Risk and Consumption

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Summary

This paper offers an overview of the links between risk and consumption that are discussed in the theoretical literature and the empirical support these theories have received. In the theoretical literature we find two mechanisms whereby risk affects consumption. The first is precautionary saving. Greater risk regarding future income may lead to increased saving to create a buffer against potential bad events in the future. The second mechanism builds on the existence of transaction costs for durables. If it is costly to reverse a purchase of a durable, this creates a value of waiting for more information about future earnings and prices before making the purchase decision. This value may increase as risk increases so that a shift to higher risk may cause consumers to postpone purchases. In an empirical application, the relation between variations in financial volatility and consumption in Sweden is also investigated. Increased financial volatility is found to have a strong negative effect of on new car registrations.

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Risk and Consumption

John Hassler*

It is often argued that uncertainty about future economic conditions has had a tendency to increase over time, especially if we compare the golden decades after the Second World War (the 1950s and 1960s) with the present. Such a general statement is certainly hard to verify, but some indicators exist. For instance, the volatility on the Swedish stock market, measured as the standard deviation of nominal percentage return by holding an average share, has been almost three times as high during the current decade as during the 1950s and 1960s. Gottschalk and Moffit (1994) have shown that individual earnings in the US have become substantially more volatile over recent decades. Increasing risk, or uncertainty about the future could have effects on saving and consumption. Sometimes it is even claimed that increased uncertainty is one of the main factors behind the large increase in private saving that has occurred during the current Swedish recession. In spite of the abundance of arguments emphasizing the importance of variations in risk, very little empirical work has been done in this area. To some extent this is due to the obvious difficulty in measuring uncertainty. The subjective probability that agents assign to different possible future events is not observable and may not be well correlated with other, observable variables.

The purpose of this paper is twofold. First, I want to describe the links between risk and consumption that we find in the theoretical literature and the empirical support they have received. Second, I attempt to add to the empirical literature by measuring Swedish financial volatility and its variation and investigating the empirical relation between financial risk and consumption.

Risk can be taken to be synonymous with uncertainty regarding future events of relevance to the agent. The agent would like to know which events are going to occur but can only assign probabilities to them. In this paper I will use a narrow definition and consider the volatility of some variables that are exogenous to the individual and that affect the individual's future actions and/or his utility, e.g., wages and prices. An example of a risk increase is that the probability of getting a wage cut increases. We can decompose this change into two components, a change in expected or mean income and an increase in the volatility or standard deviation of income. It will be important to keep these two components separate though the rest of this article since I will define a risk increase as an increase in volatility only. In reality shifts in mean and volatility often occur at the same time. To study the effects of changes in volatility we therefore have to control for changes in the expected value.

We should also make a distinction between risk for an individual and the pooled risk of all individuals. Some individual risk disappears when we aggregate over individuals. This also means that they, at least in theory, may make insurance arrangements, privately or collectively, that reduce individual risk. The part of individual risk that washes out in the aggregate is called idiosyncratic risk and what remains is aggregate or systematic risk. The fact that idiosyncratic income risk can be mitigated by social security and other insurance mechanisms has to be taken into account when comparing the effects of increased volatility of for example wages and employment in different countries.

An important dimension that distinguishes different sources of risk is how fast risk is resolved. To fix ideas, let us consider the following example of two lotteries. In both cases the final outcome of the lottery is announced in, say, eight time periods from now. The first lottery consists of just one draw which is held at the end of the nine periods. The prizes are y_1 ,..., y_9. In the second lottery a draw is held at the end of each of the nine time periods. In each

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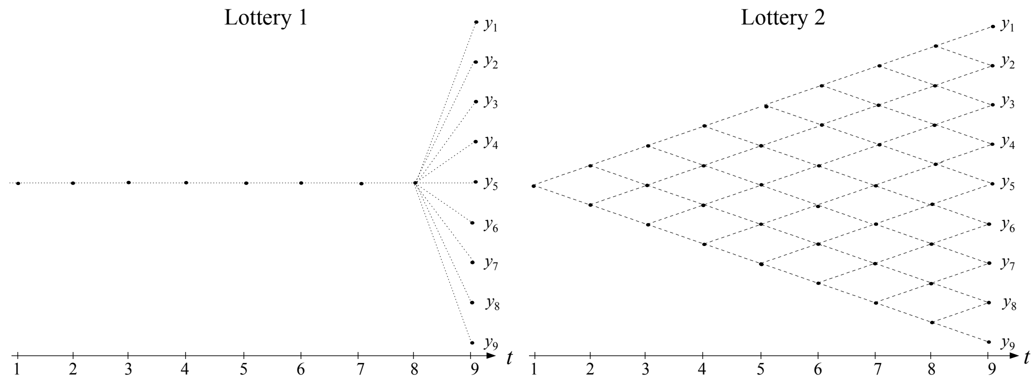
of these nine draws, the agent receives a ticket that can be a winning or a blank ticket. The probability of getting a winning ticket and its value are for simplicity assumed to be the same in all periods. The best outcome over the full nine periods is thus nine winning tickets and the worst is nine blanks.

Let us adjust the prizes and the probabilities of receiving them in the first lottery so that they exactly match the final outcome of the second lottery. Winning the best ticket in the first lottery, y_1, thus yields the same amount of money as winning nine tickets in the second and these events occur with the same probability. The distribution of the sum of the nine tickets in the second lottery then exactly matches the distribution of the prizes in the first lottery. The two lotteries are depicted in *Figure* 1.

By construction the distribution of the final outcomes, seen from period 1, are identical for the two lotteries. In this sense risk over the full planning horizon is the same for the two lotteries. The difference, however, is that in the second, but not the first lottery, risk is resolved gradually. The second lottery is thus characterized by a continuous flow of information about the final outcome – the prediction about the final result gradually becomes increasingly precise. Contrast this with lottery 1, in which the information flow is zero during the first eight periods. At the last period all information arrives in one big lump. This example highlights two concepts that will prove to be important: risk over the full planning horizon on one hand, and the current information flow on the other.

Figure 1. Lotteries



There is an empirically important difference between these two concepts. Consider a consumer who participates in lottery 2. Each period the consumer receives more information about the final outcome. For each draw he will then change his level of consumption. But a participant in the first lottery will not receive any information during the first 8 periods and his consumption should thus not fluctuate over time (unless, of course, there are other sources of risk). Similarly, if the lottery represents stochastic profits of a firm, the share price will fluctuate over time in lottery 2 but be constant during the first eight periods in lottery 1. This means that, in general, there to be a direct link between the current flow of information and the current volatility of endogenous forward-looking variables like consumption or asset prices. Long-run risk, like uncertainty over the final outcome in the lottery example may, on the other hand, have no relation to current volatility of endogenous variables. Most sources of risk should, of course, be considered as mixtures of the two lotteries. The outcome of an election, for example, is uncertain until all votes are counted. Forecasts of the outcome, however, may be perceived as better and better as election day approaches.

After these preliminaries, let us see what the theoretical literature has to say about the links between risk and consumption. There we find two principally different, but not mutually exclusive, mechanisms relating risk and consumption. The first mechanism is derived from the insight that people may want to protect themselves against bad outcomes by building up a precautionary stock of savings. This mechanism was formalized in a seminal paper by Leland

(1968). He showed that higher risk may reduce consumption by increasing the demand for precautionary savings by households.

The second link between risk and consumption is due to a quite different mechanism. Assume it is costly to reverse a purchase of a durable good. It may then be best to postpone the purchase decision until the consumer has more information about for example future income and prices. The more uncertain the future seems and the more one expects to learn by waiting, the stronger is the incentive to wait. This intuitive idea is formalized in the irreversible investment literature. McDonald and Siegel (1986) show that the value of waiting increases in risk. If trade in consumer durables involves transaction costs the irreversible investment model is applicable to consumer demand. A shift to high risk may then cause consumers to postpone purchases of durables. The fall in demand associated with a shift in risk could be important for the business cycle. Romer (1990) even argues that this mechanism was responsible for the Great Depression.

An alternative to postpone an investment decision is to try to by-pass the irreversibility. This can be done by using, for example a short term leasing contract or consuming a non-durable substitute for the durable. The incentive to engage in such substitution is also increasing in the flow of information.

Repeated irreversible investment decisions can be analyzed by combining the insights of McDonald and Siegel (1986) with the *Ss* inventory model introduced by Arrow, Harris, and Marschak (1951). This is done for labor demand in the presence of hiring and firing costs in Bentolila and Bertola (1990). In the *Ss* model, a control variable evolves stochastically over time. The more it deviates from a target level, the larger is the flow of losses. The control variable can be adjusted at any time, but there is a cost associated with adjusting. The optimal policy here can be described as variants of the famous *Ss* rule, proven optimal by Scarf (1959). The *Ss*-rule consists of three values: an upper and a lower trigger and a return point. A consumer facing transaction costs for cars for example, waits longer before changing his car than he would have done in the absence of such costs. Aggregation of *Ss* rules is difficult since demand and its sensitivity to shocks in general depends on the whole history of shocks. Important advances in the theory of *Ss* rule aggregation are, however, achieved in Caballero and Engel (1993).

The two theoretical links between risk and demand are addressed in section 1. I show that they have some different empirical implications. In particular, precautionary saving depends on risk over the full planning horizon. For the irreversibility mechanism, on the other hand, the current flow of information is the key risk measure.

In Section 2 I show that there is evidence of temporary fluctuations in financial volatility. It appears that the economy sometimes goes into periods of higher financial volatility. High risk periods are often, but not always, paralleled by high financial volatility on the US stock market. Furthermore, I find a strong positive trend in Swedish, but not US, financial volatility. This trend is not a recent phenomenon but appears to have prevailed during most of the postwar period.

In section 3, I discuss the effects which variations in financial volatility may have on demand. Theory predicts a relation between the overall measure of risk a consumer faces and his consumption decisions. I show some weak evidence of a positive relation between precautionary saving and financial volatility. Low levels of significance, however, call for caution. The evidence in support of the irreversibility mechanism is much stronger, however. Registrations of new cars are shown to be strongly related to variations in financial volatility, also when potential variations in precautionary saving have been controlled for. Section 4, lastly, concludes the paper.

1. Theoretical links between risk and saving

1.1 Precautionary saving

In order to illustrate precautionary saving, consider a simple consumption problem. A consumer is assumed to maximize expected utility in two periods. Income in period 2 is unknown when the consumption decision for period 1 is taken. The assumption of only two periods is made to simplify the exposition. Later in this section we extend the analyses to multi-period problems. For simplicity we also assume that the interest rate on borrowing or saving equals the rate at which the individual discounts the future. A necessary condition for a maximum is then that *marginal* utility, i.e., the utility gain of one extra consumption unit, in the first period equals *expected marginal* utility in the second, or

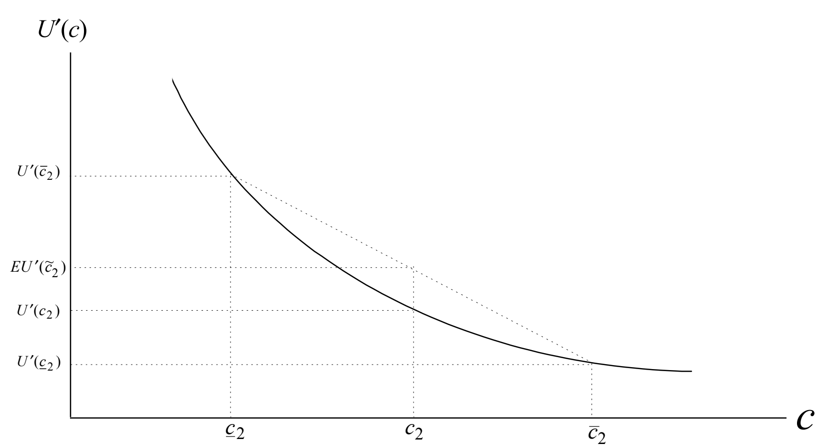
marginal utility in period 1 = expected marginal utility in period 2 (1)

This is an intuitive condition – it states that the expected consumption value of an extra dollar saved equals its consumption value today. If there is no risk, marginal utility in the second period is known. Then, but only then, does (1) imply that consumption should be equal in the two periods.

Now let us study the effect of increasing uncertainty about an income shock in period 2 if first period consumption is held constant. We assume that both very bad and very good outcomes become more likely. In case of a very good outcome, consumption will be high so marginal utility is low and the value of an extra dollar saved is low. The increased probability of this event tends to reduce saving. However, the probability of very bad outcomes also increases. In the event of a very bad outcome, marginal utility is high so the value of an extra saved dollar would be high. This thus tends to increase saving. It can be shown that the second effect dominates if marginal utility increases faster than proportionally as consumption decreases. The mathematical terminology for this is that marginal utility is convex in consumption.

To understand the statements in the preceding paragraph, consider the example in Figure 2 which compares two cases. In the first case there is no uncertainty, so consumption in the second period is known and so is marginal utility, which we denote $U'(c_2)$. In the second case, there is a 50% probability of a positive income shock, in which case we can consume $\overline{c}_2$, and a 50% probability of a negative shock, in which case we consume $\underline{c}_2$. The absolute values of the positive and negative shocks are equal, so the expected value of consumption is equal to c_2 also in the risky case. Expected *marginal utility* in the second case equals $EU'(\tilde{c}_2)$ in the figure. This is the average of the marginal utility in the two events. We see that this is larger than $U'(c_2)$ if marginal utility is convex, i.e., curved as in Figure 2. The mathematical terminology for this is that marginal utility has a positive second derivative, i.e., the *third derivative* of utility must be positive. The value of the third derivative quantifies the degree of convexity of marginal utility.

Figure 2. Marginal utility

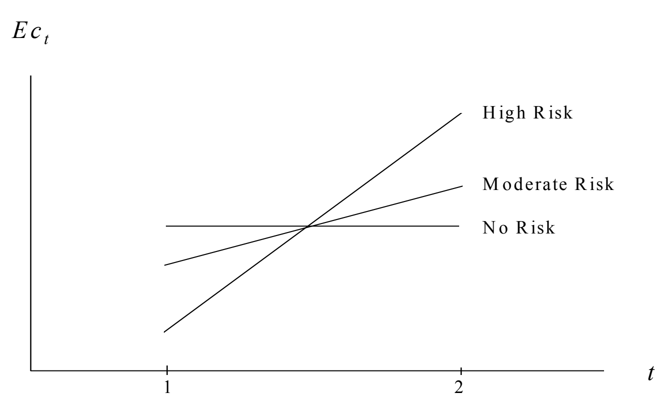


With convex marginal utility, increasing uncertainty about consumption in period 2 thus increases expected marginal utility, holding expected consumption constant. To restore the equality in (1), marginal utility today must go up and/or expected marginal utility tomorrow must fall. This is achieved by reducing consumption today, i.e., by increasing precautionary saving. Decreasing consumption (saving more) today increases the left-hand side of (1). By saving more, expected consumption tomorrow can increase which decreases the right-hand side. Both these effects help restore the balance in (1).

The higher the risk is, the larger should be the difference between expected consumption in period 2 and consumption in period 1. Put differently, the expected consumption path is steeper, the larger is income risk. This is depicted in Figure 3. Without risk, the consumer wants to smooth consumption perfectly over time. The slope of the expected consumption path is thus zero. The higher risk is, however, the stronger is the precautionary motive to save, so the slope becomes steeper as risk rises. We can quantify the strength of the precautionary saving motive as the slope of the consumption path. If the slope is steep, the consumer saves a lot in the first period to protect himself against the possibility of a bad outcome in the next period.

Now let us quantify the sensitivity of the consumption path to the level of risk. In particular, what is the relation between the expected change in consumption between the two periods and the amount of uncertainty about consumption in period 2? Kimball (1990) has shown that this relation has a very simple form – the slope of the expected consumption path is approximately proportional to the variance of consumption.[1]

Figure 3. Expected consumption paths and risk



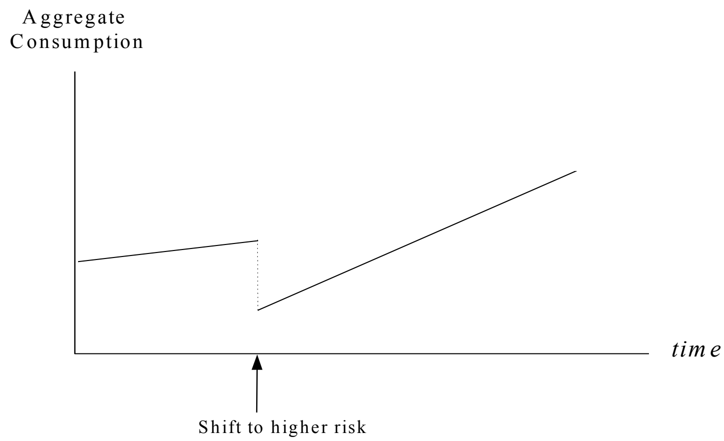
[1] It is proportional to the expected square of the consumption growth, to be more precise.

The proportionality factor is called the coefficient of absolute prudence and, for all risk averse utility functions it is positive if marginal utility is convex as in Figure 2. High prudence implies that the slope of the expected consumption profile increases a lot as risk increases. For many standard utility functions prudence is constant, i.e., it is not affected by changes in the level of consumption, wealth or prices. The constant absolute risk aversion utility function has a constant coefficient of absolute prudence which is also identical to its coefficient of risk aversion. Similar results apply to the constant relative risk aversion function. In general, however, risk aversion and prudence are two separate concepts. Quadratic utility, for example, implies risk aversion, but precautionary saving is always zero since marginal utility is linear and thus unaffected by mean preserving increases in variance.

The exposition above considers the two-period case. Extension to multiple periods is in principle straightforward. Analytical solutions to the path of optimal consumption are often difficult to derive, however.[2] In general we should expect prudent consumers to save more when risk increases. Greater saving increases future consumption possibilities by increasing wealth accumulation. Increased risk thus causes the expected growth rate of consumption to rise. Furthermore, if risk is purely idiosyncratic and thus cancels in the aggregate, an increase in risk increases saving and the actual, not only the expected, growth rate of aggregate consumption. When risk increases, consumption falls after which its growth rate increases, as is depicted in Figure 4.

[2] See Blanchard and Fisher (1989 p. 289) for a solution to a finite horizon problem with constant absolute prudence. Caballero (1990) provides further results for this utility function. Zeldes (1989) provides simulation results for the constant relative prudence case.

Figure 4. Aggregate consumption and a risk increase



Even if it is hard or impossible to find analytical solutions in the multi-period problem, we know that an analogue of (1), called the Euler equation, must hold;

marginal utility in period t = expected marginal utility in period t+1. (2)

It is then easy to establish that

marginal utility in period t = expected marginal utility in any future period. (3)

From (3) we see that what is important for how saving and consumption today react to increased risk, realized say s periods ahead, is how the risk affects expected marginal utility *at that date*. Assume that the consumer would choose a constant level of consumption, i.e., set $c_{t+s} = \underline{c}$ if there is no risk about consumption at date $t+s$. Now introduce a risk-creating variable y_{t+s} that is realized at date $t+s$. The mean of y_{t+s} is zero and the standard deviation σ_{t+s}. We could, for example, interpret y as unexpected changes in income. It is then easy to show that the change in expected marginal utility due to the risk, *ceteris paribus*, can be approximated as the product of three terms – the degree of convexity of marginal utility (i.e., the third derivative of the utility function), the variance of y, and the square of the sensitivity of consumption to y. If we interpret y as income, the last term is the marginal propensity to consume out of income.

It should be noted from (3) that risk over the full planning horizon is important. Consider the lottery example in the introduction. Increasing the variance of a ticket at any of the time periods has a direct effect on expected marginal utility that is proportional to the increase in the variance. As already noted, a positive effect on expected utility necessarily means a fall in consumption today. For example, a young person may fear that government pension systems will fail when he or she retires, say 20 years from now. If this risk rises precautionary saving will increase also if not much relevant information is likely to arrive soon. The effect of income uncertainty may even increase with the time horizon. This may occur in a life-cycle model where the propensity to consume out of income surprises increases over time.

The presence of risk causes people to save more so average wealth accumulation increases. Caballero (1991) argues that precautionary saving may account for over 60% of the aggregate net wealth stock in the US. Here Caballero relies on the constant absolute risk aversion utility function. In this case the coefficient of prudence is equal to the risk aversion coefficient he can use estimates of the latter as stand-ins for the former. This is a convenient way to by-pass the problem that few or no studies have attempted to estimate the coefficient of prudence directly. It is unclear, however, whether this result would survive if other utility functions, without this strict correspondence between risk aversion and prudence, where used. As discussed by Campbell in his article in this publication, it seems questionable on empirical grounds to assume constant risk aversion (and prudence also for that matter).

In the end, the sign and the magnitude of the coefficients of prudence are empirical issues. From introspection, however, we may argue that prudence should in any case be positive. The empirical evidence is, however, still scant. Only a few cross-section studies on the relation between saving and income risk exist. Skinner (1988) finds that consumers in supposedly risky occupations save more. Support for a positive cross-section relation between saving and measures of income risk is also provided in Guiso, Jappelli and Terlizzi (1992). In this study, however, only a small share of saving can be attributed to precautionary. Precautionary saving accounts for only 2% of households' net worth, on average.

Carroll (1994) reports a more important role for precautionary saving. Using panel data he computed individual income risk from its time series variation. This individual income risk variable is reported to be significant in regressions of individual consumption. Carrol carried out the following experiment to obtain a measure of the sensitivity of precautionary saving to variations in income risk. First, he computed the cross-section standard deviation of income risk. Then he calculated the change in consumption if an individual's income risk should increase by one cross-section standard deviation. Carroll reports that consumption should then fall by as much as between 2% and 5% of current income for an average consumer.

Given the potential importance of precautionary saving, indicated both by the theoretical results by Caballero (1991) and by popular belief, the scarcity of empirical evidence is disturbing. This is especially so for the lack of studies on the relation between variations in risk and variations in aggregate consumption. So far, the issue of the importance of precautionary saving must be regarded as an unsettled issue.

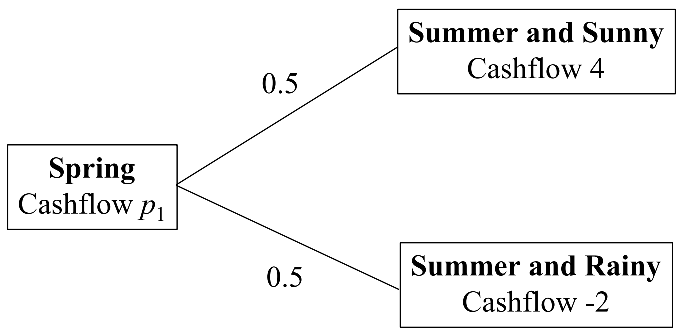
1.2 Irreversible investments

The irreversible investment literature builds on the following simple insight: Even if an investment opportunity has a positive net expected value, it may be optimal to wait before executing the investment. Consider the following example. An individual is considering to build an ice-cream stand at a beach. The building cost is 1 and is a sunk cost since there is no second-hand market for ice-cream stands. The investment decision is in this sense irreversible. Demand during the spring is known and gives a net cash flow of $p_1>0$. When summer comes it can be rainy, in which case net cash flow is -2 and it can be sunny, in which case cash flow is 4. The probability of each weather type is 0.5 (see Figure 5). The stand can be built in spring-time or he can wait before taking the decision until summer comes, when the weather is known. After summer the kiosk is useless.

The expected net profit of the investment if executed at once is $p_1+0.5\text{x}4-0.5\text{x}2-1=p_1>0$. The expected payoff of the strategy to wait until summer and only build if it is sunny is 0.5*4

-1=1. It is clearly optimal to execute the investment at once if and only if p_1>1.[3] Assume p_1 =1.25, so immediate investment is optimal. Now consider the effect of an increase in risk that keeps the expected value of investing now constant. Assume for example that the cash flow if it is rainy is -3 and if sunny 5. The expected value if he invests now is still p_1. The expected value if he wait, however, is now 0.5x5-1=1.5>p_1, so waiting is now optimal.

Figure 5. A simple irreversible investment problem



In the previous example, we can think of p_1 as the immediate temptation to invest. This has to be compared with the (informational) value of waiting, to use the phrasing in the seminal paper by McDonald and Siegel (1986). In the example, the value of waiting is the expected value of the saving to be made by not investing if the weather turns out to be rainy. The value of waiting in the first case is thus 0.5x2 and in the second case 0.5x3. The investment should be executed at once if and only if the immediate temptation to invest is larger than the value of waiting. In the example, the value of waiting increases in the level of risk. Here this was due only to the downside portion of risk. We can, however, easily construct examples such that the upside portion is also important in creating a value of waiting to build the stand.

In the literature on irreversible investments this very simple model is extended in several ways. Continuous time, infinite horizon and repeated investments are some examples. A

[3] The example can directly be generalized to risk-averse agents. This is done by thinking of the payoffs as representing utils instead of money.

common feature is that the cost of reversal creates a value of waiting to execute the investment. This value of waiting is lost when the investment is executed. By using comparative statics, McDonald and Siegel (1986) show that in their model, as in the simple example above, the value of waiting increases in risk. This is quite intuitive since the value of waiting stems from the flow of information associated with the risk. Similar results from comparative statics on the risk parameter are found in other settings by Pindyck and Solimano (1993).

Now let us introduce irreversibility into the introductory lottery example. Assume that the lottery represents uncertain income for a consumer and that he derives utility from consuming a non-durable c in the second period. The consumer can buy any amount of the non-durable in period 2 or alternatively buy a durable d in period 1 that produces the non-durable in period 2. The amount of the durable the consumer wants has to be specified already in period 1 and cannot be changed when period 2 arrives. Good d, however, is cheaper than c. We can think of c as car renting and d as buying a car. In the choice between the durable and the non-durable, the consumer thus has to balance the lower price of the former against the greater flexibility of the latter.

Take an individual who participates in lottery 1. Should he buy the durable or the non-durable in the first period? If he chooses the non-durable, the Euler equation gives that marginal utility in period 1 should equal expected marginal utility in period 2. But since no new information becomes available between period 1 and 2, there is no uncertainty about consumption in period 2. This means that marginal utility and thus also consumption should be equal in the two periods. The greater flexibility of the non-durable, which would allow c_2 to be contingent on new information in period 2, is thus of no value. It must then be optimal to take advantage of the lower price of the durable. Note that the long-run risk level, i.e., the risk associated with the full 9-period lottery, is irrelevant for this decision.

Now consider lottery 2, with its continuous flow of information over the 9 periods. First let the consumer optimize when consuming non-durables. Seen from the first period, the

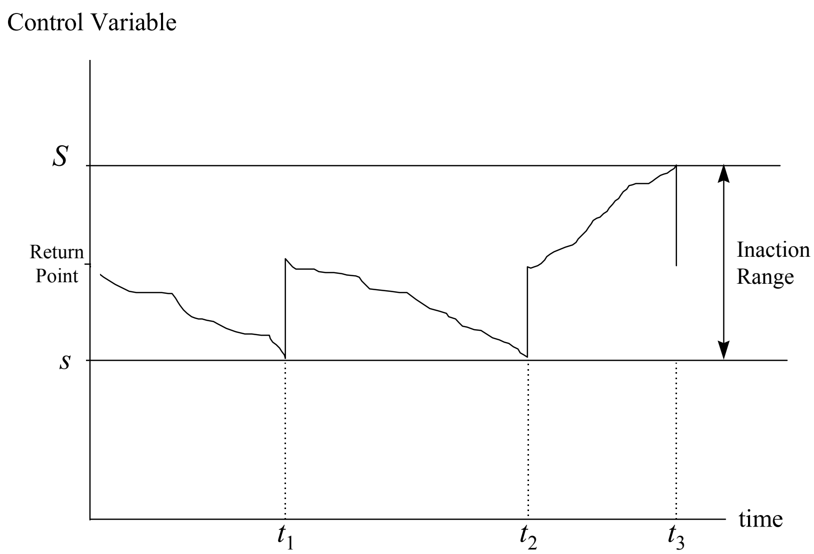
Euler equation implicitly gives a value for the optimal value of c_1. For period 2 we get a *decision rule*, rather than a specific value of c_2. For each possible event, here each possible outcome of the lottery in period 2, the rule specifies the *optimal* level of c_2 for that event. If the prize is high, c_2 is high and vice versa so c_2 is a function of p_2 , the lottery prize in period 2.

Define d_2^* as the optimal level of durable consumption conditional on consuming the durable. d_2^* can by definition not be a function of p_2. This means that the optimal value of c_2 will only occasionally coincide with d_2^*. Since c_2 was optimal, given the new information, this implies that, on average, there is a loss by not having the flexibility to make second-period consumption contingent on the lottery prize in that period. Greater second period risk makes c_2 more variable. This means that the expected absolute deviation between d_2^* and c_2 would increase. Greater second period risk thus tilts the tradeoff between greater flexibility and lower price in favor of the non-durable. Here it is also straightforward to extend the analysis to durables with a longer life than over the next period. The negative consequences of binding one's consumption plan by buying a durable that is costly to change increases as the expected information flow during the expected holding period increases.

A trade off between a durable and a non-durable was modeled in the above example. As regards durables, there is also, as noted in the introduction, a tradeoff between purchasing a durable now and waiting for new information before taking the purchase decision. This tradeoff can be modeled in the classical inventory model; see Arrow, Harris, and Marschak (1951. The optimal policy here is an *Ss*-rule. *Figure* 6 provides an illustration of such a rule. The control is held within the band given by the triggers *S* and *s*. Inside the band it is left to drift on its own. When it hits either of the triggers it is brought back into the band. This happens at t_1 and t_2, when the control variable has hit the lower trigger and is moved up to the return point and at t_3 when it is moved down.

The *Ss* inventory model is applied to consumer demand for durables in Hassler (1996b). I assume that a household derives utility from a continuously depreciating durable, for example a car. Due to transaction costs it is costly to make a discretionary change in the value (size) of the durable. To change car may, for example, involve search costs and losses due to imperfect information on the used car market. The optimal level of the stock in the absence of transaction costs, the frictionless target, is a function of some stochastic variables, e.g. prices and wealth. Shifts in these variables cause the target to shift. The level of risk is modeled as the standard deviation of the target per unit of time. Movements in the target and depreciation both cause the current stock to deviate from the target as long as the stock is not adjusted. Such deviations incur a loss that increases monotonically in the absolute value of the deviation. This is then an example of a model where the *Ss* rule is the optimal policy.

Figure 6. An *Ss* rule



The loss incurred by the current deviation from the target can be reduced by adjusting the stock. This can be called the temptation to adjust. By waiting a moment before making the decision to adjust, the agent can use more information and potentially take a better decision. This creates an option value of waiting to adjust that is directly related to the current flow of information. Higher risk means a higher flow of information and thus a higher value of waiting. This implies that the consumer is willing to accept larger deviations before adjusting.

We thus have a clear link between the triggers and the level of risk. A shift to higher risk widens the inaction range; see Hassler (1996b) for formal results.

The immediate effect of increased risk is thus that adjustments, i.e., purchases, are postponed. This causes purchases to fall temporarily. This is typically not important for average demand in the long run. Eventually, the triggers defining a wider inaction range also start to get hit. However, in Hassler (1996b) I show that the short run may be long enough to be of importance in a business cycle context. The fall in purchases after an increase in risk may still be substantial several quarters after the increase. The link between individual behavior and aggregate variables may, however, be quite complicated. Demand, i.e., purchases at every moment, as well as its sensitivity to risk shifts and other shocks, depends on the current distribution of individuals over their respective band. This distribution depends on the whole sequence of realized shocks and risk shifts. Typically, but not always, there is thus no stable function relating demand to current shocks and the risk level; see Caplin and Spulber (1987), Caballero and Engel (1991 and 1993) and Hassler (1996a).

1.3 Precautionary saving versus irreversibility effects

We have seen that the implication of both precautionary saving and irreversibilities is that increased risk leads to reductions in demand. Some important differences between these two mechanisms should be noted. First, the *current* flow of information is the most important risk measure for the irreversibility mechanism. On the other hand, the crucial parameter for precautionary saving is long-run risk over the full planning horizon. Temporary increases in the flow of information may also have larger effects than permanent increases under the irreversibility mechanism (Hassler, 1996b). For precautionary saving, we expect the opposite.

The current flow of information should in principle be easier to estimate from observable variables than the long-run risk. Using the rational expectations hypothesis, we expect forward looking variables like consumption and stock market values to be more volatile when the current flow of information is high. At each point in time when new information is received, we would generally see some shift in forward-looking variables like consumption and asset prices. But high long run risk is not necessarily related to high current volatility of observed variables. Increased uncertainty about old age pensions, for example, may not be correlated with increased volatility of observable variables at the time of the increase in uncertainty. The empirical implications of the irreversible investment model should thus be easier to test on time-series data than the implications of precautionary saving. In the empirical section, I therefore focus on a risk measure based on the current volatility.

Second, the irreversibility effect is due to neither prudence nor risk aversion. Also for a risk neutral consumer the flow of information may create an option value of waiting that increases in the level of risk.

Third, the irreversibility effect is only relevant for durables. Precautionary saving, on the other hand, should affect non-durables and durables in principally the same way. An increase in risk that increases precautionary saving reduces the frictionless target for the durable stock. This difference in how consumption of durables and non-durables react to risk will be useful when empirically distinguishing irreversibility effects from precautionary saving effects.

Fourth, the dynamic effects of changes in aggregate risk are different for the two mechanisms. Increased precautionary saving shifts the level and slope of the consumption profile, but nothing else happens dynamically. A widening of the inaction band in an irreversibility model, on the other hand, has different short and long-run effects. Just after the shift few consumers are near their new trigger levels. Few or no consumers then adjust so that purchases are small or zero. As time passes, however, depreciation, wealth and other shocks in the model move consumers so that more of them approach the trigger levels. Eventually purchases pick up and the long-run effect becomes ambiguous.

2. Does risk fluctuate on the Swedish stock market?

As noted in the introduction, we can think of two kinds of risk – long-run risk and the current information flow. The empirical work in this paper focuses on the relation between the latter risk type of risk and demand. Stock markets are supposedly quite efficient in processing the continuous flow of information. Hence, variations in the current flow of information should be detectable on the stock market as periods of higher than usual volatility. I thus examine the evolution of a stock market index to try to find such periods.

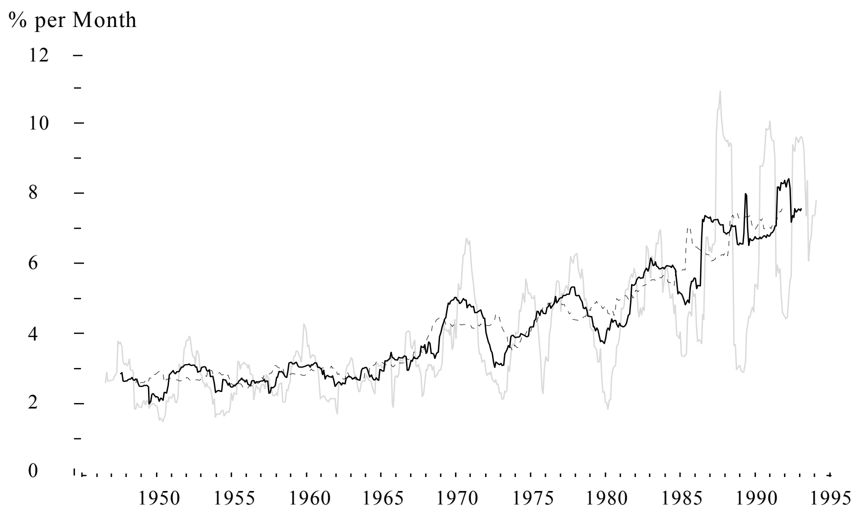
The typical household does not own much public stock and a large portion of its wealth is expected future labor income. Despite this, shifts in the volatility of the stock market may very well be good indicators of shifts in the volatility of variables relevant to the households' purchasing decisions. Fluctuations in risk may, for example, be due to variations in the volatility of a stochastic trend common to both the value of the firms and household wealth, such as technology shocks. In this case the variances of household wealth and the stock market, as well as their levels, have a positive correlation.

However, a positive correlation between the level of the stock market and household wealth is not necessary for their volatilities to be positively correlated. Another potential source of volatility is variations in the share of labor income. Such share variations would tend to give negative correlations between the value of firms and human capital. Nevertheless, increased volatility in income shares will increase the volatility of the stock market as well as of human capital. We may also think of cases in which the levels are uncorrelated while the variances are positively correlated.

2.1 A stochastic state model

A straight-forward way to estimate a time varying volatility is to use some kind of moving average.[4] We could for example estimate the standard deviation of the stock market at *t* using the realizations a certain number of months before and after *t*. Such moving standard deviations are plotted in Figure 7. The gray line represents the standard deviation during the period starting 6 months before and ending 6 months after the observation date, i.e., it covers one year centered around the observation date. The solid black line represents the standard deviation for the centered 3-year period and the dashed line the 5-year period. In Figure 7 we see that the standard deviations appear to be changing over time. Along with a clear upward trend, there seem to be extended periods of higher than average volatility.

Figure 7. Moving standard deviation on the Swedish stock market



Moving standard deviations produce estimates that change quite smoothly over time, even if the actual volatility changes abruptly. This may make it difficult to capture the effect of an abrupt change in risk. To identify high risk periods I thus used another method, pioneered by Lindgren (1978) and introduced into economics by Hamilton (1988, 1989). The

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[4] A more elaborate procedure is to use an ARCH (AutoRegressive Conditional Heteroskedasticity) model in which conditional volatility is a function of lagged and squared innovations of a GARCH (Generalized ARCH) where also lagged values of the volatility affect current volatility. See Bollerslev, Chou and Kroner (1992) for an overview of ARCH models.

idea is to assume that there exist distinct high and low risk periods. By using the realizations of the stock market, we can calculate the probability for each sample date that the economy was then in the high risk state. This method is likely to be well suited for dating shifts to higher risk.

I assume that the economy switches stochastically between two risk states, $s_t = 0$ or 1. When $s_t = 1$, risk is higher in the sense that the stock market index is more volatile. The current state of the economy, s_t, is not observable. The stock market index, w_t, is assumed to follow a generalized random walk. I allow for state shifts to be associated with shifts in volatility as well as with shifts in level and drift. The average growth rate of the stock market is μ_0 in risk state 0 and μ_1 in risk state 1. I also allow the stock market to jump by μ_2 when the risk state shifts. If the state shifts from 0 to 1, the log of the stock market shifts by μ_2 and if the state shifts from 1 to 0 it shifts by $-\mu_2$. I also allow a deterministic time trend in the volatility of the stock market. The standard deviation of the stock market in absence of state shifts is thus $\lambda_0+\omega t$ in state 0 and $\lambda_1+\omega t$ in state 1.[5]

We can interpret this model in the light of the lottery example in the introduction. Consider an infinite version of the lottery. During some intervals of time (the high risk state), many draws are held per unit of time; during others few are held (the low risk state).

The state is assumed to follow a first-order Markov process such that the probability of a state shift given that the current state is i equals γ_i. I will allow different transition probabilities in the two states so that one of the states may be shorter than the other.

We cannot observe in which state the economy was at a particular date. By observing the stock market, however, we may draw inference about the likelihood that the economy was in the high risk state, given our parameter estimates. Assume, for example, that we estimate

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[5] See the appendix for a formal description of the model.

that λ_1-λ_0>0, i.e., that state 1 is more risky than state 0. If we then observe a period with a highly volatile stock market, we concludes that the likelihood is high that the state was 1 during that period. The limits of the model are estimated by maximizing the likelihood function implied by the model. The details of the estimation can be found in Hassler (1996a).

2.2 Results

The state model was estimated on Swedish stock market data. I used the series for the nominal return on the Swedish stock market including dividends computed by Frennberg and Hansson (1992).[6] The model was estimated on monthly data for the periods 1946:1-1994:6 and 1960:1-1994:1.[7] The estimated parameters are presented in Table 1.[8] The last row reports the estimated increase in the standard deviation of the return when the high risk state is entered. We see that for both sample estimates, the standard deviation increases by around one percentage point when the high risk state is entered. For the longer sample, this increase is highly significant. We also find that the time trend is positive. The estimates of 0.594 and 0.800 imply an increase in volatility of 0.071 and 0.096 percentage points per year. In Hassler (1995) I show that this trend appears to be due to an increased sensitivity to the world markets. The alternative explanation, that the trend comes from increased volatility of domestic news flows received no empirical support. Furthermore, no trend in volatility can be found on the aggregate world market or on the US stock market.

The estimated transition probabilities are much lower than 50%, which indicates a substantial persistence in the level of risk. The average duration of the respective states can be

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[6] Ideally we want a real return. The consumer price index is probably unsuitable as a deflator since it contains seasonalities and other high frequency variation. However, the volatility in ex post one-month nominal stock market return is not likely to be driven by one-month inflation forecast errors. I have thus used nominal returns. In Hassler (1995) I also found practically the same trend in the standard deviation of excess returns, i.e., nominal stock returns minus nominal short interest rates.

[7] I have also estimated the state model on samples starting in 1918 and 1930 with remarkably close results.

calculated as the inverse of the transition probability (γ_i^{-1}). Using this we find that the low and high risk states have an average duration of 13 and 10 months for the longer and 27 and 6 months for the shorter sample.

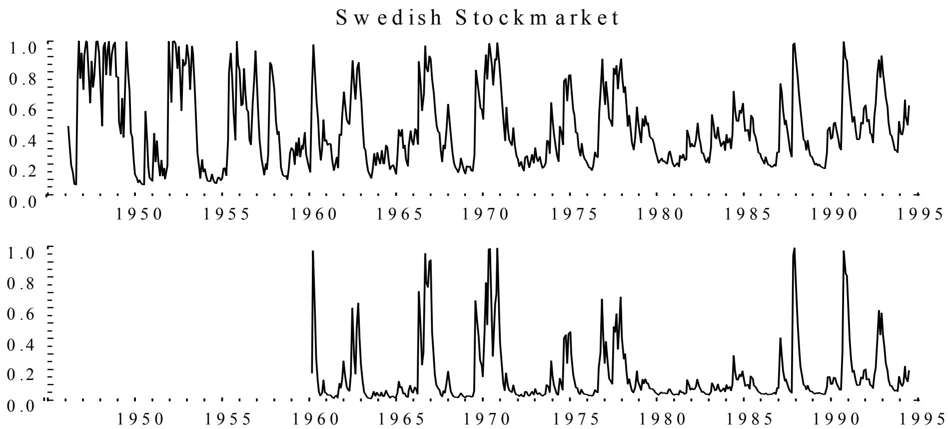
Using the estimated parameters of the model I computed the probability of the high risk state conditional on the realized series of wealth. In the upper two panels of Figure 8 I show these probabilities, calculated using the two different sample lengths. In the figure we see that high risk periods have occurred in Sweden with high probability during 1962, 1966 1970, 1987,1990. In particular the latter two episodes are directly related to periods of international high volatility (the stock market crash and the Gulf war); see Hassler (1995) for an attempt to estimate a bivariate model of the Swedish stock market where an international and a domestic news process are estimated simultaneously.

Table 1. State model parameters Swedish stock market

	1946-1994			1960-1994		
	Estimated value, % per month	Standard Error	*t*-value	Estimated value, % per month	Standard Error	*t*-value
γ_0	7.712	3.637	2.12	3.610	1.890	1.91
γ_1	9.660	4.721	2.05	16.855	8.643	1.95
μ_0	1.885	0.292	6.46	1.276	0.300	4.25
$(\mu_1-\mu_0)$	-2.041	0.463	-4.41	-2.771	1.205	-2.30
μ_2	0.174	1.128	0.15	-3.194	1.632	-1.96
$\omega*100$	0.594	0.051	11.77	0.800	0.116	6.88
λ_0	0.750	0.149	5.04	1.371	0.199	6.87
$(\lambda_1-\lambda_0)$	0.917	0.217	4.23	1.243	0.696	1.79

[8] The estimation used the recursive algorithm in Hamilton (1988). Reported *t*-statistics come from the inverse of the estimated Hessian.

Figure 8. Probability of high risk state



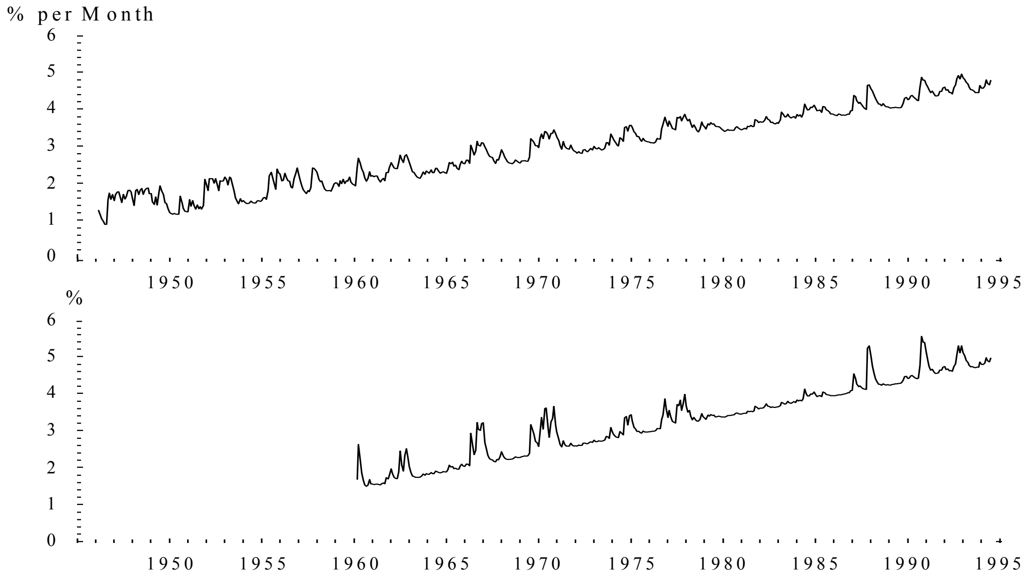
We can also use the estimated model to predict the volatility for each month of the sample. The predicted volatilities are plotted in Figure 9. There we see that the trend increase in volatility is very large compared to the stationary fluctuations caused by state shifts.

The conclusions of this section can be summarized as follows:

i) There is evidence of temporary periods of higher than usual stock volatility on the Swedish Stock market. These high risk periods have an approximate average length of one half to one year. The risk increase during these periods is around 1 percentage point per month.

ii) There is a strong upward trend in the volatility on the Swedish stock market. This trend dwarfs the stationary risk variation associated with risk state shift.

Figure 9. Estimated standard deviation on Swedish stock market



3. Risk and demand in Sweden

In the preceding section we found evidence of a strong trend in stock market volatility and stationary fluctuations around this trend. What consequences may this have for demand?

Consider the precautionary saving mechanism first. Shifts in precautionary saving require shifts in long-run risk – a temporary increase in volatility may not be very important for the volatility of lifetime earnings of individuals seen over their whole planning horizon. It is possible, of course, but clearly not obvious, that long-run risk is high when stock market volatility is high. The model for shifts in stock market volatility does not include movements in risk over long horizons and the temporary shifts in risk, induced by shifts in the risk state, are quite short lived. It is thus unclear whether such shifts should have any substantial effect on precautionary saving. The positive trend in volatility, on the other hand, may have a substantial impact on precautionary saving. However, this is empirically hard to verify from time-series data since the informational contents of a trend tends to be limited.

Putting these ambiguities aside, I first ran regressions in which I used the change in (the log of) spending as a share of disposable income as the dependent variable. The change in the probability of the high risk state, its lag, a constant and seasonal dummies were used as independent variables. I report results for both sets of high risk state probabilities that were presented in Figure 8. The consumption dataset covered quarterly observations from 1963:1 through 1994:2 for spending on cars, other durables, partly durable goods, food, and other non-durables and a regression was run for each of the goods categories. The high risk probabilities are quarterly averages of the monthly estimates.

We would expect the precautionary saving mechanism to affect all goods. To the extent that precautionary saving increases when stock market volatility is high, this would give negative regression coefficients on the probabilities of the high risk state in all regressions.[9] In the regressions of durable goods we may also pick up potential effects of risk variations due to the irreversibility mechanism. The results were negative, however, the *t*-statistic on the high risk state probability with the largest absolute value was -1.12.

Regressions of first differences tend to emphasize high-frequency relations. Regressions of levels, on the other hand, are more suited to pick up relations on lower frequencies, which may be informative. Here I added a time trend to the set of independent variables and excluded the lagged state probability. The coefficients on the high-risk state probability are presented in Table 2. Due to a substantial residual autocorrelation I used the relatively conservative Newey-West t-statistics.[10] In the table we find that all coefficients are negative and of large absolute size – spending on food, for example, is estimated to be around 8% lower in the high risk state. However, none of the estimated coefficients are significant at

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[9] It is reasonable to believe that the agents have better information about the true risk state than our estimates. However, this does not cause any inconsistency of the parameter estimates in this case (Hassler, 1994).

[10] The regressions are fairly ill-behaved with low DW-statistics so it seemed necessary to use Newey-West standard errors, see Newey and West (1987). Note also that since I used estimated regressors, all significance levels are at best approximations to the true levels and must be interpreted with caution.

reasonable levels. We should also note that in these regressions we did *not* control for the fact that a shift in state may be associated with changes in expected future earnings.

Table 2. Regression of log consumption shares

	State Model 1947-94		State Model 1960-94	
Cars	-0.235	(-1.45)	-0.110	(-0.63)
Other Durables	-0.105	(-1.40)	-0.083	(-1.36)
Partly Durables	-0.108	(-1.48)	-0.080	(-1.02)
Food	-0.084	(-1.52)	-0.074	(-1.29)
Other Non-Durables	-0.120	(-1.47)	-0.126	(-1.48)
Sum of all above	-0.031	(-0.81)	-0.018	(-0.56)

Notes:
Newey-West t-statistics computed with four lags in parentheses,
120 degrees of freedom

Now let us study the irreversibility mechanism separately. The precautionary saving mechanism affects durables and non-durables in a similar fashion. We can thus use consumption of non-durables to control for variation in precautionary saving.

Recall the discussion in Section 2. There we concluded that high stock market volatility is a good indicator of a high (expected) flow of information to the stock market. We also found that an increase in this flow increases the value of waiting. We expect shifts to higher volatility to cause a fall in purchases of durable goods, given that the flow of information to households is large during high volatility periods.

To provide a null hypothesis of no irreversibility mechanism, I thus assume that all agents have access to perfect capital and leasing markets and that no transaction costs exist. With access to a perfect leasing market the distinction between durables and non-durables lose meaning. Leasing a durable one period is just like consuming a non-durable and the cost per period of using a durable good equals the depreciation plus the interest rate times the price of the durable.[11] If the consumer has Cobb-Douglas utility he will use a constant share of each period's spending on leasing costs for the durable. The stock of durables should then be proportional to non-durables consumption. Note, however, that this implies that it is the stock of durables, not purchases, that is proportional to non-durables consumption. (See the Appendix for a formal derivation of this.) A test of the irreversibility hypothesis is whether measures of risk enter significantly into variants of a regression based on this idea.[12] As above, the measures of risk are the two series of the probabilities that the economy is in the high risk state. I also included more lags of non-durables consumption to allow a slow adjustment of the durable stocks.

Note that if the effect of higher risk is only to increase precautionary saving or to change the expected value of future income, we do not expect the probabilities of the risk states to help predict variations in durables purchases. In this way, the specification controls for variation in precautionary saving and expected changes in future income. If, on the other hand, there is also an irreversibility effect, which only affects durables demand, the coefficient on the high risk probability should be negative.

The probabilities that the economy is in the high risk state were estimated monthly. Since the irreversibility mechanism in theory is short run in nature, we need high frequency data to find it. Unfortunately the Swedish national accounts only include quarterly consumption data. I thus used registrations of new cars to represent purchases of durables in real terms and retail sales of food to represent non-durable purchases. The data-set covers observations from 1968:1 to 1994:10. To account for the strong seasonality in registrations a dummy for each month was also included in the regression.

In the regression of changes in registrations of new cars against changes in the risk, I found a significantly negative effect on registrations when the economy goes into the high risk state, i.e., when financial volatility increases. For the two series of estimates of high risk state probabilities, I estimated the coefficients on the second lag, two months after the change

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[11] I disregard uncertainty that could give rise to capital gains by holding the durable.

[12] See the Appendix for the derivation of the regression.

in high risk state, to -4,100 and -5,400 cars. As seen in Table 3, these effects are significant at any standard level. The negative effects on registrations are large, amounting to over 20 % of the average number of registrations per month, which was 19,626.

As noted above, regressions of first differences tend to emphasize high frequency relations between the series. I thus ran level regressions in addition to first difference regressions. The coefficients on the two different state probabilities lagged two months were estimated to -3967 and -3304. These regressions are quite ill-specified, with high error auto-correlation. Nevertheless, they indicate that the negative effect of shifts in risk state on car purchases is quite persistent, i.e., it is strong on low frequencies.

Table 3. Effect of changes in risk state on car registrations

	State Model 1947-94		State Model 1960-94	
Contemporaneous	345	(0.15)	1201	(0.58)
1 month lag	638	(0.39)	-652	(-0.42)
2 months lag	-5393	(-2.30)	-4100	(-2.44)
Durbin–Watson	2.51		2.53	
R^2	0.43		0.44	
Degrees of freedom	280		280	

Note:
* Newey-West t-statistics computed with four lags in parentheses

I also ran the regressions on shorter samples, excluding the first 5 years of observations. The total effect of changes in the risk state did not change much. The lag structure, however, changed, with a tendency for a quicker response of registrations (see the Appendix).

4. Conclusion

In the theoretical discussion of this paper we have seen that the level of risk as well as its variation may have important effects on consumption and saving. The overview of earlier empirical work, however, showed no clear evidence of the extent to which variations in uncertainty are responsible for the sometimes large variations in observed saving and consumption. Thus, whether the dramatic drop in consumption that occurred in Sweden during the early 1990's was due to increased uncertainty is still a very open question. It was also shown that precautionary saving is affected by uncertainty over the individual's full horizon. Due to the inherent difficulty in measuring the individual's perception of his lifetime uncertainty, it seems unlikely that it will soon be possible to quantify precautionary saving and its volatility unambiguously.

Quantifying the importance of the irreversibility mechanism seems to be a route with fewer obstacles. There should be a close link between the volatility of observable variables and the rate at which new information reaches the household. In the empirical section, I report that financial volatility in Sweden has increased steadily over most of the postwar period. In addition to this trend it is possible to identify periods when volatility is higher than its trend. Theory indicates that such periods could be associated with lower demand, i.e., lower rates of purchases of durables. I find evidence supporting this prediction. Demand for cars falls substantially more after an increase in risk than would be predicted if no irreversibility effects were present. Both the size of the effect and the length of the high risk periods suggest potential importance for the irreversibility mechanism in the business cycle. The dynamics of the response appear to be quite unstable, however, possibly due to changes in recording practices at the statistical authorities. Changes in car dealers' inventory practices may also change the lag structure over time.

The degree of the effect of financial volatility in Sweden appears to be at least as large as in the US. For example, Hassler (1996a) found that car purchases fall by 6-8% when a high risk state is entered. This high sensitivity to risk was obtained despite the finding that financial volatility increases relatively less in Sweden than in the US when a high risk state is entered. Such a fall in demand could in principle be detrimental to general business conditions. Before drawing such a conclusion, however, it should be recalled that the effect of risk shifts on purchases may be large, but is temporary in nature. It is thus far from obvious that it should have a large effect on production.

There is also some, but much weaker, evidence of changes in precautionary saving in response to higher financial volatility. Consumption as a share of disposable income was estimated to fall substantially when financial volatility increases temporarily. The point estimates indicate large effects. The significance levels, however, are low so the estimates have to be interpreted with caution. Furthermore, the relation between financial volatility and precautionary saving relies on several links that may be quite weak. First, it is not clear that high volatility of financial markets is associated with high long-term risk. Second, shifts to high risk periods may be associated with downward revisions about expected future income. Then also a risk neutral consumer should reduce consumption when entering high risk periods.

The overall conclusion of the paper is that the importance of variations in risk for demand, business cycles and general business conditions is still a very open issue. From theory we find that the effects of variations in risk may be large, but the empirical evidence remains scant.

Appendix

A. 1. A state model of financial volatility

I assume that the economy switches stochastically between two risk states, s_t = 0 or 1. The state follows a first-order Markov chain with continuation probabilities γ_1 and γ_2. When $s_t = 1$, risk is higher in the sense that the stock market index is more volatile. The current state of the economy, s_t, is not observable. The stock market index, w_t, is assumed to follow a generalized random walks;

$$\Delta \ln w_t = \mu_0 + (\mu_1 - \mu_0)s_t + \mu_2 \Delta s_t + \left(\lambda_0 + (\lambda_1 - \lambda_0)s_t + \omega t\right)\vartheta_t \tag{A1}$$

where Δ is the first difference operator and ϑ is a sequence of i.i.d. standard normal innovations. (A1) together with the transition matrix for the states and an assumption about the initial state of the economy define the loglikelihood function which is maximized numerically using the recursive algorithm in Hamilton (1988). The probability that the economy is in the high risk state at time zero is set to the unconditional probability.

A.2. Derivation of regression model for durables spending

Assume a Cobb-Douglas utility function.

$$U = K^{\alpha} C^{1-\alpha} \tag{A2}$$

where K is the stock of durables and C is the amount of non-durables consumed. The cost of using (leasing) K is $(r+\delta)PK$ where r is the interest rate, δ is depreciation and P denotes the relative price of K. The first-order condition for intra-temporal utility maximization then implies that

$$\begin{aligned} K_t &= \frac{\alpha}{1-\alpha}\frac{1}{(r+\delta)P_t}C_t \\ &\equiv \theta_t C_t . \end{aligned} \tag{A3}$$

With Cobb-Douglas utility the agent wants to spend constant shares on durables and non-durables. Then note that the relation between stocks and purchases (D) of durables in real terms is given by

$$D_t = K_t - (1-\delta)K_{t-1}. \quad \text{(A4)}$$

Using (A3) and (A4) and taking first differences we have

$$\begin{aligned} D_t &= \theta_t C_t - (1-\delta)\theta_{t-1}C_{t-1} \\ \Delta D_t &= \Delta\theta_t C_t - (1-\delta)\Delta\theta_{t-1}C_{t-1}. \end{aligned} \quad \text{(A5)}$$

A test of the irreversibility hypothesis is whether measures of risk enter significantly into variants of (A5). The measure of risk will be the conditional probability that the economy is in the high risk state, and two lags will be included to allow for a delayed response. I also include more lags of $\Delta\theta_t C_t$ to allow a slower adjustment of the durable stocks. This results in the regression models

$$\Delta D_t = \sum\nolimits_{i=0}^{2} \alpha_i \Delta P(s_{t-i}=1) + \sum\nolimits_{i=0}^{5} \beta_i \Delta\theta_{t-i}C_{t-i} + \varepsilon_t. \quad \text{(A6)}$$

Monthly seasonal dummies are also included in the regression. The results are presented in Table A.1.

Table A1. Regression results

	State Model 1947-94		State Model 1960-94	
α_0	345	(0.15)	1201	(0.58)
α_1	638	(0.39)	-652	(-0.42)
α_2	-5393	(-2.30)	-4100	(-2.44)
β_0	3470	(1.16)	4127	(1.35)
β_1	-7728	(-1.44)	-6980	(-1.32)-
β_2	-7405	(-1.70)	-6999	(-1.63)
β_3	1067	(0.22)	984	(0.20)
β_4	5679	(1.07)	5873	(1.12)
β_5	7649	(1.69)	8448	(1.83)
Durbin–Watson	2.51		2.53	
R^2	0.43		0.44	
Degrees of freedom	280		280	

Note:
* Newey-West t-statistics computed with four lags in parentheses

When the first five years of observations are excluded, the estimates for α_1 - α_3 are -3200, 2744 and -3543 for the 1947-94 state probabilities and -2188, 1946 and -2590 for the 1960-94 state probabilities.

A.3. Data sources and definitions

Stock market

Swedish monthly stock market returns are calculated as first differences of the logarithm of the nominal stock market index with reinvested dividends, computed by Frennberg and Hansson (1992).

US monthly stock market returns are first differences of the log of the nominal S&P500 index from CITIBASE.

Quarterly consumption data

The dependent variables in the regressions are the logarithms of nominal spending on different goods categories as a share of disposable income. Sources for data from 1963:1, N 1973:35, N 1981:2.1 and for data from 1980:1 various issues of BNP Kvartal, all published by Statistics Sweden.

Monthly consumption data

Data on car registrations for 1954:1-1973:12 are from Bilindustriföreningen, AB Bilstatistik and for 1974:1-1994:10 *Allmän Månadsstatistik*, Statistics Sweden.

Before 1972 registrations are reported with January representing registrations between 1/1-1/15, February represents 1/16-2/15, March represents 2/16-3/15 and so on through November. December represents registrations between 11/16 and 12/31. From 1972 January means 1/1-1/31 and so on. A linear interpolation has been used before 1972 to distribute registrations into calendar months.

Data on retail sales of food are from SM H1969:11-1974:10, Statistics Sweden for the period 1969:1-1973:6, after that Allmän Månadsstatistik from Statistics Sweden is used. The price index for cars was computed by Statistics Sweden for the purpose of this paper while the price index for food is the food CPI from Statistics Sweden's time-series database (TSDB).

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