Should Households Establish Emergency Funds?

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This paper uses both an individual cost-benefit model and a deterministic simulation to investigate whether or not households should sacrifice higher rates of return in more liquid and less volatile investments in order to be prepared for a financial emergency. The cost of having an emergency fund is the difference between the rate of return in an illiquid, volatile investment and the rate of return in an emergency fund. The benefits of an emergency fund are the borrowing costs avoided in an emergency. With reasonable assumptions about borrowing and lending rates, emergencies would have to occur very frequently for an emergency fund to be optimal.
Key words: *Emergency funds, Financial ratios, Liquidity, Risk*

Introduction

This paper describes the costs and benefits of having an emergency fund – the allocation of assets into a liquid and relatively risk-free investment vehicle. Nearly all household finance textbooks recommend allocating such resources in the event of a financial emergency. For example, according to one textbook:

"In addition to needing cash for everyday transactions, most people want to hold a portion of their assets in case of emergencies. An illness, the loss of a job, or any other unfortunate event can severely strain a family's budget, and without some liquid assets, the family could be forced to sell other assets, such as a house or automobile, to meet daily living expenses…Many financial planners recommend a reserve of three to six months' after tax-income." (Winger & Frasca, 1997, p. 60.)

This suggestion is echoed in most of the available textbooks on financial planning (Garman & Forgue (1997, p. 191; Gitman & Joehnk, 1996, p. 143; Kapoor, Dlabay & Hughes, 1996, p. 408; Keown, 1998, p. 381). Authors suggest that emergency funds should have two criteria: they need to be in highly liquid investment vehicles, so that you have access to them in the event of an emergency, and they need to be in low-risk investments. If the investment is too volatile, there is a chance the level of the asset balance may not be adequate at any particular time.

These recommendations have prompted researchers to examine how many households actually meet these levels (DeVaney, 1995; Chang & Huston, 1995). Huston and Chang (1997) find that older and married-couple households were more likely to have liquid assets adequate for three months' expenses. They also find that income increases the chance that you have an emergency fund, but not by much. This result is important because casual observation might lead one to conclude that emergency funds are easier to accomplish if you are a high-income household. This conclusion is not supported, however, by the Huston and Chang (1997) study for narrow definitions of emergency funds – controlling for other variables, income was not significantly related to the chance of meeting the emergency fund guideline. Another important result from the Huston and Chang study is that households where the heads have more formal education are more likely to have emergency funds, suggesting, but not demonstrating, that emergency funds represent "smart" financial planning.

The appropriateness of emergency funds has been under assault in the literature. Particularly, Chang, Hanna and Fan (1997) demonstrate that the level of emergency fund holdings, and therefore the decision to be "adequately" funded according to the sources cited above, depends upon the household's expectations about the future. Households that expect large income increases in the future would not be expected to have "adequate" emergency funds. This work highlights the subjective nature of what level of funds is "appropriate."

This paper uses a simple cost-benefit analysis approach to understand when putting money in an emergency fund is a good decision and when it is not. The cost of having an emergency fund is the difference between the rates of return you could be earning in an illiquid, volatile

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investment and the rate of return you receive on an emergency fund. The benefits of having an emergency fund are the borrowing costs one wouldn't have to pay in the event of an emergency. The analysis suggests that with reasonable assumptions about borrowing and lending rates, emergencies would have to occur fairly frequently for an emergency fund to be optimal for a household.

Modeling the decision to have an emergency fund

Before examining the question of whether or not to have an emergency fund, it should be noted that the analysis below does not require an assumption about the appropriate size of the emergency fund. In other words, this analysis focuses on the costs and benefits of holding an emergency fund exactly equal in amount to the costs of a contingent emergency. This analysis does not help inform how large an emergency fund should be. If financial emergencies were actually smaller than what is assumed here, then this analysis would be an overstatement of the value of having an emergency fund (or an understatement of the value of not having one). This is because the household with an emergency fund could have put the difference in a higher-paying investment and still have been protected, and the household without an emergency fund would not have had to borrow the entire amount.

Imagine a household that is deciding whether or not to put $(M) into an emergency fund. Suppose this emergency fund investment vehicle pays an interest rate of (r_1). Alternatively, the household could put this $M into a less liquid investment which pays an interest rate of (r_2). This alternative investment could either be a Certificate of Deposit (a conservative estimate of r_2) or a more volatile investment. For example, even if the household is extremely risk averse, Hanna and Chen (1997) recommend that a household with a one-year investment horizon have 31% of assets in the stock market (Hanna & Chen, 1997, p. 21). It is reasonable to assume that this alternative investment would be invested for the long term, since the alternative investment is not going to be used for emergencies.

Whatever investment vehicle the household considers as the alternative to having an emergency fund, it is reasonable to assume that r_2 is greater than r_1. This difference is henceforth referred to as the "liquidity premium." It is the added interest the household would receive from surrendering the liquidity that comes with having an emergency fund. The cost per year of having an emergency fund, then, is the income surrendered that year, or $M ($r_2$-$r_1$). The costs of having an emergency fund can also be conceptualized as the benefits the household would receive from not having an emergency fund.

Similarly, the benefits of having an emergency fund are the costs associated with not having a fund. If the household chose not to have an emergency fund, it would be forced to borrow $M in the event of an emergency. The per-year borrowing costs would depend upon when the emergency happens during the year. For example, if the household put its emergency fund into a 1 year CD on January 1, and the emergency happened on Dec 31, then there would have been no borrowing costs for the year. Therefore, the costs of not having a liquid emergency fund for the year would be zero. If an emergency occurred on January 2, however, then the household would be faced with an entire year of borrowing costs. If we assume that the average length of time in a given year before an emergency occurs is 6 months (which is halfway between the two extreme examples above), then the per-year benefits of having an emergency fund if an emergency occurred during the year would be M * r_b, where:

$$r_b = \left(1 + \frac{APR}{12}\right)^6 - 1$$

and APR is the Annual Percentage Rate (the annual cost of borrowing for the household).

Since there are not necessarily benefits every year, what is needed is a measure of benefits that accrue to the household whether an emergency occurs or not. If P is the probability that an emergency actually occurs in a given year, then the benefits of an emergency fund = P* M * r_b, the expected borrowing costs that come with an emergency of M, *given that it happens P of the time.* The rational household, therefore, should have an emergency fund whenever the benefits are greater than the costs, i.e. when P * M * r_b > M (r_2 – r_1), or when…

$$P > \frac{r_2 - r_1}{r_b}$$

This represents a straightforward way for a household to decide whether to hold an emergency fund. First, determine the difference between the rate of return received on investments and the return on an emergency fund. Next, divide the difference by the borrowing rate

(a reasonable credit card rate of return would be an appropriate estimate for households without access to other forms of credit) and divide the result by two (a fairly good estimate of r_b is APR/2). If the chance of having an emergency is greater than the resulting proportion, then investing in an emergency fund is better than not having one. If the chance is less than this proportion, then not having an emergency fund is better than investing in one.

All of this analysis assumes that the household is risk neutral. In other words, the household values the costs of borrowing in terms of its expected costs. If the household is risk-averse then these are actually a lower bound on the expected costs, and a poorer estimate of those costs the more risk averse the household is. In other words, the benefits of having an emergency fund are an underestimate of the true benefits if the household is risk-averse. The costs of having an emergency fund are also over-represented if the alternative rate of return (r_2) under consideration is a riskier asset than the emergency fund investment (r_1).

Table 1 gives, for different borrowing rates and liquidity premiums, the probability of an emergency (P) required to make the costs and benefits of having an emergency fund equal. Each entry is approximately equal to the quotient of its corresponding liquidity premium and half the APR. For example, if the cost of borrowing is 16% per year, and the difference between the return on an emergency fund and a less liquid investment is 5%, then emergencies would need to occur 6 out of 10 years or more for the expected benefits from holding that fund to outweigh the expected costs.

Table 1
What Does the Probability of an Emergency Need to Be for an Emergency Fund to Make Sense?

	Borrowing Costs (APR%)						
Liquidity Premium (%)	10	12	14	16	18	20	22
2	0.39	0.33	0.28	0.24	0.21	0.19	0.17
3	0.59	0.49	0.42	0.36	0.32	0.29	0.26
4	0.78	0.65	0.55	0.48	0.43	0.38	0.35
5	0.98	0.81	0.69	0.60	0.54	0.48	0.43
6	1.18	0.98	0.83	0.73	0.64	0.58	0.52
7	1.37	1.14	0.97	0.85	0.75	0.67	0.61
8	1.57	1.30	1.11	0.97	0.86	0.77	0.69

A probability of more than 1.0 represents the need to have more than 2 emergencies possible for an emergency fund to make sense.

One can see from this table that at reasonable assumptions about liquidity spreads and borrowing costs (and even using some not-so-reasonable assumptions), emergencies would need to be fairly frequent to justify an emergency fund. In situations where the liquidity spread was over 8% (not too unreasonable if funds are invested in the stock market) and the borrowing rate is less than 15%, more than one emergency would need to occur each year (i.e., P>1) for the fund to be an optimal household finance decision. The simple analysis employed above suggests that only those households with high borrowing costs, high risk aversion (i.e. unwilling to put money in volatile, high yield investments) and high chances of having an emergency should have an emergency fund.

Will a Household with an Emergency Fund Be Financially Better Off ?

In addition to the assumptions about risk aversion, another major limitation of this analysis is that it is on a per-year basis. If the household without the emergency fund has to borrow for more than the six months the analysis assumes, then the benefits of an emergency fund are greater. Similarly, if the household were able to pay off such a debt sooner, then the benefits of the emergency fund would be smaller. A better way to address these issues would be to simulate the life cycle, complete with periodic $M financial emergencies. These simulations will shed light on whether the household that saves for the event of an emergency has more net worth at the end of the life cycle than the household that saves into illiquid investments only. These simulations do not require assumptions about risk aversion, and debt repayment can be simulated using assumptions about the savings process.

Suppose two individuals with zero net worth have 40 years until retirement. Each person earns $1 per year in wages. Each pays 30 cents in taxes per year, spends 60 cents per year in consumption, and saves the remaining 10 cents. Person 1 has a desired emergency fund equal to 3 months' expenses, which in this case is 15 cents. Person 1 always puts savings into an emergency fund

until it reaches 15 cents. If Person 1's emergency fund is adequate, all remaining savings goes into a completely illiquid "investment" fund that will not be accessed until 40 years from the start of the simulation. At the start of the simulation, and right after each emergency occurs, Person 1 has to start replenishing the emergency fund through additional saving (it takes Person 1 about 1.5 years to save enough to have an adequate emergency fund). The emergency fund earns 4% per year (in the simulations, the investment fund's rate of return is varied only to generate variation in the liquidity premium). The return Person 1 receives on a fully funded emergency fund goes into the investment fund.

Person 2 always puts savings into the investment fund unless an emergency occurs. In the event of an emergency, Person 2 borrows and uses the 10 cents per year of saving to pay off the debt until it is retired, at which point Person 2 resumes allocating savings into the investment fund. For both Person 1 and Person 2, emergencies of 15 cents are simulated periodically and in a deterministic fashion (one simulation is an emergency every fourth year and the other is one every eighth year). Since the emergencies are equal to the size of Person 1's emergency fund, and since they never happen more than once every two years, Person 1 always has enough to fund the emergency, and Person 2 always pays the loan back before the next emergency occurs. The simulations were manufactured in this manner so that Person 1 would never be a borrower.

The simulations are in discrete time: interest accrues (and is charged) at the beginning of the period on balances from the end of the previous period. Emergencies are simulated before interest accrues/is charged. For Person 1, this means that 4% is not earned on the emergency fund during the period the emergency occurs. For Person 2, it means the 15 cents to be borrowed is charged a full period's interest before it begins to be repaid in that period. This represents a rather stiff interest payment to Person 2, who really would presumably be paying this loan back over time. This was done both for ease of computation and to create a fairly conservative estimate of the benefits of not having an emergency fund.

Eighteen (18) different simulations were run using varying borrowing costs (8%, 12% and 16%), rates of return on the savings fund (6%, 8%, 10%) and frequencies of emergencies (every 4 years and every 8 years). Of primary interest is which person had the greater net worth at the end of the simulation. The Appendix has the results of each particular simulation, including year-by-year balances for each person, for each permutation of the three assumptions. For each table in the Appendix, Person 1 is the person who maintains an emergency fund. The three columns show the balances each year from 1 to 40 (the length of the simulation is 40 years) in the hypothetical investment fund (Inv. Fund), the emergency fund (Efund) and the person's Net Worth (NW) which is the sum of investment and emergency funds. Person 2 also holds balances each year in an investment fund, but instead of an emergency fund, Person 2 has a credit card balance (CCard) and Person 2's net worth (NW) is the investment fund balance *less* the credit card balance. Since hypothetical emergencies deplete the emergency fund, the balance is not always the recommended size in each period, so at the bottom of the table, that percentage of periods where the emergency fund is fully funded is reported.

Tables 2 and 3 present the results from the simulations in a more succinct and manageable fashion. Table 2 reports the results from the simulations in which an emergency occurs every four years. For each rate of return on the retirement fund, and each borrowing rate, Table 2 reports the proportion of Person 1's net worth after 40 years divided by that of Person 2. A number greater than 1 indicates that Person 1's net worth was greater at the end, a number less than 1 indicates that Person 2's net worth was greater. Entries greater than one, therefore, imply that at these rates, having an emergency fund is better than not having one. When borrowing costs are fairly high, this appears to be the case, although recall that Person 2 has to pay the full year's borrowing cost the year emergencies are simulated. If emergencies happen every 4 years, rates of return on investments have to be as low as 6% for emergency funds to be preferred (the entry for 16% borrowing and 8% return on the investment fund is very close to one). Consistent yields of at least 10% on investments, borrowing costs of as much as 16%, and emergencies occurring as often as every four years, are conditions under which not having a fund is preferred.

Table 2
The Net Worth of an Emergency Fund Holder Divided by the Net Worth of a Non-emergency Fund Holder at Different Borrowing and Saving Rates (Emergencies occurring every fourth year.)

	Borrowing Cost (%)		
Return on Savings (%)	8	12	16
6	0.985	1.017	1.053
8	0.944	0.971	1.003
10	0.904	0.930	0.958

Table 3 reports the same proportions for the same rates of return, but now emergencies happen every eight years. With borrowing rates as high as 16% and rates of return as low as 6%, the simulations suggest that households should not have emergency funds. Note also that the 10% investment return and 8% borrowing rate entry is higher in Table 3 (.915) than its corresponding entry in Table 2 (.904). This is because when lending rates are higher than borrowing rates, then the more you borrow the better. Person 2 actually does better relative to Person 1 in the scenario when (s)he is forced to borrow more frequently. Note further that the entries for Table 2 and Table 3 when both the investment and borrowing rate are the same (8%) are the same (.944). This is because if these rates are the same, borrowing money does not hurt the relative net worth of Person 1, so it doesn't matter how frequently (s)he must borrow.

Table 3
The Net Worth of an Emergency Fund Holder Divided by the Net Worth of a Non-emergency Fund Holder at Different Borrowing and Saving Rates. (Emergencies occurring every eighth year.)

	Borrowing Cost (%)		
Return on Savings (%)	8	12	16
6	0.977	0.986	0.998
8	0.944	0.954	0.995
10	0.915	0.923	0.932

Finally, it should be noted that Person 1 does not always have enough to fund an emergency. When emergencies happen every 4 years, Person 1 has a fully funded emergency fund in 72.5% of the periods. When emergencies occur every 8 years, it is fully funded 87.5% of all periods. This is because it takes approximately 1.5 periods for Person 1 to replenish the emergency fund. If emergencies happen randomly, Person 1 might find situations where borrowing is the only solution, which means the analysis above underestimates the benefits of having an emergency fund. On the other hand, Person 2 has to be able to borrow 15% of his/her yearly income to be able to finance emergencies with a credit card. Furthermore, Person 2 needs enough savings to make the minimum payment in the first month (Person 2's first month saving, .83 cents (.0083 dollars), represents 5.5% of the 15 cent initial debt). If these assumptions about Person 2's access to credit are not appropriate (i.e. if credit card companies require that you pay back more than 5.5% of your balance each month), then the analysis underestimates the costs of having an emergency fund.

Implications

Using both an individual model of choice and a deterministic simulation, it is concluded that emergency funds are only optimal at fairly low rates of return on alternative investments (rates similar to short-term Certificates of Deposit) and/or frequent rates of emergencies (more frequent that once every four years). This analysis would have been even more critical of emergency funds had the assumptions about what constitutes an adequate fund been more conservative (some textbooks recommend a fund for 6 months' expenses, for example). The study has several limitations. First, it assumes that individuals have only two recourses for dealing with emergencies, spending savings or borrowing. The results are meaningless if households cannot borrow for some reason, or if there are savings vehicles that simultaneously offer higher, competitive expected rates of return and are highly liquid (keep in mind that the latter alternative would imply that you need not hold an emergency fund). Also, this study did not address the issue of what is plausible as a probability of an emergency. (An event with a very high probability is a planned expense rather than an emergency.) This study also did not address the appropriate size for an emergency fund, assuming one is warranted.

Should financial planners advise households to hold emergency funds? Perhaps a more appropriate question is: Who should hold emergency funds? According to this analysis, people who have high borrowing rates, and people who have lots of emergencies should hold emergency funds. Limited resource households might fall into this group, which is unfortunate, since they are the most likely households **not** to have adequate

emergency assets. Another candidate group might be the elderly, whose time horizons might suggest a preference for lower-return investment alternatives, and therefore makes the costs of an emergency fund smaller.

There are many opportunities for further study on this topic. Particularly, one might want to add risk aversion explicitly into the analysis. Fan, Chang and Hanna (1993), for example, incorporate risk aversion into a two-period model of when it is optimal to borrow. With long time horizons, the results probably will not differ significantly, but they could at shorter time horizons. Another alternative would be to simulate stochastic or even larger emergencies. In this case, the household with the emergency fund would also have to borrow. If having a liquid emergency fund influences (positively) the rate one receives on a credit card or from a bank, one might find that the household that establishes an emergency fund is better equipped to handle large emergencies, or emergencies which happen one after the other.

Appendix
Simulations of Emergencies

Emergency Every 4th Year
Cost of Borrowing =.16 Return on Savings = .1
Return on Efund = .04

	PERSON 1			PERSON 2		
period	Inv.	Efund	NW	Inv. Fund	C.Card	NW
1	0.00	0.10	0.10	0.10	0.00	0.10
2	0.05	0.15	0.20	0.21	0.00	0.21
3	0.17	0.15	0.32	0.33	0.00	0.33
4	0.18	0.10	0.28	0.36	0.07	0.29
5	0.25	0.15	0.40	0.41	0.00	0.41
6	0.39	0.15	0.54	0.56	0.00	0.56
7	0.53	0.15	0.68	0.71	0.00	0.71
8	0.58	1.00	1.58	0.78	0.07	0.71
9	0.70	0.15	0.85	0.88	0.00	0.88
10	0.87	0.15	1.02	1.06	0.00	1.06
11	1.06	0.15	1.21	1.27	0.00	1.27
12	1.17	0.10	1.27	1.40	0.07	1.32
13	1.34	0.15	1.49	1.55	0.00	1.55
14	1.58	0.15	1.73	1.80	0.00	1.80
15	1.85	0.15	2.00	2.09	0.00	2.09
16	2.03	0.10	2.13	2.29	0.07	2.22
17	2.29	0.15	2.44	2.54	0.00	2.54
18	2.62	0.15	2.77	2.89	0.00	2.89

Emergency Every 8th Year
Cost of Borrowing = .08 Return on Savings = .06
Return on E-fund = .04

	PERSON 1			PERSON 2		
	Inv.	Efund	NW	Inv.	C.Card	NW
1	0.00	0.10	0.10	0.10	0.00	0.10
2	0.05	0.15	0.20	0.21	0.00	0.21
3	0.16	0.15	0.31	0.32	0.00	0.32
4	0.28	0.15	0.43	0.44	0.00	0.44
5	0.40	0.15	0.55	0.56	0.00	0.56
6	0.53	0.15	0.68	0.70	0.00	0.70
7	0.67	0.15	0.82	0.84	0.00	0.84
8	0.71	0.10	0.81	0.89	0.06	0.83
9	0.81	0.15	0.96	0.98	0.00	0.98
10	0.96	0.15	1.11	1.13	0.00	1.13
11	1.12	0.15	1.27	1.30	0.00	1.30
12	1.30	0.15	1.45	1.48	0.00	1.48
13	1.48	0.15	1.63	1.67	0.00	1.67
14	1.68	0.15	1.83	1.87	0.00	1.87
15	1.88	0.15	2.03	2.08	0.00	2.08
16	2.00	0.10	2.10	2.21	0.06	2.15
17	2.17	0.15	2.32	2.37	0.00	2.37
18	2.41	0.15	2.56	2.62	0.00	2.62

19	2.99	0.15	3.14	3.28	0.00	3.28
20	3.29	0.10	3.39	3.61	0.07	3.53
21	3.67	0.15	3.82	3.98	0.00	3.98
22	4.15	0.15	4.30	4.48	0.00	4.48
23	4.67	0.15	4.82	5.03	0.00	5.03
24	5.13	0.10	5.23	5.53	0.07	5.46
25	5.70	0.15	5.85	6.10	0.00	6.10
26	6.38	0.15	6.53	6.81	0.00	6.81
27	7.12	0.15	7.27	7.59	0.00	7.59
28	7.83	0.10	7.93	8.35	0.07	8.28
29	8.67	0.15	8.82	9.20	0.00	9.20
30	9.64	0.15	9.79	10.22	0.00	10.22
31	10.71	0.15	10.86	11.34	0.00	11.34
32	11.78	0.10	11.88	12.48	0.07	12.40
33	13.02	0.15	13.17	13.74	0.00	13.74
34	14.42	0.15	14.57	15.21	0.00	15.21
35	15.97	0.15	16.12	16.83	0.00	16.83
36	17.57	0.10	17.67	18.52	0.07	18.44
37	19.38	0.15	19.53	20.38	0.00	20.38
38	21.42	0.15	21.57	22.52	0.00	22.52
39	23.67	0.15	23.82	24.87	0.00	24.87
40	26.04	0.10	26.14	27.36	0.07	27.28

Percent of periods with a fully funded E-fund = 72.5%

19	2.66	0.15	2.81	2.87	0.00	2.87
20	2.92	0.15	3.07	3.14	0.00	3.14
21	3.20	0.15	3.35	3.43	0.00	3.43
22	3.50	0.15	3.65	3.74	0.00	3.74
23	3.82	0.15	3.97	4.06	0.00	4.06
24	4.05	0.10	4.15	4.31	0.06	4.25
25	4.34	0.15	4.49	4.60	0.00	4.60
26	4.71	0.15	4.86	4.97	0.00	4.97
27	5.10	0.15	5.25	5.37	0.00	5.37
28	5.51	0.15	5.66	5.80	0.00	5.80
29	5.95	0.15	6.10	6.24	0.00	6.24
30	6.41	0.15	6.56	6.72	0.00	6.72
31	6.90	0.15	7.05	7.22	0.00	7.22
32	7.32	0.10	7.42	7.65	0.06	7.59
33	7.81	0.15	7.96	8.15	0.00	8.15
34	8.38	0.15	8.53	8.73	0.00	8.73
35	8.99	0.15	9.14	9.36	0.00	9.36
36	9.64	0.15	9.79	10.02	0.00	10.02
37	10.32	0.15	10.47	10.72	0.00	10.72
38	11.05	0.15	11.20	11.46	0.00	11.46
39	11.82	0.15	11.97	12.25	0.00	12.25
40	12.52	0.10	12.62	12.99	0.06	12.93

Percent of periods with a fully funded E-fund=87.5%

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