impact on consumption was at its strongest, consistent with the emergence of 'stagflationary' conditions, particularly since business investment intentions were clearly affected. The sharp deviation of inflation well above real interest rates in three bouts of stagflation is clear in Chart 5.

Chart 5

Inflation, US 3 Month (SHORT) and 10 Year (LONG) Real Bond Rates
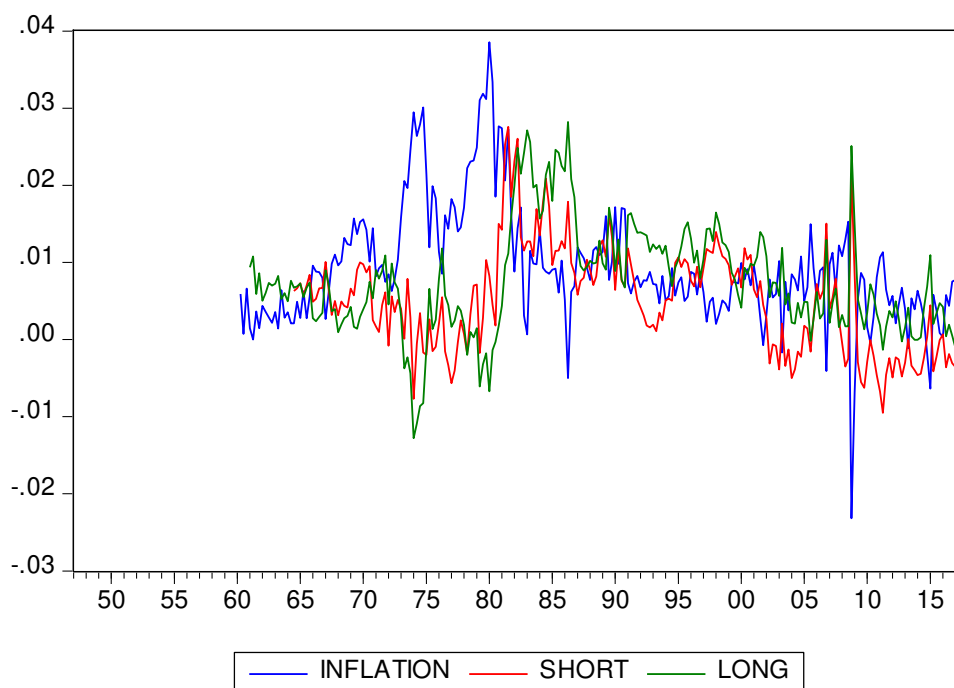
Another issue that arises is sample stability. Despite the fact that RLS estimated coefficients are very stable in Chart 2, it is still possible that that shifts in the estimated parameters occur in sub-periods, particularly when long series of data are involved. When the sample is split into two periods – 1964-1990 and 1991-2016 - the first period result is found to be similar to the whole period result, as might be expected given the very stable RLS plots in Chart 2. However, the real interest rate terms lost significance in the second period. If we examine Chart 5 we can see that there is much greater variability in real interest rates in the first period, compared to the second, when there is a downward decline. This is likely to have blurred any short period relationship at the macroeconomic level, particularly when using first differenced data for two possible reasons. First, it may be a statistical issue whereby smaller variations become dominated by random variations or, second, it

may be due to the fact that system-wide responsiveness to incentives weakens below a threshold.[30] This has implications for the impact of monetary policy on consumption decisions when real interest rates are low and relatively stable, as they have been over the past few years.

So there is support for the hypothesis that the positive impact of the diffusion of the culture of consumerism now close to zero. It suggests that it has become more difficult for innovation on the supply side to be translated into economic growth. Of course, income growth can still increase consumption growth, but non-proportionally. This tendency is now weakly offset by increasing novel consumption growth. So, even with exogenous impulses boosting GDP, for example, via expansionary fiscal policy, the reaction is likely to be lukewarm. This may be what we have begun to observe over the past decade in the US. The corollary is that larger and larger exogenous expansions of credit-financed budget deficits and/or business investment are necessary to keep consumption growing at a rate adequate to keep unemployment 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.

In complex systems, approaching a diffusion limit increases the probability that fundamental structural change will occur. How structural change will manifest itself is always difficult to anticipate. A higher share of consumption in GDP means a lower share in other parts of the macro-economy. In particular, a lower share of government outgoings and/or increases in budget deficits to maintain services, tend to render a government unpopular. Also, the decline in the proportion of personal savings out of income means that businesses come to rely more heavily on retained earnings for capital investment. Over the past decade, 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, because both short and long rates have been very low by historical standards, the results reported here suggest that net effect on consumption has been small and, therefore, quantitative easing has had a slow and weak effect on the economy.

6. Conclusions

It is established that viewing the US economy as a complex system yields a model of aggregate consumption that is strongly supported. This very simple model can be viewed as a combination of

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[30] 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%.

the old intuitions of Marshall, Schumpeter, Kuznets and Keynes, all formed before the economy was looked on, explicitly, as a complex system. Such a model is driven both by behaviour that adheres to the connective rules that prevail and contrasting behaviour that seeks out new connective rules that make new forms of consumption possible. The extent to which neoclassical variables explain aggregate consumption within a model that is explicitly historical in construction is explored. Such variables are found to explain a surprising amount. Placing them in a model that is historical in nature seems to lead to a better focus upon their role and importance, even when the model is kept very simple. This evidence supports the view that, even though it is fully accepted that individual decision-making is the fundamental building block of an economy, what we observe at the aggregate level cannot be just a reflection of constrained optimization logic applied to a representative decision-maker. Complex systems analysis tells us that this is an impossibility.

The evidence suggests that both long and short-term real interest rates impact on consumption decisions involving expenditure on new kind of goods and services but their impacts on existing patterns of consumption are weak. The significance of the long-term real rate of interest confirms what many neoclassical economists have argued: that wealth is important in determining consumption. It was found that the income elasticity of consumption is low, implying, in Keynesian terminology, a low marginal propensity to consume. Most of the 'action' comes from upward shifts in autonomous consumption because of the uptake of novel products that are made available by innovation diffusion processes on the supply-side. This is not a neoclassical prediction but one that flows from Schumpeter's vision of how growth takes place in a capitalist economy.

It is argued that a key driver of consumption and economic growth in the post-war period was the adoption of a culture of consumerism and an associated bundle of meso-rules. This gave rise to the hypothesis here that the ratio of consumption to GDP should rise, but not without limit. Strong empirical support is found for this hypothesis. So, at the core of the model specified is a long-term process involving the effects of wide-ranging socio-economic changes. The evidence suggests that this socio-economic diffusion process is approaching its limit in the US. What this means is that consumption growth is becoming dominated by an inelastic consumption response to changes in GDP because of prior commitments. With an income elasticity of just below 0.5, the impact of exogenous shocks on expenditure via multiplier effects is low. So approaching the diffusion limit means that, for example, any attempt to stabilise the economy using fiscal policy requires much larger spending or tax cutting, as well as accommodative monetary expansion. Equally, an

exogenous shock because of a surge in optimism and investment intentions, as has happened since 2017, is likely to have a smaller multiplier impact on GDP than in the past.

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. Lack of consumption growth inevitably slows business investment growth and this, in turn, slows economic growth.[31] But this has not occurred suddenly. It has been a tendency that has been present for a long time. For example, Gordon (2014) has observed a long-term slowing down of US growth for a range of reasons, mainly on the supply side. However, he does also argue that the slowdown in the expansion of consumption opportunities has contributed to the slowing growth that he observes and predicts in the future.[32] The evidence here suggests that it is likely to be the most important factor. As Adam Smith (1776) emphasised, growth ultimately depends upon the "the extent of the market".

Keynes understood this and urged governments to ensure that consumption is continuously stimulated, essentially by having governments engaging in active policies, both to stabilise fluctuations and to facilitate the development of new rule systems, for example, in the public provision of health, education and welfare, that would ensure that effective demand is expanded. There is little doubt that this strategy paid off as long as the consumer culture gained new adopters. But this expansion has had its costs. For example, core social institutions, outside markets – the clubs, churches, etc. – have been severely 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 the outcome of crisis and conflict. In this regard, some of the political polarisation that we have recently witnessed may be a symptom of the growth of consumerism coming to an end. However, as economists, we cannot offer any reliable predictions about the unfolding of such an uncertain process so we must turn to historians and political scientists for assistance.

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

[32] 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, is 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.

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