Inflation as a Redistribution Shock: Effects on Aggregates and Welfare*

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Abstract

Episodes of unanticipated inflation reduce the real value of nominal claims and thus redistribute wealth from lenders to borrowers. In this study, we consider redistribution as a channel for aggregate and welfare effects of inflation. We model an inflation episode as an unanticipated shock to the wealth distribution in a quantitative overlapping-generations model of the U.S. economy. While the redistribution shock is zero sum, households react asymmetrically, mostly because borrowers are younger on average than lenders. As a result, inflation generates a decrease in labor supply as well as an increase in savings. Even though inflation-induced redistribution has a persistent negative effect on output, it improves the weighted welfare of domestic households.

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1 Introduction

Inflation surprises are a salient characteristic of modern economies. Throughout most of the inflation episode experienced by the United States along with other industrialized countries in the 1970s, realized inflation exceeded prior expectations.[1] More generally, inflation volatility emerges as a key stylized fact in Fischer, Sahay, and Vegh (2002), a detailed study of more than 200 postwar high-inflation episodes in 92 countries. Surprise inflation redistributes wealth from lenders to borrowers by reducing the real value of nominal assets and liabilities. This redistribution effect is not taken into account in most existing research on the welfare cost of inflation, which employs a representative-agent framework (see, for example, Lucas 2000 and the references therein).

This study analyzes the effects of inflation as a *redistribution shock*, that is, an unanticipated wealth transfer between different sectors and groups of households. In particular, we quantify the aggregate and welfare effects of a hypothetical ten-year inflation episode on the U.S. economy, assuming that the only real effects of inflation are due to the revaluation of nominal assets and liabilities. The resulting welfare effects on individual cohorts easily outweigh conventional measures of the welfare costs of inflation. Moreover, the weighted welfare of domestic households *improves*—the opposite of what standard monetary models predict. Redistribution alone also generates effects on economic aggregates that are as large as those in representative-agent models with monetary frictions. Another difference from standard models is that the effects of redistribution persist long after the end of an inflation episode.

Surprise inflation affects households not only directly by changing the value of their nominal positions, but also indirectly through changes in fiscal policy. Fiscal policy must adjust in some dimension during an inflation episode, since the reduction of real government debt presents the government with a windfall gain. We use our model to illustrate how the welfare impact on households depends on how this gain is spent. For example, we describe one policy scenario under which a majority coalition that includes all but the richest households benefits from a surprise inflation episode. The young net borrowers in the coalition benefit directly, while the government uses its gain to compensate old net

[1] Between June 1973 and June 1974 the CPI grew by 10.4 percent. For the same period, the median inflation forecast among more than 40 professional forecasters interviewed for the Livingston Survey was 3.4 percent, and even the highest forecast was only 7 percent. Between June 1978 and June 1979, the second oil price shock led once more to an inflation rate of 10.4 percent, much higher than the median forecast of 5.6 percent.

lenders through higher social security transfers. Under this policy, the bill is paid by rich old households and the foreign sector. The result suggests that the temptation for policy makers to inflate might be greater than is commonly thought.

The starting point for our calculations is a fairly standard neoclassical growth model. Households differ by age and labor productivity to generate a heterogeneous population. The other important players in credit markets—the business sector, the government, and foreigners—are also present. The model is calibrated so that its balanced growth path matches key aggregate statistics of the U.S. economy, as well as properties of the wealth and income distribution from the Survey of Consumer Finances (SCF). In order to isolate the effects of inflation that are generated by wealth redistribution, we abstract from monetary frictions.

We model an inflation episode as an unanticipated zero-sum redistribution of real wealth that displaces the economy from its balanced growth path. Since a period in our model corresponds to ten years, we calibrate the magnitude of the redistribution shock to the present-value gains and losses from an inflation episode during which the inflation rate increases by ten percentage points for a ten-year period. We estimate these gains and losses along the lines of Doepke and Schneider (2006), who document nominal asset and liability positions for different sectors and groups of households in the United States. We consider different scenarios for the adjustment of expectations during an inflation episode. This is important because surprising changes in inflation expectations—in addition to simple jumps in the price level—also entail redistribution through their effects on nominal interest rates. The extent to which agents are exposed to changes in inflation expectations depends on the maturity structure of nominal positions, which varies across agents.

Despite the fact that inflation-induced wealth changes sum to zero across agents, the responses of winners (net borrowers) and losers (net lenders) do not cancel out. Among households, the key asymmetry is that net borrowers tend to be younger than net lenders. This asymmetry gives rise to two life-cycle effects. First, a reduction in the labor supply of the young winners (that is, an increase in their consumption of leisure motivated by an increase in wealth) is not offset by an increase in labor supply by the old losers, since many of the latter are retired. Second, an increase in the savings of the young winners is not fully offset by a decrease in the savings of the old losers, since young households spread any gain or loss over more remaining periods of life than old households.

In our calibrated model, the first effect causes aggregate labor supply to decline by up to 2 percent in the decade after the inflation episode. The second effect increases the capital stock by up to 1.3 percent above trend two decades after the start of the inflation episode. The net result is a decline in output over the first two decades after the shock of up to 1.2 percent relative to trend, followed by a smaller temporary increase. When viewed as a redistribution shock, inflation has persistent effects because it leads to wealth transfers, which are propagated through standard life-cycle behavior. This is in contrast to standard models, where persistence requires long-lived rigidities.

The effects on the welfare of individual cohorts are large. Retirees lose the most and experience a decrease in their consumption of up to 14 percent relative to the balanced growth path. Among the winners, consumption of the young poor and middle-class cohorts increases by up to 6 percent. Overall, domestic households gain at the expense of foreigners. Using standard weighted welfare measures, we find that the aggregate welfare effect of inflation on domestic households is positive, and larger in absolute value than conventional measures of the welfare cost of inflation based on monetary frictions. We show that this would be true even if foreigners were not affected by inflation, since the redistribution effect tends to level the overall wealth distribution, which improves weighted welfare. However, the losses incurred by foreigners substantially increase the positive welfare effect.

Our analysis incorporates multiple fiscal policy scenarios for the evolution of government debt and the method through which the government rebates its gain to households. The aggregate effects of inflation are qualitatively similar in all scenarios. However, fiscal policy plays a key role in determining how many losers and winners from inflation there are overall. For example, if the government lowers income taxes in response to its gain, young winners from inflation tend to do even better. If the government increases social security transfers, in contrast, most of the old losers from inflation can be fully compensated.

In the next section, we review the literature. Section 3 presents the theoretical framework. The model parameters as well as the redistribution shock are calibrated to data in Section 4. In Section 5, we use the calibrated model to analyze the economic implications of the redistribution brought about by an inflation shock. Section 6 concludes.

2 Related Literature

To the best of our knowledge, this is the first comprehensive study of the redistributional effects of inflation in a quantitative framework. However, a number of specific aspects have been discussed in the existing literature. The surprise revaluation of nominal government debt is the focus of Bohn's (1988) study of fiscal policy. Bohn considers a stochastic model with incomplete markets where government debt is nominal. Nominal debt provides insurance against the effects of economic fluctuations on the government's budget. A negative productivity shock leads to an increase in the price level (through the quantity equation), and thereby deflates the value of existing government debt. This windfall enables the government to continue to provide its services without being forced to raise taxes in the downturn. Nominal debt therefore serves as a mechanism that implements event-contingent insurance.[2]

Persson, Persson, and Svensson (1998) are also interested in the effect of inflation on government finances. For the case of Sweden, they conduct a thought experiment that is similar in spirit to ours: what would be the present value change in the government budget, as of 1994, if there was a permanent 10 percentage point increase in inflation? They find a sizeable effect, about as large as 1994 GDP. However, most of this effect is accounted for by incomplete indexation of the tax and transfer system, as opposed to the direct devaluation of government debt. Despite the large positive impact on the government's budget, the authors conclude that the net social gains of the inflation policy are likely to be negative. A key difference from our analysis (apart from the fact that we do not focus exclusively on the government) is that we use a quantitative model to explore different fiscal policy scenarios, rather than assuming that the tax and transfer system will remain unchanged.

Burnside, Eichenbaum, and Rebelo (2006) examine the fiscal implications of currency crises in three middle-income countries. They find that devaluation of the dollar value of government debt (an effect that is also present in our analysis) is a more important source of depreciation-related government revenue than seigniorage, which is the source emphasized by most standard currency crisis models. Neumeyer and Yano (1998) document the effects of U.S. monetary shocks on other countries that arise from cross-border

[2] See also Bohn (1990b) for some empirical evidence on this mechanism, and Bohn (1990a, 1991) on open-economy extensions. Barro (2003) compares optimal debt policies with indexed and nominal bonds, and argues that if the government is subject to moral hazard, issuing nominal bonds for insurance purposes may be undesirable.

holdings of nominal assets, and argue that during the 1980s these were especially large for Latin American countries.

A connection between inflation and the wealth distribution can also arise through asymmetric incidence of the inflation tax. Erosa and Ventura (2002) observe that poor households hold more cash relative to other financial assets than rich households do. They rationalize this fact in a monetary growth model where access to credit markets is costly. The poor then pay a disproportionate share of the inflation tax and are hurt more by inflation. Since inflation acts like a nonlinear consumption tax—with higher rates for the poor—it also encourages precautionary savings and thereby leads to a higher concentration of wealth. Albanesi (2006) derives a positive correlation between inflation and inequality in a similar model, where the inflation tax rate is set in a political bargaining game. Since the poor are more vulnerable to inflation, their bargaining power is weak, and the rich succeed in implementing high inflation. The key difference between the inflation tax literature and our paper is that the former deals with the effect of anticipated inflation on cash holdings. In contrast, we are concerned with unanticipated shocks on all nominal asset holdings, of which cash holdings are only a small part.

Our study is also related to a large literature on the link between the earnings and wealth distributions in the U.S. The key stylized fact that this literature has wrestled with is that the distribution of wealth is much more concentrated than that of earnings (see Budría Rodríguez, Díaz-Gimenéz, Quadrini, and Ríos-Rull 2002 for an overview of the stylized facts). Both models with dynastic households (for example, Aiyagari 1994, Krusell and Smith, Jr. 1998, Quadrini 2000) and life-cycle models (Hubbard, Skinner, and Zeldes 1995, Huggett 1996, Storesletten, Telmer, and Yaron 2004) have been explored. More recently, several papers have combined features of these two setups by accommodating both life-cycle concerns for saving and altruism (for example, Castañeda, Díaz-Gimenéz, and Ríos-Rull 2003, De Nardi 2004, Laitner 2001).

The model used here is simpler than those in most of the above studies in that households face no uncertainty. In particular, idiosyncratic labor income risk, the typical source of heterogeneity in the literature, is absent from our setup. Instead, all earnings heterogeneity is due to differences in deterministic skill profiles across types of households, and wealth inequality is partly generated by preference heterogeneity. We choose this modeling strategy in order to calibrate the model to observed features of specific groups of households, as opposed to aggregate moments of the earnings and wealth distribution. Furthermore, our environment allows us to compute transition paths, rather than just comparing steady states. At the same time, our model shares several broad themes with existing studies. One is the importance of bequests for generating a group of rich households that holds most of aggregate wealth. In our model, agents with high earnings also have a greater 'warm glow' taste for transfers to their children. This may be viewed as a simplified version of the setups in Carroll (2000) and De Nardi (2004), who employ preferences where bequests are a luxury good. A second model feature that helps reconcile the different properties of the earnings and wealth distribution is the presence of a social security system.

Our model also has two features that are not staples of the wealth distribution literature. One is the explicit treatment of durables (both consumer durables and houses), which allows a distinction between financial and nonfinancial wealth. In addition, we assume that labor supply is endogenous, and we calibrate both earnings and wealth observations to a cross section of data from the SCF. In this respect, we follow Castañeda, Díaz-Gimenéz, and Ríos-Rull (2003). In contrast, most other studies work with an exogenous earnings process estimated from panel data.[3]

3 The Model

This section introduces a theoretical framework that can be used to assess the economic implications of redistribution shocks. We use an overlapping-generations model in which people differ both by age and by "type," where the types will later be calibrated to different groups of households in the U.S. population. Apart from predicting the reaction of firms and consumers, the model will also allow us to analyze the role of government behavior. In our baseline redistribution experiment, the government receives a windfall through a reduction in the real value of existing government debt. We use the model as a laboratory to explore different reactions of the government to this windfall, such as tax cuts, higher government expenditures, or increased social security pensions.

Preferences

We consider an overlapping-generations economy in which consumers live for $N + 1$ periods (from 0 to N). Every period, a cohort of size one is born. People derive utility

[3] We do not use panel data since, unfortunately, common panel data sets contain little information about rich households, who are particularly prominent owners of nominal assets.

from durable and non-durable consumption goods as well as leisure. The utility function of a household of type i born in period s is:

$$\sum_{t=s}^{s+N} \beta_i^t \, u_i(c_{i,s,t},\, d_{i,s,t},\, 1 - l_{i,s,t}) + v_i(b_{i,s}), \tag{1}$$

where $c_{i,s,t}$ is non-durable consumption in period t (of a type-i consumer born in period s), $d_{i,s,t}$ is consumption of houses (i.e., durable consumption), $l_{i,s,t}$ is labor supply, $1 - l_{i,s,t}$ is leisure, and $b_{i,s}$ is the bequest left to the next generation.[4] Preferences for bequests are of the "warm-glow" type; that is, parents derive utility directly from the bequest given to their children, as opposed to the children's utility. We also assume that children are of the same type as their parent.

The consumer receives a bequest in the first period of life, works for the first $N-1$ periods, and is retired during the last two periods. During retirement, the consumer receives a social security benefit from the government. Utility is maximized subject to the following budget constraints:

$$c_{i,s,s} + d_{i,s,s} + a_{i,s,s+1} = (1-\tau_s)\, w_s\, \phi_{i,0}\, l_{i,s,s} + b_{i,s-N}, \tag{2}$$

$$c_{i,s,t} + d_{i,s,t} + a_{i,s,t+1} = (1-\delta)\, d_{i,s,t-1} + R_t\, a_{i,s,t} + (1-\tau_t)\, w_t\, \phi_{i,t-s}\, l_{i,s,t} \quad \text{for } s < t < s+N-1, \tag{3}$$

$$c_{i,s,s+N-1} + d_{i,s,s+N-1} + a_{i,s,s+N} = (1-\delta)\, d_{i,s,s+N-2} + R_{s+N-1}\, a_{i,s,s+N-1} + tr_{s+N-1}, \tag{4}$$

$$c_{i,s,s+N} + p_{s+N}\, d_{i,s,s+N} + b_{i,s} = (1-\delta)\, d_{i,s,s+N-1} + R_{s+N}\, a_{i,s,s+N} + tr_{s+N-1}. \tag{5}$$

Here $a_{i,s,t}$ are savings, τ_t is the tax rate on labor income, w_t is the wage, $\phi_{i,t-s}$ is an age- and type-specific skill parameter, R_t is the interest rate, and tr_{s+N-1} is a social security transfer. Notice that the social security transfer is indexed by the first period of retirement, and is the same in both periods of retirement.

In the last period, instead of buying houses outright, consumers rent the houses at price p_{s+N}. The rental units are owned by other households as part of their assets $a_{i,s,t}$, and the price of renting adjusts such that the return on owning houses is equal to the return on other assets. Equivalently, we could have assumed that rental services are supplied by a competitive industry that borrows money to build and rent out houses. We assume

[4]The explicit treatment of durables allows us to distinguish financial and nonfinancial wealth. The importance of durables for understanding life cycle patterns in consumption and wealth has been stressed by Fernández-Villaverde and Krueger (2001).

that young people buy houses, since otherwise the model could not match the empirical observation that a sizable fraction of households has positive net worth, but negative financial assets. At the same time, we assume that old people rent, so that we do not have to introduce additional assumptions on what happens to the houses of people after they die.

In a frictionless environment, owning a house and renting in a competitive market are equivalent. For a part of our analysis, however, we are going to assume that households face a borrowing constraint. In particular, households are only able to borrow up to a fixed fraction ψ of the value of their houses:

$$a_{i,s,t+1} \geq -\psi d_{i,s,t}. \tag{6}$$

As long as $\psi < 1$, a financially constrained household would be better off renting housing services in a competitive market instead of buying. We still maintain the assumption that young households buy their houses, because this is the prevalent situation in the data. This choice could be formally justified by introducing additional frictions (such as tax advantages) that favor buying over renting.

Technology

There is a competitive industry that produces the (nondurable) consumption good from efficiency units of labor L, physical capital K, and intangible capital E according to the production function:

$$Y_t = (z_t L_t)^{1-\alpha} \left(K_t^{\rho} E_t^{1-\rho}\right)^{\alpha}.$$

Output can be transformed into either type of capital or into the durable consumption good (houses) without adjustment costs. Both K_t and E_t are owned by households and rented to firms. Productivity z_t grows at the exogenous and constant rate g:

$$z_{t+1} = (1+g)z_t.$$

Firms rent physical and intangible capital at the common rental rates R_t, and the depreciation rates are δ_K and δ_E. In equilibrium, both types of capital have the same expected return. If in addition the two depreciation rates are the same (as they are in our calibration), the two types of capital can be aggregated, and the model economy will behave just like the usual model with labor and physical capital only. Nevertheless, introducing intangible capital is useful for calibrating the model; in particular, we will be able to match both the ratio of business capital K_t to output and the return to capital.

The firms' first-order conditions equate the marginal product on either type of capital to the rental rate and the marginal product of labor to the wage rate. Due to the absence of arbitrage, the net returns on both types of capital must also be equal to the interest rate. We thus have:

$$R_t = 1 - \delta_k + \alpha\,\rho\,\frac{Y_t}{K_t}, \quad R_t = 1 - \delta_E + \alpha\,(1-\rho)\,\frac{Y_t}{E_t}, \quad w_t = (1-\alpha)\,\frac{Y_t}{L_t}. \tag{7}$$

Government and Foreigners

The government in our model economy taxes labor income and issues new government debt B_{t+1} to finance social security transfers, general government expenditures G_t, and interest on existing debt B_t. The labor tax τ_t is linear, does not depend on the type of the worker, and may vary over time. The social security system consists of lump-sum payments tr_{t-1} and tr_t to every adult who retired in periods $t-1$ and t, respectively. The period budget constraint of the government is:

$$B_{t+1} + \tau_t\,w_t\,L_t = R_t\,B_t + G_t + tr_{t-1} + tr_t. \tag{8}$$

Notice that the size of each cohort of retirees is one, so that population size does not enter on the right-hand side of the budget constraint. We do not assume that the government is benevolent or maximizes any particular objective function. Instead, our strategy is to calibrate government behavior in the balanced growth path to U.S. observations, and then to explore the consequences of different government policies in reaction to a redistribution shock.

In addition to the domestic consumers, we also allow for the possibility that foreigners are investing in the domestic market. Similar to our treatment of the government, the behavior of the foreigners will be taken as exogenous. The assets held by foreigners in period t will be denoted $a_{F,t}$. In the model economy, net exports are given by interest payments to foreigners minus new foreign investment in domestic assets.

This completes the description of the main elements of our model. In Appendix A, we provide the remaining market-clearing conditions, specify the rental market for houses in more detail, and formally define an equilibrium.

Redistribution Shocks

A redistribution shock is an unanticipated zero-sum redistribution of assets among the agents in the economy that displaces the economy from its balanced growth path. In particular, suppose that the economy is still on the balanced growth path in period t. The redistribution takes place among financial assets saved in period t for period $t+1$. The generations affected by redistribution are thus all generations alive at the beginning of $t+1$. Since the shock is unanticipated, it does not affect decisions in period t. Agents begin period $t+1$ with the asset position after the redistribution shock took place, and adjust their behavior accordingly. We concentrate on a one-time shock: no further redistribution takes place after period $t+1$, and agents do not expect future redistributions. This approach is designed to isolate the wealth effect of redistribution on individuals' behavior.

The economic effects of the redistribution shock can be assessed by comparing the adjustment path after the shock with the balanced growth path. When computing the adjustment path, we have to take a stand on the behavior of the government and the foreigners after the shock. Unlike households and firms, whose behavior is ruled by utility and profit maximization, the decisions of government and foreigners are taken as exogenous in the model. We use simple parametric decision rules for these agents, and explore the sensitivity of the results to the government's and foreigners' behavior by experimenting with different rules. More specifically, in the analysis below we assume that the government and foreigners target the ratio of their net asset position to GDP, either holding this ratio constant, or adjusting it at a constant rate towards the original balanced growth path. In the case of the government, we also have to determine how the different components of the government's budget (tax revenue, pension payments, government expenditures) adjust. In the quantitative analysis below we explore a number of different assumptions on this point.

Within the theoretical model, we do not take a stand on the origin of the redistribution shock, or the precise mechanism through which it is implemented. In the case of an inflation shock that we analyze below, a more direct interpretation could be given if we distinguished between nominal and real assets, which are affected differentially by inflation. Such an extension, however, would not change the predictions of the model. Since there is no uncertainty in the model, there is no meaningful distinction between nominal and real. If we formally introduced both types of assets, and both were held in positive quantities, agents would be indifferent between them in any equilibrium, so that *any* profile of nominal positions could be maintained as an equilibrium outcome. In particular, there would be one equilibrium where the nominal asset positions exactly reproduce the redistribution vector calibrated in Section 4 below, given an unanticipated change in the unit of account of suitable size. However, no further insights would be gained from this formal exercise.[5]

4 Calibration

4.1 Model Parameters

We calibrate the balanced growth path of the model to aggregate statistics of the U.S. economy as well as data on the cross section of households. We specify household heterogeneity in the model to match the empirical analysis of nominal positions in Doepke and Schneider (2006). In that study, we sort households, by age of the household head, into six cohorts: households under the age of 35, 36–45, 46–55, 56–65, 66–75, and above 75. To match this sorting, we assume that a model period lasts ten years, with the youngest cohort corresponding to ages up to 35 and the oldest cohort comprising those aged 76 and older. In Doepke and Schneider (2006), the top 10 percent of households by net worth within each cohort are referred to as the *rich* households. The rest of the households are then sorted by income into two additional groups, labeled the *middle class* (70 percent of the population) and the *poor* (the bottom quintile of the income distribution). Consistent with this breakdown, we distinguish three types of households in our model, indexed as $i = r,\ m,\ p$, which are calibrated to match characteristics of the rich, middle class, and poor groups in the data.

In order to choose values for household, technology, and government parameters, we select a set of target moments. The parameter values are chosen such that the balanced growth path of our economy matches each of these statistics. In most cases, there is no one-to-one relationship between a moment and a particular model parameter. Nevertheless, it is helpful to distinguish three sets of moments, one for each sector. For households,

[5] Of course, it would be a much harder exercise to match the empirical nominal position profiles using a *stochastic* model with nominal and real assets, in which an inflation shock is expected with some probability. Constructing such a model is beyond the scope of this paper. Nevertheless, given that, as long as the profiles are matched, the resulting redistribution would be the same, we conjecture that most of the findings from our model would carry over to a more complicated setting. In particular, the post-inflation predictions would be unchanged if after the realization of the shock there were no further uncertainty.

the preference parameters and households' skill profiles are chosen to match data on labor earnings and wealth profiles of different groups of households. The technology parameters determine the accumulation of tangible and intangible capital in the business sector. Here we target the labor share, the return on capital, and the ratios of depreciation and business capital to GDP. Finally, government behavior is calibrated in order to match the ratios of tax revenues, social security spending, and public debt to GDP.

Preferences and Skill Profiles

A key requirement for the functional form of the utility function is to be consistent with balanced growth. We therefore choose the following period utility function:

$$u_i(c_t, d_t, 1-l_t) = \frac{\left((c_t)^{1-\sigma_i-\eta}\,(1-l_t)^{\sigma_i}\,(d_t)^{\eta}\right)^{1-\gamma}}{1-\gamma},$$

and the utility derived from bequests is given by:

$$v_i(b) = \xi_i \frac{b^{1-\epsilon_i}}{1-\epsilon_i}.$$

The Cobb-Douglas specification of preferences over consumption and leisure is standard in the real business cycle (RBC) literature. We also follow the RBC literature in choosing the weight of leisure σ_i to match average labor supply to a target of 40 percent of the time endowment (in other words, a working adult works an average of 40 hours per week out of a total of 100 "disposable" hours, i.e., excluding sleep and basic maintenance). The parameter is allowed to vary across groups so that we can match labor supply for each group individually. Specifically, if all groups placed the same weight on leisure, the rich group would work too little relative to the data because of their higher wealth. Furthermore, having identical leisure weights would result in widely different labor supply elasticities for the different groups.[6] The elasticity parameters γ and ϵ_i govern risk attitudes and the intertemporal elasticity of substitution. We set γ to the standard value of $\gamma = 2$. Balanced growth then requires that we set $\epsilon_i = 1-(1-\sigma_i)(1-\gamma)$.

The utility weight η determines the expenditure share of durables (which we interpret as houses). To calibrate η, we take two different targets into account: the ratio of residential

[6] In the calibrated model, the Frisch labor supply elasticity at average hours is essentially identical across types, varying from 1.05 for the middle class to 1.10 for the poor. These elasticities are within the range of existing empirical estimates, see Browning, Hansen, and Heckman (1999). In particular, the values are well below estimates for the elasticity of female and aggregate labor supply, but exceed estimates for continuously employed males, which is appropriate since the model is formulated at the level of households.

capital to physical capital in the National Income and Product Statistics (NIPA), which is 1.44 in 1989, and the ratio of nonfinancial wealth to net worth in the SCF data, which is 58 percent in 1989. The valuation procedures used in these two data sources are not mutually consistent, so we cannot match both statistics at the same time. As an intermediate target that takes account of both numbers, we target a ratio of 1.8 for durables to physical capital, which results in a 36 percent share of durables in net worth.

The parameter ξ_i determines the expenditure share of bequests. In the data, bequests are highly concentrated among the richest groups of the population, and many households do not receive significant bequests at all (see Gale and Scholz 1994 and Hurd and Smith 1999). We therefore assume that only rich people care about bequests, setting $\xi_p = \xi_m = 0$. To calibrate ξ_r, we follow De Nardi (2004) and target the transfer wealth ratio, which is the fraction of total net worth accounted for by transfers from other households, including bequests and inter-vivos transfers (but not college payments). Using the estimate of Gale and Scholz (1994), we target a transfer wealth ratio of 60 percent.

The time preference parameters β_i determine the amount of capital accumulation in the economy, the steepness of lifetime asset and consumption profiles, and the relative net worth of different types of households. We use three different targets to set the β_i: the ratio of the measured capital stock to output in the business sector, which was 1.55 in 1989 NIPA data, the ratio of rich to middle-class net worth, which was 13.69 in the 1989 SCF, and the ratio of middle to poor net worth, which was 4.54. To match these targets, we have to assume that the rich type is significantly more patient than the other types. This follows because the rich have a steeper asset profile, and their share of total wealth is much higher than their share of labor earnings.[7]

The skill parameters $\phi_{i,n}$ are chosen such that the cross-section of labor earnings in the model's balanced growth path matches observed earnings in the 1989 SCF. Notice that because the balanced growth rate is positive, the cross-section of earnings is not identical to the lifetime profile of earnings for a given type. In particular, the lifetime profile is steeper than the cross-section profile, since wages rise over time. Before we can match model earnings to data, a couple of steps are necessary to ensure a consistent measurement of earnings in model and data. In the SCF, we observe labor earnings, business income, private business wealth, and other financial wealth for each type and cohort. The model does not distinguish between private business and other financial assets; busi-

[7] It is a well known fact that, in most countries, the distribution of wealth is much more concentrated than the distribution of income; see also Carroll (2000).

ness wealth in the data is therefore interpreted as a part of overall financial wealth in the model. Here, however, a potential measurement problem arises. Since in the model there is just one type of financial asset, by definition business wealth has the same rate of return as any other type of financial wealth. In the data, however, we see that the implied returns on private business wealth (the ratio of business income to business wealth) greatly exceeds the return on other financial assets. We deal with this inconsistency by assuming, perhaps realistically, that part of what is labeled as business income in the SCF should actually be interpreted as labor income, since it is derived from running the private business. We therefore construct earnings targets by adding observed labor income and business income that exceeds the income implied by the return on financial assets in the model.[8] This adjustment is important to match the earnings of the rich, who derive a large part of their income from private business. Using $e_{i,n}$ for the SCF earnings of type i and cohort n, $bi_{i,n}$ for business income, $bw_{i,n}$ for business wealth, and R for the rate of return, the earnings targets $\hat{e}_{i,n}$ are:

$$\hat{e}_{i,n} = e_{i,n} + [bi_{i,n} - (R-1)bw_{i,n}].$$

The average level of earnings in the economy is a scale factor. We therefore normalize the skills of the youngest poor cohort to one, and choose the $\phi_{i,n}$ to match the ratio of the earnings of each type and cohort to the earnings of this group. Table 1 displays the (relative) earnings targets, which are based on the 1989 SCF data.

Technology Parameters

The only non-standard aspect of our technology is the presence of intangible capital. Since investment in intangible capital is not measured as investment in NIPA, production Y_t and measured output are not identical concepts in our economy. To link model output and measured output in the balanced growth path, we use the resource constraint of the economy:

$$C_t + I_t^k + I_t^h + G_t = Y_t - I_t^e.$$

We equate the right-hand side to the NIPA GDP for the business sector. This output is either consumed or invested in physical (household or business) capital. As mentioned earlier, the ratio of business capital to measured output is matched to data by choosing the time preference parameters of consumers. Given this ratio, the share of intangible capital

[8]For the 56–65 cohort of the poor type, business income is negative on average. For this group, the earnings target is based on labor earnings only.

$1-\rho$ determines the equilibrium rate of return. Given our other calibration choices, we find that setting $\rho = 0.5$ leads to a return of 8.25 percent per year, which is close to the 8.4 percent real annual return on the U.S. stock market computed by Jagannathan, McGrattan, and Scherbina (2000) for the period 1945–1999. If we did not allow for intangible capital, the model would imply a much higher, counterfactual return. The share parameter α determines the fraction of output going towards compensation of capital and labor. Once again, we cannot match α to the capital share directly due to the presence of unmeasured output. The measured labor share of our economy is given by $w_t L_t/(Y_t - I_t^e)$, which we match to the observed value of 0.66 in the data. The depreciation rate on physical capital can be inferred directly from NIPA. Given the observed NIPA rate for the business sector, we select 7 percent per year, or $\delta_k = 1-(1-0.07)^{10}$. We also impose that all depreciation rates are identical, so that $\delta = \delta_e = \delta_k$. Finally, the productivity growth rate g is set to 2 percent per year, which approximates the average growth rate of the real output per person in the U.S. economy over the past century.

Behavior of the Government and Foreigners

The government parameters to be calibrated are the labor tax rate τ_t, the social security transfer tr_t, and general government spending G_t. Given these choices, the interest rate and productivity growth rate pin down the ratio of government debt B_t to GDP in the balanced growth path. We choose τ to match the ratio of tax revenues to measured GDP to its observed value of one-third. The social security transfer tr_t is chosen to match the ratio of social security transfers to measured GDP, which is seven percent. Finally, G_t is chosen to target the ratio of government debt to GDP. Our target measure of government debt is the government's net nominal position in 1989, as computed in Doepke and Schneider (2006).[9]

Finally, we need to calibrate the asset holdings of foreigners. Consistent with the calibration to a balanced growth path, we assume that foreign asset holdings grow at the same rate as output. The level of foreign assets is calibrated to the net nominal position of the rest of the world in 1989, which is 13.23 percent of measured GDP. The complete model parameterization is summarized in Table 2.

[9] An alternative strategy would be to choose G_t to target the ratio of (non-social-security) government spending to GDP. However, following this strategy would lead to a counterfactually low ratio of government debt to GDP. The reason for this discrepancy is that the model has just one rate of return, which is targeted to match average stock market returns. Since in the real world government debt has a lower return than equity, we cannot match the government spending ratio and the debt ratio at the same time. For our redistribution exercise, it is important for the model to have a realistic ratio of public debt to private debt, which is why we target the debt-to-GDP ratio.

4.2 The Redistribution Shock

To calibrate the redistribution shock implied by an inflationary episode, we use evidence on sectoral and household nominal positions in 1989 and 2001. In Doepke and Schneider (2006), we document the distribution of nominal assets and liabilities in the United States, combining data from the Survey of Consumer Finances (SCF) and the Flow of Funds Accounts of the United States (FFA). We include not only direct nominal asset holdings and debt, but also nominal assets held indirectly (such as ownership of shares in a mutual fund that holds nominal bonds) and debt owed indirectly (for example, through ownership of a business that in turn has issued nominal debt). To capture the maturity structure of nominal positions, we construct *nominal payment streams*: using data on interest rates and maturities for several broad asset classes, we determine, for every sector and group of households, a certain net payment stream that the sector or household expects to receive in the future. The market value of this nominal position can be calculated by discounting the nominal payment stream with the nominal term structure.

Now suppose that, starting from the end of a given benchmark year (i.e., 1989 or 2001), realized inflation over the next 10 years is 10 percentage points higher than initially expected. We estimate the present value gain or loss from such an inflation episode for every sector and group of households.[10] Both the scale and the nature of redistribution depend on how quickly agents adapt to higher inflation. We do not take a stand on exactly how expectations are formed or portfolios adjusted. Instead, we construct two scenarios that provide upper and lower bounds on redistribution. We provide a brief discussion of these calculations here; a more formal description is contained in the appendix.

Under the upper bound, or *Full Surprise*, scenario, we confront agents with a surprising one-time *jump* in the price level that leaves nominal interest rates unchanged. Redistribution occurs because a jump in the price level proportionally lowers the real value of all nominal payments. The size of the jump is set to the total change in the price level over the inflation episode (a cumulative increase of 172 percent over 10 years in our base-

[10]Implicitly, our calculations assume that redistribution arises only as the result of the *current* nominal asset or liability positions that are documented in the FFA and SCF. In principle, additional redistribution between the government and private agents could arise in the future if the tax and transfer system is only imperfectly indexed, and does not change as a result of the inflation shock. We know, however, that the government is a major winner from an inflation shock, which implies that fiscal policy has to adjust in some dimension. Rather than incorporating future redistribution in the calibration of the inflation shock, we therefore account for the role of the government by exploring different fiscal policy reactions in the model simulations.

line episode). In contrast, the lower bound, or *Indexing ASAP*, scenario corresponds to a surprising one-time *announcement* that inflation will be 10 percentage points higher than expected for the next 10 years. Bond markets immediately incorporate the revised inflation expectations into the nominal yield curve. Redistribution occurs because future nominal payments are discounted at higher interest rates. The present value gains and losses are smaller here than in the Full Surprise scenario because any given position is not affected by the change in the price level over the entire episode, but only by the change up to the maturity of the position itself. The Indexing ASAP scenario is equivalent to assuming that agents switch to inflation-indexed securities as soon as their nominal positions reach maturity, which accounts for the label. Quantitatively, this second scenario delivers a lower bound for gains and losses, since nominal wealth invested in a given instrument is protected from any inflation that occurs once the instrument has matured. Qualitatively, the Indexing ASAP scenario is special in that it affects longer positions more than short positions.

Redistribution across Households

Table 3 summarizes the redistribution of wealth across sectors after the 10 percent inflation experiment, stated as a percentage of GDP. Due to its large nominal debt, the government is the main winner from inflation, with gains between 9.1 and 20.8 percent of GDP for a hypothetical inflation episode starting in 1989, and 6.2 to 17.4 percent for an episode starting in 2001. Both the government and the rest of the world (i.e. foreigners) have positive nominal positions, and thus stand to lose from inflation. However, as documented in Doepke and Schneider (2006), the foreigners' exposure to inflation has quickly increased through the 1990s. The potential losses from an inflation episodes were between 5.2 and 8.4 percent of GDP in 1989, but have increased to 8.0 to 12.3 percent in 2001. For households, in contrast, losses under the Full Surprise scenario have declined from 11.8 percent of GDP in 1989 to 2.0 percent in 2001. Under Indexing ASAP, households actually stand gain from inflation in 2001.

Table 4 considers redistribution within the household sector for the benchmark year 1989, with gains and losses of the different household types stated relative to average net worth in each group. In Table 5, the same gains and losses are expressed as a fraction of total losses incurred by the household sector. Even within the household sector, the redistribution effects are sizeable. In 1989, a coalition of relatively old households stands to lose between 10 and 25 percent of GDP. Up to three quarters of the loss are born by the top 10 percent of the wealth distribution, who hold a lot of long-term fixed-income securities.

However, poor agents who hold most of their savings as deposits are also vulnerable to inflation. Within each wealth category, the largest losses are born by the oldest households, who are already in retirement. The main winners within the household sector are young middle-class and poor households who bought a home and have large fixed-rate mortgages.[11]

Mapping the Shock into the Model

We map the redistribution totals for baseline year 1989 in Tables 3 and 5 into a redistribution vector in the model by matching (for each group) the ratio of the total wealth gain or loss to measured GDP between model and data.[12] Two different redistribution vectors are used, one for the Full Surprise and one for the Indexing ASAP scenario. In the household sector, the losses or gains of the cohort up to age 35 affect the initial assets of the cohort 36–45, losses and gains from 36–45 affect initial assets at age 46, and so on. The youngest cohort under 35 starts with zero assets, and therefore does not experience a change in its initial assets. The young rich, however, may receive a different bequest because of the impact on their parents. The level of government debt and net asset holdings of foreigners are adjusted as well. Since in the model the last cohort dies at age 85, there is no cohort whose initial assets are affected by the gains and losses of the cohort aged 76–85. For simplicity, we disregard the redistribution occurring in this age group.[13]

5 Findings from the Model

In this section, we use the calibrated model to assess the economic implications of the wealth redistribution triggered by an unanticipated inflation episode. As discussed above, we model the arrival of inflation as a redistribution shock that displaces the economy from its balanced growth path. The (zero sum) redistribution vectors that we feed into the model have been calibrated in Section 4.2. As can be seen from Table 3, the government is a major winner in the redistribution. We thus need to take a stand on how it will adjust

[11] Additional detail on the sectoral and household positions and redistribution numbers is provided in Doepke and Schneider (2006).

[12] The redistribution in Table 3 does not add up exactly to zero because of data limitations; in each case, we adjust the gain of the government to ensure a zero-sum redistribution.

[13] To maintain a zero-sum redistribution, we reduce the gain of the government by the amount of losses in this cohort. We have also tried an alternative procedure in which the last cohort is interpreted as "open ended" and receives a larger total redistribution. The results were very similar to the baseline approach. The main difference is a larger decline in the old cohorts' consumption, with little effect on aggregates.

its behavior. If tax rates and real government spending do not change, the government budget will be in surplus due to lower payments on existing debt, and the real value of government debt will decline even further. Alternatively, the government could use the extra revenue to raise government spending or to lower taxes. In the benchmark fiscal policy regime, the government uses the extra revenue to raise government spending. The real value of government debt returns to its balanced-growth value, so that we do not induce permanent effects solely by imposing them on the reaction of the government. In this regime, the gap to the balanced-growth debt/GDP ratio is assumed to shrink by 50 percent per decade. Alternative fiscal policy regimes will be considered below. We also have to take a stand on the behavior of foreign investors, who lose from inflation. We treat the foreigners similarly to the government, that is, we assume that the real value of the foreigners' assets returns to the balanced growth value over time.[14]

The Impact on Households

We begin describing the impact of the inflation shock by looking at individual groups of households, leaving aggregates for later. Our baseline results are for a 10 percent inflation experiment with baseline year 1989 and rely on the version of the model without a borrowing constraint. Figure 1 shows the impact on the consumption of each cohort that is alive at the time of the redistribution shock under the Full Surprise scenario. Consumption is displayed as a percentage deviation from consumption in the balanced growth path. Each panel shows the reaction of each cohort over their entire life cycle, and periods are labeled by their midpoint. For the cohort 76–85, for example, the inflation shock hits only in the last period. The graph therefore shows a zero effect until age 70 (that is, the decade 65–74), because for the oldest cohorts those ages are reached before the inflation shock takes place. The middle-class cohorts 36–55 and the poor cohort 46-55 enjoy the largest positive effects, with a gain in consumption of up to seven percent relative to the balanced growth path. These cohorts have a relatively large amount of debt (mainly mortgages to finance houses), and inflation lowers the real value of this debt. The pre-retirement cohorts of the poor and the middle class (up to age 65) and the poor and rich aged 36–45 also gain, but to a lesser degree. Finally, the youngest cohort of the poor and the middle class are winners as well, albeit for a different reason. These cohorts are not directly affected by redistribution, but they gain from general equilibrium price effects. In

[14]Using other assumptions (such as a permanent reduction in the foreigners' assets) made little difference to the results, and so we do not report them here. For the foreigners, we assume that 50 percent of the gap to the pre-inflation net nominal position is closed per decade (the same assumption is used for the government).

particular, a decline in total labor supply leads to a rise in wages.

All other types and cohorts lose from the inflation shock. The young rich lose because they receive a smaller bequest; the others lose because they hold nominal assets that decline in real value. The oldest cohort of the middle class takes the largest hit, with a decline in consumption in excess of 14 percent. The old are disadvantaged in two different ways. First, they hold large amounts of nominal assets, which exposes them to inflation. Second, they are at or near the end of their life cycle, which implies that they cannot smooth the impact on consumption by lowering savings. The impact on consumption of durables or houses (not shown) is very similar to the impact on consumption.

Figure 2 shows the impact on labor as a percentage deviation from average labor supply in the balanced growth path. With the exception of retired households, who have lost this margin of adjustment, the losers from inflation compensate for the impact by working more, while the winners enjoy more leisure. Notice that the cohort with the largest increase in labor supply is the pre-retirement cohort age 56–65 of the rich. These households have to use their "last chance" of adjusting, while younger households are able to smooth their adjustment over several decades.[15]

Figure 3 shows the impact on savings. What is striking about this figure is the size of the effects. The poor aged 46–55 increase their savings by up to 40 percent of their average savings in the balanced growth path, while the households 66–75 experience a decline of up to 17 percent.

The Impact on Aggregates

Figure 4 displays the effect on economic aggregates. Here period 0 is the impact period, and effects are displayed for the first five decades after the shock. The change in the interest rate is displayed in basis points, and the effect on the other variables is given as a percentage deviation from the balanced growth path. In each panel, the solid line corresponds to the Full Surprise scenario discussed so far. In absolute terms, aggregates move a lot less than type- and cohort-specific variables, indicating that the individual effects partially offset each other. Nevertheless, a clear pattern emerges, which can be related to the individual characteristics of borrowers and lenders in the economy. The first notable feature is a persistent decline in labor supply. This decline is driven by the

[15]Given that the labor decision in the model concerns household labor supply per decade, many of these changes are best interpreted as adjustments at the extensive margin. For example, some younger households may switch from having two wage earners to one in response to their gain, while for the cohort 56–65 the time of retirement is an important margin.

younger cohorts of the poor and the middle class, who profit from a positive wealth effect and choose to enjoy more leisure. The decline of labor supply is partially offset by the rich and the old. The net effect is still negative, however, since a large fraction of the losers from inflation are retirees, who are unable to adjust their labor supply. Hence, the age structure of gainers and losers from inflation is key for the aggregate effect on labor supply.

The evolution of the capital stock is driven by life-cycle effects as well. The capital stock increases for two decades after the impact of the shock. The relatively young gainers from inflation increase their savings, while the older losers have a smaller decrease in savings, since they are closer to the end of the life cycle. The capital stock continues to increase over the first decades, because the losers reach the end of their life cycle before the gainers do. The poor and middle-class gainers from inflation are still alive after twenty years, and their additional savings account for the high capital stock in this period. The effect is reversed when the cohorts who initially had the largest gains reach the end of their life cycle. After a number of decades, none of the cohorts that were directly affected by the inflation shock remain, and the aggregate effects begin to peter out.

The net impact on output is a decline of up to 1.2 percent relative to the balanced growth path during the first two decades, and an increase of up to 0.5 percent thereafter. Notice that while the effects are moderate in magnitude, they are extremely persistent. Given an average decline of about 0.8 percent relative to the balanced growth path over the first twenty years, the cumulative amount of output lost is large. In addition, the output effect is of the same order of magnitude as what is generated by representative-agent models with monetary frictions. For example, Cooley and Hansen (1989) find that in a standard cash-in-advance model with stochastic money supply, a permanent increase in inflation from 0 to 10 percent reduces steady-state output by about 0.8 percent (with a cash-in-advance constraint that requires that the equivalent of one month of consumption has to be held in cash). Our model, which abstract from monetary frictions, generates roughly the same output effect over two decades based on surprise redistribution only.

So far, we have only considered the Full Surprise scenario. Under the alternative Indexing ASAP scenario, assets and liabilities with maturities below ten years are affected less by inflation, since nominal interest rates are assumed to adjust to the new expected inflation path right away. As Table 3 shows, under this assumption the net loss of the household sector is only 4.0 percent of GDP, instead of 11.8 percent under the Full Surprise scenario. Despite the lower total amount of redistribution, the economic effects under the Indexing

ASAP scenario are not just a scaled-down version of the Full Surprise results. The reason is that the maturity structure of assets and liabilities differs across sectors and groups of households.

In Figure 4, the effects of the Indexing ASAP scenario are given by the dotted lines. The responses still have a similar shape, but are generally smaller. The initial impact on output declines to 0.5 percent, but it is more persistent than in the Full Surprise scenario. Additional insights can be gained if we decompose the overall redistribution experiment into two components: redistribution among households, and redistribution among the household sector as a whole and the government and foreigners. The dashed lines in Figure 4 ("Indexed Debt") show what happens in the Full Surprise scenario if we only redistribute among households in the same amount as before, but isolate the government and foreigners from the redistribution (i.e., we assume that the assets and liabilities of the government and foreigners are indexed to inflation). In terms of labor supply and output, this households-only redistribution leads to an even larger labor supply and output effect. The reason is that if the government receives its windfall, the households are poorer, while the demand for government consumption increases. Both effects increase labor supply. Similar effects arise under the Indexing ASAP scenario (not shown).

We repeated both experiments in versions of the model with a binding borrowing constraint, i.e., consumers can only borrow up to fraction ψ of the value of their houses. We experimented with a variety of values for ψ, but found that in each case the results were virtually the same as in the model without financial constraints. Intuitively, a borrowing constraint will change the reaction of households who are right at the constraint when the inflation shock hits. Since these households are borrowers, they gain from inflation; that is, the real value of their debt declines. Compared to an unconstrained household, a constrained household will spend a larger fraction of the windfall on additional consumption in the impact period, since consumption was previously limited by the constraint. At the same time, there will also be a larger increase in leisure, since a constrained household tends to increase labor supply to overcome the restriction. Quantitatively, however, these effects turn out to be small. The reason is that only the youngest households are financially constrained, and these households account for only a small part of the overall effects.

Alternative Fiscal Policy Regimes

While our model makes precise predictions about the reaction of the household and business sectors to a redistribution shock, we had to make assumptions about the reaction of the government, which is a major beneficiary of the inflation-induced redistribution. The question arises whether our results are sensitive to alternative assumptions about the government's reaction to the inflation windfall. To evaluate the role of the government, we computed outcomes under a variety of fiscal policy regimes after the inflation shock.

In our model, apart from increasing government spending, the government may put additional funds to two alternative uses: it could lower taxes, or it could increase social security spending. The top panel in Figure 5 compares the impact on output across the three possible "pure" policies, i.e., the entire windfall is used either to increase general spending, lower income taxes, or increase social security. In each case, we use the Full Surprise scenario; corresponding results for the Indexing ASAP scenario are displayed in Figure 6. We maintain the assumption that real government debt returns to its original balanced-growth value. The shape of the impact on aggregate output is remarkably similar across the three policies. In each case, output initially declines due to the negative effect on labor supply, and later increases due to the increased capital stock. Throughout the entire transition, output is highest if taxes are lowered, and lowest if pensions are increased. The intuition is that cutting taxes lowers distortions at the labor-leisure margin, which increases output. Subsidizing pensioners, in contrast, lowers incentives for saving.

So far, we have taken as given that the effect of wealth redistribution on the government is transitory, i.e., real government debt returns to its original balanced-growth value. However, the government could also decide to permanently keep government debt at its lower post-inflation value, which would allow either a permanent increase in spending or a permanent decrease in taxes. The bottom panel of Figure 5 displays the output effects under this fiscal policy regime. Since the economy now converges to a different balanced growth path, permanent effects on output arise. Cutting taxes leads to the largest increase—about three percent of output in the balanced growth path. Thus, in the long run, cutting taxes increases output more than increasing government spending. Raising pensions has almost no long-run effect. Since pensions are paid late in life, in this case the lower government debt is counteracted by lower private saving.

Welfare Implications

While the redistribution numbers computed in Section 4.2 give us a good indication of who gains and who loses from inflation, they are not sufficient to determine the overall welfare impact on each group. Households are also affected by the reaction of the government to inflation, as well as by general equilibrium price changes. To gauge the impact of inflation on group-specific welfare, Table 7 compares the utility of each type and cohort of consumer alive in the impact period to balanced-growth utility in the Full Surprise scenario under the three possible fiscal policy regimes, with government debt returning to the balanced-growth value. Table 8 provides the same information for the Indexing ASAP scenario. For ease of interpretation, the numbers are expressed as equivalent proportional variations in consumption (both nondurable and durable). For example, an entry of -1.00 would indicate that the utility of the household in the inflation scenario is equivalent to the utility gained from the balanced growth allocation, with consumption and housing scaled down by one percent until the end of the life cycle. For people from the poor and middle class groups who have reached the final period of their life, the welfare number is exactly equal to their percentage change in consumption. For younger people, this is not the case, because they can also adjust leisure, and the old rich can adjust bequests. We also display a weighted welfare criterion that places equal weight on each group alive in the impact period.[16] We discuss the results for the Full Surprise scenario first; qualitatively, the results under the Indexing ASAP scenario are similar.

The welfare calculations show that the fiscal policy regime determines the sign of the welfare effect for a number of groups of households. In the baseline experiment in which government spending adjusts, the sign of a group's welfare change is the same as the sign of its direct redistribution effect in Table 4.[17] The poor aged 46–55 gains most from inflation with a positive effect in excess of 11 percent relative to the balanced growth path, while the oldest cohort of the middle class suffers the largest welfare loss of over 14 percent. In this scenario, there is a direct link between redistribution and welfare, because the government uses its windfall to increase government spending, which does not enter anybody's utility.

The situation is different, however, if the government rebates its windfall to the households. If the government decides to cut taxes, the sign of the welfare effect stays the same

[16]While a formal political economy analysis is beyond the scope of this paper, our individual and aggregate welfare measures correspond to the objective functions of two commonly used political economy models, and in this sense indicate the "political popularity" of inflation. Under majority voting, each voter picks the party whose policies yield higher utility. In this case, each group's political preferences can be read off the sign of the group-specific welfare effect. Probabilistic voting (see Persson and Tabellini 2000) introduces noise to voting decisions, and it can be shown that voting outcomes are equivalent to maximizing a weighted welfare function of the same type as our aggregate welfare measure.

[17]Recall that the gain or loss of a given cohort in the data affects beginning-of-period assets of the following cohort in the model. For example, the gains or losses of the 36–45 cohort in Table 4 correspond to the welfare effect on the 46-55 cohort in Table 7, and so on.

for all groups, but the absolute welfare gain increases substantially for the working-age population. The largest gain now accrues to the middle class cohort aged 36–45, with a positive welfare effect of almost 16 percent. If the windfall is used to increase pensions, the sign of the welfare effect switches for a number of groups. A broad majority of households now gain from the redistribution shock, including all of the poor. The oldest group among the poor, which suffers a 5 percent welfare loss if the adjustment is through government spending, now experiences a gain of 25 percent. For a number of groups (including this one) the direct loss through the revaluation of their assets is more than offset by the compensating higher pension payments. Thus, while the poor as a group experience a negative direct redistribution effect, this loss turns out to be easy to compensate, precisely because it does not take much in terms of transfers to improve the well-being of the poor.

¿From a political economy perspective, these findings lead us to conclude that the government can adopt simple fiscal policies in reaction to an inflation shock which imply that the shock benefits a majority. Thus, policymakers may be tempted to inflate the economy not just because they take some direct interest in the fiscal position of the government, but also because such a policy may actually have wide support if the losers from inflation receive some compensation. It is intriguing to observe that the U.S. inflation episode in the 1970s started right after social security was first indexed to inflation in 1972. While this policy change is unlikely to have been the main cause of the episode, it certainly lowered the political cost of inflation, and therefore may help explain why it took a decade until inflation was brought under control. In fact, the formula for the cost-of-living adjustment of social security was originally specified incorrectly. The retirees were actually overcompensated for inflation until 1978 (see Duggan, Gillingham, and Greenlees 1996), so real pensions rose as a result of inflation, just as in our "Higher Pensions" fiscal policy regime.

The temptation of inflation becomes even more apparent when we consider the weighted welfare measure, which is positive in each case. Under the Full Surprise scenario, the gain varies from 2.5 percent if government spending is increased to 5.7 percent if the windfall is put towards higher pensions. Under Indexing ASAP, the gains vary from 1 to 2.6 percent. Three effects are at work here. First, the economy as a whole experiences a net gain, because inflation deflates the wealth of foreigners. Second, a reduction in government debt also registers as a welfare gain, since Ricardian equivalence does not hold in our OLG-economy with distortionary taxation. Third, inflation redistributes wealth from the rich to the middle class and the poor. Since the rich have the lowest marginal utility, this redistribution also has a positive impact on the weighted welfare measure.

We can gauge the relative importance of the taxation of foreigners by computing results for an otherwise identical experiment that leaves the real value of the foreign asset holdings intact. In other words, redistribution takes place only between domestic households and the government, while the rest of the world is protected from inflation. To balance the total redistribution, we assign a smaller gain to the government (i.e., the situation is as if the position of the foreigners consisted only of inflation-indexed government bonds). In this scenario, the overall welfare effect remains positive, but is smaller. In the Full Surprise scenario with government debt returning to the balanced-growth value, the weighted welfare effects are 2.47 if government spending is increased, 3.74 with tax cuts, and 3.96 when pensions are raised. If the government windfall goes towards higher government expenditure, the exclusion of foreign debt has no effect on welfare. The reason is that neither government spending nor the consumption of foreigners enter domestic households' utility. In contrast, in the tax-cut and higher-pensions regimes, the implicit taxation of foreigners contributes about 30 percent of the overall welfare effect. The welfare effect is also positive if neither foreigners nor the government are affected by inflation, i.e., if we consider redistribution among consumers only. In this case, the aggregate welfare effect is the same as what we got previously in the regime where the government puts its windfall towards higher spending.

The welfare effects are essentially unchanged if we work under the alternative assumption that government debt does not return to the balanced-growth value. Even though we saw that making permanent changes to debt and taxes can have a sizable effect on output in the balanced growth path, this is of little relevance to the initial generations. The results are also qualitatively unchanged if we consider the Indexing ASAP scenario (see Table 8). Individual welfare effects are generally smaller due to the reduced redistribution volume, but duration effects are important. For the poor, for example, losses are much smaller under the Indexing ASAP scenario relative to Full Surprise, since most of their nominal assets are short term. For the rich as well as for the government and foreigners, the difference between the two scenarios is smaller. Once again, the weighted welfare effect is positive in each scenario.

When interpreting these results, one has to keep in mind that our model isolates the welfare implications of only the redistribution effect of an inflation shock. The traditional literature on the welfare cost of inflation, in contrast, builds on monetary frictions (from which we abstract), and finds that inflation lowers welfare. At the same time, the size of the effects is generally shown to be small, so that the positive effects arising from redistribution that we document here are likely to dominate. To give a concrete example, the estimates by Lucas (2000) imply that a *permanent* rise in inflation from zero to ten percent lowers welfare in steady state by the equivalent of slightly less than one percent of consumption.[18] In our analysis, as long as the government's windfall is not used exclusively to increase government spending (which does not enter utility), the positive weighted welfare effect arising from redistribution is at least twice as large in absolute value as Lucas' welfare cost estimate. In the Full Surprise scenario, the positive welfare effect exceeds five percent for both the tax rebate and pension policies. To be sure, the estimates are not directly comparable, in that Lucas considers the implications of a permanent, but anticipated rise in inflation, whereas we focus on a surprising temporary inflation shock. Nevertheless, for real world inflation episodes both redistribution and monetary frictions are a relevant source of welfare effects. Here the conclusion remains that even if we account for standard estimates of the welfare cost of inflation arising from monetary frictions, under suitable government policies the overall welfare effect of an unanticipated inflation shock is positive and large.

Results for Baseline Year 2001

Doepke and Schneider (2006) document substantial changes in the net nominal positions of different sectors of the U.S. economy over the last 15 years. Most importantly, there has been a large decline in the net nominal position of the household sector, and a corresponding increase in the position of the rest of the world. We repeated our experiment with redistribution numbers generated from data in 2001 to gauge how important these changes are for the effects of inflation. To make results comparable, we used the same model calibration as before (apart from the asset positions of the rest of the world and the government, which were adjusted to their 2001 values).

Figure 7 shows the impact on economic aggregates for the 2001 experiment. Qualitatively and quantitatively, the effects are very similar to 1989 results. Some differences do arise, however, when we consider the welfare implications. The weighted welfare measures now show a slightly smaller positive effect of up to 4.57 percent in the Full Surprise scenario with higher pensions (3.09 if spending adjusts, and 4.37 with tax cuts; the numbers for the Indexing ASAP scenario are 1.82, 2.24, and 2.33 in the higher spending, tax cuts,

[18]The welfare cost of inflation is larger in economies where money is held to smooth consumption, and there is a lack of other liquid assets that can serve this function (see Imrohoroglu and Prescott 1991 and Imrohoroglu 1992), as well as in search-theoretic models of money (see Lagos and Wright 2005).

and higher pension regimes). A key difference to 1989 is that the taxation of foreigners now accounts for a larger share of the total welfare effect due to the increased net nominal position of the rest of the world. The importance of foreigners can be gauged by recomputing the experiment under the assumption that foreigners are isolated from inflation (as if, counterfactually, foreigners only held inflation-indexed bonds). This reveals that as long as the government either cuts taxes or raises pensions, the inflation tax on foreigners accounts for between 40 and 55 percent of the overall weighted welfare effect.

In summary, across all our experiments for both baseline years we find that inflation-induced redistribution has a positive effect on standard weighted welfare measures. Even if we abstract from the fact that foreigners hold a sizable amount of domestic nominal assets, these positive effects are large enough to outweigh standard estimates of the welfare cost of inflation arising from monetary frictions. The large recent increase in foreigners' holdings of domestic, dollar-denominated debt, however, has made inflation an even more attractive proposition from a U.S. perspective. In effect, foreigners are currently lending large amounts of funds to the U.S. at terms of repayment that are under control of the U.S. Federal Reserve System. Even moderate taxation of these funds through an increase in inflation would result in substantial welfare gains for U.S. households.

While these findings depend on the specific distribution of nominal assets and liabilities that we documented for the U.S., there is evidence to suggest that similar features may have played a role in other historical inflation episodes. For example, concerning the German hyperinflation of 1923, Holtfrerich (1986) finds that the distribution of wealth was leveled, with the rich losing the most and the gains being concentrated in the middle class. Moreover, "a significant proportion of creditor's losses arising out of the inflation was borne by foreigners who had taken up creditor positions in marks. The losses these suffered were of at least the same order of magnitude as German Reparation Payments between 1919 and 1923." (p. 333). Thus, despite the severe economic disruption caused by the hyperinflation, the distributional impact may have been among the key factors that rendered inflation attractive.

6 Conclusions

The goal of this paper was to examine the importance of wealth redistribution as a channel for real effects of inflation. Building on the empirical work in Doepke and Schneider

(2006), we have computed the wealth redistribution that would be induced by a moderate inflation episode. We find that even moderate inflation leads to sizeable redistribution of wealth. The wealth effects of inflation induce highly persistent effects on both individual welfare and aggregate economic activity. The main source of aggregate effects is that borrowers are younger than lenders. Standard life cycle considerations imply that the responses of young winners and old losers are not offsetting.

Discussion of optimal monetary policy in the U.S. is often based on models with monetary frictions, where inflation causes inefficiencies and therefore lowers welfare. Our model abstracts from frictions to isolate the distributional effects of inflation. Based on U.S. data, we show that the redistribution caused by an inflation episode tends to increase the welfare of domestic households on average. This conclusion arises for two reasons. First, inflation imposes a tax on foreigners who hold domestic nominal assets. If the foreign net nominal position is positive, inflation creates a windfall from the perspective of domestic households. Second, inflation tends to redistribute income from the relatively rich to the relatively poor, which is also registered as an improvement by standard weighted welfare measures.

Our findings therefore lead to some doubts regarding the conventional wisdom that low inflation is always in the best interest of the domestic population. There is a sizable fraction of the U.S. population which would stand to gain if another inflation episode such as the one in the 1970s were to occur. As more and more nominal assets are held by foreigners, this fraction of the population continues to grow. Currently, the potential welfare gains from taxing foreigners' nominal assets through a moderate increase in inflation easily outweigh standard estimates of the welfare cost of inflation. The current widespread optimism regarding continued low inflation in the foreseeable future may be misplaced.

We do not mean to suggest that policymakers should use inflation systematically to achieve distributional purposes. Clearly, a systematic policy of this kind would be impossible to implement, since redistribution arises only to the extent that inflation is unanticipated. At the same time, if the potential gains from inflation through redistribution are large, policymakers may find it more difficult to resist the temptation of inflation. Being aware of the potential redistribution effect may be important even if controlling inflation is the ultimate aim.

To this end, our analysis may provide a useful starting point for future research into the political economy of inflation. One of our key findings is that the cohort welfare effects are highly sensitive with respect to the fiscal policy regime followed by the government. If the government simply raises general spending, only young mortgage borrowers experience a net gain from inflation, so that inflation would not be widely popular. If the windfall is used to raise pensions, however, the poor as well as the old middle class are compensated for all their losses, and most groups, apart from the very rich, stand to gain from inflation. As we discuss above, during the 1970s the U.S. did have a policy of compensating retirees, since social security pensions were (perhaps inadvertently) over-indexed to inflation starting in 1972. Our results suggest that this policy may have contributed to the political sustainability of inflation. In future research, we plan to explore the role of fiscal policies and redistribution effects in other historical inflation episodes.

A Definition of an Equilibrium

To simplify notation, we define aggregate consumption, domestic assets, net exports, and investment in houses, physical capital, and intangible capital as follows:

$$\begin{aligned}
C_t =& \sum_i \mu_i \sum_{s=t-N}^{t} c_{i,s,t}, \\
A_t =& \sum_i \mu_i \sum_{s=t-N}^{t-1} a_{i,s,t}, \\
NX_t =& R_t a_{F,t} - a_{F,t+1}, \\
I_t^h =& \sum_i \mu_i \sum_{s=t-N}^{t} [d_{i,s,t} - (1-\delta) d_{i,s-1,t-1}], \\
I_t^k =& K_{t+1} - (1-\delta_k) K_t, \\
I_t^e =& E_{t+1} - (1-\delta_k) E_t.
\end{aligned}$$

Here μ_i is the size of group i, and we have $\sum_i \mu_i = 1$. For the definition of an equilibrium, we also need to specify the rental price of houses and the amount of assets committed to housing the old. The houses rented by old people are part of the stock of assets owned by other households. The rental price of houses adjusts such that the return to investing in houses is equal to the interest rate. If the rent is p_t per unit, investing in a house requires an investment of $1 - p_t$ per unit today for a return of $1 - \delta$ tomorrow. The returns are therefore equalized if:

$$\frac{1-\delta}{1-p_t} = R_{t+1}, \quad \text{or: } p_t = 1 - \frac{1-\delta}{R_{t+1}}. \tag{9}$$

The amount of assets D_t committed to housing the old is given by:

$$D_t = (1-p_t) \sum_i \mu_i d_{i,t-N,t} = \frac{1-\delta}{R_{t+1}} \sum_i \mu_i d_{i,t-N,t}.$$

Definition 1 (Equilibrium) *An equilibrium consists of a sequence of prices* $\{w_t, R_t, p_t\}$*, household allocations* $\{c_{i,s,t}, d_{i,s,t}, a_{i,s,t}, l_{i,s,t}, b_{i,s}\}$*, foreigners' assets* $\{a_{F,t}\}$*, firm decisions* $\{Y_t, K_t, E_t, L_t\}$*, and government decisions* $\{B_t, \tau_t, G_t, tr_t\}$ *such that:*

1. *Given prices, the decisions of every type and cohort of households maximize utility* (1) *subject to the budget constraints* (2)-(5) *and the borrowing constraint* (6).

2. *Given prices, firms maximize profits, i.e.,* (7) *is satisfied in every period.*

3. *The government budget constraint* (8) *is satisfied in every period.*

4. *The rental market clears, i.e.,* (9) *holds in every period.*

5. *The goods market clears in every period:*

$$C_t + I_t^k + I_t^e + I_t^h + G_t + NX_t = Y_t.$$

6. *The labor market clears in every period:*

$$L_t = \sum_i \sum_{s=t-N}^{t} \phi_{i,t-s} l_{i,s,t}.$$

7. *The asset market clears in every period:*

$$A_t + a_{F,t} = K_t + E_t + D_t + B_t.$$

B Computation of Gains and Losses from Inflation

It is convenient to represent the computations underlying both of our scenarios as adjustments to the nominal term structure, holding the real term structure fixed.[19] Let $\imath_t^n$ and r_t^n denote the total yields on n-year nominal and indexed zero-coupon bonds, respectively, in the benchmark year t. Suppose that the Fisher equation holds ex ante in the benchmark year, so that $\pi_t^n = \imath_t^n - r_t^n$ is cumulative expected inflation. Let $\tilde{\pi}_t^n$ denote the new inflation path realized from t to $t+n$. We take the real interest rate to be equal to the nominal rate minus realized CPI inflation, with the 2003 inflation rate used for expectations beyond 2003.[20] The new inflation path is ten percentage points higher over ten years than the initially expected path.

Under Indexing ASAP, the new inflation path is announced at the end of the benchmark year. The nominal yield curve thus immediately adjusts to $\tilde{\imath}_t^n = r_t^n + \tilde{\pi}_t^n$. To determine gains and losses, we revalue the payment streams associated with bonds and fixed rate mortgages using this new yield curve. Consider a position that promises a single payment ν_{t+k} in year $t+k$. The percentage loss on this position is $1 - e^{-\left(\tilde{\pi}_t^k - \pi_t^k\right)}$. The difference between cumulative inflation paths is steeply increasing in maturity. This reflects the fact that the Indexing ASAP scenario allows for implicit adjustment by agents towards indexed portfolios. To see this, let $\tilde{\imath}_{t+k}^{10-k}$ and r_{t+k}^{10-k} denote the $(10-k)$-year nominal and indexed forward interest rates quoted at t, respectively and let $\tilde{\pi}_{t+k}^{t+10}$ denote cumulative expected inflation

[19]The assumption that real interest rates do not move with redistribution is in line with the calibrated model in Section 5, where the redistribution shock has only a small effect on the real interest rate.

[20]An alternative would be to estimate a time series model for inflation and use the forecast from that model. However, since inflation is very persistent, the results would be rather similar, at least after the high inflation of the 1980s.

from $t+k$ to $t+10$. Since the Fisher equation holds after the announcement, the present value of the position can be rewritten as:

$$e^{-\tilde{i}_t^k}\nu_{t+k} = e^{-\tilde{i}_t^{10}}\left(\nu_{t+k}e^{\tilde{i}_{t+k}^{10-k}}\right) = e^{-\left(r_t^{10}+\tilde{\pi}_t^{10}\right)}\left(\nu_{t+k}e^{\left(r_{t+k}^{10-k}+\tilde{\pi}_{t+k}^{10-k}\right)}\right) = e^{-r_t^{10}}\left[\left(e^{-\tilde{\pi}_t^k}\nu_{t+k}\right)e^{r_{t+k}^{10-k}}\right].$$

In other words, once the payment is due at $t+k$, it may be thought of as reinvested at the forward rate $\tilde{i}_{t+k}^{10-k}$ which fully incorporates future inflation. Equivalently, in real terms, once the loss or gain from inflation up to $t+k$ has been realized, reinvestment takes place at the real rate.

The simplest way to think about the Full Surprise scenario is that all positions are multiplied by the same factor, $e^{-\left(\tilde{\pi}_t^{10}-\pi_t^{10}\right)}$. It thus represents revaluation in hypothetical situations where either the ten-year inflation occurs in one day, or, equivalently, where agents are not allowed to touch their portfolios for ten years.

Since the period length in our valuation framework is one year, the above discussion applies directly only to positions with maturity of one year or longer. We make analogous calculations for shorter claims. Under Indexing ASAP we assume that positions in deposits, non-mortgage loans and short term paper—all valued at par in our valuation exercise—can be adjusted within the first year of the inflation episode. The idea is that while it typically takes some time before loans can be repriced or deposits can be withdrawn, agents will try to earn a different interest rate as soon as possible. We devalue the par values by a six-month inflation surprise. Similarly, we devalue adjustable-rate mortgages with a one-year inflation surprise. This captures the fact that, for most ARMs, adjustment can only occur at specific times. Under the Full Surprise experiment, all positions are multiplied by the same surprise inflation factor, namely $s_t^{10} = \tilde{\pi}_t^{10} - \pi_t^{10}$. By analogy, we also multiply deposit, non-mortgage loan, and ARM positions by that factor.[21]

[21] We assume indexing even on instruments for which current interest rates are zero, such as some checkable deposits. This is in line with the role of the Indexing ASAP scenario as a lower bound.

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Table 1: Relative Earnings Targets

	≤35	36–45	46–55	56–65
Poor	1.00	1.79	1.37	0.21
Middle Class	6.15	9.84	10.02	5.61
Rich	10.25	21.29	17.38	12.84

Table 2: Calibrated Parameter Values

Preferences	Skills			Technology	Government
$\gamma = 2$	$\phi_{r,0} = 9.91$	$\phi_{m,0} = 8.28$	$\phi_{p,0} = 1.00$	$\alpha = 0.41$	$\tau = 0.5$
$\sigma_r = 0.56$	$\phi_{r,1} = 19.88$	$\phi_{m,1} = 10.75$	$\phi_{p,1} = 1.60$	$\rho = 0.5$	$tr = 0.12$
$\sigma_m = 0.60$	$\phi_{r,2} = 24.20$	$\phi_{m,2} = 11.10$	$\phi_{p,2} = 1.54$	$\delta = 0.52$	
$\sigma_p = 0.53$	$\phi_{r,3} = 33.42$	$\phi_{m,3} = 8.67$	$\phi_{p,3} = 1.04$	$\delta_K = 0.52$	
$\eta = 0.16$	$\phi_{r,4} = 0$	$\phi_{m,4} = 0$	$\phi_{p,4} = 0$	$\delta_E = 0.52$	
$\xi_r = 0.02$	$\phi_{r,5} = 0$	$\phi_{m,5} = 0$	$\phi_{p,5} = 0$	$1 + g = 1.02^{10}$	
$\beta_r = 1.04^{10}$					
$\beta_m = 0.96^{10}$					
$\beta_p = 0.99^{10}$					

Table 3: Wealth Redistribution Across Sectors After 10 Percent Inflation Experiment

	Government		Rest of World		All Households					
					Total		Losses		Gains	
Year	FS	IA	FS	IA	FS	IA	FS	IA	FS	IA
1989	**+20.8**	+9.1	−**8.4**	−5.2	−**11.8**	−4.0	−**24.5**	−9.7	**+12.7**	+5.7
2001	**+17.4**	+6.2	−**12.3**	−8.0	−**2.0**	+1.6	−**13.2**	−6.2	**+11.2**	+7.8

Note: Gain or loss of each sector after 10 percent inflation experiment as a percentage of U.S. GDP under two scenarios, **Full Surprise** (FS) and Indexing ASAP (IA), and for two baseline years (start of the inflation episode), 1989 and 2001.

Table 4: 1989 Wealth Redistribution Across Households After 10 Percent Inflation Experiment Relative to Average Net Worth in Each Group

	Poor		Middle		Rich	
Age Cohort	FS	IA	FS	IA	FS	IA
≤35	**+23.1**	+0.5	**+72.0**	+31.8	**+8.8**	+3.6
36–45	**+21.4**	+6.9	**+20.0**	+9.7	−**2.4**	−1.5
46–55	**+3.5**	+0.9	**+2.9**	+1.6	−**4.2**	−2.7
56–65	−**4.7**	−0.9	−**8.9**	−2.7	−**10.2**	−4.0
66–75	−**11.0**	−2.3	−**15.9**	−4.6	−**10.5**	−4.8
>75	−**16.7**	−1.9	−**24.1**	−4.6	−**17.4**	−7.9

Note: Gain or loss after 10 percent inflation experiment as a percentage of average net worth in each group under two scenarios, **Full Surprise** (FS) and Indexing ASAP (IA), for baseline year 1989.

Table 5: 1989 Wealth Redistribution Across Households After 10 Percent Inflation Experiment Relative to Total Loss of Household Sector

	All		Poor		Middle		Rich	
Age Cohort	FS	IA	FS	IA	FS	IA	FS	IA
≤35	**+29.1**	+31.2	**+ 0.5**	+0.0	**+ 22.0**	+24.3	**+ 6.6**	+6.9
36–45	**+15.8**	+17.5	**+ 1.7**	+1.3	**+ 17.7**	+21.7	−**3.6**	−5.6
46–55	−**4.6**	−8.7	**+ 0.3**	+0.2	**+ 3.2**	+4.3	−**8.0**	−13.1
56–65	−**29.0**	−26.6	−**0.3**	−0.1	−**9.2**	−7.1	−**19.5**	−19.3
66–75	−**32.3**	−31.1	−**0.5**	−0.3	−**13.7**	−10.0	−**18.1**	−20.8
>75	−**27.2**	−23.7	−**0.6**	−0.2	−**10.2**	−4.9	−**16.4**	−18.7
All Ages	−**48.2**	−41.4	**+ 1.1**	+0.9	**+9.8**	+28.3	−**59.0**	−70.6

Note: Gain or loss after 10 percent inflation experiment as a percentage of total loss of household sector under two scenarios, **Full Surprise** (FS) and Indexing ASAP (IA), for baseline year 1989. Losses across classes and age cohorts sum to −100.

Table 6: 2001 Wealth Redistribution Across Households After 10 Percent Inflation Experiment Relative to Total Loss of Household Sector

	All		Poor		Middle		Rich	
Age Cohort	FS	IA	FS	IA	FS	IA	FS	IA
<35	**+ 29.4**	+ 38.3	**+ 1.5**	+ 1.3	**+ 23.9**	+ 29.3	**+ 4.0**	+ 7.8
36–45	**+ 41.6**	+ 64.8	**+ 2.2**	+ 2.6	**+ 34.4**	+ 53.0	**+ 4.9**	+ 9.2
46–55	**+ 8.8**	+ 15.7	**+ 1.8**	+ 1.6	**+ 12.4**	+ 20.5	−**5.4**	−6.4
56–65	−**29.8**	−36.1	− **0.0**	− 0.2	− **5.4**	−7.3	− **24.4**	−28.6
66–75	−**37.2**	−36.3	− **0.1**	− 0.1	− **14.3**	−11.0	− **22.9**	−25.3
>75	−**27.6**	−21.2	− **0.8**	− 0.1	− **14.1**	−7.6	− **12.7**	−13.5
All Ages	−**14.8**	+25.2	**+ 4.6**	+ 5.1	**+ 36.9**	+ 76.9	−**56.5**	−56.8

Note: Gain or loss after 10 percent inflation experiment as a percentage of total loss of household sector under two scenarios, **Full Surprise** (FS) and Indexing ASAP (IA), for baseline year 2001. Losses across classes and age cohorts sum to −100.

Table 7: Welfare Effects based on Redistribution in 1989 for Different Fiscal Policy Regimes, Full Surprise Scenario, Public Debt Returns to Steady State

	Higher Spending			Tax Cuts			Higher Pensions		
Age	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
$\leq$35	+0.71	+0.95	−2.44	+4.61	+5.39	−0.97	+0.96	+0.97	−2.17
36–45	+4.24	+10.98	+3.94	+7.97	+15.85	+5.07	+5.19	+11.24	+4.09
46–55	+11.59	+8.77	−3.45	+13.61	+12.86	−2.92	+14.32	+9.50	−3.29
56–65	+1.07	+1.28	−4.76	+1.59	+3.54	−4.43	+9.70	+3.65	−4.52
66–75	−2.32	−6.92	−7.57	−2.24	−6.64	−7.26	+31.23	+4.35	−6.91
$>$ 75	−4.95	−14.18	−6.72	−4.62	−13.72	−5.98	+25.07	−2.62	−6.32
Total		2.47			5.30			5.68	

Table 8: Welfare Effects based on Redistribution in 1989 for Different Fiscal Policy Regimes, Indexing ASAP Scenario, Public Debt Returns to Steady State

	Higher Spending			Tax Cuts			Higher Pensions		
Age	Poor	Middle	Rich	Poor	Middle	Rich	Poor	Middle	Rich
$\leq$35	+0.28	+0.37	−1.08	+2.23	+2.58	−0.37	+0.41	+0.38	−0.95
36–45	+0.23	+4.78	+1.69	+2.11	+7.21	+2.27	+0.69	+4.90	+1.77
46–55	+3.71	+4.24	−1.79	+4.76	+6.29	−1.57	+4.99	+4.59	−1.71
56–65	+0.21	+0.75	−2.71	+0.46	+1.87	−2.59	+4.49	+1.93	−2.60
66–75	−0.50	−2.22	−3.02	−0.46	−2.08	−2.87	+16.20	+3.38	−2.70
$>$ 75	−1.09	−4.19	−3.05	−0.92	−3.94	−2.68	+13.78	+1.52	−2.86
Total		0.98			2.42			2.56	

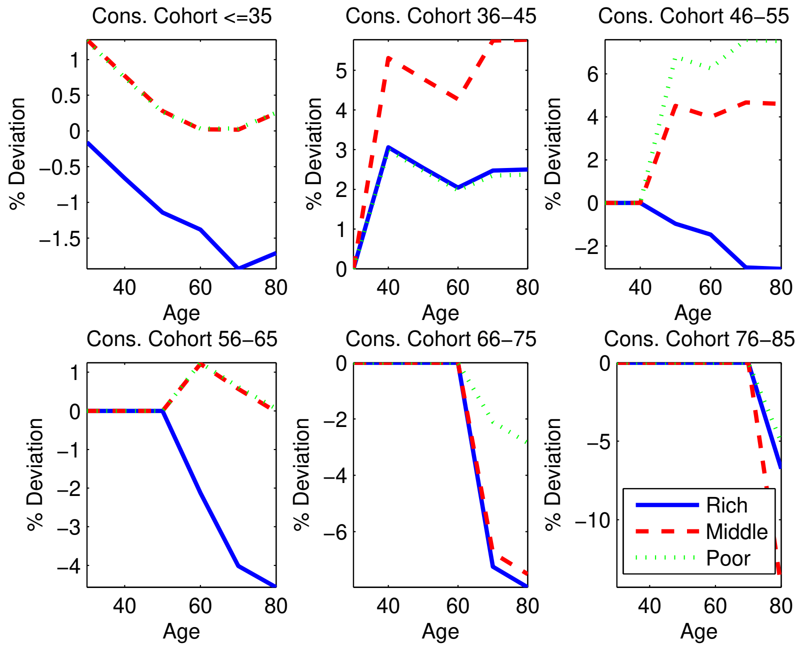

Figure 1: Impact on Lifetime Consumption, in Percent Deviation from Balanced Growth Path, based on Redistribution in 1989, Full Surprise Scenario

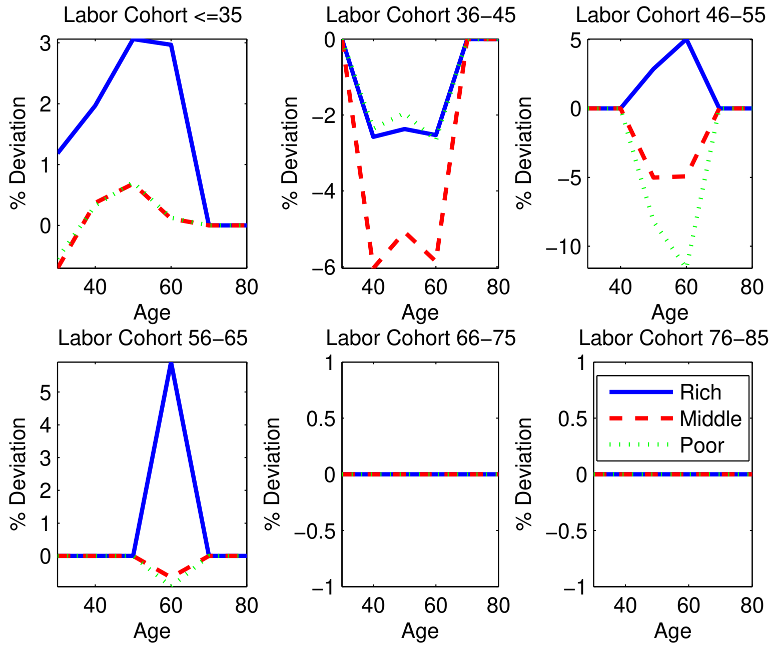

Figure 2: Impact on Lifetime Labor Supply, in Percent Deviation from Average Labor Supply on Balanced Growth Path, based on Redistribution in 1989, Full Surprise Scenario

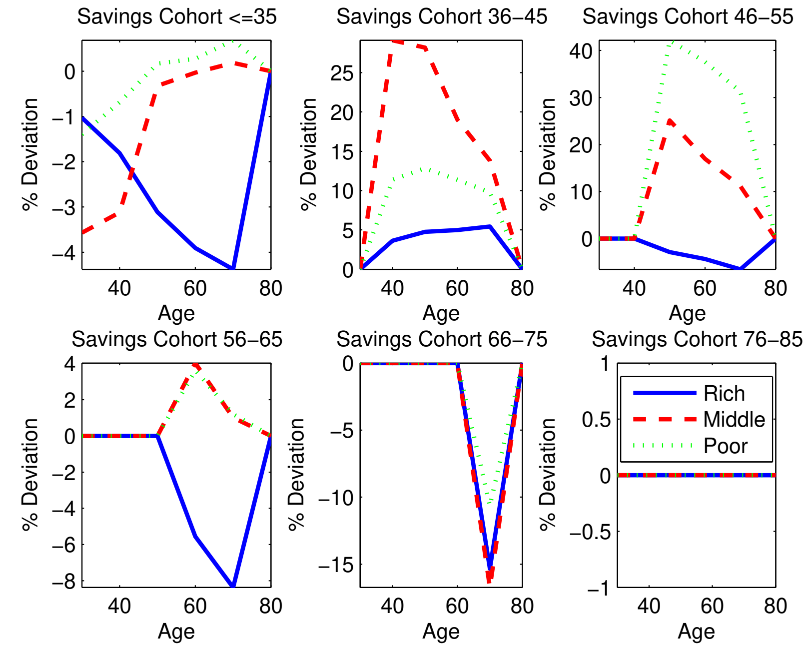

Figure 3: Impact on Lifetime Savings, in Percent Deviation from Average Savings on Balanced Growth Path, based on Redistribution in 1989, Full Surprise Scenario

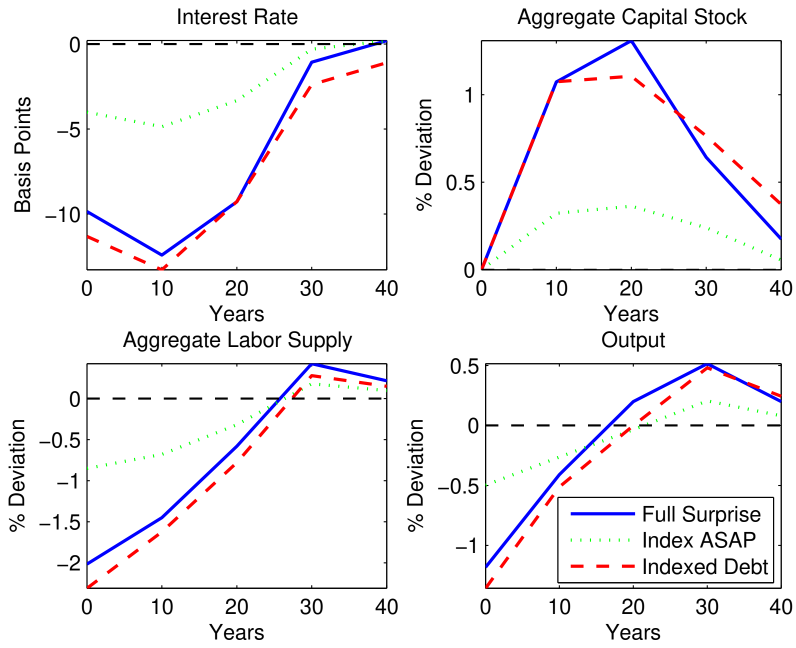

Figure 4: Impact on Economic Aggregates, in Basis Points (Interest Rate) and Percent Deviation from Balanced Growth Path (other Variables), based on Redistribution in 1989

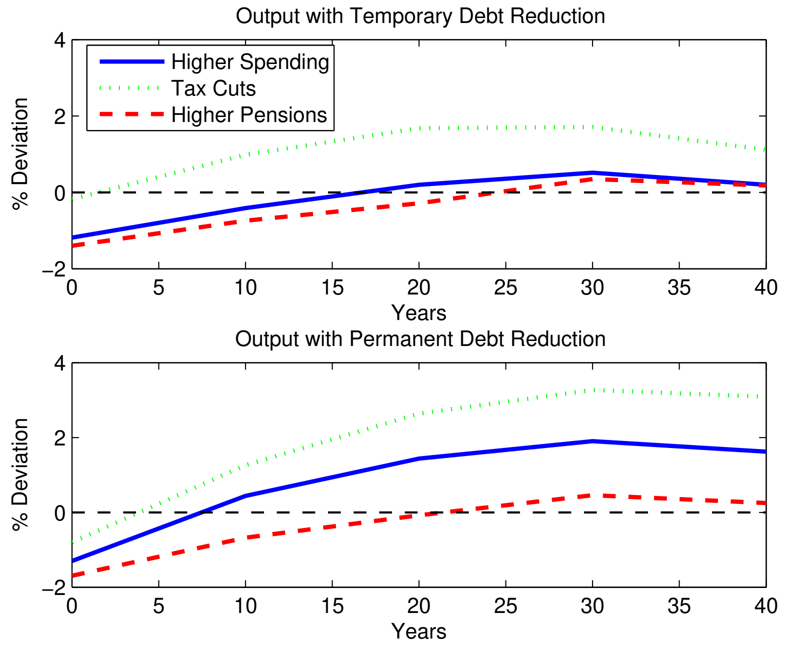

Figure 5: Impact on Aggregate Output by Policy Experiment, in Percent Deviation from Balanced Growth Path, based on Redistribution in 1989, Full Surprise Scenario

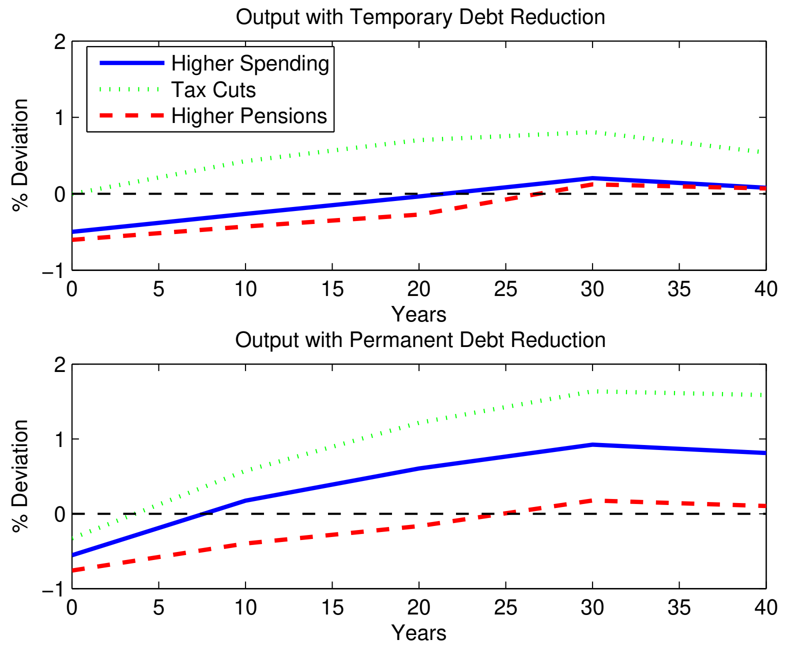

Figure 6: Impact on Aggregate Output by Policy Experiment, in Percent Deviation from Balanced Growth Path, based on Redistribution in 1989, Indexing ASAP Scenario

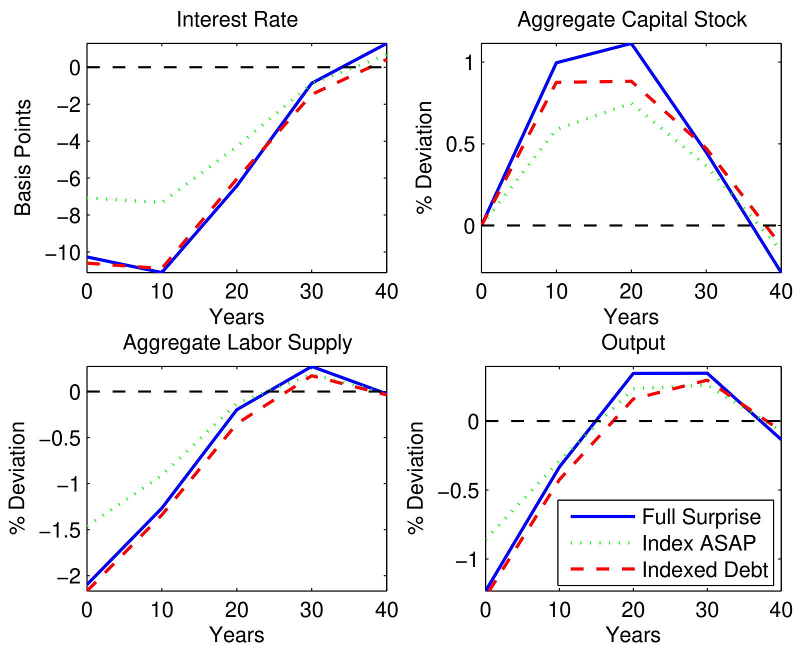

Figure 7: Impact on Economic Aggregates, in Basis Points (Interest Rate) and Percent Deviation from Balanced Growth Path (other Variables), based on Redistribution in 2001