The optimal inflation rate revisited

Giovanni Di Bartolomeo, Università di Teramo gdibartolomeo@unite.it
Patrizio Tirelli, Università di Milano Bicocca patrizio.tirelli@unimib.it
Nicola Acocella, Università La Sapienza, Roma nicola.acocella@uniroma1.it

Milano Bicocca

October, 2010
Optimal monetary policy analyses (Khan et al., 2003; Schmitt-Grohé and Uribe, SGU henceforth, 2004a) identify two key frictions driving the optimal level of long-run (or trend) inflation.

1. Adjustment cost of goods prices, which invariably drives the optimal inflation rate to zero.
2. Monetary transaction costs that arise unless the central bank implements the Friedman rule, i.e. a negative steady-state inflation rate as long as the steady-state real interest rate is positive.

Phelps (1973) conjectured that to alleviate the burden of distortionary taxation it might be optimal for governments to resort to monetary financing, driving a wedge between the private and the social cost of money.
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SGU (2004a) show that, even accounting for the Phelps’ effect, the optimal inflation rate lies between zero and the Friedman rule, being very close to zero for apparently plausible parameterizations of the model.

“Consensus” view: stable prices are the proper policy target because monetary transactions costs are relatively low at zero inflation.

In their survey of the literature, SGU (2010) argue that the optimality of zero inflation is robust to other frictions, such as nominal wage adjustment costs, downward wage rigidity, hedonic prices, incompleteness of the tax system, the zero bound on the nominal interest rate.
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"Consensus" view is in sharp contrast with empirical evidence. Both in the US and in the Euro area, average inflation rates over the 1970-1999 period have been close to 5%.

Even the widespread central bank practice of adopting inflation targets between 2 and 4% is apparently at odds with theories of the optimal inflation rate (SGU, 2010).

Estimates of the Fed implicit inflation target: Ireland. "The target rose from 1.25% in 1959 to over 8% in the mid-to-late 1970s before falling back below 2.5% percent in 2004" Fernandez-Villaverde and Rubio-Ramirez (2008) 3.2% over the period 1957-2000 and 5.6% over the high inflation sub-sample 1973-1991
In this paper we reconsider the issue, showing that dismissal of the Phelps’ effect is due to an unrealistic parameterization for public expenditures and overall taxation and thus appears premature.

Standard calibrations of public expenditures focus on public consumption-to-GDP ratios, typically set at 20% (SGU, 2004a; Aruoba and Schorfeide, 2009). This follows a long-standing tradition in business cycle models, where only public consumption decisions have real effects. In our framework this choice is not correct, because the focus here is on distortionary financing of public expenditures in steady state, where also other components of public expenditure matter.

In the US, over the period 1998-2008 government transfer payments and government purchases respectively were 11.8% and almost 20% of GDP.
<table>
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<td>45.25</td>
<td>Euro area</td>
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<td>27.11</td>
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(1) public consumption; (2) other public expenditures; (3) total revenues

* ratios to GDP – Source OECD
Results in a nutshell

- We show that just allowing for a plausible parameterization of public transfers to households in the SGU (2004a) model reverses their conclusion about the optimal inflation rate, which now monotonically increases from 2% to 12% as the transfers-to-GDP ratio goes from 10% to 20%.

- We also find that an identical increase in the public-consumption-to-GDP ratio would have a negligible impact on the optimal inflation rate. So, what is special about public transfers?
Assume that lump-sum taxes can be used to finance expenditures.
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In case of public transfers changes, the overall effect on the household budget constraint is nil, and labor-consumption decisions are unchanged. An increase in public consumption generates a negative wealth effect that raises the labor supply.
Intuition

- Assume that lump-sum taxes can be used to finance expenditures.
- In case of public transfers changes, the overall effect on the household budget constraint is nil, and labor-consumption decisions are unchanged. An increase in public consumption generates a negative wealth effect that raises the labor supply.
- If lump sum taxes are not available, the different wealth effect, i.e. the different labor supply response, explains why financing transfers requires higher tax rates than financing an identical amount of public consumption.
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Since the incentive to monetary financing is increasing in the amount of tax distortions, this explains why the optimal financing mix requires stronger reliance on inflation when we take transfers into account.
Our result is robust to the inclusion of nominal wage rigidity, and is strengthened when we allow for a moderate degree of price and wage indexation (20%).
Extensions

- Our result is robust to the inclusion of nominal wage rigidity, and is strengthened when we allow for a moderate degree of price and wage indexation (20%).

- Consumption scale effects in the monetary transactions technology (Theoretical models: Baumol, 1952; Khan et al., 2003; empirical evidence: Attanasio et al., 2002). We find that such consumption scale effects unambiguously contribute to raise the optimal inflation rate.
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Intuition. An increase in inflation allows a reduction in distortionary taxation but it raises the monetary transaction costs. This latter effect is weakened when the transaction cost is inversely related to the amount of consumption, which, in turn, increases if the tax rate falls.
Finally, we calibrate the model to the US economy.

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- We consider different estimates of price rigidities found in the literature, and find that in all cases the optimal inflation rate is positive and increasing during the 1973-1991 subsample.
The model
Households

\[
U = \sum_{t=0}^{\infty} \beta^t u(C_{t,i}, l_{t,i}) \quad ; \quad u(C_{t,i}, l_{t,i}) = \ln C_{t,i} + \eta \ln (1 - l_{t,i})
\]

\[
C_{t,i} = \left( \int_0^1 c_{t,i}(j)^{\rho} \, di \right)^{\frac{1}{\rho}}, \quad l_{t,j} = \left[ \int_0^1 l_{t,j}(i)^{\frac{\sigma - 1}{\sigma}} \, di \right]^{\frac{\sigma}{\sigma - 1}}
\]

\[
C_{t,i} (1 + S_{t,i}) + \frac{M_{t,i}}{P_{t,i}} + \frac{B_{t,i}}{P_t} = \frac{(1 - \tau_t) w_{t,i} l_{t,i}}{P_t} + \frac{M_{t-1,i}}{P_t} + \frac{T_t}{P_t} + \frac{R_{t-1} B_{t-1,i}}{P_t}
\]
Monetary transaction costs (no consumption scale effects) strictly follow SGU (2004a)

\[ S_{t,i} = s(v_{t,i}) = Av_{t,i} + \frac{B}{v_{t,i}} - 2\sqrt{AB} \]
We assume a sticky price specification based on Rotemberg (1982) quadratic cost of nominal price adjustment:

$$\frac{\xi_p}{2} \left( \frac{P_t(j) / P_{t-1}(j)}{\pi_{t-1}^\delta} - 1 \right)^2$$

where $\xi_p > 0$ is a measure of price stickiness and $\pi_t = P_t / P_{t-1}$ denotes the gross inflation rate and $\delta \in [0, 1]$ is the degree of price indexation to past inflation.
The labour market is also characterized by monopolistic competition and rigid nominal wages. Under flexible wages,

\[
\frac{W_t}{P_t} = \mu^w \Omega_t \frac{u_l(C_t, I_t)}{u_c(C_t, I_t)}
\]

where \(\mu^w = \sigma (\sigma - 1)^{-1}\) denotes the gross wage markup and \(\Omega_t = \frac{1+s(v_t)+v_t s'(v_t)}{1-\tau_t}\) denotes the policy wedge, which depends on both tax and inflation decisions.
We model nominal wage stickiness as in Rotemberg (1982). 

\[ \frac{\xi_w}{2} \left( \frac{W_t(j)/W_{t-1}(j)}{\pi_t^{\delta_w}} - 1 \right)^2 \]
The model

Government and aggregate resource constraint

**Government budget constraint**

\[
R_{t-1} \frac{B_{t-1}}{P_t} + G_t + T_t = \tau_t \frac{w_t}{P_t} l_t + \frac{M_t - M_{t-1}}{P_t} + \frac{B_t}{P_t}
\]

**Aggregate resource constraint**

\[
Y_t = C_t (1 + S_t) + G_t + \frac{\zeta_p}{2} \left( \frac{\pi_t}{\pi_{t-1}^{\delta}} - 1 \right)^2 + \frac{\zeta_w}{2} \left( \frac{w_t}{w_{t-1} \pi_{t-1}^{\delta_w}} - 1 \right)^2
\]
Replicate SGU (2004a) with the addition that $0 < \frac{T}{Y} < 20\%$.

Table 2

<p>| | | | |</p>
<table>
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<tr>
<td>$\beta$</td>
<td>$\mu^p$</td>
<td>$\mu^w$</td>
<td>$\xi_p$</td>
</tr>
<tr>
<td>$A$</td>
<td>0.011</td>
<td>4.37</td>
<td>0.00</td>
</tr>
<tr>
<td>$B$</td>
<td>0.075</td>
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<td>0.00</td>
</tr>
</tbody>
</table>

$\delta_w = 0.00$
Figure 1 – Public expenditure and optimal inflation

variation in government consumption
variation in government transfers
Driving factors behind the optimal policy mix

- The distortionary taxation necessary to finance the additional transfers adversely affects the labour supply and reduces the tax base.
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By contrast, the increase in public consumption generates a negative wealth effect that triggers a positive labour supply response and expands the tax base. In this case the incentive to increase inflation is much reduced.
$\pi_t, \tau_t$ have different effects on the policy wedge

$$\Omega_t = \frac{1 + s(v_t) + v_t s'(v_t)}{1 - \tau_t}$$

$\Omega'_t(\tau_t), \Omega'_t(\pi_t) > 0$ but $\Omega''_t(\tau_t) > 0, \Omega''_t(\pi_t) = 0$. This explains why the Ramsey planner increasingly relies on the inflation tax as public expenditures grow.
In Figure 2 we compare the optimal steady state value of $\Omega$ with the value that would obtain if inflation were constrained at zero.

Figure 2 – Public transfers and the policy wedge
Eichenbaum and Fischer (2007) infer that firms re-optimize prices once every 2.3–3 quarters, but cannot reject the hypothesis that firms reoptimize prices once every two quarters.)
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We consider the effects of different degrees of stickiness (measure as average duration of price-setting decisions) assuming that $T/Y = 10\%$. 
Figure 3 Price adjustment and trend inflation $T/Y = 10\%$
Figure 4 – Public transfers, monopolistic distortions and optimal inflation
$\mu^w = 1.2, \; \zeta_w = \zeta_p = 4.37$

Figure 5 – Optimal inflation: Flexible vs. sticky wages
$\delta_p = \delta_w$

Figure 6 – Public transfers, indexation and optimal inflation
Consumption scale effects in the monetary transactions technology

- Theoretical models accounting for consumption scale effects include Baumol (1952) and Khan et al. (2003).
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- Attanasio et al. (2002) find substantial economies of scale in cash management using microdata.
Consumption scale effects in the monetary transactions technology

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- Why bother? In a different model, Guidotti and Vegh (1993) show that the constant elasticity of scale is an unduly restrictive assumption and that it is optimal to resort to the inflation tax if the transactions costs technology does not exhibit constant returns to scale.
\[ S_{t,i} = s(v_{t,i})g(C_{t,i}); \quad g(C_{t,i}) > 0, \quad g'(C_{t,i}) < 0 \]

\[ g(C_{t,i}) = C_{t,i}^{-\theta} \quad \theta \geq 0 \]

\[ \frac{M_t}{P_t} = \frac{C_t}{\sqrt{\frac{B}{A} + (R_t - 1) \frac{C_t^\theta}{A}}} \]

\[ \eta_m = \frac{\partial (M_t / P_t)}{\partial C} \frac{C}{M_t / P_t} = \left[ 1 - \frac{1}{2} \frac{\theta (R - 1) C^\theta}{B + (R - 1) C^\theta} \right] \leq 1 \]
The transactions-induced wedge between the marginal utility of consumption and the marginal utility of wealth unambiguously falls in $\theta$ for any level of money velocity. Our conjecture is that this should support an increase in the optimal inflation rate.
Scenarios

Three different scenarios.

1. We represent an economy calibrated as in SGU (2004a), where parameters are calibrated as in table 2 with $G/Y = 0.2$, $T/Y = 0$.

2. We assume sticky wages (with $\mu_p = 1.2$ and $\xi_w = 4.37$), 20% indexation on both prices and wages, public consumption set at 20% and a transfer equal to 11% of output.

3. We assume that prices are relatively flexible and the degree of price indexation to past inflation is modest, whereas wages are characterised by strong indexation, as found in Galí and Rabanal (2005), Rabanal and Rubio-Ramírez (2005), Fernandez-Villaverde and Rubio-Ramirez (2008) and Christiano et al. (2010). Relative to scenario 2, we set $\xi_p = 2.5$ (i.e., price are reset about every six months on average), $\delta_p = 0.15$ and $\delta_w = 0.85$
Table 3 – Consumption scale effects

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<th>θ</th>
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- During the period 1957-2000 the average government-consumption-and transfers-to-GDP have respectively been 20% and 9%.
- For the sub-sample 1973-1991 we find similar figures for $G/Y$ and a slightly higher transfers ratio, about 10%.

For the crucial parameters $(\theta, \xi_p, \xi_w, \delta_p, \delta_w, \mu^p, \mu^w)$ we consider 5 alternatives.
Five alternatives

1. SGU (2004a) model: perfect competition in the labor market and no indexation.
2. Add consumption scale effects in monetary transaction costs.
3. Introduce monopolistic competition and nominal rigidities in the labor market and allow for a moderate degree of price and wage indexation (25%).
4. The parameters describing nominal rigidities $\left(\xi_p, \xi_w\right)$ imply that prices re-optimized on average every 10 months and wages every 9 months as in Smets and Wouters (2007).
5. We consider the highest frequency of price adjustment we found in the literature, 2 quarters, as reported in and Eichenbaum and Fisher (2007).
# Five alternatives (calibrations)

Table 4 – The US economy calibration

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Table 5 – Optimal, observed and targeted inflation

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<td>(*) CPI inflation, excluding</td>
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(*) CPI inflation, excluding food and energy.
Since Phelps we know that a positive inflation rate might mitigate the distortions induced by need to finance government budgets. In contrast with previous research, we show that this argument is relevant given the policy mix between government consumption and transfers that we observe in OECD countries.
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This result holds for plausible parameterization of price and nominal wage adjustment costs. The size of monopolistic distortions, the degree of price and wage indexation, the consumption scale effect in monetary transaction costs unambiguously increase the optimal inflation rate.
Since Phelps we know that a positive inflation rate might mitigate the distortions induced by need to finance government budgets. In contrast with previous research, we show that this argument is relevant given the policy mix between government consumption and transfers that we observe in OECD countries.

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Unfortunately, empirical evidence on these latter variables is rather limited. In fact estimated DSGE models typically impose markup parameters, assume a vertical long-run Phillips curve and neglect monetary transaction costs.
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A fortiori, our reconsideration of the Phelps conjecture appears even more appropriate when considering countries in the Euro area where the welfare state plays a more important role.

In contrast with SGU (2010), who argue that central bank inflation targets are too high, our contribution shows that a 2\% target might be too low, at least for countries where the burden of taxation is rather high, such as continental Europe.
The explanation for this might be that commitment to a low inflation rate is used to discipline spending decisions, assumed exogenous in our model. In fact several political economy models point out that distorted policymakers’ incentives inflate public expenditures (Tornell and Lane, 1999; and Persson and Tabellini, 2003, 2004).
The explanation for this might be that commitment to a low inflation rate is used to discipline spending decisions, assumed exogenous in our model. In fact several political economy models point out that distorted policymakers’ incentives inflate public expenditures (Tornell and Lane, 1999; and Persson and Tabellini, 2003, 2004).

As shown in Acemoglu et al. (2009), the Ramsey-optimal taxation is substantially affected when taxes and public good provision are decided by a self-interested politician who cannot commit to policies. In a similar vein, further research should investigate how these two frictions, i.e. politicians’ self-interest and lack of commitment, may affect the choice of the optimal inflation target.