OPTIMAL FISCAL AND MONETARY POLICY WITH DISTORTING TAXES

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ABSTRACT. When the interest rate on government debt is low enough, it becomes possible to roll it over indefinitely, never taxing to retire it, without producing a growing debt to GDP ratio. This has been called a situation with zero "fiscal cost" to debt. But when low interest on debt arises from its providing liquidity services, zero fiscal cost is equivalent to finance through seigniorage. Some finance through seigniorage is generally optimal, however, despite results in the literature seeming to show that this is not so.

In recent articles Blanchard (2019) and Mehrotra and Sergeyev (2019) have reminded us that real rates of return on government debt have in most years been so low that the debt-to-GDP ratio would decline or remain stable even it the debt were simply rolled over. That is, without any taxation to "back" the debt, with interest and principal payments being financed entirely by the issue of new debt, the debt-to-GDP ratio would not increase. They characterize this situation as one in which there is zero or negative "fiscal cost" to public debt.

Conventional thinking about public debt sees debt as requiring fiscal backing, so that increased debt requires increased future taxes. If the taxes are distorting, this is a burden. But if debt has zero or negative "fiscal cost", this conventional argument seems to fail. Indeed, it seems to lead to the conclusion that unless we expand the public debt, we are imposing an unnecessary welfare-reducing fiscal burden. Of course issuing more public debt might eventually force up interest rates, but until the "fiscal cost" is driven to zero, additional debt is providing a service people are apparently willing to pay for. Optimal fiscal policy then should, apparently, expand the debt until fiscal costs are driven to zero.

There is something to this argument, but it is essentially the same as the argument Milton Friedman made for an "optimal quantity of money", which he said would be reached when the nominal interest rate was driven to zero. This is sometimes called the "Friedman rule". In this paper we lay out the connection of the "fiscal cost" arguments to the Friedman rule and also explain limitations to the results in some papers in the literature that have claimed that the Friedman rule is optimal even when only distorting taxes are available.

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Seigniorage is a source of revenue and inflation is a kind of tax. If an array of distorting taxes is available, generally making some use of each of them is optimal, as lower tax rates are less distorting. It seems then likely that when only distorting taxes are available, it is optimal to make at least some use of the inflation tax, so that other tax rates can be lower.

In a classic article Chari and Kehoe (1999)[1] proved that in an apparently quite general setting, it is optimal not to use the inflation tax, even when the only other taxes available are distorting. That is, when money pays no interest, the nominal interest rate on other assets should be zero, or if money pays interest, the rate on it should match that on other assets.

The Chari/Kehoe result depends on an assumption, which they make explicit but do not emphasize, that the government can at an initial date inject money into the economy by purchasing bonds from the private sector. Under the commonly invoked assumption that government interest-bearing debt must remain non-negative, the Chari/Kehoe result does not hold.

To see this point, we first set out a simple model in which it is easy to prove analytically that using the inflation tax is optimal. This model satisfies the conditions that Chari and Kehoe emphasize as important for their result. As we will discuss, it does not satisfy the assumptions about the economy's initial conditions that Chari and Kehoe impose.

I. Simple model

A representative individual chooses the time paths of C (consumption), L (labor), B (nominal government debt) and M (non-interest-bearing money) while taking P (the price level) and τ (the tax rate on labor) paths as given (and known in advance). The individual's objective is to maximize

$$\int_0^\infty e^{-\beta t}(\log C_t - L_t)\, dt \tag{1}$$

subject to

$$C \cdot (1+\gamma v) + \frac{\dot{B}+\dot{M}}{P} = (1-\tau)L + \frac{rB}{P} \tag{2}$$

$$v = \frac{PC}{M}\,. \tag{3}$$

Here v is a version of "velocity", and $\gamma v/(1+\gamma v)$ can be interpreted as the fraction of consumption spending that is absorbed by transactions costs. An equivalent

[1] Chari, Christiano, and Kehoe (1996) showed this result earlier, in a paper that assumed cash-in-advance transactions technology. The later paper by Chari and Kehoe extended the result to other transactions technologies, including that in this paper.

specification would define

$$C^* = C \cdot (1 + \gamma v)$$

and then make utility depend on

$$\log\left(\left(\sqrt{1 + \frac{4\gamma C^*}{m}} - 1\right) \cdot \frac{m}{2\gamma}\right) ,$$

where $m = M/P$ is real balances, rather than on $\log C$. The money-in-budget-constraint formulation makes it easier to see what fraction of spending is absorbed by transactions costs, and in particular avoids allowing implied transactions costs becoming negative. The money-in-utility version makes utility homethetic in m and C^*, as Chari and Kehoe assume.

The linear disutility of labor and unbounded supply of labor are chosen to make the algebra of deriving our results simpler. As should become clear, the results don't depend on these details of the specification.

The private agent's problem leads to first order conditions

$$C \cdot (1 + 2\gamma v) = 1 - \tau \tag{4}$$

$$\frac{-\dot{\tau}}{1 - \tau} = \gamma v^2 - \beta - \frac{\dot{P}}{P} . \tag{5}$$

$$r = \gamma v^2 \tag{6}$$

The government has to finance a given path G of expenditures, which provide no utility to the private agents. Its budget constraint is

$$\frac{\dot{B} + \dot{M}}{P} + \tau L = G + \frac{rB}{P} . \tag{7}$$

The social resource constraint

$$C \cdot (1 + \gamma v) + G = L \tag{8}$$

is derivable from the government and private budget constraints.

Suppose policy fixes constant values for r and τ, from $t = 0$ onwards. From (6) we see that this also fixes a constant value for v. Then the private labor-consumption tradeoff equation (4) and the social resource constraint (8) provide two equations in the two unknowns C and L. If the policy is feasible, therefore, C and L will be constant. The private sector's Euler equation (5) then becomes $r = \beta + \dot{P}/P$ and implies that inflation is constant. Since real balances $m = M/P$ are just C/v, they also are constant.

Substituting these relations into the government budget constraint (7) allows us to arrive at

$$\dot{b} = G - \tau L - m\frac{\dot{P}}{P} + \beta b , \tag{9}$$

where $b = B/P$ is real debt. Everything on the right of (9) except b, we already know to be constant. With $\beta > 0$, this is an unstable differential equation in which all solutions but one grow in absolute value at the rate β. Assuming that both B and M must be non-negative, the private sector's transversality condition is

$$e^{-\beta t} \frac{b_t + m}{C \cdot (1 + 2\gamma v)} \xrightarrow[t \to \infty]{} 0 \,, \tag{10}$$

where the time subscripts have been omitted on variables we know must be constant. Obviously (10) implies b cannot explode at the rate β, so there is only one solution to (9) consistent with private sector optimization, that with b constant at

$$b = \frac{\tau L + m \frac{\dot{P}}{P} - G}{\beta} \,. \tag{11}$$

That is, real interest-bearing debt is the excess of tax revenues and seigniorage over government expenditure, discounted to the present at the rate β. Because the government budget constraint implies a continuous time path for $B + M$, and $b + m$ is determined by the equilibrium conditions, the initial price level is uniquely determined.

If (11) delivers a negative value for b, the τ, r policy choice is not feasible — there is not enough tax revenue and seigniorage to cover G. Assuming no constraints on the ability of the policy authority to impose a surprise jump inflation or deflation at time 0, it is optimal to choose an r, τ pair that makes $b = 0$. With $b > 0$, fiscal effort must be greater, either through seigniorage or taxation, and this is welfare-reducing.

There is a menu of choices of r, τ pairs that deliver $b = 0$, and welfare differs along this menu. It is clear from (11), though, that setting $r \doteq 0$ and thus $m \doteq \infty$ is not feasible, much less optimal, since this would require the seigniorage term $m\dot{P}/P \doteq -\infty$ and τL can be shown to be bounded above.

Where does this model deviate from the assumptions that allow Chari and Kehoe to derive their result? They observe that this model, in which the policy-maker is assumed to fully commit to future policies, has the property that it is optimal for the government to default on any outstanding net debt at the initial date, while issuing new liabilities on which it promises believably that it will never default. A policy recommendation like this is obviously unrealistic, so in models like this it is usual to constrain what the government can do at the initial date. Chari and Kehoe assume the government has zero net worth at $t = 0$, as would be true if it initially defaulted on outstanding debt and initially there was no money. They assume that to get money into the hands of the public at $t = 0$, the government undertakes "open market operations", buying from the private sector non-money nominal assets (bonds, or loans to the public from the government). In other words, they assume that government interest-bearing debt can be negative, and arbitrarily large in absolute value. At the initial date, their assumptions imply government has exactly matched nominal assets and nominal liabilities, with M being the liabilities, $B = -M$.

By promising to shrink M (and B) at the rate $-\beta$, the government can then guarantee a nominal interest rate of zero. It can shrink the stock of money entirely by open market operations, selling its loans or bonds back to the public at the rate $-\beta$. This keeps assets and liabilities perfectly aligned, and no taxes are ever required to maintain the M shrinkage rate.

II. What are reasonable assumptions about initial conditions?

The government budget constraint (7) implies that total government liabilities, $B + M$ has a continuous time path. In other words, to change $B + M$ requires changing tax revenues τL, government expenditures G, or interest payments on debt rB. It is unreasonable to think of any of these as being changeable at infinite rates. Treating the rate of growth $\dot{B} + \dot{M}$ as well defined at every date, which is implied by treating (7) as a non-forward-looking equation, makes economic sense.

The government budget constraint does not require that B and M individually have continuous time paths. With B_{-0} and B_{+0} (for example) as notation for the left and right limits of B at time zero, we have

$$B_{-0} + M_{-0} = B_{+0} + M_{+0}\,, \tag{12}$$

while $B_{-0} \neq B_{+0}$ and $M_{-0} \neq M_{-0}$ are possible. But then if $B_{-0} + M_{-0}$ is non-zero, to arrive at zero net worth at time zero requires a policy that makes P_{+0} infinite. If B is bounded below, this implies in turn real balances $m_{+0} = M_{+0}/P_{+0}$ are zero and that transactions costs absorb all of output.

While setting interest bearing debt to zero (or its minimum feasible value) is beneficial, in the model money balances are important. An optimizing government, free to choose a time path of policy that fixes the price level at time zero, will choose a combination of interest rate and tax policies that make $M_{+0} = B_{-0} + M_{-0}$ and thus $B_{+0} = 0$.

Another way to explain our initial date assumption is that we assume the government issuing nominal debt is recognized to have the option at any date of diluting the claims of holders of the debt and of money balances by deficit finance, but is assumed to be committed not to introduce a new currency, and debt denominated in it, that has a higher seniority as a claim on future revenues.

Of course if the government at time zero can repudiate both existing debt and existing currency, then issue new currency and use it to buy private sector liabilities, and if it can do all this while preserving its perfect credibility, it can achieve a better outcome than is obtainable by just setting the P_{+0} so that agents choose $B_{+0} = 0$. However defaulting on outstanding debt and currency is an action that the government is assumed never to do in the future. On the other hand using unanticipated price level fluctuations to stabilize the real value $b + m$, and maintaining $b \doteq 0$, is not only optimal at time zero, in a stochastic version of the model the fully committed government does this at every date.

In mapping the conclusions of this model into an actual economy, the optimality of $b \equiv 0$ should not be taken as implying that interest-bearing debt does not or should not exist. In reality government debt comes in many maturities, all or most of which pay real returns lower than what is apparently available on other investments. What we have called M in the model could pay interest without any change in the model's logic or implications. In this light, the $b = 0$ conclusion is a conclusion that government debt that exists should pay an interest rate less than or equal to what is available on other investments, with equality only when demand for liquidity has been saturated.

III. Numerical example

In this section we solve numerically for optimal equilibrium with a given constant G. Based on the argument of the previous section, we assume all government debt provides transactions services, and switch notation to call this service-providing debt B. We assume the optimizing government sets τ and i, the nominal interest rate on B, with the objective of maximizing the equilibrium value of the private agent's objective function (1). The government takes (4), (5), (7) and (8) as constraints. Equation (6) is replaced by

$$i = \beta + \frac{\dot{P}}{P} - \gamma v^2 \,. \tag{13}$$

We define

$$\rho = i - \frac{\dot{P}}{P}, \tag{14}$$

which is the real rate of return on government debt.

We can rewrite the system with ρ replacing i, and, because i and $\dot{P}/P$ enter the system only as their difference, we then have a system of 5 equations in 5 unknowns, which we assemble here for convenience, imposing $\dot{\tau} = 0$:

$$C \cdot (1 + 2\gamma v) = 1 - \tau \tag{4}$$

$$\rho = \beta - \gamma v^2 \tag{15}$$

$$C(1 + \gamma v^2) + G = L \tag{8}$$

$$\dot{b} = \rho b + G - \tau L \,. \tag{7}$$

$$v = \frac{c}{b} \,. \tag{16}$$

Note that by using ρ, we have eliminated both i and $\dot{P}/P$ from the system. This implies that given τ, i affects the equilibrium only by changing the inflation rate. Changing i has no effect on the other five variables: C, v, ρ, L, and b.

While it seems likely that with G constant, keeping τ constant is optimal, I haven't proved this. We are finding equilibrium with constant τ, and optimizing the constant τ. We also will solve for an equilibrium with b constant. An argument in the appendix shows that transversality and feasibility guarantee this when τ is constant.

Because b can (via a jump in initial price level P_0) jump at the initial date, there is no transition path from equilibrium with one level of constant τ to another. In this flex-price model, the economy goes immediately to the new equilibrium. The same is true if there is a one-time, unanticipated shift in a parameter, like the transactions cost or liquidity service parameter γ.

The equation system can be solved analytically, resultling in a univariate quadratic equation. For feasible values of G and τ, it has a unique solution with positive v. In the tables below τ is the optimal constant τ for the table's assumed value of G. It was found by a one-dimensional grid search on τ.

γ	C	b/y	L	$\dot{P}/P$	U	τ	σ	$\frac{\gamma v}{1+\gamma v}$	P_0
0.001	0.97	1.31	0.97	0.0006	-1.00	0.03	-0.0254	0.0007	0.76
0.01	0.94	2.70	0.94	0.0012	-1.01	0.05	-0.0507	0.0035	0.37
0.1	0.87	5.27	0.88	0.0027	-1.02	0.10	-0.0912	0.0162	0.19
1	0.72	9.27	0.78	0.0061	-1.10	0.17	-0.1293	0.0722	0.11

TABLE 1. Optimal steady state with $G = 0$, $\beta = .02$, $i = .02$

γ: transactions cost parameter; C: consumption; b/y: debt/output; L: labor; $\dot{P}/P$: inflation rate; U: utility; τ: labor tax rate; σ: seigniorage revenue; $\gamma v/(1+\gamma v)$: proportion of consumption expenditure absorbed by transaction costs; P_0 : initial price level, assuming $B_0 = 1$; G non-productive government expenditure; β: discount rate.

γ	C	b/y	L	$\dot{P}/P$	U	τ	σ	$\frac{\gamma v}{1+\gamma v}$	P_0
0.001	0.74	0.28	0.99	0.0069	-1.29	0.26	-0.0037	0.0026	3.56
0.01	0.72	0.83	0.98	0.0076	-1.30	0.27	-0.0103	0.0086	1.21
0.1	0.67	2.19	0.94	0.0107	-1.34	0.29	-0.0234	0.0296	0.46
1	0.55	4.68	0.86	0.0137	-1.46	0.32	-0.0295	0.1047	0.21

TABLE 2. Optimal steady state with $G = .25$, $\beta = .02$. $i = .02$

See notes to Table 1

Tables 1 2, and 3 show the model's optimal steady state at various levels of government spending G and transactions cost parameter γ. Even in Table 1, where there is no government spending to finance, it is optimal to have a positive rate of labor tax τ, in order to induce low inflation, a positive real return ρ on government debt, and hence a reduced incentive to conserve on real balances. However even in this

γ	C	b/y	L	$\dot{P}/P$	U	τ	σ	$\frac{\gamma v}{1+\gamma v}$	P_0
0.001	0.20	0.02	1.00	0.0823	-2.63	0.80	0.0013	0.0090	46.27
0.01	0.19	0.06	0.99	0.0855	-2.66	0.80	0.0042	0.0284	15.55
0.1	0.17	0.17	0.98	0.0955	-2.78	0.80	0.0129	0.0890	5.87
1	0.12	0.37	0.96	0.1137	-3.06	0.79	0.0342	0.2522	2.74

TABLE 3. Optimal steady state with $G = .8$, $\beta = .02$, $i = .02$

See notes to Table 1

case the inflation rate does not go to zero, as would be required to make $\rho = .02$ and thereby implement the Friedman rule. The most realistic of these cases, might be Table 2's $\gamma = .01$ row. This produces a "debt to GDP" ratio of about 0.8, transactions costs absorbing about 1% of consumption and a tax rate of 27%. In this case the optimal real rate on debt ρ (the 2% nominal rate i minus the inflation rate) is 1.24%.

If government expenditure becomes large enough, it becomes optimal to make seigniorage positive, as we see in Table 3. In that table taxes and inflation substantially depress consumption in order to accommodate the high level of G. Inflation is over 8%, implying sharply negative real rates of return on government debt. Nonetheless seigniorage delivers only a small fraction of total revenue.

With $\tau = 0$, seigniorage is increasing in v over the whole $(0, \infty)$ range, and approaches .5 from below as $v \to \infty$. Even in Table 3, where government expenditure is taking up around 80% of output and the tax rate is about 80%, seigniorage remains well below its upper bound. Even though the Friedman rule is not optimal in this model, the inflation tax produces little revenue relative to the distortion it induces, so that it is optimal to use it to generate revenue only when the other tax available is at highly distortionary levels.

IV. ALLOWING FOR GROWTH

The arithmetic of "zero fiscal cost" debt seems to rest on there being positive growth. The idea is that if the economy is growing at a rate exceeding the real rate of return on government debt, debt can be increased today, without any actual or expected future increases in taxatiion (or reductions in expenditure). with debt nonetheless shrinking relative to output over time.

This line of reasoning is misleading. It ignores wealth effects and inflation. People must be induced to hold the additional debt. They can be induced to do so, even without increased taxation, but only by lowering its real value through inflation. This is true whether or not there is economic growth.

In fact, in this paper's model if we introducing constant labor augmenting technical progress at the rate θ and interpret C, G and σ as ratios to $e^{\theta t}$, the model is unchanged except that the discount rate now has to be interpreted as the discount rate β of private agents plus the rate of technical progress θ. None of the table entries then change. The "β = .02" line in the captions would change to $\beta + \theta = .02$.

Of course, tables calculated with private agents' $\beta = .02$, $\theta = .02$, would differ from those shown. But the difference would not be lower labor taxes at a given G. Because the Friedman rule requires a higher return on B with an increase from β to $\beta + \theta$ in the discount rate, the optimal tax rate emerges as higher, not lower, with increases in θ.

V. Implications for policy

Krishnamurthy and Vissing-Jorgensen (2012) present evidence that US Treasury securities have historically paid a lower yield than comparable corporate bonds, that this cannot be explained by default risk, and that the yield spread shrinks as the supply of treasury securities increases. They argue that Treasuries behave much like non-interest-bearing high-powered money in these respects. Our simple model can be regarded as a stylized equilibrium model built on their observations.

Under what conditions in this model is it welfare-improving to increase reliance on unbacked deficit finance? Since the model implies a tradeoff of one kind of finance (seigniorage) against another (labor taxation), both of which are distorting, the answer to this question must depend on both the rate of labor taxation and the "fiscal cost" (i.e. seigniorage). Increased unbacked deficits will generate revenue and allow reduction of labor taxes, or increased G with no increase in labor taxes. But this is not always welfare-improving. In our simple, casually calibrated, model, in the $G = .25$, $\gamma = .01$ case, it is optimal to expand seigniorage to reduce labor taxes only when seigniorage is excessively negative. With seigniorage positive welfare can be improved by reducing inflation and seigniorage, while increasing labor taxes.

The model, as we have noted, goes to its steady state immediately when G and τ are fixed. We can see the consequences of going from the optimal steady state with $G = .2$ to the optimal steady state with $G = .25$ by comparing lines 1 and 2 of Table 4.

The table shows that it is optimal to have negative seigniorage in both cases, with the change in G almost entirely covered by a change in τ. The effects on C, L and utility U are minor. However the effects on b/y and P_0 are substantial. Optimal policy requires reducing b/y by nearly 20 per cent, and accomplishing this mainly through a jump in the price level of over 20 per cent. Within the model, this jump in the price level is costless, but in reality it would be costly. That it would be costly does not necessarily imply that in a model recognizing price stickiness a rapid temporary inflation would not be part of an optimal solution. Avoiding the jump would require credibly announcing a decreasing time path for the tax rate.

Comparing lines 1 and 4 shows that increasing G without any adjustment in τ would greatly increase both the initial jump in prices and the resulting steady state

G	τ	C	b/y	L	$\dot{P}/P$	U	σ	$\frac{\gamma v}{1+\gamma v}$	P_0
0.20	0.22	0.77	1.00	0.97	0.0059	-1.238	-0.0142	0.0076	1.00
0.25	0.27	0.72	0.83	0.98	0.0076	-1.304	-0.0103	0.0086	1.21
0.20	0.27	0.73	2.51	0.93	0.0008	-1.247	-0.0481	0.0029	0.40
0.25	0.22	0.71	0.15	1.00	0.2281	-1.336	0.0310	0.0456	6.71

TABLE 4. Optimal and suboptimal financing of G

See notes to Table 1 for variable definitions. Lines 1 and 2 show solutions with optimal tax rates for the given G values. Lines 3 and 4 are solutions for given G and τ, with no optimization. Comparing lines 1 and 4 shows the change in going from $G = .20$ with optimal τ to $G = .25$ with unchanged τ. Comparing lines 2 and 3 shows the reverse case.

inflation rate. Thus it is possible to increase G and finance the increase entirely without change in tax rates, but only at the cost of high inflation.

We can do a similar exercise comparing lines 1 and 2 or lines 2 and 3 of Table 2. This lets us see the optimal policy response to a sudden increase in the demand for B. Going either from line 1 to 2 or from line 2 to 3, we see that the values of steady state C, L τ and U are little changed by the rise in demand for government liquid assets. But P_0 and b/y are drastically affected. The optimal response to the rise in liquidity produces a downward jump in P_0 by a factor of roughly 3. Unlike an upward jump in P_0, it seems possible that the jump could be eliminated by a feasible fiscal intervention. What would be required is a sudden expansion of B_0 at the initial date, in proportion to the drop in P_0 that would be required without any change in B_0. This could be accomplished by a "helicopter drop" — lump sum transfers of government paper to the public.

It is tempting to take this case of response to a rise in demand for liquidity as roughly corresponding to the policy problems of the US (and other countries) in the wake of the Great Financial Crisis. In this interpretation, the rise in outstanding real debt was required to avoid rapid deflation. With debt expansion arising from this source, the lack of any rise in inflation or interest rates is not surprising.

The expansion is not in itself a reason for greatly increased fiscal stringency. Just as before the increase in real debt, the desirability of unbacked debt finance, i.e. of increased reliance on seigniorage, depends on comparing the distortion from constricting the supply of liquidity services from government debt to the reduced distortion from direct taxation, or the benefits from productive government expenditures, that would be allowed by increasing reliance on seigniorage. So long as inflation, interest rates on government debt, and tax rates remain as they were before the debt expansion, the optimal balance of seignorage vs. direct taxation is not much affected by the level of debt.

On the other hand, on this interpretation, the fact that interest rates and inflation have been stable in the face of the recent rise in debt cannot be taken as implying that debt financed fiscal expansion can be continued without limit without inflationary consequences.

VI. Real world complications

Blanchard (2019), based on his Figure 15, argues that there is some evidence for a decline in the real return on capital, measured as the rate of profit relative to market capitalization. If there is such a decline[2], we could interpret it in this paper's model as a decline in θ, the rate of labor-augmenting technological improvement. This would imply that the gap between the return on debt and private asset returns might have been declining despite the stable rate of inflation, and therefore that the economy has been moving toward less reliance on seigniorage finance. This does not in itself, of course, imply that returning to previous levels of seigniorage would be optimal.

This paper uses a representative agent model, and therefore cannot consider intergenerational tax-shifting or "crowding out" issues. Blanchard and Mehrotra/Sergeyev instead assume away tax distortions in order to focus on intergenerational issues. Both aspects of debt finance are important, and should be considered jointly. Furthermore, liquidity premia on government debt vary somewhat across the term structure and across time, and currency, bearing no interest, does exist. A more serious quantitative evaluation of the effects of debt finance should consider all of these potentially important factors as operating jointly.

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[2]The rate was in the 6-8% range in the 1960's in the US, and has been in the same range since 2001. There is some apparent downward trend, but it is not strong or uniform.

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