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THE COST OF BUSINESS CYCLES AND THE BENEFITS OF STABILIZATION: A SURVEY

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ABSTRACT

This article reviews the literature on the cost of U.S. post-War business cycle fluctuations. I argue that recent work has established this cost is considerably larger than initial work found. However, despite the large cost of macroeconomic volatility, it is not obvious that policymakers should have pursued a more aggressive stabilization policy than they did. Still, the fact that volatility is so costly suggests stable growth is a desirable goal that ought to be maintained to the extent possible, just as policymakers are currently required to do under the Balanced Growth and Full Employment Act of 1978. This survey was prepared for the Economic Perspectives, a publication of the Federal Reserve Bank of Chicago.

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The Cost of Business Cycles and the Benefits of Stabilization: a Survey*

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Introduction and Summary

During the last half century, policymakers in the U.S. have consistently sought to chart a stable course for economic growth. The importance accorded to this goal does not merely owe to the views of select policymakers, but is mandated by law. In 1946, Congress passed the Employment Act, which encouraged the federal government to adopt policies that would lead to maximum employment and price stability. Evidently dissatisfied with the fulfillment of these goals, some thirty years later Congress passed the Full Employment and Balanced Growth Act in 1978 (also known as the Humphrey-Hawkins Act after its two co-authors) that strengthened the original Employment Act. Among other things, the 1978 law mandated that the Federal Reserve should specifically aim to maintain economic growth in line with the economy's potential to expand. That is, policymakers were instructed to steer the economy in such a way as to insure steady output growth, fast enough to maintain full employment but not so fast as to ignite inflation.

In stark challenge to the conventional wisdom that inspired such legislation, Robert Lucas argued in his influential 1987 monograph *Models of Business Cycles* that deviations from stable growth over the post-War United States were actually a minor concern that did not merit

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the high priority accorded to them under the law. More precisely, Lucas asked how much individuals should be willing to give up in principle to live in a world not subject to the degree of macroeconomic volatility the U.S. witnessed during this period. Assuming preferences that many economists view as a reasonable benchmark, he calculated that individuals would sacrifice at most one-tenth of one percent of lifetime consumption, prompting him to conclude that there would be little benefit to "devising ever more subtle policies to remove the residual amount of business cycle risk."

Not surprisingly, Lucas' results have attracted quite some controversy, and various researchers have revisited his calculation since his monograph was published. This article reviews the literature prompted by Lucas' original observation, with an emphasis on two questions. First, does the subsequent literature confirm that post-War macroeconomic volatility is as minor of a problem as Lucas' original calculation suggests? And second, what do these estimates tell us about the inherent benefits from further pursuing stabilization policy?[1]

I will argue that subsequent work suggests Lucas' calculation significantly understates the true cost of post-War macroeconomic volatility. But at the same time, the mere fact that post-War business cycles were costly need not imply that attempting to neutralize them would have been highly desirable; that depends on what shocks were responsible for this volatility and whether they could have been effectively offset, questions economists have yet to fully resolve. As such, Lucas' conclusion that there was little to gain from more aggressive stabilization may be correct. But even if there is little benefit from *further* stabilization, it need not follow that macroeconomic stabilization *per se* is unimportant; society might have been much worse off had policymakers not pursued stabilization to the extent they did during the post-War era, and avoiding even greater volatility over this period should have ranked as a high priority.

The Original Lucas Calculation

In calculating the cost of business cycles, Lucas (1987) reasoned that people's concern about macroeconomic fluctuations is primarily due to how these fluctuations affect the amount of goods and services they get to consume. He then argued that we can view aggregate consump-

[1] Two other recent surveys are Lucas (2003) and Yellen and Akerlof (2004). Each reaches a somewhat different conclusion than the present survey on at least one of the questions above.

tion expenditures each year as the amount of resources that can be used to satisfy such needs.[2] Since aggregate consumption fluctuates over the business cycle, Lucas attributed the cost of business cycles to the fact that individuals are forced to contend with volatile and unpredictable consumption rather than stable and predictable consumption growth.

To be more precise, Lucas assumed consumption can be decomposed into a part that grows systematically over time and a part that fluctuates with prevailing economic conditions. Let us refer to the systematic part as trend consumption, and denote its value in year t by C_t^*. Actual consumption in year t, denoted C_t, will deviate from trend by a random percentage ε_t, i.e.

$$C_t = (1 + \varepsilon_t)\, C_t^*$$

The random deviation ε_t is assumed to have a zero mean and to be independent across time. That is, consumption C_t will be equal to trend consumption C_t^* on average, although in any given year it may be higher or lower than trend, independently of what happened to consumption in previous years. Figure 1 shows log per-capita consumption from 1948 to the present, together with an estimate for trend consumption C_t^* as Lucas suggested constructing it.[3]

Lucas further assumed that the way individuals value consumption can be summarized with a simple utility function that assigns a value to every sequence of consumption expenditures $\{C_t, C_{t+1}, C_{t+2}, ...\}$. Let $U\,(C_t, C_{t+1}, ...)$ denote the value a typical individual assigns to the corresponding consumption sequence. To quantify the cost of volatility, Lucas asked by what fraction we would need to increase lifetime consumption to make an individual with this utility function just as happy as in a world where consumption never deviated from trend, i.e. where the individual could consume C_t^* each year. Formally, Lucas calculated the value of μ for which

$$U\left((1+\mu)\, C_t, (1+\mu)\, C_{t+1}, ...\right) = U\left(C_t^*, C_{t+1}^*, ...\right)$$

The exact details of Lucas' calculation are provided in Box 1. Under his assumptions, he found the cost of business cycles can be approximated by the formula

$$\mu = \frac{1}{2}\gamma\sigma_\varepsilon^2$$

where γ measures how averse an individual is towards risk and σ_ε^2 denotes the variance of deviations from trend consumption. Thus, business cycles are more costly the more volatile is

[2] Subsequent work has argued for omitting expenditures on durables, since it is the stock of durable goods that matters. The implied cost of volatility using non-durable consumption is not dramatically different.

[3] That is, $\{C_t^*\}$ is the Hodrick-Prescott filter of the original consumption series $\{C_t\}$. Since I estimate this from annual data, I use a weight of 100. Lucas' original calculation was based on quarterly data.

their consumption (i.e. the higher is σ_ε^2) and the more averse individuals are to consumption volatility (i.e. the higher is γ).

Using empirically plausible values for γ and σ_ε^2, Lucas arrived at a cost of 0.008%. That is, individuals would be willing to sacrifice no more than one one-hundredth of one percent of their consumption to achieve macroeconomic stability. While acknowledging that his calculation abstracts from many important issues, Lucas argued it was unlikely that the cost of macroeconomic volatility would exceed one-tenth of one percent. A quick glance at Figure 1 reveals why: since aggregate consumption is not especially volatile, C_t and C_t^* are not dramatically different, and individuals will be close to indifferent between the two paths.

In the next few sections, I discuss the ways subsequent authors have criticized the above calculation. These are summarized in Table 1. The table is organized according to which feature of Lucas' calculation each article modifies, and provides the range of cost estimates each paper presents as plausible. Below I survey these critiques as well as the differences among the various papers.

Alternative Ways of Implementing Lucas' Calculation

Even if one accepts the approach that underlies Lucas' calculation, it is still possible to quibble with the particular assumptions Lucas used to arrive at his estimate. I begin by reviewing criticisms that are in this spirit.

One problem concerns the particular function $U(\cdot)$ Lucas used. Although this utility function is common in applied macroeconomics and has some empirical support, it has a difficult time accounting for attitudes towards certain types of risks, and as such might understate how much individuals dislike consumption risk. For example, individuals whose preferences correspond to those Lucas assumed would be quite willing to invest in risky equity, while the large premium on stocks over bonds suggests that in practice individuals are more risk averse given they require a hefty return to invest in equity. One way to fix this is to allow for a higher degree of risk aversion. For example, whereas Lucas focused on the case where $\gamma = 1$, Obstfeld (1994) and Dolmas (1998) argue that a value of γ as high as 20 may be plausible, which would increase the costs relative to those Lucas reported by a factor of 20; but since the cost Lucas calculated was so small, the implied cost of business cycles is still no more than 0.5% of lifetime consumption. Both authors also consider a more general utility function advocated by Epstein and Zin (1991) that can be more easily reconciled with data on asset prices. This alternative specification suggests consumption volatility can be far more costly, but only when fluctuations in consumption are highly persistent, which for reasons I discuss below may not correspond to what we usually think of as business cycle volatility. Tallarini (2000) uses the same generalized utility from Epstein and Zin (1991), but argues that far greater values of risk aversion are needed to accord with the premium on risky equity. As a result, he estimates the cost of business cycles to be much larger, between 2% and 12% of lifetime consumption.[4] Pemberton (1996) and Dolmas (1998) consider a different utility specification known as first-order risk aversion. The implied cost of business cycles for this specification is only slightly larger than the one Obstfeld and Dolmas report, and for reasonable parameter values does not exceed 1% of lifetime consumption. Otrok (2001) proposes still another specification for utility, but finds that plausible parameter values yield even more negligible costs.

Thus, most of the papers that propose alternative utility formulations continue to find small costs of business cycles, although a few argue the costs are significantly larger. So which of these specifications best captures individual preferences? Fortunately, Alvarez and Jermann (2000) develop an approach that does not require imposing a utility function, but infers one indirectly from a variety of asset prices, including the return on equity.[5] They argue that asset prices reveal that individuals strongly dislike fluctuations in trend consumption growth, not cyclical fluctuations in consumption. To appreciate this point, consider Figure 1. The growth rate of trend consumption C_t^* varies over time: per capita consumption grew at roughly 3% per year in the 1960s, compared to about 2% per year in the remaining post-War period. Alvarez and Jermann infer that the reason individuals require a high premium to hold stocks is because the return on stocks tended to be low in those periods when trend consumption growth was low. But the fact that households are so concerned with slow trend growth does not mean they are equally alarmed about temporary deviations from trend. Indeed, Alvarez and Jermann calculate that individuals would be willing to sacrifice at most 0.3% of lifetime consumption to eliminate only business cycle volatility in consumption, although they would sacrifice a lot more to avoid fluctuations in trend consumption growth. The preferences that are most consistent with data on asset prices therefore suggest the cost of business cycles is fairly small.

[4] Campbell and Cochrane (1995) similarly argue the equity premium implies a large cost of business cycles.

[5] DiTella, MacColloch, and Oswald (2003) and Wolfers (2003) propose using survey data on how happy people feel as another way of estimating the cost of cycles without imposing a particular utility function. For example, Wolfers regresses well-being data on the mean and variance of unemployment to arrive at a tradeoff between the two. One could do the same with the mean and variance of consumption; however, while consumption grows over time, average reported well-being does not. This incongruity suggests either individuals do not strongly prefer more consumption to less, or, more likely, that well-being measures are not directly comparable over time.

Another objection to Lucas' calculation concerns his assumptions regarding deviations from trend consumption. Lucas assumed that the fact that consumption is below trend this year says nothing about whether it will be above or below trend next year. In practice, though, if consumption is below trend this year it is also likely to be below trend next year. Depending on how persistent shocks are and which utility function one assumes, this can affect the implied cost of consumption volatility. Even if shocks are likely to persist for several years, as would appear to be the relevant case from Figure 1, the cost of business cycles is typically less than 1% for most utility specifications. But when Obstfeld (1994) assumes shocks are permanent, so a fall in consumption today is expected to persist *indefinitely,* he finds that the cost of cycles can be as much as 1.8%. Dolmas (1998) shows that the cost of business cycles can be even larger – over 20% of lifetime consumption – when shocks are permanent and individuals have preferences that exhibit first-order risk aversion. Yet these permanent shocks are essentially changes in trend consumption growth, which presumably reflect changes in the economy's potential, rather than temporary deviations from trend that policymakers can try to offset. The fact that the cost of permanent fluctuations in consumption can be so large thus mirrors the findings of Alvarez and Jermann that what individuals particularly dislike are fluctuations in trend consumption. Although society would be much better off if these permanent shocks were avoided, this is not a cost that could be avoided by conventional stabilization policy.

Using Individual-Level Data: Preliminary Results

A potentially more compelling criticism of Lucas' estimate concerns its reliance on aggregate data. To see why using aggregate data might be problematic, suppose there was a small fraction of the population whose consumption was highly volatile, while consumption for everyone else was constant. Average consumption across the entire population would not appear very volatile; but for the unlucky few whose consumption is volatile, fluctuations will be quite costly. More generally, suppose that the small declines in aggregate consumption during recessions are driven by large declines in the consumption of a small but *randomly chosen* number of individuals, reflecting the fact that it is hard to predict exactly where the effects of downturns will be most severe. Since any individual runs the risk of a dramatic fall in his consumption, eliminating cyclical fluctuations might make *all* individuals much better off. In essence, focusing on aggregate consumption understates the volatility of consumption σ_ε^2 individuals face, and as such understates the cost of business cycles.

Unfortunately, there is no time series on consumption at the level of households with which to carry out Lucas' calculation.[6] Instead, estimates of the cost of business cycles based on household data rely on more readily available observations on earnings. More precisely, researchers use individual earnings data to estimate a stochastic income process for a typical household, and then use theory to predict the consumption of a household facing this income process. They then calculate the cost of business cycles from predicted as opposed to actual consumption.

An important assumption in this line of work is that credit markets are "incomplete," i.e. credit markets provide only limited protection against income risk. Households facing volatile incomes would naturally try to borrow when their incomes are low to maintain a constant level of consumption. Such borrowing will not allow them to escape consumption volatility altogether, since in recessions there will be more low income households who wish to borrow and fewer high income households willing to lend, raising interest rates and making it too costly to keep consumption constant. Still, with unlimited access to credit, one can show that individuals will be able to limit the volatility of their consumption to that of aggregate consumption, in which case Lucas' original calculation would be applicable. But his calculation would not be applicable is if households were limited in their borrowing, as is often the case in practice.

Formally, let y_t denote the annual labor income for a given individual in year t. We begin by constructing a stochastic income process whose realizations mimic the incomes we observe for different households. For example, suppose income fluctuations were primarily due to periodic episodes of unemployment. We can then capture income fluctuations with a simple process whereby the income of an individual household can take on two values, one that corresponds to the average earnings of employed workers and one that corresponds to the average earnings of unemployed workers (e.g. unemployment benefits). We can then estimate the transition probabilities between employment and unemployment from individual observations. A more sophisticated approach would also take into account the possibility that workers earn more on their jobs in boom times than they do in recessions.

Let a_t denote the net value of the individual's asset holdings in year t, and let r_t denote the interest rate paid on assets held between year t and year $t+1$. Likewise, let c_t denote the individual's consumption expenditures in year t. Individuals are assumed to choose consumption expenditures to maximize utility $U(c_t, c_{t+1}, ...)$ given the process for y_t and subject to the

[6] However, it is possible to disaggregate consumption at the level of individual states, as in Robe and Pallage (2002). They find that retail sales at the state level are more volatile than at the national level, suggesting the effects of macroeconomic shocks are concentrated among a subset of states. Accordingly, the cost of volatility they find is somewhat larger than Lucas computed from total U.S. data.

constraint that $a_{t+1} = (1 + r_t)\, a_t + y_t - c_t$. This constraint states that the value of the assets an individual has at the beginning of year $t+1$ is just the sum of the value of the assets he held in year t, the interest he earned on these assets, and the wage income he earned, minus whatever he spent on purchases in year t. To capture the limited ability of households to borrow, we can add the restriction that $a_t \geq 0$ for all t, i.e. individuals are not allowed to carry any debt. A weaker restriction would allow for some amount of debt, so the lower bound on assets would be a negative number rather than zero. Solving this maximization problem yields a predicted sequence for consumption $\{c_t, c_{t+1}, ...\}$.

Next, we use economic theory to forecast how the income process would change once aggregate fluctuations are stabilized. Denote the process for income in a stable world by $\left\{y_t^*, y_{t+1}^*, ...\right\}$, so an asterisk denotes the value of a variable once aggregate fluctuations are eliminated. Once again, we can solve for the consumption decisions $c_t^*, c_{t+1}^*, ...$ of an individual facing the constraints $a_{t+1}^* = \left(1 + r_t^*\right) a_t^* + y_t^* - c_t^*$ and $a_t^* \geq 0$. Given the two consumption paths, we can once again ask how much we need to increase consumption in the world with volatility to make an individual as happy as when aggregate volatility is eliminated, i.e. what value of μ would ensure $U\left((1+\mu)\, c_t, (1+\mu)\, c_{t+1}, ...\right) = U\left(c_t^*, c_{t+1}^*, ...\right)$.

The various papers that pursue this hypothesis disagree on how to model the income process y_t^*. Atkeson and Phelan (1994) argue that as long as income while employed and income while unemployed do not vary with the business cycle, the income process y_t^* should be identical to y_t. To see why, suppose the probability an individual will be unemployed is 3% in a boom and 9% in a recession, and that each year is equally likely to be a recession or a boom. From an individual's perspective, then, the probability of being unemployed in some year in the future is $\frac{1}{2} \times 3\% + \frac{1}{2} \times 9\% = 6\%$. Now, consider a stabilization policy where the government hires workers in recessions but not in booms to keep the probability of being unemployed constant at 6%. Each worker now faces the same earnings risk once as before, namely a 6% probability of being unemployed in any given year. But this does not mean individuals are not affected by stabilization. Without government intervention, demand for borrowing will be higher in recessions when more people are unemployed, and consequently the equilibrium interest rate r_t will be higher as well. By contrast, in the stable environment, the interest rate r_t^* will be constant over time. Stabilization thus eliminates variations in the rate at which an individual can borrow or lend. For this reason, the consumption choices c_t^* in the stable economy may differ from c_t. But when Atkeson and Phelan ask how much individuals would need to be as happy as when they get to consume c_t^*, the answer is only 0.02% of lifetime consumption.

By contrast, Imrohoroglu (1989) argues that stabilization *does* affect earnings risk, although at the same time she ignores the interest rate risk that Atkeson and Phelan emphasize. Her argument relies on the observation that unemployment spells are typically short in booms but long in recessions, whereas in a stable environment unemployment durations would presumably be of average length. The virtue of stabilization is that it allows individuals to avoid long spells unemployment which are hard to save for.[7] While stabilization also eliminates short unemployment spells, borrowing-constrained households do not suffer as much from eliminating short spells as they benefit from eliminating long ones. When Imrohoroglu computes the cost of business cycles assuming individuals cannot borrow and earn zero real interest on their savings, she finds a cost of business cycles of 0.3%. When she also allows individuals to borrow at a real rate of 8% (while saving at a rate of zero), the cost falls to a mere 0.05%. While her analysis ignores fluctuations in the interest rate over the cycle, recall that Atkeson and Phelan find these to be negligible. Thus, preliminary work on the cost of business cycles with incomplete markets appeared to reaffirm Lucas' original conclusion.

More Recent Work Using Individual-Level Data

More recent work, however, has questioned this conclusion. The reason for the small cost of business cycles above is that interest rates are not particularly volatile over the cycle, nor are unemployment spells in the U.S. very long, even in recessions. Since households could easily save enough to sustain them through short periods of unemployment, these papers conclude that business cycles should not be especially costly. Yet there are two problems with this conclusion. First, fluctuations can contribute to earnings risk beyond just unemployment risk. For example, since wages are procyclical, workers who are laid off in recessions will re-enter the work force at lower wages that may remain low for far longer than the duration of a typical unemployment spell. Second, even though individuals could save for bad times, evidence on the distribution of wealth suggests a significant number of them do not. More recent work has taken these observations into account, and suggests more significant costs of business cycles.

Consider first the work of Krusell and Smith (2002).[8] They allow the interest rate r_t to vary

[7] Atkeson and Phelan do not deny that unemployment duration varies over the cycle; rather, they argue stabilization makes long spells less likely to occur *at the same time others experience long spells*, rather than less likely to occur *at all*. Which view is more reasonable depends on the underlying model and the nature of stabilization.

[8] The 2002 paper is a revised version of their 1999 paper; my discussion is based on the 2002 version.

over the cycle, so individuals face interest rate risk as described by Atkeson and Phelan (1994). At the same time, they follow Imrohoroglu (1989) in assuming that stabilization will allow individuals to avoid long spells of unemployment. But they also introduce two new features: (1) they assume stabilization has a more significant effect on earnings risk than in Imrohoroglu's formulation, in line with empirical evidence; and (2) they modify the model to accord with the observation that a considerable fraction of all households hold very little wealth.

Turning first to the effects of stabilization on earnings risk, Krusell and Smith incorporate Imrohoroglu's observation that stabilization allows individuals to avoid long spells of unemployment. But they introduce two additional features. First, they assume that the wages households earn while employed vary over the cycle but would remain constant under stabilization, so y_t^* would be less volatile than y_t even for households that avoid unemployment. Second, they assume stabilization lowers the risk of becoming unemployed. This can be motivated by the observation that some jobs that are profitable in booms turn unprofitable in recessions. Workers employed on those jobs would earn high wages in booms, but will be immediately laid off in the next recession. If these jobs remain profitable after stabilization, workers on these jobs would no longer have to fear unemployment whenever a downturn occurs. At the same time, these workers would earn lower wages on these jobs under stabilization, since they will no longer earn the high wages they would have earned in booms.

In addition to changing the way stabilization affects earnings risk, Krusell and Smith modify Imrohoroglu's model to accord with evidence on the distribution of wealth across households, specifically with the observation that wealth is highly concentrated. To do this, they allow for heterogeneity in discount rates across individuals. Households who are more patient than the average household save more and as such account for a disproportionate share of total wealth. Similarly, households who are more impatient than the average household hold very little wealth. While this leaves them vulnerable to periods of low consumption while unemployed, they are too impatient to cut back on their current consumption and save for when their income is low. By choosing the distribution of discount rates appropriately, Krusell and Smith are able to reconcile their model with the empirical distribution of wealth.

For households that are unemployed and have exhausted their borrowing capacity, Krusell and Smith estimate that eliminating fluctuations would be worth almost 4% of lifetime consumption. However, the cost of fluctuations for other individuals in the economy is much smaller, and is even negative for households with moderate savings (these households are not concerned about earnings volatility given their savings, and they like the fact that in the cyclical environment wages are high precisely when they are more likely to be employed). Wealthy households do have a strong preference for stabilization, although this has nothing to do with volatility directly; rather, eliminating fluctuations would lead other households to cut back their precautionary savings, causing the supply of loanable funds to shrink and interest rates to rise, which obviously benefits those who own many assets. On the whole, Krusell and Smith find that the majority of households would be made worse off under stabilization, and averaging over all individuals implies business cycles are socially beneficial on net, although mildly so. As such, their findings hardly point to stabilization as a pressing social concern. But their results do illustrate that business cycles are costly for households with few assets.

Subsequent work has argued that Krusell and Smith themselves understate the degree of earnings risk individuals face. For example, although Krusell and Smith allow wages to fluctuate over the cycle, the degree to which they let wages vary with economic conditions depends on the predictions of a model rather than on direct evidence on earnings. When Storesletten, Telmer, and Yaron (2001) look at reported household earnings, they find that the standard deviation of earnings across households more than doubles in recessions, far more than implied by Krusell and Smith's model. Moreover, Storesletten *et al* find that earnings shocks are highly persistent, so that when a household's income falls this year, for whatever reason, its earnings are likely to be low for far longer than in Krusell and Smith. Using the same utility function Lucas considered, they estimate that eliminating fluctuations would be worth 0.6% of lifetime consumption, while households with little savings (who in their model are young households that have yet to accumulate any wealth) would be willing to sacrifice 1.5% of their consumption. For somewhat higher degrees of risk aversion, but still within the range Lucas considered, they estimate the cost for the population as a whole at 2.5% of lifetime consumption, while those without any savings would be willing to sacrifice 7.4%.

Although Storesletten *et al* assume earnings shocks are highly persistent, households can still protect themselves fairly well against these shocks by saving. This is because earnings are persistent, but not permanent.[9] Krebs (2003) considers a similar model where shocks are permanent, so a fall in income today will lead expected income in all future years to fall by the same amount. In this case individuals will not be able to borrow to offset negative shocks to their income, even when credit markets operate perfectly; after all, who would lend to an individual to cover earnings losses that are never expected to be recovered? Krebs estimates that, overall, individuals with the same preferences as Lucas assumed would be willing to

[9] There appears to be some confusion about this in the literature. Several papers claim that Storesletten *et al* assume earnings shocks are permanent, when in fact they do not.

sacrifice 7.5% of lifetime consumption to eliminate fluctuations in this case. But it is hard to tell from the data whether earnings shocks are permanent or just highly persistent, and the cost of cycles is considerably smaller in the latter case.[10]

Beaudry and Pages (2001) do not assume earnings shocks are permanent, but they do assume shocks are sufficiently persistent that individuals have no incentive to save at the going interest rate. Moreover, rather than estimating earnings volatility from evidence on earnings dispersion as Storesletten *et al* and Krebs, they use data on the cyclicality of *starting* wages. Their logic is that, just as in earlier work, layoffs contribute to much of the earnings risk individuals face. However, unlike previous work, this is not because of the earnings workers forgo while unemployed, but because laid-off workers typically re-enter the work force at a lower wage than they previously earned. While it is never a good thing to be laid off and start from scratch, it is particularly bad if you have to do so in a recession. They calibrate their model to data on the volatility of starting salaries over the cycle, and using Lucas' original utility function, estimate that individuals would be willing to sacrifice 1.4% of consumption to eliminate fluctuations in starting salaries over the cycle. When they allow for more risk aversion as in Storesletten *et al*, they estimate a cost of 4.4%. However, this cost is only borne by workers; employers in their model are assumed not to care about volatility, and the implied cost of business cycles for the population as a whole is smaller.[11]

In sum, once we take into account evidence on the low savings rates of many households, as well as the fact that cyclical fluctuations can lead to persistent earnings declines, post-War business cycles start to matter; specifically, there is a core of households who are disinclined to save and as such would be willing to sacrifice between as much as 4 and 7% percent of lifetime consumption to avoid such volatility. Remaining households are likely to suffer less from cyclical fluctuations, and may even benefit from them. The overall cost of cycles is thus more modest, but can still run as much as 2.5%.

[10] Turnovsky and Bianconi (2005) also consider a model where shocks are permanent. But they assume stabilization reduces the average level of volatility rather than its variation over time. Moreover, they allow households to vary their labor supply in response to shocks. Their estimate for the cost of cycles is about 2%.

[11] Several papers claim Beaudry and Pages obtain large costs because they assume stabilization eliminates *all* earnings risk. While it is true that workers in their model face no risk in the stable economy, the maximum risk workers are assumed to face in the volatile economy is calibrated to the extra amount workers lose when they are laid off in recessions as opposed to booms, *not* the much larger amount they lose on average upon layoff. Thus, their welfare estimates only reflect the gains from eliminating the cyclical part of idiosyncratic risk.

The Effects of Volatility on the Level of Consumption

A separate problem with Lucas' calculation is his assumption on how stabilization affects the level of consumption. Lucas asserted stabilization would eliminate deviations from trend, implying consumption will revert to its average level. But as various economists have since noted, the level of consumption might change in response to stabilization, so that stabilization might increase average consumption relative to the volatile economy.

The papers described in the previous section using household income data are immune to this criticism, since they derive consumption c_t^* as the solution to a household problem rather than setting it to the average of observed consumption. However, they still abstract from some of the ways that stabilization can affect the level of consumption, and as such can still understate the true cost of business cycles. As in most of the literature that explores this hypothesis, my discussion will focus on aggregate data.

One critique along these lines comes from DeLong and Summers (1988). They argue that rather than steadying economic activity at its average level, stabilization would prevent economic activity from falling below its maximum potential, in line with the mandates of the Full Employment and Balanced Growth Act of 1978. Thus, stabilization policy would "fill in troughs without shaving off the peaks." While their discussion is couched in terms of output, one can easily adapt their argument for consumption. Let C_t^* denote the level of consumption that would prevail in year t in the counterfactually stable economy. Previously, C_t^* also reflected the average of consumption; but now the two series are no longer assumed to be the same. Let ε_t denote the percent deviation of actual consumption in year t from C_t^*, i.e. $C_t = (1 + \varepsilon_t) C_t^*$. If consumption in the stable economy represents the maximum level consumption can attain, ε_t must be less than or equal to zero. The average value of ε_t is therefore negative, as opposed to zero. Consequently, the consumption path in the stable economy C_t^* exceeds the average level of consumption in the volatile economy.

Just as Lucas used the assumption that ε_t is zero on average to recover C_t^* from data on $C_t = (1 + \varepsilon_t) C_t^*$, DeLong and Summers propose a way to recover C_t^* from C_t when $\varepsilon_t \leq 0$. Their approach is described in Box 2. Alternatively, we can use data on business cycle peaks to isolate years when $\varepsilon_t = 0$, and then interpolate between these points to recover C_t^*. In particular, the National Bureau of Economic Research (NBER) has attempted to identify peaks and troughs in economic activity ever since 1850, which we can use to identify years in which ε_t was presumably equal to 0. This approach is also detailed in Box 2. Both series are illustrated in Figure 2, together with the original data on aggregate consumption from Figure 1. The average deviation ε_t is 1.9% using DeLong and Summers' approach and 1.6% using the series interpolated from NBER peaks. The cost of business cycles turns out to be roughly equal to this average, so these magnitudes also represent the amount individuals would sacrifice to attain C_t^*. In closely related work, Cohen (2000) finds a slightly smaller cost of business cycles of 1%, still much larger than the cost Lucas calculated.

The difference between Lucas' estimate and the one that emerges from DeLong and Summers' analysis stems from their different views of stabilization. Which of these is more compelling? Each imposes what it views as reasonable assumptions on the deviation ε_t between actual consumption and its level after stabilization to estimate C_t^*. But a more compelling approach would be to derive C_t^* using economic theory, rather than impose fairly ad-hoc restrictions on ε_t to recover it, and to see whether it is higher than average consumption in the cyclical economy.

One explanation for why stabilization should increase consumption is that shocks affect the economy asymmetrically: positive shocks boost economic activity less than negative shocks dampen it.[12] Mankiw (1988) and Yellen and Akerlof (2004) sketch out such an argument and cite evidence that unemployment responds asymmetrically to changes in inflation, suggesting that if the Federal Reserve were able to stabilize inflation at its average level, unemployment would fall and more output could be produced and consumed. Mankiw estimates that stabilization should increase output on average by about 0.5% per year, while Yellen and Akerlof's estimates suggest output would increase by between 0.5 and 0.8%. On a similar theme, Gali, Gertler, and Lopez-Salido (2003) develop a formal model in which market frictions imply that welfare (and under certain assumptions, consumption) responds asymmetrically to employment fluctuations. They find that a policy that stabilizes employment would increase welfare by an amount equivalent to increasing lifetime consumption by between 0.30 and 0.75%.

Ramey and Ramey (1991) suggest an alternative explanation for why stabilization ought to increase the average level of consumption. Their argument is based on the notion that firms need to precommit to a specific technology before they commence production. In an uncertain environment, firms may end up with a technology that is inappropriate for the scale of production they would have to undertake. Thus, volatile environments are more likely to involve inefficient production, resulting in lower average output. Ramey and Ramey estimate that fluctuations lower output by 1.7% on average, although they also note that if households

[12] Technically, this asymmetry is corresponds to the notion that consumption is a concave function of whatever variable is being stabilized.

are risk-averse they would sacrifice slightly more than this to avoid fluctuations. This is on par with the magnitudes suggested by DeLong and Summers.[13]

A third reason for why stabilization might change the level of consumption concerns its effect on capital accumulation. If individuals accumulate more capital in the stable environment, there will be more inputs available for production in the long-run and thus average output will eventually be higher than in the volatile environment. However, as I discuss in more detail in the next section, the theoretical effects of stabilization on the capital stock are ambiguous; investment can either rise or fall in response to stabilization. For now, I simply note that the welfare effects associated with such changes are negligible and would not contribute much to the cost of business cycles. But the other explanations for why stabilization ought to increase average consumption suggest a cost of business cycles of just under 2%.

The Effects of Volatility on Consumption Growth

The previous section focused on scenarios in which eliminating fluctuations increases the *level* of consumption. Graphically, this implies stabilization induces a parallel shift up in consumption from the path Lucas assumed and which is displayed in Figure 1. But eliminating fluctuations may also affect the *growth rate* of consumption. I now discuss work that explores this possibility.

The most commonly cited reason for why stabilization should affect consumption growth concerns its effect on investment. The intuition for this is as follows: since firms are likely to be more cautious about investing in uncertain environments, eliminating fluctuations should lead firms to accumulate capital more rapidly. This allows firms to produce more output, enabling households to enjoy more consumption and presumably make them better off. However, as I now explain, this line of reasoning turns out to be misleading.

First, eliminating volatility can just as plausibly discourage investment as encourage it. For example, recall that in the face of volatility, households choose to maintain precautionary savings to sustain them through periods of low earnings. Stabilization would mitigate the need for such savings. As savings become more scarce, interest rates would rise and may discourage

[13] Portier and Puch (2004) make a similar point, although in their framework firms commit to a price rather than to a technology. While they demonstrate that this commitment magnifies the cost of business cycles, they view their model as too stylized to yield informative estimates for the true cost of business cycles.

firms from investing.[14] But even if stabilization encourages investment, the resulting increase in consumption growth comes at a cost. This is because investment uses up resources that would otherwise have been used to produce consumption goods, so households get to enjoy less initial consumption. Whether households are better off under faster growth is therefore ambiguous.

To put it another way, the effects of stabilization on investment do not reflect a simple change in the rate at which consumption grows; rather, they involve changes in the tradeoff between present and future consumption. In a well-functioning economy where households act in their own best interest, changes in this tradeoff ought to reflect the preferences of households and as such make them better off. Hence, assuming trend consumption remains unchanged once the economy is stabilized ignores an implicit benefit from stabilization. But this benefit is likely to be modest given households already chose their consumption optimally in the volatile environment. In fact, when Matheron and Maury (2000) and Epaulard and Pommeret (2003) calculate the welfare cost of business cycles due to their effects on investment, they find effects of no more than 0.5%.

The reason that an increase in investment has such a small effect on welfare is that most of the benefits from the faster growth it gives rise to are offset by lower initial consumption. But Barlevy (2004a) argues that eliminating fluctuations can increase consumption growth even when initial consumption is *unchanged*. This is because changes in investment affect growth asymmetrically; an increase in investment increases growth less than a similar decrease in investment decreases growth, reflecting among other things the inability of firms to undertake too many investment projects at once. In this case, simply eliminating fluctuations in investment without ever changing the level of investment should increase growth. Estimates reported in the paper suggest that if stabilization would steady investment at its average level, the growth rate of per-capita consumption would increase from 2% per year to about 2.35% per year, which is well within the range of historical variation in trend consumption growth.

Figure 3 illustrates how trend consumption C_t^* from Figure 1 would change if consumption grew by an additional 0.35 percentage points per year. Although the effect on growth is modest, its cumulative effects are large, and households would presumably significantly prefer this new consumption path. Indeed, Barlevy (2004a) estimates the cost of cycles due to their effect on

[14] Even ignoring precautionary savings, uncertainty may encourage firms to invest rather than discourage them. With more volatility, profits will be higher if uncertainty is resolved favorably but no lower if uncertainty is resolved unfavorably as long as firms can cut their losses by shutting down or adjusting their labor hiring. While this point has long been recognized in the investment literature, it has not figured much in work on the cost of business cycles, where the notion that firms can cut their losses is typically ignored.

growth at $7.5 - 8.0\%$ of lifetime consumption, much larger than the cost of business cycles described so far.

Note that Figure 3 assumes stabilization has no effect on average investment. But recall that stabilization might also lead to a change in the level of investment, so consumption may be steeper or flatter than captured by the figure. However, as noted earlier, in a well-functioning economy, changes in the tradeoff between present and future consumption will only be to the benefit of households. In that case, households should be at least as well off without cycles as with the consumption path depicted in Figure 3, even if stabilization causes investment to fall by enough to lead to a lower overall growth rate. What matters is not whether consumption actually grows more rapidly in the absence of fluctuations, but that stabilization makes it possible to grow more rapidly from the same amount of resources.

In the opposite direction, various papers have argued that business cycles facilitate rather than depress growth. One hypothesis relies on the idea of intertemporal substitution; firms can take advantage of the fact that productivity is lower in recessions to undertake growth-enhancing activities without having to sacrifice as much output. While there is some truth to this, Barlevy (2004b) argues that one of the main inputs into productivity growth, research and development, is concentrated precisely when its opportunity cost is most expensive, i.e. in booms. Thus, at least with regard to one of the primary inputs of productivity growth, business cycles force society to trade off present and future consumption less favorably, not more favorably, imposing a social cost equal to 0.3% of lifetime consumption. This reinforces the view that business cycles retard the economy's growth potential, in this case by increasing the cost of achieving growth.

In a separate paper, Shleifer (1986) argues that volatility may be essential for growth. His reasoning is that firms invest in developing new technologies because to earn excess profits. If stabilization eliminates periods of high profits, it may discourage investment and growth. Shleifer develops an illustrative example in which the absence of fluctuations leaves the economy stagnant. Since the economy operates inefficiently in his example, the argument that changes in investment make households better does not apply, and the falloff in investment makes households worse off. However, recall from the previous section that stabilization is also likely to increase the level of economic activity, and with it average profits. This partly mitigates the concern that stabilization would suppress the incentives to innovate.

Finally, Jovanovic (2004) argues that volatility is an unavoidable byproduct of growth, so stabilization may curtail growth. His argument is that growth involves experimentation: firms try out new ideas, some of which fail spectacularly. If the only way to stabilize the economy is to preclude such experimentation, stabilization may lead to stagnation. However, it is not obvious that stabilization would necessitate suspending experimentation, as opposed to moderating the negative consequences of failure. Indeed, in Jovanovic's model, reducing the volatility that results from experimentation would both facilitate growth and make society better off.

Taking Stock: How Costly is Post-War Volatility?

Research that has followed up on Lucas' original insight regarding the cost of post-War U.S. business cycles has raised important shortcomings with his approach. On the one hand, Lucas correctly pointed out that aggregate consumption does not fluctuate very much over the business cycle, so an individual household whose consumption mirrored aggregate consumption would not be much better off if these fluctuations were smoothed out. This conclusion proves to be robust. But in a world with imperfect credit markets, the consumption of individual households may be far more volatile than aggregate consumption, and as such they would benefit more from eliminating macroeconomic volatility. Even when we take into account wealthier households who are not much affected by business cycles, the average cost to society can be as large as 2.5% of aggregate consumption per year.

Beyond the direct cost of consumption volatility, there is evidence that business cycles impose an even larger indirect cost through their effect on the level and growth rate of economic activity. That is, living in a volatile world not only forces households to contend with unpredictable consumption, but also to consume less than they would otherwise. These costs are not mutually exclusive of the cost of higher uncertainty, so the true cost of business cycles relative to a world with no fluctuations should be the sum total of these costs. The final tab comes to over 10% of lifetime consumption, an unquestionably large cost.

The costs are based entirely on the way business cycles impact consumption. But as various commentators have noted, business cycles might be costly in other ways as well. For example, they may force households to work a different number of hours each, something they may be just as reluctant to do as varying their consumption over time. Likewise, business cycles may make households anxious and stressed about the prospect of earnings losses, even those whose incomes are spared. There is probably some truth to these arguments. However, one can easily fall into the trap of adopting a utopian view of what stabilization can achieve. By restricting attention to the fairly conventional and, more importantly, measurable ways by which business cycles impact on consumption, the work surveyed above makes an effective case that post-War business cycles were quite costly after all.

Policy Implications: Is Stabilization an Important Priority?

The large cost of business cycles during the post-War period naturally raises two questions regarding policy. First, should policymakers have acted more aggressively to stabilize the economy during this period than they actually did? And second, is stabilization an important priority that should guide policymakers, as current law dictates? I now argue that despite the apparently large costs of business cycles over the post-War period, it is far from obvious that society would have been much better off if policymakers had pursued a more aggressive stabilization, since at least some of the shocks that were responsible for cyclical fluctuations over this period were not something that could be easily offset. At the same time, the fact that even modest amounts of volatility can impose such a large social cost reaffirms that stable growth should be an important goal that policymakers aspire to. In other words, it may not be possible to defend against all sources of volatility, including potentially those responsible for much of the volatility during the post-War period, but preventing the economy from being even more volatile should certainly rank as a high priority.

In his original monograph, Lucas reasoned that since the cost of business cycles is so small, there is little to be gained from further stabilization. In revising his estimates, some of the papers cited above have argued that the inverse is also true, i.e. the fact that the implied cost of business cycles is so large implies that the benefits to more aggressive stabilization must also be substantial. But just because business cycles are costly does not automatically imply that stabilization is desirable; instead, that depends on what causes business cycle fluctuations, what tools are available to policymakers, and whether these tools can effectively offset the underlying shocks. Even if Lucas' original calculation understates the cost of business cycles, his conclusion that further stabilization is unwarranted may very well hold true.

In his recent review article, Lucas (2003) argues that evidence on the nature of cyclical fluctuations over the post-War period suggests there was very little scope for policymakers to pursue stabilization more aggressively. He reviews the evidence on the sources of output volatility during the post-War period. Various decompositions reveal that at most one third of the variation in output can be attributed to monetary shocks, which the Federal Reserve presumably has the best chance of offsetting. The remaining 70% of output volatility is due to changes in real economic variables. For example, one shock to real economic variables that was relevant during this period is the sharp changes in oil prices. A dramatic run-up in the price of oil raises production costs and affects the economy's potential for producing goods in the short-run, i.e. as long as existing production technologies are still in place. In this case, there is probably little that policymakers can do to successfully stabilize the economy. At best, they can try to offset the shock by lowering other aspects of production costs, but such intervention can easily do more harm than good by distorting the incentives of firms to abandon more costly energy-intensive technologies. In fact, one can formally show that, at least under certain assumptions, policymakers should not try to offset exogenous fluctuations in real economic variables. In this case, policymakers would have at best been able to reduce macroeconomic volatility by one third, and the benefits to pursuing more aggressive stabilization would be far more modest than the implied cost of aggregate fluctuations.

However, one has to be careful in interpreting evidence on the source of fluctuations. For example, consider fluctuations in aggregate productivity over the business cycle. These would be counted as fluctuations in real as opposed to monetary factors. As pointed out above, if these changes are driven by technological considerations, e.g. changes in the economic environment that affect the viability of existing technologies such as a change in the relative price of a key input such as oil, there may be little for policymakers to do anything. But fluctuations in aggregate productivity might instead reflect fluctuations in variables that policymakers could affect. For example, Benhabib and Farmer (1994) develop a model in which if firms are optimistic about economic conditions, they will choose to operate at a larger scale, which in turn contributes to raising aggregate productivity and reaffirms their decision to operate at a larger scale. But if firms are pessimistic about economic conditions, they will choose to operate at a smaller scale, resulting in lower aggregate productivity. In this case, policymakers might be able to credibly announce policies that dissuade firms from being pessimistic; for example, they might pledge to pursue an accommodative policy if productivity were low. If firms find it optimal to expand their scale under easy monetary policy, such a policy would preclude the economy from settling at a low level of productivity. Policymakers could then stabilize fluctuations by affecting expectations, a point Benhabib and Farmer themselves allude to. The extent to which the large cost of post-War business cycles could have been avoided through prudent policy thus depends on what forces were responsible for this volatility in the first place.

Without further research as to the underlying source of business cycle fluctuations, then, we cannot reject Lucas' conclusion that there was little to be gained from pursuing a more aggressive stabilization over this period. Nevertheless, the fact that even small amounts of volatility are of such great consequence suggests that, in answer to the second question this section began with, stabilization should rank as a high priority for policymakers. Lucas himself was careful in his original monograph to argue that while there is little to gain from eliminating *residual* risk above and beyond whatever stabilization policies were already being pursued at the time, this does not invalidate the potentially grave importance of existing stabilization policies. For example, he readily acknowledged in his monograph that "fluctuations at the pre-Second World War level, especially combined as they were with an absence of adequate programs for social insurance, were associated with large costs in welfare." This is confirmed in recent work by Chatterjee and Corbae (2001), who show that the same calculation by Imorohoroglu (1989) that yields such small costs of business cycles for the post-War period suggests individuals should have been willing to sacrifice more than 6% of lifetime consumption to avoid prolonged episodes such as the Great Depression, since very long unemployment spells are very costly. Incorporating the other features described in this survey would magnify this cost even more. To the extent that the alternative to the stabilization policies that were pursued in the post-War period was the risk of another Great Depression, there can be no dispute that prudent policies that keep the economy relatively stable are an important priority, especially in light of evidence suggesting that it was bad policies that either exacerbated or prolonged the Depression.[15]

That said, one does not need to appeal to the extreme of the Great Depression to appreciate the benefits inherent to stabilization policy. As the work surveyed in this article reveals, even a modest amount of macroeconomic volatility can impose significant social costs. The fact that there are some shocks policymakers are unable to do much about, and that such shocks may have accounted for a significant share of the macroeconomic volatility during the post-War period, should not take away from the observation that household are likely to be significantly better off in stable environments than in volatile ones. Even if policymakers were not in a position to stabilize much more aggressively than they did during the post-War period, they could still have played an important role in safeguarding the economy from any additional shocks that would have made output even more volatile.

[15] Chatterjee and Corbae's estimates assume policy did not change between the post-War and pre-War period. However, since their results assume downturns of the magnitude of the Great Depression are rare given the fact that they failed to occur in the post-War period, their 6% would represent a lower bound on the true cost of eliminating these crises.

Conclusion

Economists have split as to whether post-War business cycles were costly. On the one hand, there are those who accepted Lucas' original conclusion, a view reinforced by early work that appeared to confirm his results even after accounting for greater degrees of risk aversion and the fact that credit markets provide only incomplete protection against earnings risk. At the other extreme are those who from the outset dismissed Lucas' conclusion as implausible and were convinced that stabilization is an important policy goal, even if they didn't always offer much to directly counter his argument. This article argues that more recent work which explores particular features absent from Lucas' calculation reveals that post-War business cycles were in fact costly, but that this does not necessarily imply that more aggressive stabilization during this period was warranted. Determining whether policymakers should have acted more aggressively requires a better understanding of what forces are ultimately responsible for business cycle fluctuations, a difficult question that economists are slowly but surely making progress on. But even if ultimately there wasn't much more that policymakers could have done to further insulate the economy from cyclical shocks during this period, maintaining a stable growth path does appear to be a highly desirable goal. To the extent that policymakers prevented the economy from being even more volatile during this period, then, they deserve much credit.

Box 1: Lucas' Calculation

Lucas' calculation begins by assuming $C_t^* = \lambda^t C_0^*$ where $\lambda > 1$ measures the average growth rate for consumption during the post-War period. Actual consumption C_t is then set equal to $(1+\varepsilon_t)\, C_t^*$, where $1+\varepsilon_t$ are independent and identically distributed lognormal random variables with mean 1 and variance σ^2. The standard deviation of σ can be computed from the standard deviation of $\ln(C_t/C_t^*) \approx \varepsilon_t$. Rather than estimate a linear trend, Lucas used the Hodrick-Prescott filter of aggregate consumption as his measure for C_t^*, from which he estimated $\sigma = 1.3\%$.

For his utility function, Lucas used the constant relative risk aversion utility function

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

Here β denotes the rate at which utility is discounted over time and γ is equal to the coefficient of relative risk-aversion, i.e. the higher is γ the more reluctant the individual is to face a volatile consumption path. Lucas sets β to 0.95 and γ to 1, parameters which many macroeconomists would view as reasonable benchmarks. Standard arguments can be used to show that for $\gamma = 1$ the function $\dfrac{C_t^{1-\gamma} - 1}{1-\gamma}$ reduces to $\ln C_t$.

A little algebra reveals that the solution to the equation

$$E\left[\sum_{t=0}^{\infty} \frac{\left[(1+\mu)(1+\varepsilon_t)(\beta\lambda)^t C_0\right]^{1-\gamma}}{1-\gamma} \right] = \sum_{t=0}^{\infty} \beta^t \frac{\left[(\beta\lambda)^t C_0\right]^{1-\gamma}}{1-\gamma}$$

yields the approximate formula $\mu = \frac{1}{2}\gamma\sigma^2$. For the coefficient of relative risk-aversion. The implied cost is thus $\mu = \frac{1}{2}(1)(0.013)^2 = 0.00008$, i.e. less than one-hundredth of one percent.

Box 2: Estimating Potential Consumption C_t^*

Consider a process $C_t = (1+\varepsilon_t)\, C_t^*$ where $\varepsilon_t \leq 0$ and where the probability that $\varepsilon_t = 0$ is strictly positive. In addition, suppose that $C_{t+1}^* = \lambda C_t^*$. We observe data on C_t, and want to use it to estimate C_t^*.

DeLong and Summers (1988) suggest the following recursive approach for estimating C_t^*. In the first year of the sample, define $\ln C_t^* = \ln C_t$. Then, in each subsequent year, define

$$\ln C_{t+1}^* = \ln C_t^* + \max\left[0, \max_{i=1 \text{ to } k}\left\{\frac{\ln C_{t+i} - \ln C_t^*}{i}\right\}\right]$$

where k is an arbitrary integer. DeLong and Summers suggest setting $k = 3, 5$, and 8. Figure 2 is illustrated using $k = 8$. By construction, this series will satisfy $C_t^* \geq C_t$, consistent with the restriction that $\varepsilon_t \leq 0$. One can show that this approach will yield a consistent estimate for C_t^* for large t as long as we use a sufficiently large value of k.

An alternative approach relies on using additional observations that supposedly identify periods in which $\varepsilon_t = 0$. Let $t_1, t_2, ...t_n$ denote years in which the NBER business cycle committee identifies a business cycle peak. These periods are assumed to correspond to years in which $\varepsilon_t = 0$. For any t, define $\underline{\tau}(t) = \max_{i=1 \text{ to } n}\{t_n < t\}$ and $\overline{\tau}(t) = \min_{i=1 \text{ to } n}\{t_n > t\}$, i.e. $\underline{\tau}(t)$ reflects the most recent business cycle peak prior to year t and $\overline{\tau}(t)$ reflects the first business cycle peak to occur after year t. Then define

$$\ln C_t^* = \frac{\overline{\tau}(t) - t}{\overline{\tau}(t) - \underline{\tau}(t)} \ln C_{\underline{\tau}} + \frac{t - \underline{\tau}(t)}{\overline{\tau}(t) - \underline{\tau}(t)} \ln C_{\overline{\tau}}$$

To the extent that NBER dates identify true peaks (i.e. periods where $\varepsilon_t = 0$), we would be assured that $C_t^* \geq C_t$. In practice, this approach yields exceptions for which $C_t > C_t^*$. Note that this approach remains valid even if the growth rate $\lambda = C_{t+1}^*/C_t^*$ varies between business cycle peaks, whereas the approach suggested by DeLong and Summers may not. Figure 2 uses all years in which the NBER dating committee identifies a business cycle peak, with the exception of January 1981, which follows a trough six months earlier in July 1980. This recovery was likely too short for the economy to have returned to its potential, i.e. it is unlikely that $\varepsilon_t = 0$ in 1981. A similar problem may arise in some of the early years of the sample, especially given that in some of those years the implied value of ε_t is significantly positive.

Table 1: Alternative Calculations for the Cost of Business Cycles

Panel A: Modify preferences and/or persistence of shocks

Article	Cost	Preference specification	Nature of consumption fluctuations
Obstfeld (1994)	0.02 - 0.5%	Epstein-Zin preferences	independent over time
	0.01 - 1.8%	Epstein-Zin preferences	permanent
Dolmas (1998)	0.04 - 0.7%	Epstein-Zin preferences	serially correlated with autocorrelation of 0.98
Tallarini (2000)	2.1 - 12.6%	Epstein-Zin preferences (but a much higher risk-aversion)	serially correlated with autocorrelation of 0.99
Pemberton (1996)	0.01 - 1.1%	First order risk-aversion	independent over time
Dolmas (1998)	0.05 - 2.4%	First order risk-aversion	serially correlated with autocorrelation of 0.98
	0.4 - 22.9%	First order risk-aversion	permanent
Otrok (2001)	0.004%	Time non-separable preferences	moderately persistent but not permanent
Alvarez and Jermann (2000)	$\leq$ 0.3%	Estimated non-parameterically from asset price data	moderately persistent but not permanent

Panel B: Calibrated risk to match household data rather than aggregate data

Article	Cost	Assumed Effect of Stabilization	Other Remarks
Imrohoroglu (1989)	0.30%	Workers less likely to be unemployed for long periods	
Atkeson and Phelan (1994)	0.02%	Interest rates become less volatile	
Krusell and Smith (1999, 2002)			
average across all households:	-0.66%	Earnings and interest rates both less volatile	Also match wealth distribution (so some households do not save)
for households with no wealth:	3.68%		
Storesletten et al (2001)			
average across all households:	0.6 - 2.5%	Earnings and interest rates both less volatile	Reduction in earnings volatility is calibrated differently from above
for households with no wealth:	1.5 - 7.4%		
Krebs (2001)	7.5%	Earnings less volatile	Earnings shocks assumed permanent
Beaudry and Pages (2001)	1.4 - 4.4%	Earnings less volatile	Cost is for households with no wealth

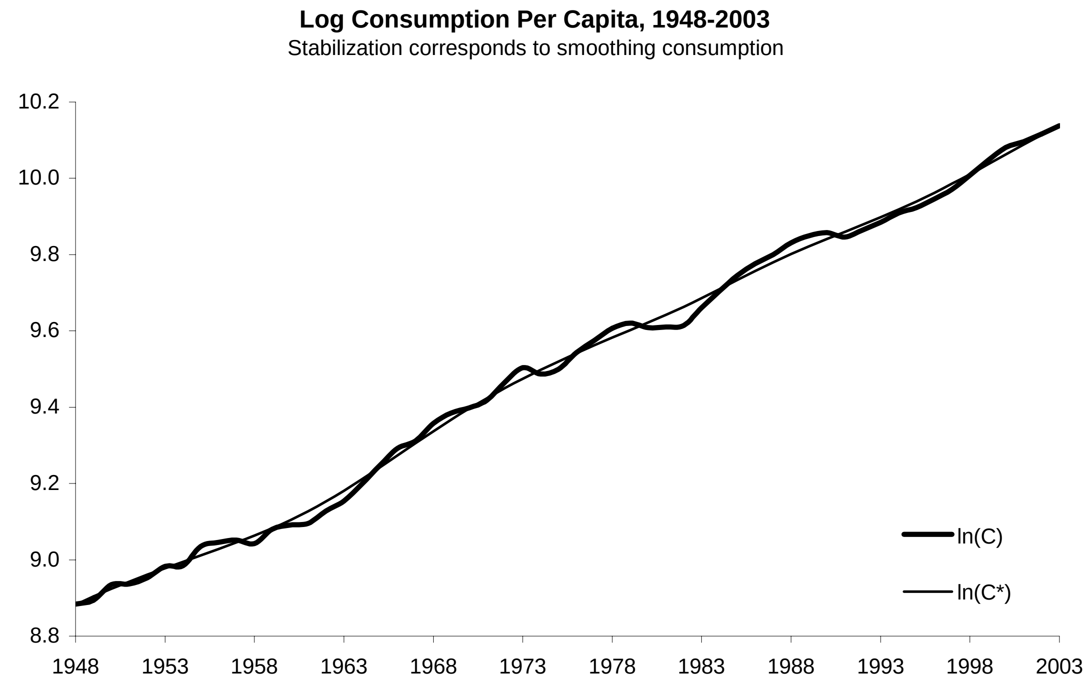
Panel C: Stabilization increases level of consumption rather than leave it unchanged

Article	Cost	Assumed Effect of Stabilization
Ramey and Ramey (1991)	1.7%	Increases output by avoiding mismatch between technology and economic conditions
DeLong and Summers (1988)	1.6 - 1.9%	Avoid temporary declines in output (implied cost is based on calculations in Box 2)
Cohen (2000)	1.0%	Avoid temporary declines in consumption
Gali et al (2003)	0.3 - 0.8%	Lower distortions in the economy (higher consumption from a given amount of labor)

Panel D: Stabilization affects long-run growth rather than leave it unchanged

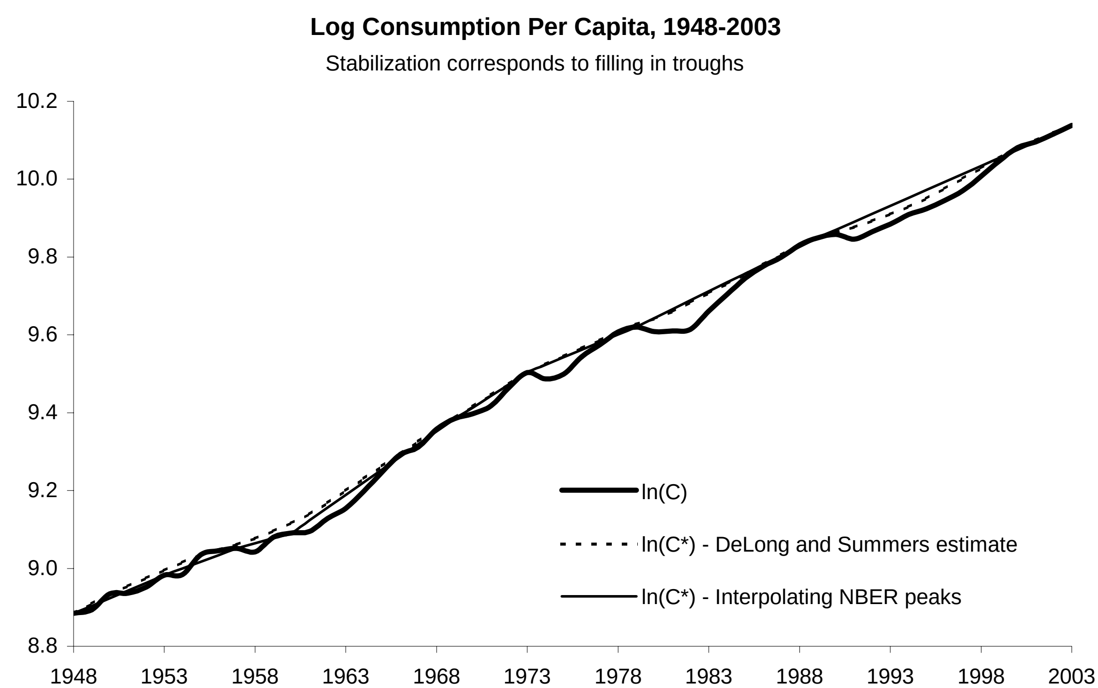
Article	Cost	Assumed Effect of Stabilization
Matheron and Maury (2000)	0.1 - 0.5%	Increases/decreases investment and long-run growth (cost only reflects this effect)
Epaulard and Pommeret (2003)	0 - 0.3%	Increases/decreases investment and long-run growth (cost only reflects this effect)
Barlevy (2004a)	7.5 - 8.0%	Allows the economy to achieve more growth from a given average level of investment
Barlevy (2004b)	0.3%	Avoids inefficient timing of growth (and thus lowers the cost of achieving growth)

Figure 1



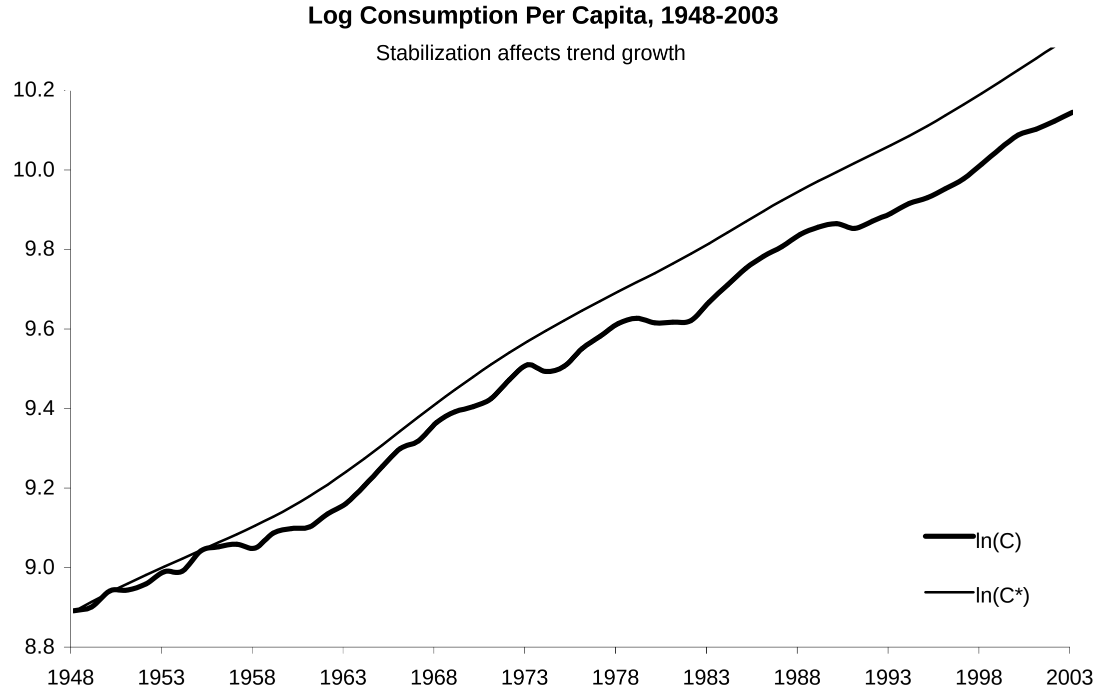
Sources: consumption data is from the Bureau of Economic Analysis; population data is from the Census Bureau

Figure 2



Sources: consumption data is from the Bureau of Economic Analysis; population data is from the Census Bureau

Figure 3



Sources: consumption data is from the Bureau of Economic Analysis; population data is from the Census Bureau

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