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Erica L. Groshen / Mark E. Schweitzer

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Erica L. Groshen** and Mark E. Schweitzer***

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Abstract: As inflation rates in the United States decline, analysts are asking if there are economic reasons to hold the rates at levels above zero. Previous studies of whether inflation "greases the wheels" of the labor market ignore inflation's potential for disrupting wage patterns in the same market. This paper outlines an institutionally-based model of wage-setting that allows the benefits of inflation (downward wage flexibility) to be separated from disruptive uncertainty about inflation rate (undue variation in relative prices). Our estimates, using a unique 40-year panel of wage changes made by large mid-western employers, suggest that low rates of inflation do help the economy to adjust to changes in labor supply and demand. However, when inflation's disruptive effects are balanced against this benefit the labor market justification for pursuing a positive long-term inflation goal effectively disappears.

Keywords: Inflation, Nominal Wage Rigidity, Wage Setting

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* The views expressed in this paper are those of the authors and not necessarily reflective of the views at the Federal Reserve Bank of New York or Cleveland, or the Federal Reserve System.

** Research and Market Analysis Group, Federal Reserve Bank of New York, 33 Liberty Street, New York, NY 10045, Tel. +1 (212) 720-7685, E-mail: erica.groshen@ny.frb.org

*** Research Department, Federal Reserve Bank of Cleveland, P.O. Box 6387, Cleveland, OH 44101, Tel. +1 (216) 579-2014, E-mail: mark.e.schweitzer@clev.frb.org

"Higher prices or faster inflation can diminish involuntary, disequilibrium unemployment...The economy is in perpetual...disequilibrium even when it has settled into a stochastic macro-equilibrium...[When wages are rigid downward] price inflation...is a neutral method of making arbitrary money wage paths conform to the realities of productivity growth."

James Tobin, 'Inflation and Unemployment,' AEA Presidential Address (1972).

"[Higher, more variable inflation causes: a] reduction in the capacity of the price system to guide economic activity; distortions in relative prices because of the introduction of greater friction, as it were, in all markets; and very likely, a higher recorded rate of unemployment."

Milton Friedman, 'Inflation and Unemployment,' Nobel Lecture (1977).

Who is right? The question is particularly relevant now, because of widespread reductions in core inflation and the growing use of explicit inflation targets by central banks. Is the most economically efficient level of price changes zero (as Friedman argues) or somewhere above that (as per Tobin)? This debate centers on the labor market, because labor accounts for two-thirds of production costs and its prices are thought to be stickier (particularly downward) than goods prices.

Tobin's argument has been called the "grease" effect: a certain amount of inflation benefits economic performance in the labor market by allowing greater wage flexibility. Maintaining the metaphor of the economy as a geared machine, we refer to Friedman's description of inflation as "sand," because it interferes with transmission of price signals, disrupting the smooth operation of the economy.

Were monetary policy-makers to adopt an inflation target, the appropriate goal would hinge on whether inflation adds beneficial grease or grating sand. We find that the key to distinguishing between the Tobin and Friedman arguments is to place them in the context of the relevant labor market institutions. A simple model of labor markets consistent with these institutions suggests an empirical strategy for identifying and contrasting "grease" and "sand." Applying this technique to unique data over a forty-one-year period we find that inflation's *net* benefits in the labor market are, in fact, very small and are exhausted at consumer price index rates above 2.5 to 3 percent. We conclude that

the labor market provides little guidance on an optimal long-run inflation goal and, in particular, does not appear to justify maintaining ongoing inflation goals of above 2.5 percent.

Inflation s Costs and Benefits in the Labor Market Institutional Perspective

Inflation affects labor market efficiency by influencing firms' wage-setting practices and compensation schemes. In economies with competitive labor, capital, and product markets, comparable workers at equivalent jobs should be compensated similarly.[1] If an employer sets wages too low, employee morale and productivity may suffer, and turnover may rise—all resulting in lower profits. However, if an employer pays too much, it will also experience lower profits or have to lay off workers because it will be unable to price products competitively and still be profitable. Thus, any factor that interferes with firms' accurate wage setting can raise unemployment, worker turnover, or company failures.

How Inflation Impairs Economic Efficiency: The Sand Effect. Inflation can cause firms throughout the labor market to make miscalculations in wage setting. This interference—the sand effect—occurs in the first stage of the two-stage annual wage-setting process, when an employer's senior management sets the average wage change for its work force. The average wage change selected reflects inflation forecasts, labor market surveys, and projections of sales and product prices.[2] Management aims to maintain the company's profitability by not over- or underpaying employees to prevent both excessively high labor costs and unwanted turnover. Many employers pursue this goal by maintaining some ongoing desired parity with other employers.

Despite this planning, inflation forecasts can cause employers' salary budgets to differ in unintended ways. This happens partly because the coming year's inflation is never

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[1] Compensation includes wages, benefits, and working conditions. For simplicity, we focus on wages in this analysis. Wages are the largest and most flexible part of compensation and are most subject to the effects of inflation.

[2] In a unionized company, wage determination also involves negotiation with union leaders and a long (usually three-year) time horizon.

known in advance. Typically, the higher the inflation level, the less certain employers are about current and future rates. Thus, high inflation results in uneven wage changes among firms, as each relies on its own set of information. Even without this uncertainty, high and fluctuating inflation raises the dispersion of wage changes because different firms adjust wages in different months and some face cash or other constraints that temporarily prevent them from adjusting fully. Therefore, wage mistakes caused by differing perceptions of the state of the economy under high inflation can misdirect resources from their most productive uses.

How Inflation Overcomes Wage Rigidity: The Grease Effect. Despite its negative effects, inflation does allow firms to reduce some workers' pay without cutting their dollar wages. This flexibility benefit—the grease effect—is conferred at the second stage of the wage-setting process, because it helps employers overcome an important impediment to accurate wage setting.

Each corporate division of an employer allocates its share of the salary budget among its workers to match market wages and reward performance. However, the divisions face two constraints. The first is financial—they cannot overspend their budget. The second is the prevalent social (or bureaucratic) norm that discourages employers from cutting the wages of good workers who face unfavorable labor market conditions -- even when inflation is low. The two main reasons offered for this "downward wage rigidity" are either personnel practices designed to promote fairness or strong worker resistance to wage cuts—stemming from money illusion (that is, workers resist cuts in their dollar earnings more than they resist equivalent rises in the prices of what they buy) or the importance of mortgage, car loan, and other fixed-dollar payments in peoples' expenses.

Yet employers often need to reconfigure wage differences among occupations in their divisions to respond to external influences. In a competitive labor market, an occupation's wages reflect the amount and kind of training necessary, working conditions, and whether such workers are in short supply compared to firms' need for them. These circumstances can change, as technology, products, demographics, or input prices shift.

Corresponding wage changes influence people's job-search and training decisions toward occupations in high demand and away from those with too many workers.

As inflation frees employers from wage rigidity, it lends corporate divisions more flexibility to match market wages.[3] As other prices rise, employers can effectively lower wages that need to fall even without imposing nominal pay cuts. Inflation, thus, helps to prevent overpayment of those workers in occupations with falling relative wages, eliminating the need for more unpleasant alternatives. With this grease in place, wage signals travel more rapidly through the economy, reducing layoffs and providing more accurate incentives to workers choosing occupational training and career paths.

Formalizing the Labor Market Model

The effects described above can be incorporated into a formal model that yields testable hypotheses about grease and sand. Such a model must be consistent with the following common corporate wage adjustment practices:

1. Firms look to other firms to ensure that their wages are in line with those of their labor and product market competitors.
2. Firms use observed wage patterns in other firms to adjust relative wages for their occupations.
3. Maintaining these market parities is considered critical to maintaining an effective workforce.

These characteristics can be incorporated into a generalization of the Sparks (1986) efficiency wage model.[4] In addition, this model has the desirable feature of allowing persistent unemployment.

The Sparks (1986) model rests on three key assumptions: employees' disutility of working rises with their effort on the job, an efficiency-wage firm's output depends

[3] Similarly, in a union setting, higher average wage gains make it more likely that the union will accept differential gains between types of workers.

[4] Sparks (1986) is itself a generalization of efficiency wage models of Shapiro and Stiglitz (1984).

critically on the effort expended by their workforce, and efficiency-wage employers evaluate their workers' effort imperfectly. We extend the model by adding two features: (1) workers are classified into occupations that represent specific production skills and experience independent shocks, and (2) a spot-market sector of employers competes with efficiency-wage firms for labor, but not in the product market (because they produce a complementary good). Groshen and Schweitzer (1998) details the further assumptions and specifics of our model.

The model is consistent with the three wage adjustment practices listed above and yields important testable conclusions. We start with predictions about the grease effect and then continue with the sand effect.

In our model, nominal wage rigidity comes from some inflection of worker preferences at the zero nominal wage change—that is, workers may experience a discrete rise in the disutility of their effort after nominal wage cuts. This story is consistent with prevalence of nominally-priced contracts in the U.S. economy. If firms do avoid nominal wage cuts, the workers most affected are those whose occupation gets a negative shock, no matter what type of firm they are in.[5] Thus, most of the effect of downward rigidity will occur across firms—as all firms that employ an affected occupation respond to the relative productivity shock. This observation provides a way to judge the prevalence of downward nominal wage rigidities in an economy: measure the scope and limits of occupation wage adjustments in relation to the level of inflation. As the inflation rate rises, the same relative productivity shocks will cause fewer and fewer workers to face possible nominal wage cuts. So, in an economy with downward rigidity, the variance of occupational wage changes rises with the level of inflation—up until the rigidity no longer binds.

Turning to the sand effect, the model shows that each firm's inflation outlook appears in its wage adjustments. Any employer's mistakes in projecting product price

[5] Note that, while firms that expect poor (or negative) price growth are potentially constrained, the impact of the constraint will be strongest for the occupations with lowest wage growth in the economy as a whole.

growth shows up uniformly in the wages of all its workers. Because this information on the firm's expectations appears in each wage, averaging over all workers yields the best estimate of this factor in wage adjustments. Furthermore, because firms try to maintain their positions relative to alternative employers, the average wage change across all firms provides a good estimate of what a firm would have preferred to offer (ex-post) as an average or baseline adjustment. Thus, the sand effect predicts a positive relationship between inflation and the variance of firms' mean wage adjustments.

Finally, the model allows us to estimate the cost (in terms of profits) to the firm for the two effects. A Taylor-series approximation of the firm's profit levels at wage rates near but not at the optimum shows that the firms costs for either wage adjustment failure depend on the size of the discrepancy not it's source. The key term being the squared difference between the optimal and the realized wage. Empirically, Friedman and Tobin's effects of inflation on the labor market can be summarized and compared using the standard deviations of wage adjustments, once certain controls have been implemented.

Estimates of Inflation s Effects in the Labor Market

How important are these grease and sand effects? On the negative side, since inflation causes mistakes in firms' salary budgets (sand), we can measure sand by identifying how much inflation raises wage-change disagreement among employers. On the positive side, since inflation frees employers from wage rigidity, we can measure grease by the degree to which inflation allows occupations to have different wage changes.[6]

Grease Effect Estimates. Chart 1 shows an empirical measure of the grease and sand effects of inflation in the labor market, taken from our earlier studies of the effects of inflation in a unique forty-one-year data set of firm-level wage changes (Groshen and Schweitzer 1997, 1998). Despite substantial differences in approaches, our results are

[6] A wide range of tests supports the validity of this identification strategy. See Groshen and Schweitzer (1997) for a full description of the tests of this identification strategy.

consistent with those of other studies that have found a beneficial grease effect.[7] We find that the labor market benefits of inflation increase most rapidly at the lowest inflation rates and peak at about 7.5 percent (the positive vertical axis), allowing for 1.5 percent productivity growth (about the average over the forty-one years examined).[8]

Policymakers, however, would be unlikely to set inflation goals simply by looking for the maximum on a curve such as the one shown in Chart 1. To see why, note how the grease curve levels off as it nears the peak. That is, inflation rates of 4 to 5 percent deliver most of the benefits of a 7.5 percent rate. Thus, a conservative approach, implicitly recognizing that inflation has some undesirable effects, would dictate choosing an inflation goal in the range of 4 to 5 percent. Interestingly, despite important differences in approach, our results qualitatively confirm previous studies' conclusions that the beneficial grease effect exists and operates most strongly at inflation rates below 4 percent.

Sand Effect Estimates. Unlike other studies on grease effects, we also estimate the substantial role played by inflation's sand effects in the labor market: measured as the extent to which inflation raises the disagreement among employers about their average wage changes (adjusted for the skills they employ). Because this inflation-induced sand is detrimental to the labor market, we plot it on the negative vertical axis in Chart 1.

On the basis of sand effects in the labor market alone, the preferred inflation goal is clearly zero. For inflation rates up to 13 percent (where we have recent experience), we find that disruptive sand effects grow continually as inflation rises. The disruption increases most rapidly at the lowest inflation rates. However, at least until inflation levels of 13 percent, more inflation adds more disruption to employers' wage parities. Thus, the

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[7] See, for example, Akerlof, Dickens, and Perry (1966), Kahn (1995) and Card and Hyslop (1996). Other economic studies question the existence of downward wage rigidity and, thus, the need for grease (McLaughlin 1994 and Lebow, Stockton, and Wascher 1995). Our analysis convinces us that the negative results reflect data quality issues, not the absence of downward wage rigidity.

[8] The relationship between productivity growth and inflation goals is described in Groshen and Schweitzer (1998). Our measure of productivity growth is the percentage change in output per hour (reported by the Bureau of Labor Statistics) based on pre-chain-weighted GDP data. Since analysts disagree in their forecasts of future productivity growth, we choose the historical mean for this analysis: from 1956 through 1996, the mean is 1.62 percent.

disruptive impact of inflation may be unbounded.[9] Our estimates are consistent with those of sand effects in retail markets (for example, see Lach and Tsiddon 1992).

Net Benefits Estimate. Which effect dominates? We can answer this question by recognizing that typical personnel policies try to minimize upward or downward wage errors equivalently, implying firms treat the costs symmetrically.[10]

Since grease and sand effects apply only to the portion associated with positive inflation rates, estimates of standard deviations must be normalized around no inflation estimates.[11] Then, subtracting our measure of inflation's sand disruptions from our measure of grease benefits yields a net benefits curve (Chart 2). Compared to the pure grease effect in Chart 1, when we account for inflation's costs, we find that net benefits decrease and the peak of the curve shifts closer to zero.

Strikingly, at low rates of inflation the net effect almost disappears. At their very highest, inflation's net benefits amount to less than a tenth of their gross benefits at 3 percent inflation. Indeed, the very flat net benefits curve near zero inflation suggests that little labor market efficiency is lost from moving inflation closer to zero. Furthermore, we conclude that the net benefits from inflation peak at about 2.5 percent inflation, meaning that 2.5 percent is the *highest* inflation rate justifiable on the basis of labor market efficiency.[12] Thus, our results dispute some analysts' findings that the existence of downward wage rigidity implies that inflation should remain above 3 percent in order to promote efficiency in the labor market.

Moreover, at inflation levels above 7 percent, the disruptive effects of inflation on the labor market dominate the positive effects. Indeed, our results suggest that at levels

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[9] If persistent higher rates of inflation led companies to index their wages to inflation, the sand effect would level off. However, we do not detect strong evidence of this.

[10] The formal model described above provides an alternative mathematical route to approximating net benefits from inflation that yields qualitatively similar results. For ease of exposition, we present this simpler formulation here.

[11] We normalize our estimates around zero inflation and the average rate of productivity growth over the sample period: 1.5%.

[12] If as some analysts expect, productivity growth averages 1 percent over the next decade, then the maximum inflation goal would rise to 3 percent.

above 10 percent, inflation's negative effects will mount very rapidly. Thus, these levels are likely to cause serious inefficiencies in the economy.

Factors that Could Alter Long-Run Inflation Goals

Despite our finding that the labor market provides little guidance on the best long-run inflation goal, it is important for policymakers to consider how various circumstances -- such as persistent, very low inflation, productivity growth fluctuations, and major economic shocks -- might affect inflation goals. We note that measures of these conditions are extremely imprecise and are available to policymakers only after long lags, so these circumstances would be difficult to identify as they occur. Nevertheless, in principle, they could justify adjusting inflation goals.

Persistent, Very Low Inflation. All estimates of the effects of inflation (including our own) assume that firms' wage-setting practices and compensation schemes do not evolve in response to an inflationary environment. The implicit assumption that such changes do not occur is the unavoidable result of limiting our analysis to the recent past, during which time inflation was not below 3 percent for any long period.[13] Estimates for very low inflation rates are produced by projecting findings over lower rates than were observed. Although this is a reasonable strategy (and the only one available for now), policy makers should be aware that current research cannot fully rule out better, or worse, outcomes under low inflation than our extrapolations suggest.

Why might these outcomes be better? Reinforcing the conclusion that low inflation may not harm the labor market is the argument that persistent inflation below 3 percent could relax wage rigidity -- lowering optimal inflation even closer to zero. In a low-inflation environment, competition would pressure participants to accept more flexible practices to allow for pay reductions. Examples of such innovations already exist and would proliferate: bonus and incentive pay and contingent contracts, to name a few. Widespread use of such pay schemes would reduce the need for grease, so inflation would

[13] Our study, unlike others, has the advantage of including the low-inflation 1950s, 1960s, and early 1990s, giving us more precise measures of the effects of low inflation.

be less helpful than before. Indeed, preliminary evidence from our data suggests that occupational wage flexibility has been higher in the low-inflation 1990s than would have been expected under historical relationships (Groshen and Schweitzer 1997).

Productivity Growth Fluctuations. Productivity growth constitutes a key consideration in choosing inflation goals because it also injects grease and sand into wage-setting, meaning that inflation's effects are added to those already in place.

Because general productivity growth is most likely even harder to gauge than inflation, it adds confusion (sand) in the first stage of wage setting. Also, because productivity growth raises dollar wages, it adds grease in the second stage of wage setting the same way as inflation does. To demonstrate this, we will suppose that the growth of trade allowed firms to operate on a larger scale, where average costs are lower and productivity is higher. As firms saw their sales rise and costs drop, they would add workers. Wages would then be bid up by the competition for workers and firms would be willing to pay these higher wages because labor hours were more productive than before. General productivity increases, therefore, act like inflation to raise dollar wage levels.[14]

Now, imagine that productivity stopped growing -- or fell -- as has happened occasionally. For example, a large oil price shock spurred so much reorganization that output stopped growing or fell for a while. Since general productivity growth is inflation's main alternative for easing wage rigidity, inflation would then provide all the grease in the labor market. Stagnant growth, therefore, could justify raising inflation goals to compensate for the economy's temporary shortage of grease.

Thus, productivity growth produces grease and sand effects. Hence, even though productivity growth is not a monetary policy instrument or target, it is a factor to consider in setting inflation goals. In particular, as productivity growth strengthens, the amount of grease and sand in the labor market becomes greater, which reduces the benefit to adding

[14] Unlike inflationary wage hikes, productivity-induced wage increases are not eroded by corresponding increases in prices.

more inflation. Conversely, as productivity growth becomes lower, the amount of grease and sand in the labor market also becomes lower, increasing the net benefit of inflation.

Major Shocks to Occupational Markets. Imagine that a massive, abrupt market shock affected occupations differentially. For example, say a hike in imported oil prices jacked up wages and the need for workers in occupations involved in providing domestic energy, simultaneously reducing opportunities and wages for occupations in energy-intensive industries. Under those circumstances, unemployment would be minimized if wages could change more dramatically than normal: that is, enough to avert layoffs in shrinking jobs and draw workers rapidly into expanding ones. Until the adjustments are complete, the net benefits of inflation would be higher than normal and peak at a higher level. Thus, in the aftermath of shocks, allowing higher inflation would mitigate some of the pain (such as unemployment) of adjustment.

Conclusion: Tobin and Friedman are Both Right

Unfortunately for those who prefer simplicity, this paper shows how inflation causes both grease and sand effects in the labor market. We describe both the institutional mechanisms and a formal labor market model that incorporate and accommodate both effects simultaneously. Using these to direct empirical tests of the two effects, we detect clear evidence of both grease and sand effects of inflation.

From a policy standpoint, our investigation of long-run inflation goal options in detailed wage data finds that low inflation rates (below 4 percent) are unlikely to impair labor market efficiency and raise unemployment. When productivity growth is low, we find that inflation does have beneficial grease effects -- that is, it helps the economy adjust more rapidly to ongoing changes in the supply or demand for groups of workers. However, inflation also imposes offsetting costs, as it can mislead employers and other market participants about true prices. When we incorporate these costly sand effects into our analysis, we see that the measured net benefits of inflation fall markedly, making inflation goals of higher than 2.5 percent unjustifiable on the basis of labor market considerations. Thus, we conclude that the labor market provides minimal guidance on what would be the best low inflation goal.

Since the labor market is the focus of most public worry about ill-effects from low inflation, our results should alleviate concern about the risks of maintaining the present low rates of inflation. Indeed, our results are fully consistent with the recent performance of U.S. unemployment, which shows no signs of having been aggravated by three years of inflation rates in the neighborhood of 2.5 percent.

Unfortunately, when we ask, how *low* should inflation go? our results are less conclusive. That is, they suggest that the choice of a long-run inflation target will likely ultimately rely on evidence of inflation's impacts in arenas beyond the labor market.

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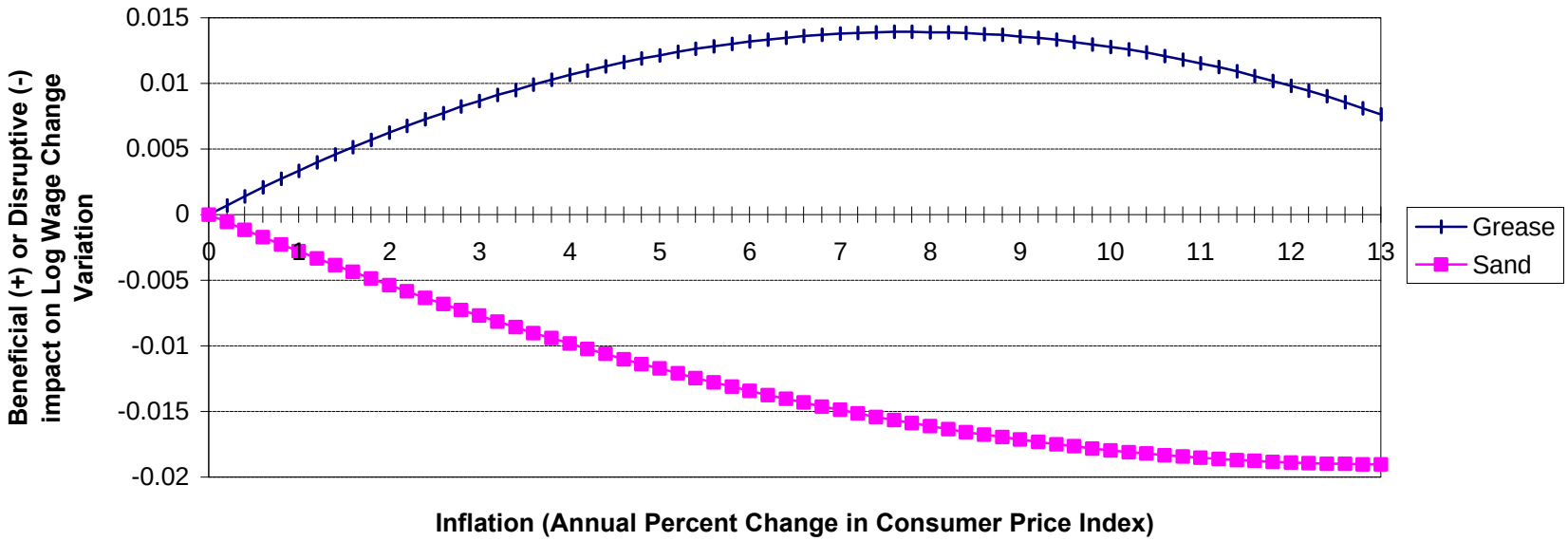
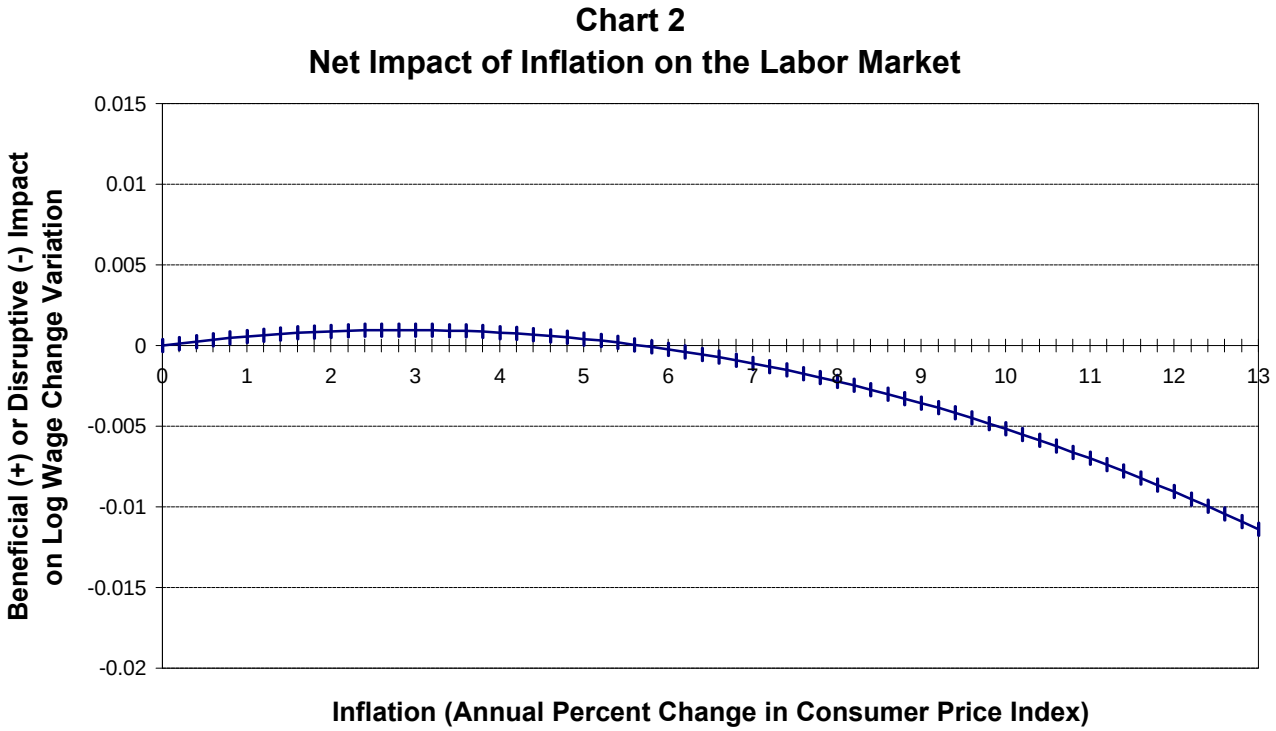
Chart 1
Estimates of Inflation's Grease and Sand Effects in the Labor Market



Source: Authors' calculations using the Federal Reserve Bank of Cleveland Community Salary Survey. For details, see Groshen and Schweitzer (1997, 1998).



Source: Authors' calculations using the Federal Reserve Bank of Cleveland Community Salary Survey. For details, see Groshen and Schweitzer (1997, 1998).