

8-1-2022

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Technical Report: UTEP-CS-22-92

Recommended Citation

Aguilar, Sean and Kreinovich, Vladik, "How to Make Inflation Optimal and Fair" (2022). *Departmental Technical Reports (CS)*. 1749.

https://scholarworks.utep.edu/cs_techrep/1749

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How to Make Inflation Optimal and Fair

Sean Aguilar and Vladik Kreinovich

Abstract A reasonably small inflation helps economy as a whole – by encouraging spending, but it also hurts people by decreasing the value of their savings. It is therefore reasonable to come up with an optimal (and fair) level of inflation, that would stimulate economy without hurting people too much. In this paper, we describe how this can be potentially done.

1 Formulation of the Problem: Inflation Is Often Useful

Sometimes, countries need more capital. In some cases, the country's economy is stagnant, and to boost its economy, the country needs more capital – e.g., to invest in traffic or electronic infrastructure, to replace obsolete manufacturing abilities with more modern ones, etc.

How a country can get more capital: two ways. A natural way to get this capital is to borrow money, either from its own citizens or from abroad. Borrowing money means imposing a debt on the next generations – i.e., in particular, on the country's young citizens – but since these new generations will benefit from the resulting economic growth, this additional burden sounds fair (provided, of course, that the borrowed money is indeed invested in economic growth and not just lead to increased consumption).

In the past, when money was supported by valuable assets like gold or silver, this was the only way to get more capital. However, nowadays, when everyone uses paper or electronic money without a guaranteed value, there is another way of getting

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more capital: to print more money. Since the value of the country's monetary unit is, crudely speaking, determined by the overall value of the economy divided by the number of monetary units in circulation, printing more money means decreasing the value of each monetary unit. Equivalently, it means that the prices – i.e., the value of each good expressed in the decreased-in-value units – increase, i.e., that we have inflation.

Inflation means that the country, in effect, decreases its current debts (at least those promised in the country's monetary units) and thus, has additional money to invest in the economy. It is known that an appropriate level of inflation boosts the country's economy.

Natural questions. What is the optimal level of inflation? Moreover, how can we make it fair for everyone? These are the two questions that we study in this paper.

2 What is the Optimal Level of Inflation

Main idea behind inflation: reminder. If we print more money, the prices go up, and people can consume less this year, but hopefully, the economy will be boosted, and so next year, people will be able to consume more.

Situation without inflation: a simplified description. Let us consider a simplified model in which we only trace two years of the economy: the current year and the following year.

Let us denote this year's average income by a_0 and expected next year's income by a_1 . Let s denote the average amount that people save. In the simplified two-year analysis, whatever we save this year will be consumed next year. This means that this year, we consume the value $a_0 - s$, while next year, we consume the value $a_1 + s$.

It is known that the utility is proportional to the square root of the consumed value; see, e.g., [1]. This means that this year, our utility is proportional to $\sqrt{a_0 - s}$, and the next year, the utility is proportional to $\sqrt{a_1 + s}$. When we make decisions, we add, to the current utility, next year's utility multiplied by a certain "discount" factor $q < 1$; see, e.g., [1]. Thus, to decide on how much we save, we optimize the expression

$$\sqrt{a_0 - s} + q \cdot \sqrt{a_1 + s}. \quad (1)$$

If the economy is not doing well, we expect $a_1 < a_0$, so instead of spending the money, we save it for the future to make sure that we will get something to live on when our incomes decrease.

This sounds reasonable, but, as a result, if this year's consumption $a_0 - s$ decreases, there is less demand for goods, there is less incentive to produce, and the economy shrinks even more.

Inflation may help. How can we avoid this shrinkage? It turns out that inflation helps. With inflation, if we save the amount s , next year, this same amount of money will enable us to buy fewer things than this year, to the equivalent of $d \cdot s$, for some

coefficient $d < 1$. Thus, the effective consumption next year will be not $a_1 + s$ but $a_1 + d \cdot s$. As a result, the overall utility that we want to optimize is described by the following modification of the formula (1):

$$u(s) \stackrel{\text{def}}{=} \sqrt{a_0 - s} + q \cdot \sqrt{a_1 + d \cdot s}. \quad (2)$$

So what is the optimal level of inflation? To maximally boost the economy, we want to maximize this year's consumption, i.e., minimize this year's savings s . In principle, the portion s of this year's income a_0 can be any value from 0 to a_0 . Thus, the smallest possible savings is $s = 0$.

So, we want to select the inflation parameter d in such a way that out of all possible values $s \in [0, a_0]$, the largest value of $u(s)$ is attained when $s = 0$. According to the calculus, if a function $f(x)$ attains its largest value on an interval $[x, \bar{x}]$ at its lower endpoint x , this means that the derivative $f'(x)$ of this function at this point is non-positive $f'(x) \leq 0$: otherwise, if it were positive, the function would reach higher values in the close vicinity of the left endpoint x , and thus, the left endpoint would not be the maximum.

In our case, this means that $u'(0) \leq 0$. The derivative of the expression (2) takes the form

$$u'(s) = -\frac{1}{2\sqrt{a_0 - s}} + \frac{q \cdot d}{2\sqrt{a_1 + d \cdot s}}.$$

Thus, the condition $u'(0) \leq 0$ takes the form

$$-\frac{1}{2\sqrt{a_0}} + \frac{q \cdot d}{2\sqrt{a_1}} \leq 0,$$

i.e., equivalently, that

$$d \leq \sqrt{\frac{a_1}{a_0}} \cdot q. \quad (3)$$

Many different values of the inflation parameter d satisfy this inequality, all the values from the most significant value that satisfies this inequality to the values $d \approx 0$, which corresponds to so-called hyper-inflation, when money loses value almost completely. As we have mentioned, inflation decreases the consumption abilities of people. So, out of all possible values of d , we should select the least painful value – i.e., the one which is the largest. Out of all the values of d that satisfy the inequality (3), the largest possible value is

$$d_{\text{opt}} = \sqrt{\frac{a_1}{a_0}} \cdot q. \quad (4)$$

In particular, in the case of stagnation $a_1 = a_0$, the optimal level of inflation is $d_{\text{opt}} = q$.

Comment. Of course, the recommendation (4) is only approximate: it comes from a simplified two-year description of the economy. The same ideas can be used to ana-

lyze more long-term descriptions. Although we may not get simple explicit formulas, in this case, we would probably need to perform the numerical optimization.

3 How to Make Inflation Fair

But is inflation fair? Increased prices make life harder for now, but in a few years – if the inflation level is selected properly – the resulting economic boom will help the country’s people. With the boom, unemployed folks will become employed, and many employed people will have their salaries increased.

However, a significant group of people will not benefit from this boom at all: namely, retired people who are no longer working. The rise of prices decreases their buying abilities. When most retired people got a pension in the old days, this could be compensated by adjusting the pension to the annual inflation. However, nowadays, in the US and many other countries, a large portion of retired people’s income comes from their investments – in stocks, bonds, and special retirement funds. This investment is not compensated, as a result of which inflation simply means that their level of living decreases.

Unfortunately, the resulting unfairness is not well understood. It is a common understanding that borrowing money means placing a burden on the next generations, often cited by journalists and politicians. This burden is somewhat lifted by the fact that the next generations will benefit from the country’s prosperity resulting from this borrowing. It is not as commonly understood that inflation also means placing an extra burden – this time, placing an extra burden on retired people, a burden which is not lifted at all. As a result, when the country’s central bank selects an inflation rate, their main concern in helping the economy – growth of the country’s Gross Domestic Product (GDP), decrease in unemployment, etc. – and the adverse effect on retired people, who form a significant proportion of the population, is not taken into account.

How can we make the inflation effects fair?

A seemingly natural idea that does not work. Since retired people have invested their money in all possible investment venues – stocks, bonds, bank accounts – the seemingly natural idea is to adjust all these investments based on the inflation rate. However, such a blanket increase defeats the whole purpose of inflation – the purpose is to decrease the actual value of the country’s debt by decreasing the values of all the bonds etc. If we automatically adjust all investments, we will not have extra money to invest.

A solution that can work. An alternative solution is to consider that, in most cases, retirement income comes from specially designated retirement investments. So, a fair approach is to compensate such specifically designated investments automatically.

Acknowledgments

This work was supported in part by the National Science Foundation grants 1623190 (A Model of Change for Preparing a New Generation for Professional Practice in Computer Science), and HRD-1834620 and HRD-2034030 (CAHSI Includes), and by the AT&T Fellowship in Information Technology. It was also supported by the program of the development of the Scientific-Educational Mathematical Center of Volga Federal District No. 075-02-2020-1478, and by a grant from the Hungarian National Research, Development and Innovation Office (NRDI).

References

1. D. Kahneman, *Thinking, Fast and Slow*, Farrar, Straus, and Giroux, New York, 2011.