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The Role of Stabilization Policy in Sweden

A comparative welfare cost analysis

Abstract

In Robert Lucas' 1987 monograph, *Models of Business Cycles*, he attempted to measure the cost of business cycles in the post-war U.S. At a time when we are experiencing ever more costs associated with economic downturns, this essay endeavors to quantitatively answer what cost the average Swedish individual would accept to live in an environment free of business cycle fluctuations. That is, to live in a condition of steady consumption growth. Using Lucas' work as a starting point, we expand by drawing on more advanced economic research in the field to reach a relatively similar conclusion. Based on our results, an individual, on average, would not give up much in order to smooth economic cycles, at most they would forfeit a non-trivial 1 percent of lifetime consumption. We conclude that our results suggest no further governmental stabilization policy is warranted.

Keywords: Business cycles; Habit persistence; Stabilization policy

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Glossary of Terms

Exogenous shocks	Shocks formed outside of the model resulting in deviations from trend, shocks can be asymmetric or symmetric. For our purposes, shocks should be considered symmetric unless otherwise stated.
Fluctuations	These represent deviations from trend and are calculated by differencing an unstable time series from its stable counterpart. We use shocks and fluctuations interchangeably.
Habit Persistence	A class of utility functions typically incorporating some reference to previous characteristics entered in the utility function (e.g. consumption, labor, leisure).
Hodrick-Prescott Filter	A method of smoothing that is commonly applied with economic time series. It is particularly popular to derive trends from macroeconomic variables with cyclical movements. The resulting HP-trend reflects cyclical movement in a time series.
Linear, Deterministic, Stable Trend	These terms are used interchangeably throughout our thesis to describe perfectly predictable trend consumption or growth.
Persistence, Durability of shocks	Shocks can be transitory over time (short-lived affect) or persistent (possibly permanent). We use persistence and durability interchangeably to describe the effect of shocks over time.
Time-Non Separable Preferences	A class of utility functions where utility value depends on the order of consumption. Habit-persistence is a form of TNS preferences.
Utility Function , Specification, Preferences	The mathematical form or representation of how economic agents derive utility. We use the terms shown interchangeably.

1. Introduction

Throughout history, from thinkers such as Adam Smith, David Ricardo to Joseph Schumpeter and Robert Solow, economic theory has told us that as an economy can produce more goods and services, the welfare of its citizens will improve. Today's most common form of measurement for this is the annual percent change in real GDP (gross domestic product). Despite their differences of opinion in what creates economic growth, all of the above had one idea in common: growth is good. Governments have generally agreed with this concept and along with other virtuous aims such as improving healthcare and education, they have come to realize that in order to increase the welfare of their citizens, their economies must grow.

Since the Great Depression, governments and their associated policies have undertaken the challenge to chart the course for not only growth, but continued, stable growth. Policies have been developed to steer the economy towards a steady rate of economic growth, full employment and price stability. Achieving perfectly predictable growth has not been realized by any economy and economists generally agree that it is not possible. However, economists do believe that while deterministic growth may be unattainable, mitigating large fluctuations around growth is possible through the application of economic policy. The attention given to fluctuations by policymakers, in particular the largest historical fluctuation – the Great Depression, has resulted in a steady decrease in macroeconomic volatility since then. Currently, the economic conditions are requiring governments the world over to continue to apply sound economic policy preventing further deterioration of economies, an indication that stabilization remains an objective of governments.

If we are to believe what economic history has taught us, that growth and in particular, smooth growth, will increase the welfare of individuals, then there must be some cost, or relative loss of welfare among individuals if there is no or non-smooth growth. Almost a quarter century ago, Robert Lucas tried to answer this question by attempting to show what cost, if any, was truly being paid by the existence of business cycles (i.e. non-stable growth). Is governmental stabilization policy, or rather further stabilization policy worth the attention being accorded to it? Is the possible welfare loss of society large enough to warrant more action by governments to further stabilize growth?

Contrary to popular opinion, Lucas found that the welfare gains to society were almost non-existent and certainly did not warrant implementing further stabilization measures. The results created controversy around policy application and in academia as much time and effort had been spent attempting to achieve absolute stabilization, but Lucas' results implied potential gains were not worth further government action. Since Lucas' initial work, many economists have followed suit and attempted to find what the real cost of business cycle risk is.

The aim of the following thesis is to take Lucas' study to Sweden and determine what conclusions can be drawn. Since there have been many advancements and criticisms since

Lucas' 1987 publication, we use Lucas as a firm starting point to build upon but also incorporate additions from subsequent economists, as will be explained further in the paper. In accordance with Lucas' findings in the U.S., we do not find an overwhelmingly large cost to smooth remaining shocks to output. By closely mimicking Lucas' work and then by incorporating further advanced work in the field, we attempt to learn what the Swedish individual's welfare cost is to eliminate output growth fluctuations.

An abundance of research has been produced in this field over the last twenty years and there is still no consensus on the best method for determining these costs. Therefore our results should not be viewed as the absolute cost of stabilization policy. Nevertheless, they do provide us with further confirmation that the cost is small. To our knowledge this has been attempted once with Swedish data; inclusive in Salvato et al (2005) are findings of welfare costs associated with business cycles for the entire European Union (EU-15). We will discuss these findings in our results section.

This thesis aspires to answer the following questions: *What are the welfare costs of further stabilization policy (e.g. removal of business cycle risk) in the Swedish economy? Will they be similar to Lucas' original findings for the US?* It is our hope that this essay can create further conversation on what impact output growth shocks have on Swedish consumers.

The paper is structured in the following way: Section 2 reviews previous literature associated with this topic, Section 3 introduces the decomposition of the consumption time series, Section 4 discusses the various forms of our model and how we quantify welfare costs, Section 5 we present our results and lastly in Section 6 we offer a brief discussion on our findings. Readers should be aware that we may define certain aspects more than once to emphasize the use in our context. For remaining definitions and terms used interchangeably the reader is invited to consult the glossary.

2. Previous Research

While Lucas' original monograph provides guidance and direction for this thesis, we have attempted to incorporate more than just the original methodology. A quick glance at *Figure 1* indicates that consumption volatility in Sweden was not so different from that in the US. The implication of this is that we see it as reasonable to apply Lucas' methodology and deduce that costs should be similarly small. Referencing *Figure 1*, it would not be unreasonable to suggest that policymakers are able to achieve a more stable consumption path. We believe our results will reflect the rather mild volatility in consumption levels during the period in question. The research below provides a brief but important review of the aspects relevant to quantifying welfare costs of business cycles used in this thesis. Section 2.1 elaborates on Lucas' original argument, Section 2.2 discusses modifications of exogenous shock assumptions, and finally Section 2.3 explains developments in preference specifications.

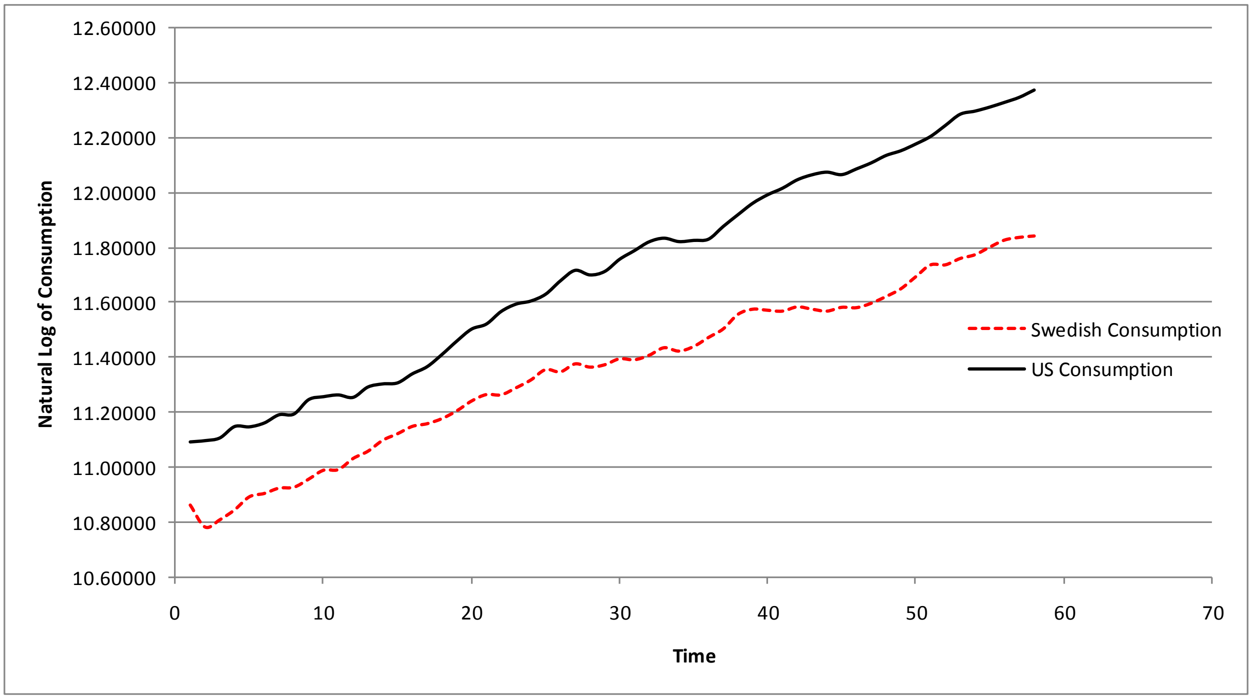

Figure 1. Log consumption for U.S. (1947-2004) and Sweden (1950-2007)

2.1 Lucas' Original Argument

The questions we will attempt to answer can most closely be tied under the subject of business cycle theory. Lucas (1987) applies business cycles as explained in Kydland and Prescott (1982), i.e. what is now referred to as real business cycle theory. Business cycles are explained by volatility in output around trend where prices are flexible so that markets 'clear' and we are left solely with determining how shocks to output cause business cycle fluctuations, e.g. recessions and booms. In this situation unemployment has little to no role.[1]

Business cycle theory and more specifically the study of the costs of business cycles has been around for quite some time. Robert Lucas' groundbreaking 1987 work, *Models of Business Cycles*, showed that fluctuations from stable growth in post-war America were of little concern to the individual and certainly did not warrant the attention given to them via U.S. law. Lucas' argument was motivated upon the common belief by policy-makers and in academia that business cycles resulted in welfare loss and subsequent legislative acts such as the U.S. Unemployment Act of 1946 stating: 'The continuing policy and responsibility of the Federal Government … to promote maximum employment, production, and purchasing power.'[2]

[1] Lucas p. 48.

[2] U.S. Unemployment Act of 1946

Governments spent much time and effort on monetary and fiscal policy to eliminate business cycle fluctuations.

As we cannot undo the past, it is impossible to know how much worse off individuals would have been, if at all, without previous governmental actions. However, what can be argued is whether or not we find the costs of further stabilization policy to be of any importance to individuals. Historical data shows that consumption is directly influenced by changes, large or small, in economic output. The case put forth from Lucas was how individuals' consumption of goods and services is affected by macroeconomic fluctuations. *How much in consumption would consumers forego in order to have predictable consumption?* To do this he made use of the traditional economics measurement of welfare. The higher an individual's welfare is, the better off he or she is. Welfare is measured as utility through the economics prism of utility functions. The relationship is a positive one; therefore, the higher utility one has the higher welfare one will also have.

It is important to mention that utility functions are intended to incorporate more than just agents' consumption behavior. For our purposes and Lucas' the primary interest is in implementing preferences based solely on consumption. Therefore, the welfare costs are based strictly on consumer preferences and we do not employ a full economic model to explain business cycle fluctuations. Accordingly, Lucas derives an individual's utility from their discounted lifetime consumption. Lucas concluded that American individuals would only concede 0.008 percent of lifetime consumption, a paltry figure. This has lead to much more work in the area with Barlevy (2005) offering a comprehensive review covering two decades of further exploration.

We can say only this; the diverse set of results reflects the variety of opinions on how agents derive utility, how these utility functions are parameterized and the assumptions on how shocks may be propagated across an economy. The costs range from fractions of a percent such as in Lucas' case to the extreme of Dolmas (1998) who finds a huge cost of 22.9 percent of lifetime consumption when using permanently persistent fluctuations and higher risk-averse agents. Ortok (2001) even states that reasonable parameter values in time non-separable preferences can lead to welfare costs of U.S. consumption fluctuations as high as 40 percent of total consumption. The range of welfare costs is evidence of the difficulty in determining an appropriate interpretation of preference form and the subsequent parameterization.

2.2 Assumptions on Shocks

Lucas' initial calculations were made under the assumption that consumption shocks are independent and identically distributed (i.i.d.) shocks around trend. This means that each shock has a transitory, one-period effect. But is this what happens in reality? For our purposes, one period is equal to one year. If there is a negative consumption shock, for example a liquidity shock seizing credit markets that make lending and borrowing prohibitively expensive[3]; is it likely that it will only have a one period impact? Or, is it more plausible for this to have a more lasting effect of some kind over time? Many economists, including Obstfeld (1994), Dolmas (1998), Tallarini (2000) and Otrok (2001) argue that it would. This is not to say that Lucas does not also believe in some durability of shocks or that the general consensus in the literature does not also comply with this belief. It may just be an oversimplification made by Lucas when calculating. One issue where little field consensus has been reached is how shocks are propagated across agents. All consumption shocks do not impact trend consumption in a similar fashion. Trying to measure each shock's impact is a difficult task. Atkeson and Phelan (1994) use theory to predict household level consumption paths and show that shocks might be asymmetrical across households. However, this type of model is highly complex requiring a large number of specific assumptions that can detract from the robustness of the results. Therefore, economists try to do the best they can by making more broad assumptions.

Obstfeld (1994) took the complete opposite approach of Lucas by using permanently durable consumption shocks. In doing this, he showed the distinction between increasing risk-aversion and intertemporal substitutability in measuring welfare costs. Instead of using an i.i.d. process, he employed a martingale process, which creates the effect of cumulative risks on dynamic welfare comparisons over time.[4] These permanent shocks that cumulate over time imply greater uncertainty in consumption than do i.i.d. shocks and therefore suggest larger welfare costs.

Dolmas (1998) offers, in addition to the original Lucas i.i.d. method, a variety of consumption processes that offer greater persistence of shocks. He makes use of business cycle fluctuations in consumption that are highly autocorrelated around a deterministic trend and fluctuations that are stochastic variations in the growth rate of consumption itself. In other words, is the growth rate of consumption constant over time with fluctuations around this trend, or do business cycle fluctuations cause the actual growth rate of consumption to change. Dolmas illustrates, like Obstfeld (1994), that welfare costs associated with business cycle fluctuations can vary significantly with changes in the consumption process. Using Lucas' specification, he finds that durability of shocks to consumption can increase the cost from 0.008 percent of consumption to 0.5 percent and using first-order risk-averse preferences, costs of about 1 percent with an i.i.d. process can increase to a dramatic 23 percent of consumption when stochastic fluctuations in the growth rate of consumption are introduced.

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[3] It is commonly known that complete credit markets allow consumers to perfectly smooth consumption to achieve the most utility – if markets are incomplete or non-functional this will have a direct impact on the ability to consumption smooth thus affecting consumption.

[4] Obstfeld p. 1473

2.3 Specification Changes

Lucas uses a standard isoelastic specification and assumes risk neutrality. Dolmas states, "the standard isoelastic specification…fails to rationalize the data on the variability of consumption growth and the structure of asset returns, particularly the level of the risk-free interest rate and the rate spread between risky and riskless assets."[5] The first-order risk aversion and habit persistence specifications have come closer to explaining the equity premium in the empirical data than the standard isoelastic specification. Habit persistence incorporates more than just increased risk aversion of individuals but also considers the ordering of consumption. In this way it more accurately models consumer behavior and as a result calculates a truer impact on consumption and welfare of macroeconomic fluctuations.

The introduction of habit persistence takes into account time non-separable (TNS) preferences. The most general idea being consumption smoothing, that individuals take into account some previous consumption level when determining their preferred present consumption level. Ferson and Constantinides (1991), Ljungqvist and Uhlig (2000) and Alonso-Carrera et al (2003) all make use of habit persistence functions. Ortok (2001) states that "the economic interpretation of preferences that are time-non-separable is that the utility that an agent derives from a consumption bundle today depends not only upon the characteristics of that bundle, but also upon the consumption bundles consumed in previous periods"[6], i.e. what they consumed in previous periods will impact what they would like to consume today. If preferences were time separable then individuals would not care about the order of choosing to eat filet mignon (higher welfare) or canned tuna (lower welfare). Applying TNS preferences means the agent always derives the highest utility from eating tuna first then filet mignon. TNS preferences can be further differentiated into how far backward looking they are. As Ortok describes it, every previous period of consumption affects the current period. However, one can also create TNS preferences that incorporate only one lagged period, two periods, etc. How the model incorporates these habit persistent preferences, if at all, is solely dependent on how the author interprets consumer behavior. As the large swath of economic literature on rational versus irrational behavior portends, there is no concrete answer regarding agent behavior in this context.

Habit persistence can be modeled in various ways. In most cases, the individual's utility is dependent on their own current consumption and some reference level of previous consumption. The reference level is what differentiates the model-type. With the internal habit persistence model the reference level is some form of past own consumption, whereas the external habit persistence model is based on an external average of consumption in the economy (Alonso-Carrera et al. (2003)). Again, the external habit model can be differentiated into two forms, the

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[5] Dolmas p. 653

[6] Ortok pp.64-65

‘keeping up with the Joneses’ or ‘catching up with the Joneses’ model. ‘Keeping up with the Joneses’ references an average consumption level at the economy’s current state in time and ‘catching up with the Joneses’ references a past average consumption level at the economy’s previous state. It is important to make this distinction as these variations determine how consumers might value consumption fluctuations.

With respect to measuring welfare costs, use of habit persistence models has only just begun in helping enlighten government policy, whereas they have become commonly used to better explain the equity premium puzzle. One early example of this is the work of Ljungqvist and Uhlig (2000). They attempt to obtain the optimal tax policy in an economy where agents derive utility from consumption and leisure with a ‘catching up’ habit persistence included in the consumption term. Preferences are applied as TNS between the current and previous periods. They show welfare levels due to taxation in three stochastic economies; laissez-faire, a social planner with optimal taxation and a steady-state taxation policy. Ljungqvist and Uhlig determine that a social planner state with optimal taxation provides the most welfare gains. They find a government that maximizes welfare ‘cools down’ an economy during booms through tax hikes and ‘stimulates’ during recessions via tax cuts. Both of these actions reverse private consumption decisions caused by the ‘catching up’ element of welfare. While our efforts do not revolve around tax policy, they do aim to determine if stabilization policy is necessary. Habit persistence utility functions may be found to help us better replicate individuals’ behavior, thereby revealing more accurate welfare costs.

3. Data Analysis

The data used in our analysis was obtained from Statistics Sweden. The analysis relied on aggregated annual private household consumption data (See *Figure 1*). We would have also liked to obtain individual household level data for comparative purposes but such data is not available. Additionally, we searched for data in more frequent intervals than annual consumption but we felt these time series, typically dating back to only 1990, were not sufficient to build a robust model. We obtain the time series of annual data dating from 1950 to 2007 using year 2000 for the base value and all values are in real terms. It should also be mentioned that our data series, representing 58 annual values, is approximately equal to the working lifetime of the average Swedish male. Finally, for our use the series was then transformed into the natural log of per capita terms.

Decomposition of the time series into trend and fluctuations around trend is fundamental to determining welfare costs as the trend represents the goal of further stabilization policy. The literature covers three ways of decomposing a time series such as consumption:

1) **Linear Trending** – Determining if linear trending is appropriate or reasonable requires one to note the movements over time. If the series appears to follow a steady trend over time, this method is usually reasonable.

2) **HP Trending** – A form of non-linear trending that is commonly used in the business cycle literature. This form of trending is explained in further detail below. Some economists argue that HP-trending is a more reasonable trending method because it reflects the notion that completely eliminating business cycles is unattainable.

3) **Hybrid Trending** – Hybrid trending methods might involve several methods depending on the movements of the series. In the event that the series contains an obvious break, they have sometimes been decomposed to reflect movement prior to and after the break occurs.

Our main focus with decomposition of the consumption series relies on the first method as one could argue that there is evidence that consumption (see *Figure 1*) has grown at a fairly constant rate over time. We used SPSS to isolate the trend component of the series using an ordinary least squares regression model.[7] This resulted in a trend component with 1.77 percent annual growth over our series. Fluctuations then consist of the difference between the trend component and the actual series. Even though Lucas originally smoothed according to a Hodrick-Prescott (HP) filter, we believe deriving costs associated with the most rigid stabilization policy – one achieving absolute certainty, would be the more interesting to explore given that this represents, in a sense, a ceiling on the costs. If consumers are indifferent between predictable consumption and unpredictable consumption or the cost is very small, then we would expect the cost to tend towards zero with a non-linear trend. We have chosen to apply the linear trend. As well, we have applied the HP-filter for comparison[8] within the habit persistence specification. Since the HP-filter is commonly used to de-trend time series, we will provide a brief definition and justification of its use.

The HP-filter is a method of smoothing time series to obtain a non-linear trend and we apply it under the conditions established by French (2001), specifically: their exists an I(2) trend in the data and the noise around trend is approximately normally distributed $\sim N(0,\sigma^2)$. We found support for the first assumption by simply running a regression on the second difference of the series. The null hypothesis of a unit root could be rejected at the 5 percent level. The second assumption is fulfilled by our assumption that shocks should be symmetric around trend implying a mean of zero and variance equal to that of the historical fluctuations around trend. In

[7] The trend component was derived from the model: $C_t = \alpha + \beta * T$, where T represents the time trend and β represents the annual growth rate. The linear trend is then the predicted regression line through the consumption series.

[8] Bear in mind, the HP-filter is used only for comparative purposes with our habit persistence specification.

addition to these two assumptions, the HP-filter requires a smoothing parameter that defines the sensitivity to short-term fluctuations; we applied a value of 100 that is consistent with data in annual frequency. The HP trend derived from our series is shown below in *Figure 2.*

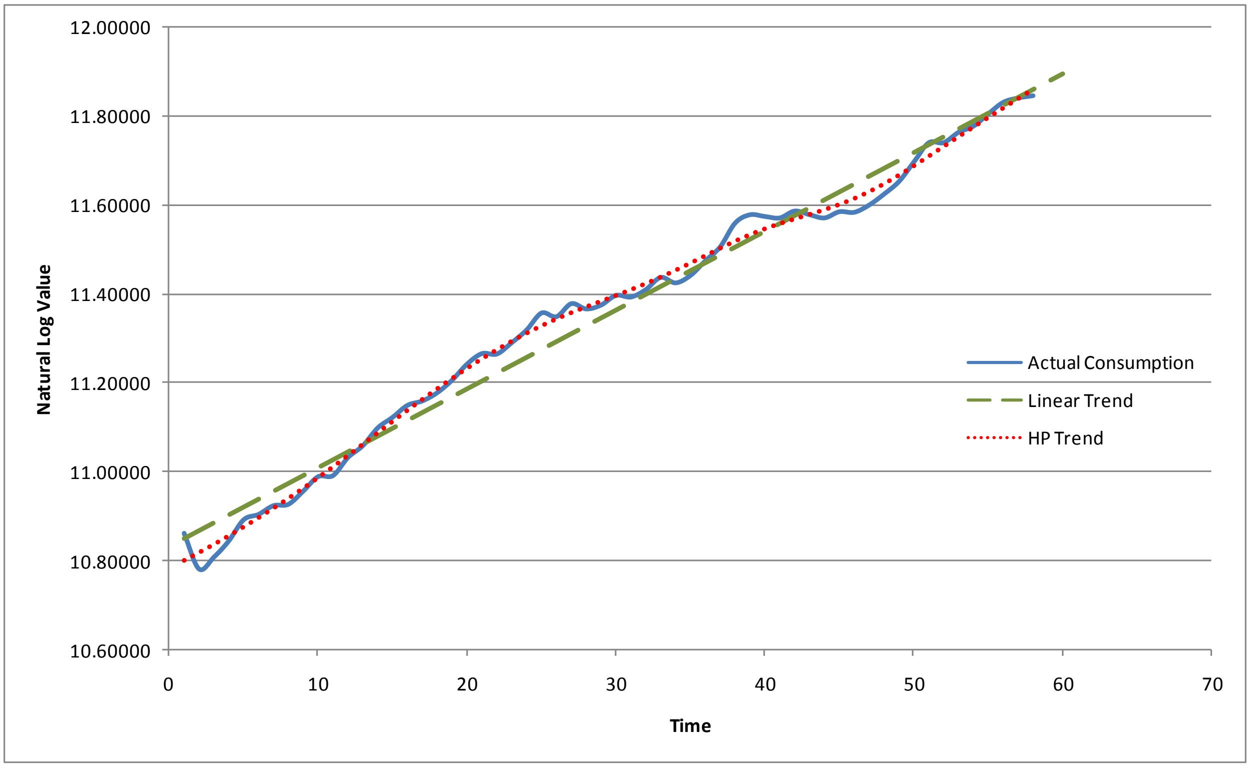

Figure 2. Linear trending and HP-trending derived from Actual Consumption

Once the smoothing techniques are applied to the data series, it is necessary to replicate the volatility around trend consumption. Lucas' original results indicate welfare costs to be minimal, thus we believe that relying on quantifying the welfare cost over many simulated paths using parameters derived from the empirical data builds robustness into the result.

4. Model

Below we explain the structure of our model and any underlying assumptions. Initially, we build a model to replicate Lucas' study directly and then we change two of the fundamental characteristics of Lucas' original study, the propagation of shocks and consumer preferences. These fluctuations around trend, as explained in the previous section, represent exogenous shocks that affect trend consumption – something to be considered an underpinning of Lucas' original work and also of this essay. We have chosen to linearly trend consumption as we believe if welfare costs are to be high, they will be highest with linear trend. If these costs are insignificant, then non-linear trending, something that more closely resembles the original time series, will not result in higher costs. Once this decomposition has been achieved, we replicate fluctuations around trend under the assumption that fluctuations are caused by shocks that are i.i.d. In the end we simulate 100 unique consumption paths[9] over 60 periods deriving variance from the original data set. As a result, the shocks generated in our study are consistent with the historical volatility of aggregate Swedish consumption. Once we have the unique consumer paths we can adjust assumptions of shocks and preferences to determine their effect on welfare. Below we cover the fundamentals underlying the shocks applied in this thesis, those that are strictly i.i.d. around trend and those that are persistent but non-permanent shocks.

Using aggregate consumption to model one representative agent requires exogenous shocks to affect consumption levels equally across all agents. There has been some interest on researching the welfare costs when a small decrease in aggregate consumption is caused by large declines in households as shown by Atkeson and Phelan (1994). To quantify results requires sophisticated models built on assumptions about certain households. For example, Ravina (2007) makes use of credit card purchases of individuals in California as a proxy for consumption when studying the effect of habit persistence on the average American. As this is beyond the scope of our essay, we have considered it as possible research to be conducted in the future.

4.1.1 Using I.I.D. Shocks

The research of literature above clearly indicates the vastness of opinions on how shocks are propagated across an economy. Lucas originally assumed that for consumption purposes shocks were strictly propagated as i.i.d. shocks from trend. In other words, a shock from one period did not have any impact or influence on the shock in the next period. Consumption can then be explained as the following process,

$$C_t^{ACT} = e^{\varepsilon_t} * C_t^{TREND}, \tag{1}$$

where C^{ACT} represents actual unstable consumption and C^{TREND} is the deterministic consumption path. We can further specify that $\varepsilon \sim N(0,\sigma^2)$. Measuring the variance around the linear trend allows us to generate a set of random shocks that conform to the size of shocks observed over the time period in question. The variance of the cyclical component derived from the linear smoothing is $\sigma_c^2 = 0.001581$ and for HP-smoothed is $\sigma_c^2 = 0.00037$. As expected, the variance of the cyclical component from HP-smoothing is considerably lower. Even though Lucas' treatment of shocks has been criticized, even two decades later it does not fly in the face of economic theory to treat shocks as Lucas has. For this reason, we have chosen to apply shocks as Lucas did

[9] We understand the limitations and the potential consequences of our sample size which was dependent on computational resources. As welfare costs tend towards zero issues of convergence become more acute requiring increasingly larger sample sizes.

as well as a method to introduce a degree of durability of shocks. Ultimately, our model relies on roughly 6,000 randomly generated exogenous shocks spread over the 60 periods. We feel this to be a robust enough number of shocks as welfare costs appears to stabilize before this point. However, it is possible to add in further shocks and simulations[10] into our model if additional simulations would provide a more robust calculation. This is something that should be considered in the further research when more complex preferences or assumptions are introduced.

4.1.2 Using I.I.D. Shocks with Durability

Recall that the actual consumption path was decomposed into the trend component and the volatile cyclical component. To simulate consistent consumption paths with durable shocks, an AR(1) regression was performed on only the cyclical component for the linear trend as shown by equation (3) and for the HP-trend. The resulting coefficients indicate the persistence of the previous period shock and the error term captures new exogenous shocks that influence consumption volatility. As before, we assume new exogenous shocks (e.g. ρ_t) to be normally distributed with mean of zero and variance equal to the variance of the fluctuations. Unique consumption paths consistent with empirical data are then created according to the following calculation,

$$C_t^{ACT} = e^{\varepsilon_t} * C_t^{TREND}, \tag{2}$$

where the residual is now described as,

$$\varepsilon_t = \beta * \varepsilon_{t-1} + \rho_t \,, \tag{3}$$

For the fluctuations derived from linear smoothing, we observe $\beta = 0.866211$ and from the HP-smoothed fluctuations $\beta = 0.393111$. The coefficients indicate that consumption volatility derived from linear smoothing more closely follows a random walk and the fluctuations take longer to return to trend than from HP-smoothing. When shocks become permanent, as explored by Dolmas (1998) and Obstfeld (1994), it is important to recognize that this also affects the *trend* itself and not only fluctuations around trend. Obstfeld (1994) considers the case when consumption deviations follow a martingale process, making shocks permanent and subsequently

[10] It is important to remember that a simulation consists of the entire consumption stream whereas shocks affect consumption on a period by period basis. Adding more shocks must first consist of adding more consumption paths in their entirety.

shifting trend consumption. His results increase the welfare costs compared to Lucas' original findings as shocks take on a life of their own. It is intuitive to understand that as β approaches unity the process is more likely to contain a unit-root and therefore will be non-stationary. In this case, we would have to consider shocks as permanent and they will not return to trend. The coefficient obtained when the series is linearly-smoothed is close to unity and represents very durable shocks but, in our opinion, not permanent. The cyclical component derived from this trending method might be considered to be weakly stationary but we do consider that it returns to trend, albeit slowly.

It is now possible to generate new consumption paths making use of the durability coefficients while using the same shocks as utilized in the i.i.d. process. An example of the two different types of consumptions paths can be seen in *Figure 3*.

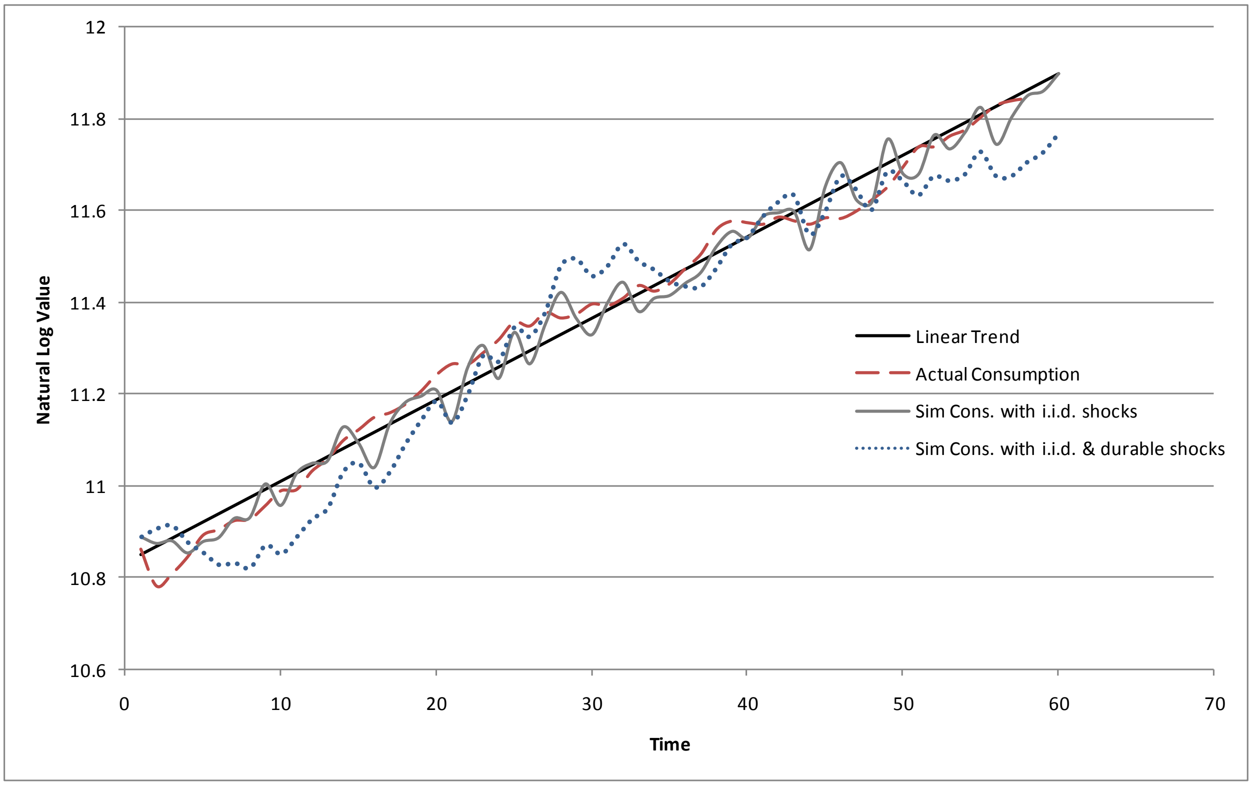

Figure 3. Linear trend derived from actual consumption with simulation consumption paths

4.2.1 Lucas' Original Specification

There is a rich literature regarding the specific form of preferences that can be used to calculate welfare costs. The variety of preferences and/or assumptions, discussed earlier, leads to a diverse set of results that range from confirmation of Lucas' original findings, to upwards of 22.9 percent of lifetime consumption as seen in Dolmas (1998). Some of the literature argues that Lucas' simplistic preferences specification is inconsistent with empirical data by abstracting away rigidities. In addition to this criticism, Lucas assumed that the representative agent was risk neutral, assuming a risk-aversion value of $\gamma = 1$. This also allows utility to collapse to log consumption but assuming risk-neutrality makes the preferences difficult to reconcile with empirical data where agents appear to operate with higher risk-aversion. While we have chosen to apply the same utility function as Lucas, we have assumed a greater degree of risk-aversion that is more consistent with the observed data. Choosing slightly higher risk-aversion parameters should increase welfare costs as agents dislike volatility more but we believe it is necessary given the risk-related choices agents make.[11] We chose to use risk aversion values of $\gamma = \{1.5, 5, 10\}$ that are consistent with economic literature such as Obstfeld (1994) and Dolmas (1998) who argue that higher risk aversion values are also plausible. Borrowing directly from Lucas, the constant relative risk aversion (CRRA) utility function is repeated here:

$$U(C_t) = E_0\left[\sum_{t=0}^{\infty} \beta^t \left(\frac{{C_t}^{1-\gamma} - 1}{1-\gamma}\right)\right] \tag{4}$$

We quantify the welfare cost of further stabilization policy by applying the above utility function to both consumption paths. The equations are set equal to each other and the welfare cost is determined by introducing a variable that equalizes the two equations. The variable is equal to $(1+\Delta)$ as shown below in equation (5). The welfare cost (i.e. Δ) is then obtained by averaging the welfare costs across all of the simulations.

$$\sum_{t=0}^{\infty} \beta^t \frac{[(1+\Delta)C_t^{TREND}]^{1-\gamma} - 1}{1-\gamma} = \sum_{t=0}^{\infty} \beta^t \frac{[C_t^{ACT}]^{1-\gamma} - 1}{1-\gamma} \tag{5}$$

4.2.2 Habit-Persistence Specification

In addition to applying Lucas' original utility function, we decided to incorporate developments in utility functions in the more recent literature. Research of the literature has shown that despite varying the underlying preferences and assumptions, Lucas' original result does not change substantially. Nonetheless, we decided to apply another utility function that has become quite popular in recent literature. We introduce a utility function that incorporates habit persistence, which is utility that depends not only on consumption in the current period but also on

[11] As evidenced by the risk-premium puzzle found in empirical data.

consumption in previous periods. The usage of habit persistence preferences can contain many nuances, mainly how and to what degree the past influences the utility today. Given that we are using an aggregated time series and assuming homogenous agents, we do not make a distinction between agents referencing their own past consumption or aggregate consumption.[12] Mehra and Prescott (1985) have used habit formation preferences to better explain the equity premium puzzle. In comparison, when using preferences without habit-formation, this has typically required very high risk-aversion parameters to explain consumption behavior. It has also been used to explain characteristics of business cycles. Accordingly, given the ability for habit formations to explain consumption behavior more accurately, we have introduced a form for comparison to Lucas' original work. We anticipate that applying habit persistence preferences would increase the welfare costs of consumption volatility. Habit preferences imply consumers prefer consumption that follows a monotonically increasing deterministic process over one whose movement is not predictable.

We chose to incorporate habit preferences using a specification provided in Ljungqvist and Uhlig (2000). We decided on this representation of habit persistence because it is intuitive to understand how a consumer derives higher marginal utility from increased consumption in the future if more is consumed today. In our application of the specification, we have chosen to exclude the labor term found in the original specification as it is unnecessary for our purposes and excluding the term will not have an impact on the results.

$$U(C_t) = E_0\left[\sum_{t=0}^{\infty} \beta^t \left(\frac{(C_t - X_t)^{1-\gamma} - 1}{1-\gamma}\right)\right] \tag{6}$$

As shown in (6), habit persistence enters the utility function via X_t and the remaining parameters, β and γ are the discount and risk-aversion parameters. Ljungqvist describe X_t as a geometric average of past per capita consumption. We apply the exact same definition in this paper where X_t is defined formally as,

$$X_t = (1 - \emptyset)\alpha C_{t-1} + \emptyset X_{t-1}, \tag{7}$$

with $0 \leq \phi < 1$ and $0 \leq \alpha < 1$. When applying Lucas and Ljungqvist, we decided to parameterize our utility functions with plausible values that already have justification in the economic literature. We had no indication or reason to believe that deriving Swedish-specific parameters

[12] Recall the earlier discussion regarding habit persistence implementation.

would be necessary. The parameters shared by both specifications, the discount rate and risk-aversion are set to $\beta = 0.98$ and $\gamma = \{1.5, 5, 10\}$. The second specification introduces two new parameters, one that weights the previous consumption period and all other previous periods and the other which determines the intensity of the habit formation. We parameterize by borrowing from Ljungqvist applying $\phi = 0$ and $\alpha = 0.8$. This is the simplest characterization of the reference level by having agents form habit preferences by only referencing the previous period. For our use, the above definition simplifies into,

$$X_t = \alpha C_{t-1} \tag{8}$$

which we substitute directly into the specification to obtain:

$$U(C_t) = E_0\left[\sum_{t=0}^{\infty} \beta^t \left(\frac{(C_t - \alpha C_{t-1})^{1-\gamma} - 1}{1-\gamma}\right)\right] \tag{9}$$

The above specification is the one used in this essay to calculate welfare costs. As one can see, we can collapse the above specification in Lucas' original utility by allowing agents to place no value on previous consumption, i.e. $\alpha = 0$. For this reason, we apply only one reference level, one of higher intensity that should provide a good idea of how habit formation affects the welfare costs. As this reference level is lowered, the results will tend towards those derived from using Lucas' constant relative risk aversion utility. To derive the welfare cost using the second specification, the equation below was solved.

$$\sum_{t=0}^{\infty} \beta^t \frac{(C_t^{ACT} - \alpha C_{t-1}^{ACT})^{1-\gamma} - 1}{1-\gamma} = \sum_{t=0}^{\infty} \beta^t \frac{([(1+\Delta)C_t^{TREND}] - \alpha C_{t-1}^{TREND})^{1-\gamma} - 1}{1-\gamma} \tag{10}$$

By solving the above equation for $(1+\Delta)$, we can determine what the cost is in consumption that the representative agent must sacrifice in order to be indifferent between the two consumption paths. The results are provided by solving for Δ directly. Before considering the results, we establish the following that applies to both specifications:

1) If $\Delta = 0$ then the consumer is already indifferent between predictable and uncertain consumption.

2) If $\Delta < 0$ then deterministic consumption must be decreased (i.e. actual consumption must be increased) in order for the consumer to be indifferent between predictable

and uncertain consumption. The value of Δ represents what the consumer is willing to give up in order obtain stable consumption

3) If $\Delta > 0$ then the consumer derives greater utility from uncertain consumption over predictable consumption. Stable consumption would have to be increased to make the consumer indifferent.

5. Results

5.1 Lucas

	CRRA with Linear Trend		
Gamma Value	**1,5**	**5**	**10**
Costs with persistent shocks	-0.774%	-0.881%	**-1.018%**
Costs with i.i.d. shocks	-0.136%	-0.170%	-0.216%

Table 1 – Welfare Loss when moving from Stable to Unpredictable Consumption with Constant Relative Risk Aversion (CRRA) Utility Function (ref. equation (5)).

We begin with our results for the Lucas section of our work. In only replicating Lucas' utility function it is understood that directly comparing our results with his would be like comparing apples to oranges. This goes without mentioning the obvious fact that he uses post-war U.S. data through 1987 and we bring the experiment to Sweden and for a slightly longer timeframe, albeit with annual versus his quarterly data. Therefore, with strong reservations, we may compare the average Swedish individual to the American equivalent because, like Lucas, we use an i.i.d. process for the first set of our results but for these we do not employ the HP filter for trending our consumption path.

The standard deviation Lucas calculates for actual consumption around the HP trend is 1.3 percent whereas our standard deviation around the linear trend is 4.0 percent. This automatically signals that we should expect our welfare costs to be higher than what Lucas found. It seems reasonable as the HP trend is non-linear and does not implicate such a drastic stabilization of output or consumption.

So, how do our results measure up? As expected, making use of a linear trend, i.i.d. shocks and Lucas' utility function, equation (4), we come to a much larger cost. The average welfare cost we calculate over 100 trial runs is 0.136 percent of lifetime consumption with a risk aversion of 1.5, 0.170 percent given a risk aversion of 5 and 0.216 percent with a risk aversion of 10. These numbers tell us that an individual would be willing to give up between 0.136 percent and 0.216 percent of lifetime consumption, given their level of risk aversion, in order to live in an economic environment where GDP growth would be constant at 1.77 percent per year over their entire life instead of the current situation of business cycle booms and busts. We expect to see this rise in cost as the risk aversion parameter is increased. Increasing the value of the parameter infers an agent is less tolerant of consumption volatility. As a result, increasing risk aversion should drive a wedge between the trend utility and utility based on the more volatile, simulated actual consumption path. In the i.i.d. set, this outcome is clearly seen as costs increase by 14 percent when the risk aversion parameter goes from 1.5 to 5 and increases by a further 16 percent when the parameter is raised to 10.

This can be loosely compared to Lucas' U.S. result using i.i.d. shocks of 0.008 percent of lifetime consumption to move from an actual consumption path to an HP smoothed consumption path. Our linear trend results are in line with our expectations. We expected to find a small welfare cost to individuals, but larger than Lucas' HP trended results. Given the smaller variance from trend with the HP filter, we would expect a smaller cost with his method. Lucas' results show that this number may be incredibly close to zero, but due to the assumption that individuals prefer consumption smoothing over time, we do expect some cost.

Using a durable shock method, the welfare costs are substantially higher. For given risk aversion parameters of 1.5, 5 and 10, the method produces costs of 0.774 percent, 0.881 percent and 1.018 percent respectively. These are between roughly four and five times larger than their i.i.d. equivalents. What may be the cause of this? The data shows that the volatility of the persistent shock deviations is 191 percent greater than the volatility of the non-persistent shock deviations. As this becomes translated into welfare costs it is logical that we see a much greater cost incurred by persistent shocks as opposed to i.i.d. shocks. Additionally, the greater cost of persistent shocks should be attributed to the fact that they take longer to return to trend than i.i.d. shocks.

5.2 Habit-Persistence Results

The results for the habit-persistence specification can be found in *Table 2* below. The results show welfare costs associated moving from volatile to predictable consumption.

	Habit Persistence using Linear Trend		
Gamma Value	**1,5**	**5**	**10**
Costs with persistent shocks	-0.235%	-0.370%	-0.563%
Costs with i.i.d. shocks	-0.120%	-0.331%	**-0.634%**

Table 2 – Welfare Loss when moving from Stable to Unpredictable Consumption (ref. equation (10)).

After exploring the original work of Lucas for Sweden's economy, the results above show incorporation of subsequent advances related to consumer preferences and underlying assumptions. As expected, as consumers become increasingly risk-averse, the welfare cost associated with moving from stable to unpredictable consumption becomes larger. Consider the cost associated with persistent shocks for an agent with risk-aversion equal to 5, the interpretation should be that this agent is willing to sacrifice 0.37 percent of lifetime consumption to move to deterministic consumption. The definition of habit-persistence tells us that marginal utility is increasing with consumption increases relative to the previous period. The expectation then is that shocks that are i.i.d. are not influenced by previous shocks introducing more consumption volatility. High risk-averse agents with habit formations seem to view these shocks as being more costly than shocks with durability. The largest cost calculated was to be 0.634 percent of lifetime consumption for these high risk-averse agents suffering i.i.d. shocks. Even though the results represent a small fraction of lifetime consumption, they are still considerably higher than Lucas' original calculation. The results using the linear trend, we anticipated that these represent the costs associated with government policy that is able to achieve deterministic consumption growth. Agents with low risk-aversion exposed to i.i.d. shocks appear to be somewhat indifferent between stable and unpredictable consumption where a cost of only 0.12 percent was seen. Introducing durability into shocks doubles the cost for these agents. It is also interesting to note that as agents become more risk-averse, the cost of shocks changes from durable shocks having higher costs to i.i.d. shocks having higher costs. A possible reason for this is that for high risk-averse agents, if shocks must occur, they prefer shocks that are smoothed over time, as is the case with durable shocks.

	Habit Persistence using HP-Trend		
Gamma Value	**1,5**	**5**	**10**
Costs with persistent shocks	-0.001%	-0.035%	-0.082%
Costs with i.i.d. shocks	-0.011%	-0.058%	-0.125%

Table 3 – Welfare Loss when moving from Stable to Unpredictable Consumption (ref. equation (10)) with HP-trend.

The results for HP-trend were provided for comparative purposes. As explained above, trending using the HP-filter results in a non-linear but smooth trend of a time series. *Figure 2* provides a graphical representation of the HP-trend derived from our consumption series. From the image, one can see that the HP-trend follows movement in the consumption series more closely than the linear trend. A direct result from this is that the variance of the cyclical component around the HP-trend is lower and the fluctuations expected to be more stationary. Thus, the results should reflect this and from the results table, it is easy to see that the costs associated with moving from HP-trend to unpredictable consumption are significantly lower than using the linear trend. Lucas' original results incorporated an HP-trend and from the table above, there is only one result that is lower than Lucas' derived cost of 0.008 percent and that is using HP-trended growth with persistent shocks and a risk-aversion value of 1.5. However, it should be noted that unlike the cost comparison of shocks with linear trending, agents strictly prefer durable shocks when the series is HP-trended. The reason for this is that durable shocks are smoothed across time.

Overall, the results for both Lucas' original specification and the habit-persistence specification are in line with expectations and confirm Lucas' original findings. Lucas concluded that, in the

U.S., further attention to stabilization would be of little concern to consumers. Suffice it to say that from our calculations there does not seem to be reason to believe that Swedes attach a high cost to consumption volatility. In a comparable study by Salvato et al (2005) concerning business cycles in Europe compared to the U.S. found similar welfare costs for Sweden but higher costs for other European countries. Their study found welfare costs above 2 percent using linear trending and a risk aversion value of 5 for France, Spain, Portugal, and Greece. One interesting consideration is - if shocks are propagated across these economies in the same way, will consumption volatility be affected differently? Even though the consideration is beyond the scope of this essay, we do find supporting evidence that further stabilization costs are low in Sweden as they are in the U.S.

6. Discussion

Though we were able to replicate small welfare costs for Sweden as Lucas originally did, it is important to note that there has been no consensus on the welfare costs associated with stabilization policy. Many economists have debated Lucas' original result applying different theories and assumptions deriving a diverse set of results but with little agreement on whose are right. So, do consumers care about volatile consumption? The answer is most likely, yes. However, Lucas' original result seems to imply that the time spent on stabilization by policymakers could probably be better spent on areas where consumers appear to attach higher costs, such as a change in the trend rate of growth. Lucas exemplified by suggesting a welfare loss of 20 percent of lifetime consumption if consumption growth was reduced from 3 percent to 2 percent. However, it is important to remember that the period in question represented fairly benign cycles around trend – this may not be the case for the future. Allowing for larger or longer lasting shocks, or possibly even shifts in trend, may result in consumers attaching a much higher cost to consumption volatility. It could also be argued that past stabilization policy resulted in these cycles becoming more benign over time, effectively meaning governments and economic institutions were achieving more predictable growth but it is no easy task to quantify the direct result of policies to determine their ultimate effectiveness.

There is also another area of literature of which we did not touch on much. Some economists have argued that stabilization policy itself may affect trend consumption. This is somewhat different from permanent shocks and alludes to a break in consumption growth as a direct result of the policy. Considering the impact of policy on the consumption trend itself has been covered by Barlevy (2005) and has implications concerning investments, capital accumulation, and how agents react to government's reduction of uncertainty. As mentioned before, building models to answer these kinds of questions are generally quite involved and are outside the scope of this paper.

Given the variety of assumptions we have made we find a welfare cost to the Swedish individual of between approximately 0.01 percent and 1.2 percent. Despite our expectation that habit persistence preferences would increase welfare costs, this was not the case. This is because the habit persistence implies that individuals prioritize smoother consumption over being on trend, whereas when replicating the utility function in Lucas, they prefer to remain as close to trend as possible. In any case, relatively small costs to achieve a smoothed business cycle over time. Therefore, as Lucas and many others before us who have studied these costs in a variety of economies, we would find it hardly worthwhile for governments to implement further stabilization policies. Of course, this only takes into account one side of the argument. What would these additional stabilization policies cost to implement? Surely if this cost was lower than what individuals would endure to achieve smoothed growth, they should be implemented. This is a question we do not currently have an answer to and it lies outside the scope of this paper. However, we would assume that these polices would not come at zero cost and are likely to be quite expensive.

What starts as a seemingly easy question quickly turns into a complex set of assumptions and many nuances regarding agent behavior. This is evidenced by the many assumptions that were made. There is little consensus on the propagation of shocks or agents' behavior in the economic literature. As economists converge on specifications that replicate agents' behavior and better shock theory develops, it will be possible to quantify truer welfare costs. Until such a consensus is reached, and given the scope of the problems associated with these achievements it is unlikely to be seen in the near future, we can only estimate cost using the tools available today. We chose individual preferences and shock durabilities that we believe to be reasonable and relatively accepted in the literature. It is already understood that there is scope for criticism of our work in this light. However, given our timeframe it was only possible for us to choose parameters we thought are sensible and justify our choices as best as we can.

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