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I am submitting herewith a dissertation written by Loren Matt Rice III entitled "Prices, Macroeconomic Fluctuations and the New-Keynesian Macroeconomics." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Economics.

Dr. Charles Garrison, Major Professor

We have read this dissertation
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PRICES, MACROECONOMIC FLUCTUATIONS AND THE NEW-KEYNESIAN MACROECONOMICS

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Loren Matt Rice III

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DEDICATION

This dissertation is dedicated to my loving wife,
Angela, and my supportive parents,
Shirley and Loren.

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ABSTRACT

This dissertation undertakes an empirical examination of the determinants of the output-inflation tradeoff using U.S. industry data. The purpose of the research is to offer a method to test two competing macroeconomic models: the price-misperceptions model and the new-Keynesian model. This is done using OLS regression analysis. The variables used as determinants of the output-inflation tradeoff include the average growth rate of relative price, the variance of the growth rate of relative price, the variance of the growth rate of relative demand, the average growth of compensation per employee, the average growth of productivity per employee, and various measures of market power.

The results of this empirical study tend to offer support to the new-Keynesian model and cast doubt on the price-misperceptions model. When these results are combined with those of Ball, Mankiw and Romer, which are based on a cross-country study, there seems to be an increasing amount of empirical evidence which supports the new-Keynesian model and casts doubt on the price-misperceptions model.

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CHAPTER 1

INTRODUCTION AND SIGNIFICANCE OF THE STUDY

INTRODUCTION

The major purpose of this dissertation is to test two competing macroeconomic theories: the price-misperceptions model and the new-Keynesian model. The goal is to determine empirically, using regression analysis, whether the price-misperceptions model or the new-Keynesian model offers more accurate predictions of the effects of idiosyncratic shocks on price and output adjustment.

There has been a large body of literature which examines the relationship between prices and output. This literature is generally associated with some sort of Phillips curve analysis. The Phillips curve has traditionally indicated that prices and output were positively related; that is, as inflation increases, unemployment decreases. It is generally accepted that if unemployment is decreasing then output must be increasing.

Price-misperceptions models predict that prices and output are positively related only in the short-run (e.g. Friedman, 1968 and Lucas, 1972). These models emphasize that changing aggregate prices will change output only as a result of people misinterpreting these price changes as

relative price changes. As a result of these misperceptions, Lucas and others argue that there is a family of Phillips curves, not one. Therefore, in the long run, since people form expectations either adaptively (in the case of Friedman) or rationally (in the case of Lucas), there will not be misinterpretations and there will be no corresponding permanent changes in output. Consequently, in these price-misperceptions models the long run Phillips curve is vertical.

In a famous paper, Lucas (1973) estimated output-inflation tradeoffs for eighteen countries for the period 1951 to 1967. It was Lucas' contention that the greater the volatility of prices in a particular nation, the more likely individual firms will perceive changes in the price of their good as general price level changes and not relative changes in price. Lucas concluded, based on his statistical evidence, that nations with high volatility of aggregate prices have lower responsiveness of output to aggregate demand changes. In macroeconomic parlance, such countries are said to be characterized by low "tradeoffs". This implied that the greater prices varied, the more likely firms were to interpret a change in their own price to be a result of an economy wide price movement. As a result the firms would not change output.

Ball, Mankiw and Romer (BMR) in 1988 estimated the same output-inflation tradeoffs using international data. BMR's

contention, based on the new Keynesian view, was that business fluctuations were a result of rigid nominal wages and prices, not merely misinterpretations of aggregated price movements. Therefore, BMR tested whether the mean level of inflation affected the tradeoff estimate across the various countries included in their study. It was BMR's prediction that the mean level of inflation in a country would be inversely related to the tradeoff estimate for that country.

BMR's prediction contradicts the traditional view, taken by followers of the price-misperceptions model, who claim that the average level of prices does not affect the magnitude of the tradeoff because firms include this information in their formation of the expected price level. BMR, on the other hand, argue that as the mean level of inflation increases, a firm which maintains its own price will be facing a declining relative price and will be forced to make more frequent price changes. If at the limit, prices change instantaneously in the face of any change in nominal demand, then there will be no change in output at the firm level. This will also result in no business fluctuations at the aggregate level.

BMR's conclusion is that, based on their statistical evidence, output-inflation tradeoffs are negatively related to the average level of inflation on an international level. In addition, BMR also conclude that the greater the variance

of prices, the more frequently firms will change prices. Thus both the price-misperceptions and new-Keynesian models predict a negative relation between the variance of inflation and the magnitude of the tradeoff.

BMR also note that the two models offer very different predictions regarding the effects of industry-specific or idiosyncratic shocks. The price-misperceptions model argues that a large variance of industry specific shocks will result in firms interpreting observed changes in their prices as relative demand shocks rather than aggregate shocks; such an interpretation means that firms are likely to change output. The new-Keynesian model, as will be explained more fully in chapter 2, expects a large variance of industry-specific shocks to offer the firm increased incentive to change price frequently and therefore to decrease the effect nominal shocks have on output.

This study provides a test of these two competing predictions of the effects of idiosyncratic shocks. This test, which will be described in chapter 3, is applied to U.S. industry data. The results offer a means to test the effects of idiosyncratic shocks in U.S. industries for the post World War II period.

A second purpose of this study is to detail and integrate recent developments in estimating price-marginal cost margins. This area of economic research has recently been very active. In spite of this activity, there has not

been any effort to integrate market structure estimates with the tradeoff literature. This combination is logical since the price-misperceptions model has at its core an economy characterized by perfectly competitive markets and the new-Keynesian model requires an economy characterized by imperfectly competitive markets.

Since imperfect competition is crucial to the new-Keynesian model's explanation of the existence of a tradeoff, the new-Keynesian model may predict a positive relation between market power and the infrequency of price changes. There are two possible reasons for this prediction. The first is that firms in imperfectly competitive industries may experience smaller losses from deviations from their profit maximizing price and therefore have less incentive to change price frequently. This is because imperfectly competitive firms, unlike perfectly competitive firms, must sacrifice output to increase price or must lower price to increase output.

The second reason for a positive relation between the tradeoff and market power is that a firm operating in a highly concentrated industry has to consider interdependency of price decisions before changing price. In other words, the higher the concentration of the industry, the greater the possibility, ceteris paribus, that a change in price will set off a price war. The cost of price war combined with the probability of its occurrence must then be included

in the potential cost of changing price; therefore, the greater the concentration of an industry the higher the menu cost associated with changing price.

SIGNIFICANCE OF THE STUDY AND PLAN OF THE STUDY

It is the controversy between the price-misperceptions and the new-Keynesian models regarding the role of idiosyncratic shocks that provides the point of departure for the study. The study will employ the same general approach used by Lucas and BMR; however, the goal will be to estimate tradeoffs across U.S. industries rather than across countries. Once tradeoffs are estimated by industry, an effort will be made to explain the variation of the tradeoff between industries. In particular, the goal will be to determine if the tradeoff varies positively with the variance of relative demand (as predicted by the price-misperceptions model) or negatively with the variance of relative demand (as predicted by the new-Keynesian model).

The method employed in this paper does not allow for the consideration of economy-wide nominal shocks since all firms face the same aggregate variables; instead, the emphasis will be on industry specific behavior. As a result, industry specific effects on the output-inflation tradeoff will be isolated for study.

After completing the tests described above, various measures of market power will be included as explanatory variables in a further effort to explain the variation of

the tradeoff across industries. In reality the new-Keynesian model only argues that imperfect competition is necessary for the model's predictions to hold. If the economy is perfectly competitive throughout then the new-Keynesian model does not offer any means to explain business fluctuations. Nevertheless, the study has as an objective to determine whether the greater the market power, the higher the tradeoff. The price-misperceptions model argues that the economy behaves as if it were perfectly competitive regardless of the actual market structure.

As will be evident, (see chapter 2 below), the proposed work confronts some major existing gaps in the literature. The output-inflation tradeoff has previously been estimated on an international basis using the specification employed by Lucas (1973) and BMR (1988). Because these studies are conducted using aggregate data they do not allow for any effects caused by idiosyncratic shocks. Kandil (1991) provides a study which uses industry data rather than country data. In spite of this, her study is intended to see how firms respond to changes in aggregate demand; as a result, her study does not examine the effects of idiosyncratic shocks on the tradeoff.

The primary goal of this study is to address this issue of how idiosyncratic shocks effect the tradeoff for U.S. industries. A secondary goal will be to offer some evidence on the relationship between market power and the tradeoff

for U.S. industries. Both of these goals will be accomplished using regression analysis.

The study is divided into five chapters. The second chapter is a statement of the problems to be addressed in the study. This chapter makes clear the area of dispute between the price-misperceptions research agenda and the new-Keynesian agenda. Chapter 3 explains the technique for estimating the output-inflation tradeoffs by industry, provides the estimates of the output-inflation tradeoffs, and describes the data and data sources. Chapter 4 includes the results of the regressions to explain the variation of the tradeoff across industries and an explanation of the new-Keynesian interpretation of these results. Chapter 5 offers a summary of the major findings of the study.

CHAPTER 2

THE OUTPUT-INFLATION RELATIONSHIP: NEW CLASSICAL VS NEW-KEYNESIAN ECONOMICS

This section provides a background of the historical development of the output-inflation relationship. It is meant to provide an historical development of the major contributions which have identified and attempted to explain this relationship. Further, the survey serves to emphasize the various predictions procedures the price-misperceptions models and the new-Keynesian models have used in an effort to support their competing views. In addition, this chapter details the recent developments in estimating market structure and explains how this literature is related to the output-inflation relationship.

A. W. Phillips (1958) was the first economist to report the empirical finding that a tradeoff between output and inflation existed. Specifically, Phillips determined that the rate of change of the money wage and the unemployment rate were negatively related. Phillips contended that microeconomics was the theoretical foundation of the relationship. He reasoned:

> When demand for a commodity or service is high relative to the supply of it we expect the price to rise, the rate being greater the greater the

> excess demand. Conversely when the demand is low relative to the supply we expect the price to fall, the rate of fall being greater the deficiency of demand. It seems plausible that this principle should operate as one of the factors determining the rate of change of money wage rates, which are the price of labour services. Phillips (1958, p.283)

Phillips continued: "It seems plausible that a second factor influencing the rate of change of money wage rates might be the rate of change of the demand for labour, and so unemployment." Phillips (1958, p.283)

Phillips tested his theoretical structure using three separate periods for Great Britain: 1861-1913, 1913-1948, and 1948-1957. Phillips' estimations led him to report "...that the rate of change of money wage rates can be explained by the level of unemployment and the rate of change of unemployment..." Phillips (1958, p.299) These empirical conclusions presented by Phillips offer the beginning of the prominent theoretical controversy regarding the existence and the explanation of a tradeoff between output and inflation that is still being actively debated in the literature today.

The original Phillips curve was soon transformed from a relationship between wages and unemployment to display a relation between price inflation and unemployment. This was accomplished through the assumption that, "...the rate of change of prices was simply the difference between the rate of change of wages (w) and the constant trend rate of

increase of man-hour productivity (q), i.e. p=w-q." Humphrey (1973, p.7) This transformed Phillips curve was alleged to offer policy makers a more useful tool to determine target inflation rates and unemployment rates. Specifically, the transformed Phillips curve claimed to be able to show policy makers two potential goals: first, the rate of inflation necessary to achieve full employment, and second, the rate of unemployment associated with zero inflation. This relationship was believed to be constant and stable across time, assuming the basic structure of the economy had not changed.

This was the prevailing view of the Phillips curve through most of the 1960s. In fact, this view was so dominant that one economist wrote: "...few questioned the usefulness, let alone the existence, of this construct. In policy discussion as well as economics textbooks, the Phillips schedule was treated as a unique, consistent, and stable relationship." Humphreys (1973, p.7) By the late 1960's, skepticism about this type of Phillips curve relationship began to mount. There were two primary empirical factors influencing the development of these doubts. The first factor was an inflationary pattern which ran counter to the Phillips curve predictions at the end of the decade. Contrary to predictions of the Phillips curve, in the late 1960s inflation rates were increasing without a

corresponding decline in unemployment. The second reason for the stationary Phillips curve declining from favor was increased statistical evidence that indicated the curve may not be stable. According to Humphrey,

> the simple two variable Phillips relationship was shown to be very loose and inexact...Apparently, there was not one Phillips curve but rather numerous families of short-run Phillips curves corresponding to the host of other variables (shift parameters) influencing the inflation-unemployment relation. Humphrey (1973, p. 8)

This shift of economic theory regarding the Phillips curve led to the formation of a new theoretical base for the Phillips curve relationship.

MARKET-CLEARING MODELS

The new theoretical explanation of the Phillips curve was called the accelerationist or expectations augmented Phillips curve. Competitive equilibrium analysis with imperfect information was the theoretical foundation of this Phillips curve analysis. Friedman introduced this idea in his presidential address to the American Economic Association in 1967. Friedman argued that the observed tradeoff between inflation and unemployment existed only in the short run. The tradeoff was a product of unexpected inflation and would disappear when expectations adjusted to incorporate the higher level of inflation.

In Friedman's analysis, unanticipated inflation results

in real wages falling, due to nominal wages not keeping pace with inflation. This occurs because workers fail to perceive the increase in the price level. The result will be a temporary period in which firms will increase the amount of labor demanded due to a lower real wage rate; the result is a lowering of unemployment. Friedman argues that this will be maintained only temporarily because the fooled workers will soon realize that their real wage has fallen. When workers realize that their real wage has fallen, they will demand increases in the nominal wage to offset this decline. The increase in nominal wages will cause real wages to increase to their pre-inflation level. Firms will then return employment to the pre-inflation levels and the net long-run result will be no permanent increase in output and a higher rate of inflation.

Friedman further argues that a high rate of steady inflation will not cause a permanent increase in output. This is because workers will adapt their expectations to include the higher rate of inflation. Instead, only a rising rate of inflation will continue to fool the workers and maintain increased output for any period of time. Friedman concludes,

> ...there is always a temporary trade-off between inflation and unemployment; there is no permanent trade-off. The temporary trade-off comes not from inflation per se, but from unanticipated inflation, which generally means, from a rising

> rate of inflation. The widespread belief that there is a permanent trade-off is a sophisticated version of the confusion between "high" and "rising" that we all recognize in simpler forms. A rising rate of inflation may reduce unemployment, a high rate will not. Friedman (1968, p.11)

The reason behind Friedman's statement that a rising rate of inflation "may reduce unemployment" is his modeling of expectations. In Friedman's theory, the public's anticipation of inflation is formed according to adaptive expectations. Adaptive expectations imply that "...people form their expectations of future inflation by looking at a weighted average of past rates of inflation." Humphrey (1973, p. 11) Because workers have adaptive expectations, they under-estimate the rise in prices. They consequently misperceive the rise in their nominal wage rate as a rise in the real wage; as a consequence, they increase the amount of labor supplied. It was a change in the modeling of expectations that constituted the next major alteration in the Phillips curve analysis.

Lucas (1972) offered a model with rational expectations. Like Friedman's explanation of the Phillips curve, Lucas' analysis emanates from a competitive equilibrium framework with imperfect information. Lucas describes his model as follows:

> The first essential presumption is that nominal output is determined on the aggregate demand side of the economy, with the division into real

> output and the price level largely dependent on the behavior of suppliers of labor and goods. The second is that partial "rigidities" which dominate short-run supply behavior result from suppliers' lack of information on some of the prices relevant to their decisions. The third presumption is that inferences on these relevant, unobserved prices are made optimally (or "rationally") in light of the stochastic nature of the economy. Lucas (1973, p.283)

In Lucas' 1973 model, the quantity supplied in any given market can be divided into a secular or trend component and a cyclical market specific component. This division is shown as

$$(2.1) \quad y_t(z) = y_{nt} + y_{ct}(z),$$

where markets are denoted by z and all variables are in logs. In (1), y_{nt} represents the trend component of supply and y_{ct} represents the cyclical market-specific component. Lucas defines the trend component as

$$(2.2) \quad y_{nt} = \alpha + \beta t,$$

where this trend captures the effects of capital accumulation and population change, and t represents time. The cyclical component is defined as

$$(2.3) \quad y_{ct}(z) = \gamma [P_t(z) - E(P_t | I_t(z))] + \lambda y_{ct_{-1}}(z)$$

where $\Upsilon[\bullet]$ represents the deviation of actual price from its expected value conditioned on information available to market z at time t. The lagged dependent variable, $y_{ct-1}(z)$,

is included to take into account any partial adjustment factors. All variables are in logs.

The information available to the suppliers at time t comes from two sources. First, the suppliers have sufficient knowledge of past demand shifts, of normal supply, and past deviations to form a probability distribution of P_t. This probability distribution has a mean P^*_t and a constant variance σ^2. Second, "...let the percentage deviation of the price in (market) z from the average P_t be denoted by z where z is normally distributed, independent of P_t, with mean zero and variance ϵ^2." Lucas (1973, p.328) The suppliers can then utilize this information through equation (2.4).

$$(2.4) \quad E(P_t|I_t(z)) = E(P_t|P_t(z), \overline{P_t})$$

$$= (1-\theta) P_t(z) + \theta \overline{P}$$

The portion of observed price change which will be considered to be relative price changes and the portion which will be attributed to economy-wide price changes is given by θ, where $\theta = \epsilon^2/(\sigma^2+\epsilon^2)$. Combining these equations gives the supply function for market z:

$$(2.5) \quad y_t(z) = y_{n_t} + \theta\gamma [P_t(z) - P_t^*] + \lambda y_{ct_{-1}}(z)$$

Averaging over markets gives the aggregate supply function:

$$(2.6) \quad y_t = y_{nt} + \theta\gamma (P_t - P_t^*) + \lambda [y_{t_{-1}} - y_{n,t_{-1}}]$$

Lucas then explains:

> The slope of the aggregate supply function (5) thus varies with the fraction θ of <u>total</u> individual price variance, $\sigma^2+\epsilon^2$, which is due to <u>relative</u> price variation. In cases where ϵ^2 is relatively small, so that individual price changes are virtually certain to reflect general price changes, the supply curve is nearly vertical. At the other extreme when general prices are stable (σ^2 is relatively small) the slope of the supply curve approaches the limiting value of γ. Lucas (1973, p. 328)

Therefore, while Lucas's model implies that ϵ^2 and the tradeoff would be positively related, Lucas's empirical approach cannot consider explicitly the role of ϵ^2 because his empirical approach is limited to aggregate data.

To test the economy-wide price relationship of the theory presented above, Lucas estimated output-inflation tradeoffs for eighteen countries over the period 1952 to 1967. It was Lucas' contention that the greater the volatility of aggregate prices in a particular nation, the more likely individual suppliers of goods and labor, if behaving rationally, will perceive unanticipated local price changes as general price level changes and not relative

changes in price. As long as producers perceive no change in relative price and therefore no change in relative demand for their products, there will be no change in output in the event of a change in aggregate demand. If there is no change in output by individual firms, there will not be any fluctuation of aggregate output. On the other hand, if a nation's inflation rate has traditionally been stable, then individual suppliers will perceive unanticipated changes in local price as a relative change. This will result in a change in output.

Lucas offered in support of this theoretical understanding of the economy the following statistical evidence. "For the sixteen stable price countries, (the output-inflation tradeoff) ranges from .287 to .910; for the two volatile price countries this estimate is smaller by a factor of 10."[1] To demonstrate his findings further, Lucas made the comparison specifically between the United States, a stable price nation, and Argentina, a nation with volatile prices. The United States has a tradeoff parameter of .910 while Argentina has a tradeoff of only .011. In Lucas's formulation, the tradeoff parameter is the percentage change in output associated with a one percent change in nominal demand. Then for the United States, if nominal demand increases ten percent, output would increase by 9.1 percent.

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[1]Lucas (1973) 332.

The remainder of the increase in nominal demand would be reflected by an increase in inflation.

Lucas then offered the following interpretation:

> In a stable price country like the United States, then, policies which increase nominal income tend to have a large initial affect on real output, together with a small positive initial effect on the rate of inflation...In contrast, in a volatile country like Argentina, nominal income changes are associated with equal, contemporaneous price movements with no discernible effect on real output. Lucas (1973, p.332-333)

Even though the initial effect on prices is small in a stable price country, it is the rise in prices to which suppliers respond. As Lucas notes, "...inflation stimulates output if, and only if, it succeeds in fooling suppliers of labor and goods into thinking relative prices are moving in their favor." Lucas (1973, p.333 emphasis added)

Lucas' data set includes observations for real output (y) and nominal output (x), where x is taken as a measure of aggregate demand. After detrending the data, Lucas estimated econometrically the following equation

$$(2.7) \quad y_{ct}=\alpha+\tau\Delta x_t+\lambda y_{ct_{-1}}$$

where all variables are in logs. Equation (2.7) has a lagged dependent variable included to capture any actions being taken by individual suppliers which are in response to disturbances in previous periods. In effect, y_{ct-1} isolates

the suppliers' reactions from changes which occur in the previous periods. Reactions which occur in the current period are represented by τ, the output-inflation tradeoff parameter. Therefore, when this equation is estimated, the objective is to determine the portion of a change in nominal demand that will be reflected as a change in output. This is represented by the tradeoff parameter τ. Lucas' interpretation is that a high value of τ is evidence that the monetary authority can "fool" suppliers of labor and goods.

Lucas' explanation of the observed Phillips curve relationship is as follows:

> ...the positive association of prices and output arises because suppliers misinterpret general price movements for relative price changes. It follows from this view, first, that changes in average inflation rates will not increase average output, and secondly that the higher the variance in average prices, the less "favorable" will be the observed tradeoff. Lucas (1973, p.333)

Alberro (1981) updates Lucas's 1973 findings. Alberro expands the sample to include forty-nine countries. Six of these countries are characterized by highly erratic aggregate demands, where Lucas' includes only two. A simple scatter-gram is used to analyze the relationship between the tradeoff and the volatility of aggregate demand. Alberro concludes, based on the evidence from this larger sample, that his findings support Lucas' claim that countries with

high variances in aggregate demand have small tradeoffs.

The Real Business Cycle (RBC) economists are in the new classical tradition. Their explanation of the Phillips curve relationship however, differs from Lucas', despite being in the market-clearing tradition. Specifically, the RBC theorists argue that there is no positive relationship between nominal variables and real variables; therefore, they would argue that the Phillips curve does not exist. The theoretical framework for this belief is based on an assumption of perfect knowledge of aggregate nominal variables. As a result of this perfect foresight, suppliers are never "fooled" by changes in prices. These economists argue that only factors which influence real productive forces will lead to changes in real output.

Gray and Spencer (1990) recently reassessed the price-misperceptions model using a cross-country approach. In their paper, the authors state that their analysis "...is distinguished from its precursors in its treatment of supply-side disturbances and the natural rate of real activity, as well as in econometric methodology" (Gray and Spencer 1990, p.661). Specifically, the authors include a measure of energy price surprises in an effort to include a source of real disturbances to the economy. In addition, the authors use joint estimation to "...appropriately impose the cross equation restrictions that arise when estimated

proxies are included among the regressors" (Gray and Spencer, 1990, p.664).

Gray and Spencer argue that this method allows for the inclusion of factors which may cause the natural rate of unemployment to vary over time. The specific factor the authors are attempting to include in their study is a proxy for energy price surprises. The authors believe that industry-specific disturbances, like energy price surprises, cause an increase in frictional unemployment and therefore an increase in the natural rate of unemployment.

Using nonlinear third stage least squares estimation, the authors conclude that

> ...the data are consistent with the hypothesis that demand-driven price level surprises are positively and significantly correlated with aggregate real economic activity....energy price surprises are negatively and significantly correlated with aggregate real activity.

Gray and Spencer conclude that their findings "...provide considerable support for the view that these models identify an important channel, namely price surprises, through which aggregate demand influences aggregate real activity." Gray and Spencer (1990, p.667)

Gray and Spencer's study is included here not so much to show a new methodology or new statistical technique, but to demonstrate that there are prominent economists who still adhere to the price-misperceptions model. Since Lucas

(1973), many price-misperceptions theorists have moved into other areas of research. Many of the former architects of the price-misperceptions model adopted the real business cycle theory.[2] As a result of some of these conversions, the Gray and Spencer paper is mentioned to demonstrate that the debate between the price-misperceptions model and other competing theories is still alive on an international level. Kandil (1990), which will be detailed shortly, demonstrates that the debate is also alive on an industry basis.

The Friedman and Lucas explanations of the Phillips curve relationship begin with the assumption of a competitive equilibrium model in which labor and goods markets always clear. There is a second type of model which has offered an explanation for the Phillips curve relationship. This model is the imperfectly competitive non-market-clearing model. The most recent example of this model has come in the form of the new-Keynesian research agenda.

NEW-KEYNESIAN MODELS

Akerlof and Yellen (1985) develop a model which demonstrates that it is "near rational" for monopolistically

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[2]One example is Robert Barro who was initially a strong supporter of the price-misperceptions model. But, Barro (1981,71) stated that, "Given the relatively minor role played by price surprises...it appears that monetary influences on output involve channels that have yet to be isolated."

competitive firms to maintain their price when aggregate demand changes. Akerlof and Yellen explain that the model "...shows that aggregate demand shocks can cause significant changes in output and employment if agents adjust wages and prices in ways that are "insignificantly" suboptimal from their individual standpoints." Akerlof and Yellen (1985, p.823) This shows that "near rational" actions result in only small losses to the firm while they can cause large macroeconomic fluctuations. This is a significant contribution to understanding firm behavior which leads to business cycles.

The model offered by Akerlof and Yellen differs from the traditional Keynesian models in that the representative firm is monopolistically competitive rather than perfectly competitive. This is not to say that all firms are monopolistically competitive, but rather only that there is a significant portion of the economy that is not perfectly competitive. This alteration is important because the perfectly competitive firm will always have large profits to be gained from adjusting price to the profit maximizing level. This can be demonstrated using two separate examples, one where the firm's price is above equilibrium and one where the firm's price is below the equilibrium price. If its price is greater than equilibrium price, the competitive firm will lose all sales if it fails to lower

price. On the other hand, if its price is below the equilibrium price, the competitive firm can raise its price without losing any sales. This is due to the assumption in perfectly competitive markets that the firm can sell all it wishes at the equilibrium price. Therefore, there will always be large gains available to the firm from adjusting price to the equilibrium price in such a setting.

When the monopolistically competitive framework is imposed, failure to keep price at the market-clearing level need not result in large losses for the firm. Because products are differentiated in such markets, a price above the equilibrium price will result only in decreased sales, not an entire loss of all sales. Alternatively, a price below equilibrium will result in increased sales since there is no assumption the firm is supplying all it can at the equilibrium price in monopolistically competitive markets. Accordingly, if the firm increases price to the equilibrium price, there will be a decrease in sales. From the analysis presented above, the consequences of price rigidity are much less harmful to the firm under monopolistic competition than under perfect competition.

Figure 1 demonstrates the profit function with respect to a firm's own price for an imperfectly competitive firm. If this function is differentiated with respect to price, at the profit maximizing price, the derivative is

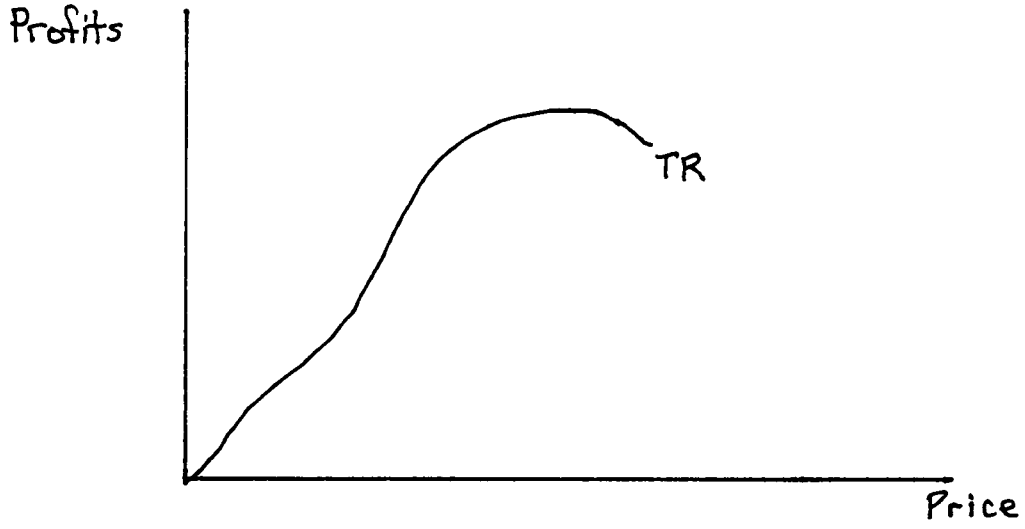


Figure 1: Total revenue function

equal to zero. As a result, small movements away from P^* cause only second order losses to the imperfectly competitive firm.

The substitution of the monopolistically competitive firm for the perfectly competitive firm allows Akerlof and Yellen to develop a macroeconomic model with price rigidity which is not subject to the criticism of a $500 bill lying on the sidewalk. Instead, the firm's "near rational" behavior of price rigidity under many circumstances will be only insignificantly suboptimal. In spite of this, the price rigidity results in large business fluctuations. Specifically, if the monetary authority increases the money supply there will be a corresponding increase in nominal aggregate demand. This increase can take the form of increased price, increased output, or a combination of both.

Since the economy is made up of both firms which will adjust price, behaving as if perfectly competitive, and firms which will maintain price, behaving as "near-rational" monopolistic competitors, there will be a change in both prices and output. In particular, near-rational firms will reduce output in response to a small decline in demand. However, they will not reduce price, because failure to cut price results in only a small (second-order) loss.

Mankiw (1985) also has contributed to this recent examination of observed price rigidities in capitalistic economies. He adds to the monopolistically competitive model the concept of menu costs. Menu costs are any cost associated with changing price. Examples of such costs include printing new menus, informing customers of changes in price, and notifying sales forces of price changes. While these costs are obviously small in nature, Mankiw demonstrates that, given these costs, firms could maximize their profits while causing the economy to slip into a recession. Specifically, Mankiw demonstrates that "...small menu costs can cause large welfare losses" Mankiw (1985, p.529)

Mankiw's menu cost approach uses a representative monopolistically competitive firm. Consider, for example, a firm which follows a "time-dependent" price-setting rule. Due to the existence of a menu cost, the firm changes price

infrequently; for example, the decision might be made to change price each year on January 1. Assume that the firm is characterized by a constant marginal cost function (See figure 2). Initially the profit maximizing price and quantity are given by P^* and Q^*. Assuming this firm is representative of all firms, the economy would be at the natural rate of output. Now consider the implications of a decrease in the money supply, which in turn causes a reduction in nominal demand for the representative firm. Because this model assumes that the firm's demand and cost schedules are functions of a nominal scale variable, both the demand curve and marginal cost curve will shift downward in the same proportion (See figure 3).

This firm must now assess how large the loss of profits will be from maintaining price at the previous profit maximizing price, P^*. This is shown in Figure 4. If the loss of profits, B-A exceeds the menu cost of changing price, Z, the firm will incur the menu cost and change price. Such a change will lead to a new price of P' and no change in output.[3] On the other hand, if the loss of profits does not exceed the menu cost of changing price, B-A < Z, it is fully rational for the firm not to reduce price and output will fall to Q'.

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[3]This type of pricing policy is known as state-dependent pricing.

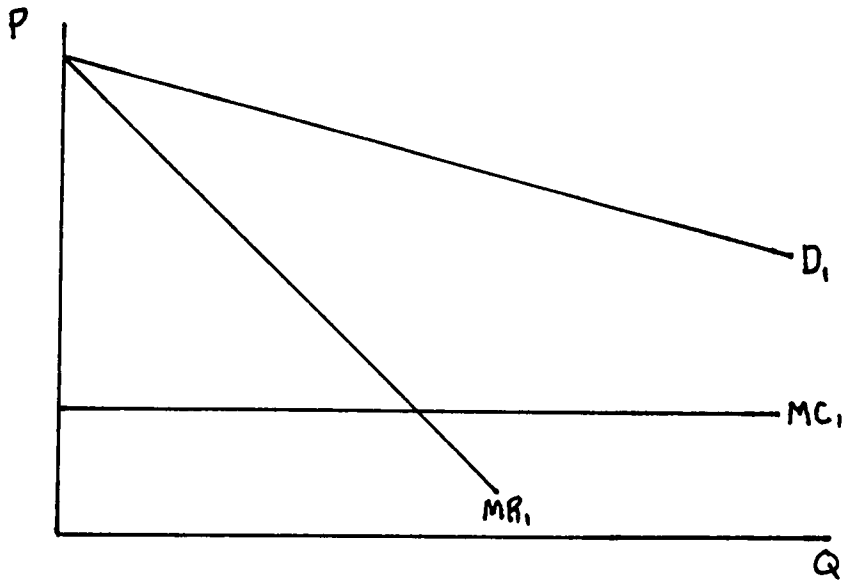


Figure 2: Initial Equilibrium

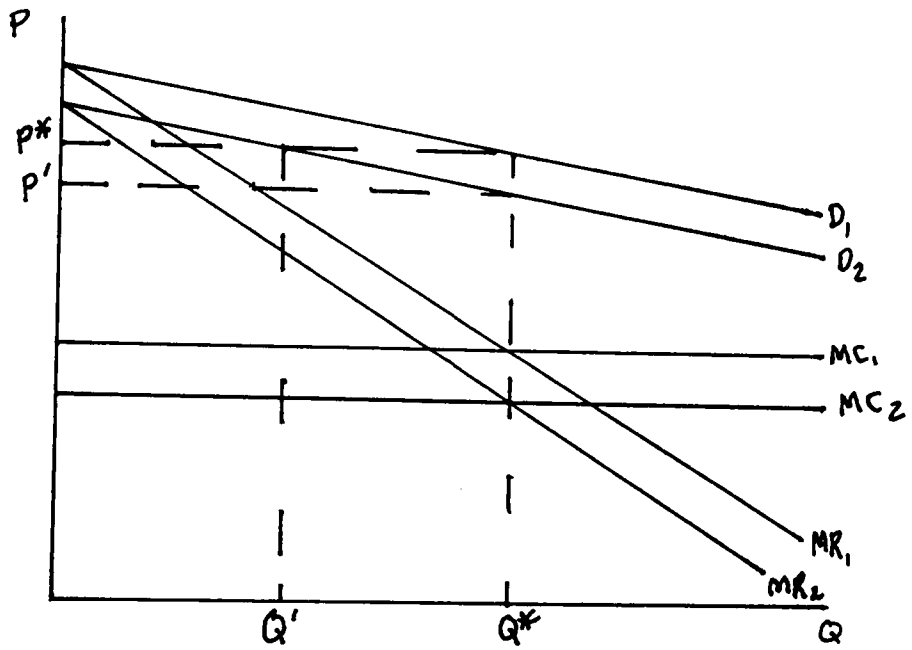


Figure 3: Equilibrium after demand shock

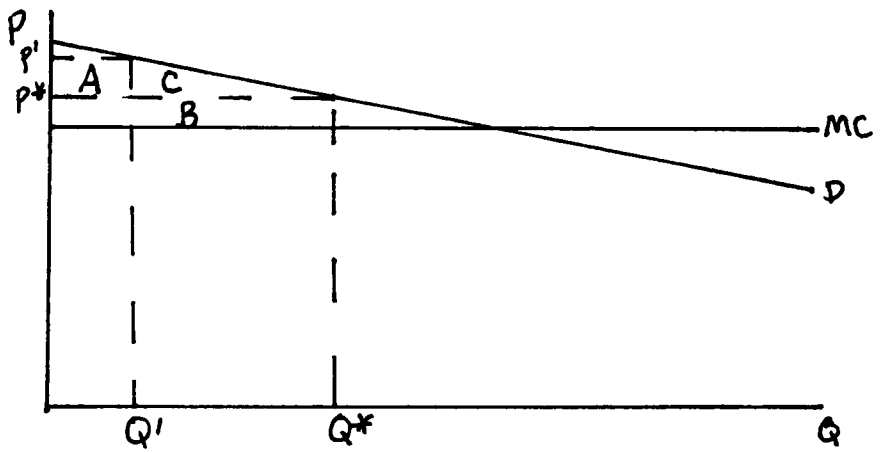


Figure 4: Gain in profits from a price change

The analysis shown in figures 2 and 3 demonstrates that, if the menu cost is less than the loss in profits, the firm actions are both privately and socially optimal. However, if the menu cost exceeds the loss in profits, then the firm's actions are privately optimal but impose a social cost on the economy. This social cost occurs because output has declined as a result of a purely nominal disturbance. In Mankiw's words "...there is an externality because adjustment of all prices would prevent a fall in aggregate demand, but each firm is a small part of the economy and thus ignores this macroeconomic benefit." BMR (1988, p.152)

Mankiw's menu cost model offers a microeconomic foundation for explaining macroeconomic fluctuations. This model, combined with the observation of Akerlof and Yellen that gains from changing price under monopolistic

competition are small, offers a strong purely rational reason for observed nominal rigidities in economies. Unlike previous macroeconomic efforts to incorporate price rigidities into macro models, the menu cost model does not require agents to behave in an irrational manner. The model offers a theoretical foundation for the explanation of nominal rigidities which is again not subject to Lucas' criticism of the "$500 bill on the sidewalk."

In an attempt to determine whether the competitive equilibrium model with imperfect information or the monopolistically competitive model with menu costs better explains observed macroeconomic behavior, Ball, Mankiw and Romer (BMR, 1988) estimate output-inflation tradeoffs for various countries, as Lucas had many years earlier. It is Ball, Mankiw and Romer's contention that "...fluctuations in output arise largely from fluctuations in nominal aggregate demand. These changes in demand have real effects because nominal wages and prices are rigid." BMR (1988, p.148) Unlike Lucas' competitive equilibrium view, this theoretical belief is based on the existence of monopolistic competition, menu costs, and non-market clearing. Specifically, BMR believe that, contrary to Lucas, it is the average rate of inflation that is key in explaining the variation across countries in estimated output-inflation tradeoffs. The authors explain:

> An increase in the average rate of inflation causes firms to adjust prices more frequently to keep up with the rising price level. In turn, more frequent price changes imply that prices adjust more quickly to nominal shocks and thus that the shocks have smaller effects. BMR (1988, p.148)

In an effort to test this theoretical belief, BMR estimate the following equation for the period 1948 to 1986.

$$(2.8) \quad y_t = constant + \tau \Delta x_t + \lambda y_{t-1} + \gamma time$$

where y_t is log of real GNP, Δx_t is the change in the log of nominal GNP, and the time variable is included to detrend the data. As in the Lucas model, it is necessary to include a lagged dependent variable to summarize the effects of past demand movements. The coefficient on the change in nominal GNP, τ, is the output-inflation tradeoff parameter. If $\tau=1$ then the entire change in nominal GNP will show up in real GNP. This would be the case of perfectly rigid prices. At the other extreme, if $\tau=0$ then none of the change in nominal GNP results in changed real GNP. This would be the case if prices were perfectly flexible.

BMR used ordinary least squares regression to estimate equation (2.8) for each individual country. The results indicate that the average tradeoff for 43 countries is .232 and the tradeoff estimate for the United States is .671, which is 1.6 standard deviations above the mean. A country-specific comparison can be made from the data provided by

the authors. The comparison is between the United States, which had an average level of inflation for the period of 4.15 percent, and Mexico, which had an average level of inflation of 13.9 percent. The United States tradeoff for the period was .671 and Mexico's tradeoff was .3139. As can be observed, the United States' inflation rate was approximately one-third that of Mexico and its tradeoff was approximately double that of Mexico. An even more dramatic comparison comes when the U.S. is compared to Argentina. Argentina's average level of inflation was 54.39 percent and its tradeoff parameter was not statistically different from zero.

Because increases in the average level of inflation create greater lost profits for firms if they maintain prices, BMR conclude that higher levels of inflation should be accompanied by more frequent price changes. The more frequently all firms in an economy change price, the smaller the effect of a nominal disturbance on real output. As a result, the higher the level of inflation, the smaller the output-inflation tradeoff.

This proposition differs substantially from Lucas' predictions. Lucas argued that the average level of inflation is irrelevant to the tradeoff for any given country; instead, he asserted that it is the variation of inflation that explains the tradeoffs. Lucas' contention is

that a stable level of inflation will be anticipated, and that anticipated changes in nominal variables do not affect real variables. Lucas' theoretical backdrop of such an interpretation is a belief that macroeconomic fluctuations are caused by nominal disturbances "fooling" the individual suppliers of goods and labor. In contrast, BMR argue that it is in fact the level of inflation, as well as the volatility of inflation, which explains the vicissitudes of the tradeoff parameter for these various countries. BMR's theoretical framework is that nominal disturbances have effects on real output due to nominal rigidities arising from monopolistic competition and menu costs.

Ball, Mankiw and Romer in their study of countries over the time period of 1948 to 1986, find that

> this trade-off is affected by the average rate of inflation. In countries with low inflation, the short-run Phillips curve is relatively flat--fluctuations in nominal aggregate demand have large effects on output. BMR (1988, 200-201)

BMR also note that the same findings exist for the tradeoff over time. Thus, countries that faced increasing inflation over the time of the study, 1948 to 1986, also experienced a decreasing output-inflation tradeoff (The United States did not follow this trend). This means that increases in average inflation cause nominal disturbances to have smaller effects on output.

BMR conclude that there are three primary implications

of their findings. First, the findings offer evidence which moves toward refuting the new classical theory of the output-inflation tradeoff. Second, the conclusions offered by the authors, "support new Keynesian theories of the business cycle that derive nominal rigidities from optimizing behavior." BMR (1988, p.201) Finally, the third implication of the authors' findings is that the tradeoff policy makers face will not necessarily be constant over time. Instead, the tradeoff varies with the level of inflation any particular country is experiencing during a particular time period.

In addition to these findings using international data, BMR offer the following observation regarding a major difference between the price-misperceptions model and the new-Keynesian model.

> According to Lucas, a large variance of relative price shocks increases the real effects of nominal shocks, because it raises the portion of these shocks that agents misperceive as real. Our model predicts that a large variance of idiosyncratic shocks, like a large variance of aggregate shocks, leads to more frequent price changes and thus *reduces* the effects of nominal shocks. If one could construct a measure of the variance of firm-specific shocks, which we do not attempt to do in this paper, then estimating the relation between this variable and the slope of the Phillips curve would be another test between the two competing theories. BMR (1988, p. 173)

Kandil (1991) offers the first attempt to incorporate a measure of firm-specific shocks into the analysis of

tradeoff behavior. Kandil uses industry-level data for the U.S. for the years 1948 to 1986 to construct such a measure. Specifically, Kandil attempts to isolate "...the determinants of the response of real output to aggregate demand shocks across industries of the U.S. economy." Kandil (1991, p.480)

Kandil uses annual data for twelve basic industries. These industries are agriculture; forestry and fisheries; mining; construction; manufacturing; transportation; communication; electric, gas and sanitary services; wholesale trade; retail trade; finance, insurance and real estate; services; and government and government enterprises. Each of these basic industries is then disaggregated into two-digit S.I.C. classifications.

I find it suspect to include electric, gas and sanitary service and government and government enterprises in such a study because prices in these categories are not market determined. In the case of electric, gas and sanitary services almost all local or state governments regulate these type of industries; therefore, the price decisions are not necessarily based on immediate market conditions. Further, in most cases control of pricing decisions is not even at the firms' discretion. In the case of the classification government and government enterprises, it seems very difficult for one to argue that members of this classifica-

tion behave in any rational profit maximizing manner. As a result, I conclude that the government and government enterprises should not be included in a study such as this.

In an effort to examine implications of the price-misperceptions model and the new-Keynesian model regarding the effects of the mean level of industry prices and the variability of industry demand, Kandil estimates the following equation

$$(2.9) \quad Dy_t = \alpha+\beta DE_{t-1}+\delta Dy_{t-1}+\tau DXs_t+\eta Dqs_t,$$

where Dy_t is the growth rate of real industrial output, $DE_{t-1}q_t$ is the change in anticipated energy price shifts, Dqs_t is the change unanticipated energy price shifts, and Xs_t is the change in unanticipated nominal GNP shifts. All variables are in log form. The coefficient τ is the estimate of the tradeoff by industry. According to Kandil, the average tradeoff across industries is .62.

Kandil considers six independent variables in an effort to explain the variation of the tradeoff across industries. These variables include the mean rate of growth of industry price, the mean rate of growth of industry price purged of any correlation with productivity shocks across industries, the standard deviation of the nominal growth of industrial output, a proxy for the change in unincorporated enterprises, the growth of employee compensation, the growth of

productivity. The purged mean rate of growth of industry price variable is included so that the proxy for productivity and a measure of the mean rate of growth of prices can be included in the same equation.

When the purged mean rate of inflation, the standard deviation of the nominal growth of industrial output, and all three proxies are included in the same equation Kandil finds the following relationships: 1. a negative and statistically significant relationship between the tradeoff and purged mean rate of growth of prices by industry; 2. a positive and statistically significant relationship between the tradeoff and the standard deviation of the nominal growth of industry output; 3. a positive and statistically significant relationship between compensation growth and the tradeoff; 4. a negative but statistically insignificant relationship between the tradeoff and the proxy for unincorporated enterprises; and 5. a positive and statistically insignificant relationship between the productivity proxy and the tradeoff.

Kandil's results offer mixed evidence for the two competing theories. The significant negative relationship between the purged mean rate of growth of prices by industry and the tradeoff supports the new-Keynesian model, since it suggests that a higher rate of industry inflation leads to more frequent price changes and therefore to a lower

tradeoff. On the other hand, the significant and positive relationship between the standard deviation of the growth of industry demand offers support for the price-misperceptions model, since it suggests that a higher standard deviation in rate of growth of industry demand increases the probability that firms will misperceive changes in economy-wide price as a change in relative demand. Finally, the positive relation between the tradeoff and the compensation variable casts doubt on the new-Keynesian model, which predicts that more rapid increases in costs offer an incentive to firms to change price more frequently and therefore to lower the tradeoff.

The model Kandil used to estimate the tradeoff seems to be subject to some criticisms. First, Kandil divides her nominal demand variable into anticipated and unanticipated portions. According the new-Keynesian theory, once prices are set in by a firm (industry) large variability of demand for the firm's output, whether anticipated or not, offers the firm incentive to incur the menu cost and change price. It is only in the price-misperceptions model that the dichotomy of anticipated and unanticipated nominal demand come into play. Further, Lucas, Alberro and BMR have not found it necessary to use this dichotomy in any of their previous work. That is to say, Lucas was able to find support for the price-misperceptions model on a cross-

country basis by simply detrending the nominal demand variable; the same is true for BMR's study which found support for the new-Keynesian model.

A second crucial characteristic of Kandil's model of estimating the tradeoff is the fact that nominal GNP is used as the demand variable for every industry. It is argued here that it is more appropriate to use nominal demand by industry to represent the particular demand conditions an industry faces. Since the question which needs to be answered is the way firms react to observed changes in their own market, it seems that industry-specific demand should be used instead of economy-wide demand. It will be shown in Chapter 4 that using industry-specific demand in estimating the tradeoff offers dramatically different results than using an economy-wide demand variable.

One final criticism of the Kandil study is the fact that Kandil includes a proxy variable for unincorporated enterprises. Specifically, the proxy is defined as the change in unincorporated enterprises measured as the average annual rate of change of employee hours minus its counterpart for total hours in each industry. What exactly this variable is attempting to get at is not clear. The only possible interpretation is that behavior in unincorporated businesses somehow differs from rational behavior in incorporated businesses. Microeconomic theory does not seem

to support such a conclusion.

Kandil concludes that her results

> ...shed some light on important factors distinguishing the response of real output across industries to aggregate demand shocks, (but) this evidence is not in total agreement with the implications of the new-classical or new Keynesian explanations under consideration. Kandil (1991, p.488)

Further, these results should be tempered by the criticisms of the method used to estimate the tradeoff. Specifically, the method uses an unusual specification of the tradeoff. This specification utilizes anticipated and unanticipated variables rather than the traditional means of estimating the tradeoff detailed earlier. In addition, it is believed that the results using industry demand rather than nominal GNP to estimate the tradeoff offer a better means of addressing the questions raised in this study. This is addressed empirically in Chapter 4.

CHAPTER 3

DATA AND METHODS USED IN ESTIMATING TRADEOFFS AND THEIR VARIATION BY INDUSTRY

DATA AND METHOD OF ESTIMATING TRADEOFFS BY INDUSTRY

Traditionally tradeoffs between output and inflation have been estimated using aggregate data for many countries. This study applies many of the techniques used in these studies to 58 industries in the U.S.. The data necessary to estimate tradeoffs in cross-country studies are real and nominal gross national product, where real GNP represents output and nominal GNP represents nominal demand (See equations 1 and 9 in Chapter 2).

When estimating tradeoffs by industry, one needs to obtain data which may appropriately represent both output and nominal demand for each industry in the study. This is accomplished by choosing real and nominal value added by industry as measures for output and nominal demand respectively. Specifically, the data set includes real and nominal value added for 58 two-digit S.I.C. industries for the period 1948 to 1986. These industries come from the general classifications of agriculture, forestry and fisheries; mining; construction; manufacturing; transportation; wholesale trade; retail trade; finance,

insurance, and real estate; and services.[1] The only industries omitted from these general classifications are electric, gas and sanitary services and holding and other investment companies. Electric, gas and sanitary services are omitted because in most cases these are regulated industries and therefore have little control over their pricing decisions, at least in the short term. The holding and other investment companies category is omitted because it is an outlier when the industry demand variables are calculated. Its outlier status stems from the fact that from 1948 to 1981 the nominal value added for the industry ranges from .1 to 1.3 billion dollars; but in 1981 the nominal demand jumps to 8.1 billion dollars. Further, there is not a corresponding jump in the real value added for this industry.

Using these data, the output-inflation tradeoff for each industry is calculated by estimating

$$(3.1)\ y_{ti}=\alpha_i+\tau_i\Delta x_{ti}+\lambda_i y_{t_{-1_i}}+\gamma_i time+u_i,$$

where y_{ti}=the log of real value added in industry i; x_{ti}=the log of nominal value added in industry i, time=a time trend and τ is the estimate of the tradeoff. The lagged dependent

[1]All data are in Tables 6.1 through 6.10 of the National Income and Product Accounts of the U.S. for the years 1948 to 1982. The years 1983 to 1986 are published in the Survey of Current Business, July 1987 in Tables 6.1 through 6.10.

variable is included to account for any partial adjustment occurring in time t which is a result of past demand movements rather than current demand conditions. (See Table 3.1 for descriptive statistics dealing with these variables)

In addition to the tradeoffs estimated using equation (3.1), I estimate tradeoffs using nominal GNP rather than industry-specific nominal value added. Kandil (1991) uses nominal GNP as the demand variable in estimating tradeoffs by industry. As a result, in an attempt to offer a direct comparison between the results of this study and Kandil's results, tradeoffs using nominal GNP also are estimated. It should be noted that equation (3.1) does not hold to the exact form used by Kandil (1991); see equation (2.9). In spite of this, it will be shown in Chapter 4 that the results are strikingly similar to Kandil's despite the change in specification.

According to BMR (1988) on an international basis, "this sort of equation has been used widely, both by new classical macro-economists such as Robert Lucas and by Keynesian macroeconomists such as Charles Shultze." BMR are addressing the general form of equation (3.1), not the specific variable used to represent nominal demand. In an attempt to address issues similar to those of Lucas and BMR, the equation's structure has been maintained.

The parameter estimate associated with the change in nominal demand, τ, is the coefficient of primary interest.

TABLE 3.1

Descriptive Statistics

Industry Description	D_y	σ^2_y	Dp_i/p	$\sigma^2 p_i/p$	D_n	σ^2_n
Farm	.01329	.00409	-.0152	.01348	.03376	.01534
Agr. Services, Forestry & Fisheries	.02177	.00159	.02449	.00245	.08682	.00253
Metal Mining	.00339	.01549	-.0066	.02561	.02564	.05469
Coal Mining	.00436	.00785	.00543	.00209	.04390	.02673
Oil & Gas Extraction	.01548	.00254	.02760	.02162	.07567	.02652
Nonmetallic Minerals, Except Fuels	.02972	.00357	-.0033	.00319	.06682	.00568
Construction	.02085	.00304	.01743	.00104	.07966	.00258
Lumber & Wood Products	.02446	.00717	-.0069	.00513	.05689	.01184
Furniture and Fixtures	.03083	.00777	-.0046	.00114	.06800	.00460
Stone, Clay and Glass Products	.02352	.00486	-.0003	.00061	.06498	.00468
Primary Metal Industries	-.0029	.01613	.00781	.00216	.04606	.01729
Fabricated Metal Products	.02774	.00564	-.0021	.00092	.06724	.00515
Machinery Except Electrical	.04447	.00881	-.0172	.00032	.06735	.00817
Electrical & Electronic Equipment	.06092	.00697	-.0247	.00092	.07746	.00540
Motor Vehicles and Equipment	.03576	.03757	-.0099	.00386	.06595	.03660
Other Transportation Equipment	.04634	.01375	.00217	.00087	.09011	.01290
Instruments & Related Products	.05478	.00463	-.0104	.00117	.08579	.00501
Misc. Manufacturing Industries	.02681	.00867	-.0126	.00202	.05517	.00520
Food & Kindred Products	.02536	.00149	.02874	.00276	.05200	.00142
Tobacco Manufacturing	.00927	.00402	.00641	.00629	.05478	.00332
Textile Mill Products	.03181	.00577	-.0351	.00280	.03652	.00732
Apparel & Other Textile Products	.02387	.00233	-.0190	.00092	.04622	.00157
Paper and Allied Products	.03355	.00649	-.0067	.00231	.06774	.00425
Printing and Publishing	.02864	.00094	.00288	.00041	.07334	.00098
Chemical and Allied Products	.05782	.00456	-.0222	.00191	.07643	.00292
Petroleum and Coal Products	.02614	.00218	.01357	.00980	.07674	.01189
Rubber and Misc. Plastic Products	.04557	.00792	-.0121	.00147	.07471	.00712
Leather and leather Products	-.0095	.00568	-.0063	.00269	.02488	.00529
Railroad Transportation	-.0128	.00595	-.0032	.00197	.02508	.00493
Local and Urban Transit	-.0382	.00267	.03717	.00330	.03873	.00141
Trucking & Warehousing	.04630	.00417	-.0054	.00556	.08256	.00196
Water Transportation	.00413	.01122	.00623	.00552	.04969	.00602
Transportation by Air	.07908	.00627	-.0061	.00507	.11247	.00266
Pipelines Except Gas	.04368	.00272	.00499	.01275	.08491	.01238
Transportation Services	.02351	.00314	.02504	.00767	.08673	.00692
Telephone & Telegraph	.06594	.00076	-.0156	.00076	.09184	.00083
Radio & TV Broadcasting	.05618	.00361	.00431	.00215	.10143	.00299
Wholesale Trade	.04218	.00099	-.0101	.00044	.07379	.00173
Retail Trade	.03205	.00084	-.0051	.00036	.06879	.00818
Banking	.03692	.00031	.01178	.00180	.08977	.00231
Credit Agencies Other than Banks	.05167	.00098	.03652	.04137	.11039	.04166
Security, Commodity Brokers	.05136	.00421	.04009	.02391	.12131	.02601
Insurance Carriers	.03675	.00061	.01929	.01276	.09173	.01012

TABLE 3.1 (CONT)

Industry Description	D_Y	σ^2_Y	Dp_i/p	$\sigma^2_{p_i/p}$	D_n	σ^2_n
Insurance Agents	.03334	.00121	.01934	.00213	.09347	.00151
Real Estate	.04365	.00033	-.0019	.00032	.08361	.00035
Hotels & Other Lodging Places	.02383	.00123	.01307	.00088	.07841	.00131
Personal Services	.01670	.00096	.00352	.00016	.06216	.00092
Business Services	.06313	.00100	.01644	.00065	.12115	.00111
Auto Repair, Services & Garages	.04876	.00203	.00310	.00020	.09377	.00180
Misc. Repair Services	.02153	.00164	.01208	.00320	.07391	.00344
Motion Pictures	.00321	.00565	.00400	.00105	.04870	.00715
Amusement & Recreation Services	.03310	.00083	-.0002	.00026	.07480	.00105
Health Services	.05160	.00313	.00974	.00080	.10294	.00102
Legal Services	.03117	.00129	.02855	.00115	.10057	.00125
Educational Services	.03198	.00040	.01721	.00098	.09058	.00093
Social Services and Membership Org.	.03832	.00056	.00752	.00052	.08758	.00039
Misc. Professional Services	.05154	.00256	.02097	.00100	.11385	.00286
Private Households	-.0121	.00292	.00500	.00054	.03464	.00198

D_Y is the growth rate of real output.
σ^2_Y is the variance of the growth rate of real output.
Dp_i/p is the growth rate of relative price.
$\sigma^2_{p_i/p}$ is the variance of the growth rate of relative price.
D_n is the growth rate of nominal value added.
σ^2_n is the variance of the growth rate of nominal value added.

It explains how much of a shock to nominal value added in a given industry results in changed output in the first year. A value of 1 for τ indicates that the entire increase in nominal value added shows up in real value added. At the opposite extreme, a value of 0 for τ indicates that the entire change in nominal value added takes the form of changed prices. It is assumed that any portion of a nominal demand shock that is not realized in a change in output must be realized in a change in prices in the industry.

Table 3.2 presents the estimated value of τ for the fifty-eight industries using industry specific demand. For each industry the time series used is 1948 to 1986. Table 3.2 also presents the estimated values of τ for two subsamples. The cutoff between these two subsamples is 1972/1973. This breakpoint was chosen because, as BMR (1988) point out, "the early 1970's are often considered a time of major structural change; certainly many empirical macroeconomic relationships broke down." In Chapter 4 this temporal disaggregation will be used in subsequent regressions to ascertain if the determinants of the tradeoff have changed over time.

Table 3.2 shows substantial variation in the output-inflation tradeoff across industries. It also shows that the tradeoff parameter rarely changes substantially from the period through 1972 to the period after 1972. There are

TABLE 3.2

TRADEOFFS FOR THREE TIME PERIODS
USING INDUSTRY DEMAND DATA
(Numbers in parenthesis are t-statistics)

Industry Description	Tradeoff 1948-1972	Tradeoff 1973-1986	Tradeoff 1948-1986
Farms	0.0848 (1.035)	0.1858 (1.255)	0.1402 (1.609)
Agricultural services	0.2633 (2.054)	0.4803 (1.552)	0.4303 (3.377)
Metal Mining	0.2938 (4.092)	0.3412 (2.360)	0.3589 (5.894)
Coal Mining	0.5326 (8.962)	-0.0038 (-0.039)	0.2730 (3.976)
Oil Mining	0.2151 (2.585)	0.1643 (3.176)	0.1299 (3.244)
Nonmetallic Mining	0.2414 (1.825)	0.4927 (2.463)	0.4517 (4.391)
Construction	0.5709 (4.563)	1.0424 (9.072)	0.5938 (5.050)
Lumber and Wood Products	0.6109 (5.035)	0.5296 (3.451)	0.5434 (6.489)
Furniture and Fixtures	1.015 (9.274)	1.2923 (8.061)	1.0673 (11.822)
Stone, Clay and Glass	0.808 (7.487)	1.008 (7.533)	0.8773 (10.989)
Primary Metal Industries	0.9242 (16.291)	0.7456 (6.323)	0.8549 (15.105)
Fabricated Metal products	0.7754 (9.096)	1.1643 (5.770)	0.8208 (8.686)
Machinery, except Electrical	0.9138 (20.346)	0.8205 (2.264)	0.7806 (6.643)
Electric and electronic eq.	0.9844 (10.034)	1.1972 (6.129)	1.0339 (11.465)

Industry Description	Tradeoff 1948-1972	Tradeoff 1973-1986	Tradeoff 1948-1986
Motor Vehicles and eq.	1.0333 (13.089)	0.9524 (8.495)	1.0105 (16.118)
Other Transportation equipment	0.9613 (16.524)	1.4862 (4.320)	0.9839 (14.855)
Instruments and related products	0.8879 (12.691)	0.5590 (2.770)	0.7707 (9.564)
Miscellaneous Manufacturing	0.9875 (14.328)	1.0318 (3.623)	0.9823 (8.493)
Food and Kindred products	0.2395 (1.374)	-0.2173 (-0.975)	-.0132 (-.099)
Tobacco Products	0.7646 (3.555)	0.5186 (2.846)	0.4796 (2.933)
Textile Mill products	0.4900 (4.267)	0.9126 (4.388)	0.6211 (6.137)
Apparel and other Textile products	0.9822 (6.897)	0.6761 (2.705)	0.9108 (7.943)
Paper and Allied products	0.7311 (7.941)	1.0981 (3.210)	0.8005 (7.098)
Printing and Publishing	0.7418 (4.742)	0.8050 (2.711)	0.6893 (5.086)
Chemicals and allied products	0.6561 (6.621)	0.2799 (0.481)	0.7151 (4.564)
Petroleum and coal products	0.1416 (2.080)	0.0752 (0.633)	0.1219 (1.871)
Rubber and Miscellaneous plastics	0.7950 (8.752)	1.2068 (6.199)	0.8717 (10.469)
Leather and leather products	0.8185 (5.416)	0.6366 (4.621)	0.7989 (7.111)
Railroad transportation	0.8289 (6.140)	0.8728 (7.504)	0.8634 (7.982)

Industry Description	Tradeoff 1948-1972	Tradeoff 1973-1986	Tradeoff 1948-1986
Local and interurban passenger transit	0.1797 (0.637)	0.1521 (0.363)	0.1924 (0.893)
Trucking and Warehousing	1.0166 (5.845)	1.2804 (8.923)	1.0799 (8.144)
Water Transportation	0.9206 (5.867)	0.7272 (3.343)	0.8238 (7.733)
Transportation by Air	0.0106 (.0327)	0.5789 (1.265)	0.3489 (1.423)
Pipelines, except natural gas	0.1222 (0.9329)	0.1378 (2.913)	0.1275 (1.873)
Transportation services	0.1888 (1.036)	0.0643 (0.722)	0.1232 (1.247)
Telephone and Telegraph	0.7526 (8.815)	0.7785 (3.127)	0.6984 (5.989)
Radio and television broadcasting	0.6221 (2.767)	0.7774 (8.700)	0.7120 (4.736)
Wholesale Trade	0.5062 (6.256)	0.5505 (2.416)	0.4840 (4.736)
Retail Trade	0.4280 (2.189)	1.1290 (3.127)	0.5272 (3.295)
Banking	0.2575 (3.893)	0.1424 (2.439)	0.2061 (4.079)
Credit agencies	0.0046 (0.1358)	0.0610 (1.906)	0.0398 (1.597)
Security and commodity brokers	-0.0055 (-0.051)	0.0212 (0.3143)	0.1388 (2.094)
Insurance carriers	-0.2382 (-4.635)	0.0865 (2.075)	-.0337 (-0.898)
Insurance agents and brokers	-0.0859 (-0.376)	0.1326 (0.571)	0.0363 (0.025)
Real Estate	0.4997 (2.047)	0.6764 (4.414)	0.2671 (2.281)

Industry Description	Tradeoff 1948-1972	Tradeoff 1973-1986	Tradeoff 1948-1986
Hotels and other lodging places	0.8467 (4.196)	0.6423 (4.381)	0.8592 (5.894)
Personal services	0.8856 (6.682)	1.0652 (6.250)	0.9246 (6.517)
Business services	0.6371 (3.902)	0.7804 (2.294)	0.5278 (3.182)
Auto repair, services and garages	0.7629 (7.200)	1.188 (8.046)	0.9112 (10.029)
Miscellaneous repair services	0.4451 (3.228)	-0.0442 (-0.266)	0.2891 (2.537)
Motion Pictures	0.7903 (8.803)	0.9289 (9.080)	0.8808 (13.698)
Amusement and recreational services	0.7923 (7.720)	1.2391 (7.351)	0.8873 (10.192)
Health services	0.0912 (0.766)	0.1758 (1.328)	0.1249 (1.215)
Legal services	0.7600 (3.887)	-0.1853 (-0.522)	0.0475 (2.631)
Educational services	0.4925 (3.247)	0.3996 (3.382)	0.4639 (5.961)
Social Services	0.6506 (3.009)	0.7506 (3.155)	0.5828 (3.598)
Miscellaneous Professional Services	0.5336 (4.577)	0.9203 (11.039)	0.6807 (8.706)
Private Households	1.0645 (9.883)	1.0594 (5.889)	1.0351 (8.439)

only four industries (chemicals, petroleum and coal products, coal mining, and legal services) which change from being statistically significant prior to 1972 to insignificant after 1972. While most industries' tradeoff does change across the two periods, the change is seldom substantial.

As stated above, Kandil estimates the tradeoff by industry using nominal GNP as the demand variable. In order to use the traditional method of estimating the tradeoff, shown in equation (3.1) above, and to use nominal GNP as the demand variable, the following equation also is estimated.

$$(3.2) \quad y_{t_i} = \alpha + \tau_{t_i} \Delta X + y_{t_{-1_i}} + \gamma time$$

Equation (3.2) is exactly the same as equation (3.1) except X is nominal GNP. The results from estimating equation (3.2) are presented in Table 3.3.

The tradeoffs estimated using nominal GNP as the demand variable suffer two defects. First, the coefficient representing the tradeoff is no longer bounded by zero and one. This makes the coefficient more difficult to interpret. When the tradeoff is bounded by zero and one, as is the case when estimation is done using nominal value added by industry, the coefficient can be interpreted as the percentage of a change in nominal output that is reflected in real output. One minus the tradeoff coefficient can then

TABLE 3.3

TRADEOFFS FOR THREE TIME PERIODS
USING NOMINAL GNP AS THE DEMAND VARIABLE
(t-statistics in parenthesis)

Industry Description	Tradeoff 1948-1972	Tradeoff 1973-1986	Tradeoff 1948-1986
Farms	-0.3173 (-1.548)	-1.7415 (1.386)	-0.0486 (-1.472)
Agricultural services	0.1949 (1.082)	1.3048 (2.016)	0.4703 (2.154)
Metal Mining	0.6877 (1.178)	4.0316 (3.244)	1.9831 (3.455)
Coal Mining	1.9312 (5.122)	0.2329 (0.384)	1.3628 (3.929)
Oil and Gas Extraction	0.9777 (5.236)	1.6239 (2.460)	0.9837 (5.411)
Nonmetallic Mineral Mining	0.7862 (4.535)	2.4357 (4.189)	1.1676 (4.902)
Construction	0.7266 (3.841)	1.0987 (1.575)	0.4959 (2.095)
Lumber and Wood Products	1.3655 (3.066)	2.0926 (2.785)	1.5019 (3.997)
Furniture and Fixtures	1.4166 (3.465)	2.3342 (3.151)	1.4871 (4.615)
Stone, Clay and Glass	1.2138 (5.385)	1.9487 (2.590)	1.4281 (5.344)
Primary Metal Industries	2.7360 (6.385)	3.3941 (2.522)	3.0146 (7.154)
Fabricated Metal products	1.5753 (5.174)	2.4217 (3.599)	1.5958 (5.596)
Machinery, except Electrical	2.1422 (5.364)	2.6864 (2.475)	1.8058 (4.212)
Electric and electronic eq.	1.8780 (4.712)	2.5076 (3.804)	1.7593 (5.358)

Industry Description	Tradeoff 1948-1972	Tradeoff 1973-1986	Tradeoff 1948-1986
Motor Vehicles and eq.	3.3776 (3.839)	4.6682 (2.446)	3.6702 (4.861)
Other Transport ation equipment	1.5943 (1.973)	0.1460 (0.147)	0.7659 (1.325)
Instruments and related products	1.6800 (4.822)	1.6697 (4.645)	1.5756 (6.800)
Miscellaneous Manufacturing	1.1083 (5.894)	2.6940 (1.966)	1.4603 (3.863)
Food and Kindred products	0.2039 (1.413)	0.0064 (0.012)	0.2245 (1.409)
Tobacco Products	0.3769 (1.169)	1.1779 (1.581)	0.6966 (2.160)
Textile Mill products	1.0938 (3.508)	2.3564 (2.591)	1.1550 (3.335)
Apparel and other Textile products	1.0063 (4.561)	1.3767 (5.119)	1.1268 (6.860)
Paper and Allied products	1.4270 (5.872)	0.9930 (1.039)	1.3959 (4.872)
Printing and Publishing	0.1511 (0.753)	0.6508 (2.333)	0.2629 (1.652)
Chemicals and allied products	0.9188 (5.125)	1.4538 (2.079)	1.0291 (3.622)
Petroleum and coal products	0.3607 (1.533)	1.0231 (1.892)	0.3583 (1.434)
Rubber and Miscellaneous plastics	2.2785 (8.911)	2.1431 (2.366)	2.0015 (6.808)
Leather and leather products	1.2809 (3.804)	1.5013 (2.215)	1.5427 (4.790)
Railroad transportation	1.7021 (6.146)	2.5117 (4.123)	1.9281 (7.175)

Industry Description	Tradeoff 1948-1972	Tradeoff 1973-1986	Tradeoff 1948-1986
Local and interurban passenger transit	0.4540 (2.158)	1.2714 (2.258)	0.4422 (2.083)
Trucking and Warehousing	1.0187 (4.899)	1.7733 (2.664)	1.2036 (4.447)
Water Transport ation	1.6728 (3.149)	1.5869 (3.817)	1.7335 (4.971)
Transportation by Air	1.0221 (2.835)	1.3955 (1.463)	0.8905 (2.615)
Pipelines, except natural gas	1.1470 (4.411)	0.6208 (1.621)	0.9651 (4.601)
Transportation services	1.0227 (3.873)	0.8056 (2.445)	1.0026 (4.815)
Telephone and Telegraph	0.3564 (3.413)	0.2816 (0.828)	0.3661 (2.892)
Radio and television broadcasting	0.7557 (2.098)	1.1170 (1.645)	0.5270 (1.749)
Wholesale Trade	0.5927 (5.082)	0.6983 (1.733)	0.5282 (3.507)
Retail Trade	0.4194 (3.173)	0.7512 (1.972)	0.4524 (3.445)
Banking	0.1142 (0.9632)	0.1664 (0.888)	0.2102 (2.277)
Credit agencies	0.2529 (1.744)	0.6184 (1.572)	0.1281 (0.776)
Security and commodity brokers	0.3333 (0.733)	0.1792 (0.422)	0.0668 (0.175)
Insurance carriers	0.2883 (1.909)	-0.0476 (-0.165)	0.2156 (1.844)
Insurance agents and brokers	0.2611 (1.515)	-0.0468 (-0.088)	0.1929 (1.169)
Real Estate	0.0939 (1.323)	0.5342 (3.816)	0.1661 (2.471)

Industry Description	Tradeoff 1948-1972	Tradeoff 1973-1986	Tradeoff 1948-1986
Hotels and other lodging places	0.1897 (0.979)	0.8256 (3.144)	0.4131 (2.309)
Personal services	-0.0074 (-0.054)	-0.0664 (-0.125)	-0.1784 (-1.061)
Business services	0.1280 (0.714)	0.8712 (2.005)	0.1593 (0.940)
Auto repair, services and garages	0.3606 (2.184)	1.1910 (2.339)	0.6645 (3.101)
Miscellaneous repair services	0.5445 (3.548)	0.4963 (1.125)	0.6325 (4.124)
Motion Pictures	0.2237 (0.659)	0.7058 (0.596)	0.2310 (0.613)
Amusement and recreational services	0.0104 (0.061)	0.1323 (0.436)	0.0301 (0.198)
Health services	0.0129 (0.118)	0.1696 (1.697)	0.0648 (0.633)
Legal services	-0.0552 (-0.214)	0.4181 (1.013)	0.0441 (0.233)
Educational services	-0.0908 (-0.922)	-0.1261 (-0.690)	-0.1514 (-1.432)
Social Services	0.0532 (0.315)	0.2684 (1.073)	0.0520 (0.416)
Miscellaneous Professional Services	0.5195 (1.963)	1.1843 (1.541)	0.5245 (2.169)
Private Households	0.3126 (0.962)	0.5576 (0.845)	0.0526 (0.176)

be interpreted as the percentage of a change in nominal output that is reflected in price. Neither of these conditions holds when the tradeoff is estimated using nominal GNP as the demand variable for all industries.

The second weakness of this method of estimating the tradeoff is that the effect of changes in relative demand faced by firms is eliminated when nominal GNP is used as the demand variable. Unlike nominal value added by industry, nominal GNP does not capture changes in demand between industries; instead, nominal GNP only captures economy wide changes in demand. Since one of the primary objectives of this study is to determine whether the new-Keynesian prediction (a negative relationship between the tradeoff and variance in relative demand) or the price-misperceptions model's prediction (a positive relationship between the tradeoff and variance in relative demand) are supported by the data, it does not seem appropriate to eliminate all relative factors when estimating the tradeoff.

A third problem of estimating the tradeoff using nominal GNP as the demand variable is that industries may differ as to the responsiveness of demand in their industry to changes in nominal GNP. The actual empirical affects of these differences in the method of estimating the tradeoff will be shown in Chapter 4.

DATA USED TO ISOLATE THE DETERMINANTS OF THE VARIATION OF THE TRADEOFF ACROSS INDUSTRIES

As shown in Chapter 2, there is a debate about the effects of the variance of relative demand on the tradeoff. Followers of the price-misperceptions model argue that increased variation of relative demand or idiosyncratic shocks will increase the tradeoff. This is because agents will be more likely to perceive any change in price as a relative shift of demand. This theory would indicate that agents faced with a shift in demand will adjust output rather than price. As a result, more of a movement in nominal demand will be reflected in increased (or decreased) output.

The new-Keynesian economists, as explained more fully in Chapter 2, assert that changes in relative demand offer the firm increased incentive to incur the menu cost of changing price and therefore to adjust price to the new conditions faced by the firm. If price changed instantly with any change in nominal demand, then the tradeoff would be zero. Regardless of the inertia of changing prices, the more frequently prices change the less output will be affected by changes in nominal demand. Therefore, the new-Keynesian economists predict that there is a negative relationship between the variance of idiosyncratic shocks and the tradeoff.

The difficulty is how to determine the appropriate

measures for the variability of idiosyncratic shocks. The variability of a firm's relative price or relative demand are considered to be good proxies for industry specific shocks. Because firm data are not available, industry group data are assumed to be sufficiently disaggregated to represent the decisions of the firms which make up the grouping.

To calculate relative price, it is first necessary to construct a price data set for each industry. Price in each industry in a given year is calculated by dividing nominal value added by real value added for that year. With this price variable calculated, each industry group's price is divided by the corresponding year's GNP deflator to determine relative price for the industry. This creates a variable which measures how industry groups are faring relative to the economy as a whole in the area of price; in other words, a relative price data series has been constructed.

To test the two competing theories, the variance of idiosyncratic shocks also must be measured in some manner. Because variance calculations of a nonstationary data set are dependent upon a nonstationary mean, their results tend to be spurious. In an effort to eliminate this problem, the relative price and relative demand data series are converted to a stationary data set. This is done by transforming the data by industry to the growth rate of the respective

series. Taking the variance of the growth rate of relative price offers a proxy for idiosyncratic shocks as is called for by both Lucas (1973) and BMR (1988).

A second measure of idiosyncratic shocks is the growth rate of relative demand by industry. Relative demand for a given industry is calculated by dividing nominal value added by industry by aggregate nominal GNP for each year. Both the variance of the growth of relative demand and the variance of the growth rate of relative price will be used in Chapter 4 as explanatory variables in explaining the variation of the tradeoff across industries. The goal will be to determine whether the output-inflation tradeoff is positively related to measures of idiosyncratic shocks (as predicted by the price-misperceptions model) or negatively related (as predicted by the new-Keynesian model). Both measures of idiosyncratic shocks are included so that any result will not be subject to the criticism of being unique to the measure used to represent the variance of idiosyncratic shocks.

Following Kandil's lead, the mean rate of growth of relative price by industry also is used as an explanatory variable of the tradeoff. Further, the proxies offered by Kandil for compensation and productivity are also used as explanatory variables. The measure of the growth of compensation is the average annual growth of compensation per full-time equivalent worker by industry. The growth of

productivity is measured as the average annual growth rate of real gross product per person engaged in production.

CHAPTER 4

THE RELATIONSHIP BETWEEN TRADEOFFS, DEMAND VARIABILITY, AND MEASURES OF MARKET STRUCTURE

Chapter 3 demonstrated the method used in this study to estimate the demand-output tradeoff for a particular industry. Chapter 3 also presented estimates of these tradeoffs for the industries included in the study. While these estimates may be of some interest in themselves, there is much more to be learned if one can explain the sources of the variation of the tradeoff across industries. In this chapter, regression analysis is used to determine if the measures of relative demand presented in Chapter 3 can explain the variation observed in these tradeoff estimates. Further, regression analysis is used to test whether various measures of market structure offer additional explanatory power with respect to the variation of the tradeoff across industries.

Before presenting the regression results, it is appropriate to review what the two competing theories would predict. The new-Keynesian model predicts that the tradeoff will be low in industries with high variation in relative demand. Lucas, on the other hand, explains that the new classical model suggests that the tradeoff should be high in

industries with high variation in relative demand. It is this difference between the two theories which will receive the primary focus in this study.

New-Keynesian economists argue that the tradeoff between output and inflation depends upon the relative frequency of price changes. The frequency of these changes depends on the gain in profits associated with changing price and on the menu cost associated with changing price. The greater the menu cost, the less frequently prices will be changed. On the other hand, the greater the cost of maintaining price, in lost profits, the more frequently price will be changed. Changes in relative demand offer firms greater chance for increased profits from changing price; that is, high variability of relative demand increases the cost of maintaining price. Therefore, the greater the variance of relative demand, the more frequently prices will be changed, given some constant menu cost. The new-Keynesian model consequently implies that a high variance in relative demand will result in smaller tradeoffs.

Lucas and the new classical economists offer a different prediction. Lucas claims the tradeoff is determined by the extent to which suppliers are "fooled" by economy wide price movements. Lucas (1973) describes this in the following equation

$$(4.1) \quad E(P_t|I_t(z)) = (1-\theta)P_t(z) + \theta\overline{P}_t.$$

In this equation, $\theta=\epsilon^2/\sigma^2+\epsilon^2$, ϵ^2 is the variance of relative price movements, σ^2 is the variance of economy wide price movements, and $\overline{P}$ is the mean of the distribution of economy wide prices. Thus ϵ^2 is the variable used by Lucas to represent industry specific shocks. Lucas argued, "...in cases where ϵ^2 is relatively small, so that individual price changes are virtually certain to reflect general price changes, the supply curve is nearly vertical." (1973, p.323) That is, when relative demand variation is small, the new classical theory predicts the tradeoff between output and inflation will be small. Changes in nominal demand consequently will result mainly in price changes with little change in output. Thus the new-Keynesian and new classical models have sharply differing predictions with regard to the effect of the volatility of relative demand on the size of the tradeoff.

BMR (1988, p.173) explain this difference as follows

> According to Lucas, a large variance of relative price shocks increases the real effects of nominal shocks, because it raises the proportion of these shocks that agents misperceive as real. Our model predicts that a large variance of idiosyncratic shocks, like a large variance of aggregate shocks, leads to more frequent price changes and thus reduces the effects of nominal shocks. If one could construct a measure of the variance of firm-specific shocks, which we do not attempt in this paper, then estimating the relationship between this variable and the slope of the Phillips curve would be another test between the two competing theories.

It is precisely this that this chapter attempts to accomplish for one country, the United States.

In addition to testing the two theories' predictions with respect to idiosyncratic shocks, the study also tests the effect that the average rate of growth of industry prices has on the tradeoff. The new-Keynesian model predicts that the faster the growth of industry price relative to economy wide price movements the smaller the tradeoff. The reason for this prediction is that as industry prices change the firm's potential gain in profits from changing price increases. Consequently, the frequency of price changes increases and the tradeoff falls.

The price-misperceptions model, on the other hand, predicts a positive relationship between the average rate of price increase and the tradeoff. The theoretical reason supporting this belief is that the faster price is growing in an industry, the more frequently the firm must interpret the price change as either an economy-wide price change or relative price change. With this increased frequency of decision making, there is an increase in the number of potential errors in interpreting price changes that are in fact due to changes in nominal aggregate demand increases. The greater the number of errors made by the firm, the higher the tradeoff. Because of this difference in the predictions of the two models, inclusion of the average growth of relative price as an explanatory variable in

regressions designed to explain the tradeoff offers another test between these two competing theories.

THE MODEL

As explained in Chapter 3, the primary difficulty of accomplishing the task set forth by BMR is constructing a measure of the variance of firm-specific shocks. In an attempt to avoid having this study's results being tied to a specific measure of idiosyncratic shocks, two different measures will be used. Both of these measures were described in Chapter 3 and both are included in the OLS regressions. These regressions are estimated in an attempt to explain the variation of the tradeoff across industries.

The first measure of idiosyncratic shocks is the variance of the growth rate of relative price.[1] Relative price in industry i is calculated by dividing the price index for each industry, P_i, by the GNP deflator, P. The growth rate of relative price measures the volatility of relative demand shocks. (This measure conforms more closely with Lucas' conception since in his model the variable observed by firms is industry price.) Using this measure for industry-specific shocks, equation (4.2) is estimated.

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[1]Throughout this study the standard deviation of the growth rate of relative price gives better results than the variance. The variance of the growth rate of relative price is used instead of the standard deviation to conform to Lucas' (1973) specification.

$$(4.2) \quad \tau_i = \alpha_2 + \beta_2 var\ \pi_i .$$

The second measure of industry-specific shocks is the variance of the growth rate of relative demand. Relative demand is calculated by dividing nominal value added for each industry by nominal GNP. That is, relative demand for the ith industry is calculated as Y_i/Y, where Y_i is nominal value added in industry i and Y is nominal GNP. The growth rate of Y_i/Y is then calculated and denoted x. It is the variance of this growth rate that is used in the regressions as a variable explaining the tradeoff. The growth rate of relative demand offers a gauge of the volatility of the industry group's economic environment as compared to other industries. Using this measure for idiosyncratic shocks, equation (4.3) is estimated.

$$(4.3) \quad \tau_i = \alpha_1 + \beta_1 Var\ x_i ,$$

where τ is the tradeoff for each industry.

In addition to measures of the variance of relative demand and relative price, the study also includes as an explanatory variable the average growth of relative price. The average growth of relative price is included because the two models being studied have differing predictions with respect to it. The new-Keynesian model predicts a negative relation between the growth rate of relative price and the tradeoff, while the price-misperceptions model predicts a

positive relation. Specifically, the following equation is estimated:

$$(4.4) \quad \tau_i = \alpha_3 + \beta_3 \overline{\pi}_i .$$

After estimating equations 4.2, 4.3, and 4.4 individually, $\overline{\pi}$ and the variance measures are combined in the following equations:

$$(4.5) \quad \tau_i = \alpha_4 + \beta_1 var\pi_i + \beta_2 \overline{\pi}_i ,$$

$$(4.6) \quad \tau_i = \alpha_5 + \beta_2 var\, x_i + \beta_3 \overline{\pi}_i .$$

As explained in Chapters 2 and 3, there are two different means of estimating the tradeoff itself being examined in this study. To review, the first method of estimation, offered for the first time in this study, uses nominal value added by industry as the demand variable in estimating the tradeoff by industry. The second method uses nominal GNP as the demand variable for all industries. The second method is used by Kandil (1991). Because there are two different methods of estimating the tradeoffs, equations (4.2) through (4.6) are first estimated using tradeoffs calculated using nominal value added by industry. These results are presented in Table 4.1. Then equations (4.2) through (4.6) are estimated again using the tradeoffs estimated using nominal GNP as the demand variable. (See

equation 3.2) These results are presented in Table 4.2. As will become clear, the method used to estimate the tradeoff is essential to the results of this study.

EMPIRICAL RESULTS

The results in Table 4.1 indicate that both measures of the variability of the of relative demand, the variance the growth rate of relative price and the variance of the growth rate of relative demand, are negatively related to the tradeoff and are statistically significant. This result holds regardless of the specifications except 4.6, which is not quite significant at the ten percent level. In addition, the average growth of relative price is also negatively related to the tradeoff and is statistically significant.

The results presented in Table 4.1 offer substantial support for the new-Keynesian model and cast doubt upon the price-misperceptions model. The new-Keynesian model predicts a negative relationship between the tradeoff and measures of the variability of industry specific shocks because as the variance of idiosyncratic shocks increases, the potential gain in profits from changing price increases. On the other hand, the price-misperceptions model, through what has become known as the variance hypothesis, predicts a positive relationship between the tradeoff and the variance of idiosyncratic shocks. The rationale behind the variance hypothesis is that firms are more likely to

Table 4.1

Determinants of the Response
Of Industry Real Output To Nominal
Industry Shocks; 1948-1986
(Numbers in parentheses are t-statistics)

Explanatory Variables	4.2	4.3	4.4	4.5	4.6
Constant	0.6769 (15.55)	0.6424 (12.96)	0.6192 (16.64)	0.6798 (17.50)	0.6578 (15.45)
Variance of x	-22.8833 (-4.54)			-16.009 (-3.31)	
Variance of x		-9.8508 (-2.47)			-6.194 (-1.76)
Mean x			-11.5273 (-5.06)	-8.811 (-3.92)	-10.615 (-4.63)
$\bar{R}^2$	0.2556	0.0818	0.3016	0.4073	0.3270

perceive a change in price to be a change in relative demand if the variability of industry specific shocks is high.

It is argued here that the results using the variance of the growth of relative price provide the closer test of Lucas' original contention that firms must react to changes in price. Specifically, when the firm observes a change in its price it must estimate the portion of the change that is due to changes in relative demand and the portion due to an economy-wide change in price. According to Lucas, if the price change is interpreted as an economy-wide change in price the firm will not adjust output; instead only price will be adjusted. It is only when the price change is interpreted as a relative price change that output will be

altered. Therefore, the negative coefficients associated with the growth of relative price combined with the highly significant t-statistics offer the most compelling reasons for doubting the predictions of the price-misperceptions model.

A second finding of the results shown in Table 4.1 is that the average growth of relative price, $\overline{\pi}$, is negatively related to the tradeoff. The new-Keynesian model predicts that there is a negative relationship between the average growth of relative price and the tradeoff. This is based on the fact that the faster the growth of industry price, the greater the firm can profit from changing price, given the level of the menu cost.

On the other hand, the price-misperceptions model predicts that there is a positive relationship between the average growth of relative price and the tradeoff. The theoretical reason supporting this belief is the fact that the faster the price is growing in an industry, the more frequently the firm must interpret the price change as either an economy-wide price change or a relative price change. With this increased frequency of decision making, the number of potential errors in interpreting the price changes increases. The greater the number of errors made by the firm the higher the tradeoff.

Equations 4.4, 4.5 and 4.6 offer a means to test the competing predictions of these two models regarding the

effect of the mean of π. The negative and highly significant coefficients associated with the average growth of relative price supports the new-Keynesian model and contradicts the price-misperceptions model. These results are robust across all three specifications.

When the mean values for all variables in equation 4.5 are used the average tradeoff for all industries is calculated to be .58. If the variance of π is increased by 50%, holding the mean of π at its average across industries, the tradeoff decreases to .54. When the variance of π is decreased by 50%, again holding the mean of π at its average across industries, the tradeoff increases to .61.[2]

The results of the regressions using equations 4.2-4.6 in which the dependent variable is the tradeoff estimated using nominal GNP as the demand variable are given in Table 4.2. A comparison of Table 4.1 and Table 4.2 indicates that the coefficient of the average growth of relative price is negative and statistically significant for both specifications of the tradeoff, thus tending to support the new-Keynesian model and to refute the price-misperceptions model. On the other hand, the coefficients associated with the measures of variance of relative shocks, whether the variance of the growth of relative price or the variance of the growth of relative demand, are very different in Table

[2]The equation is symmetrical. This difference between the change in the tradeoff when the variance of π is increased or decreased is due solely to rounding errors.

Table 4.2

Determinants of the Response
Of Industry Real Output to Nominal
Aggregate Shocks; 1948-1986
(Numbers in parentheses are t-statistics)

Explanatory Variables	4.2	4.3	4.4	4.5	4.6
Constant	0.8778 (7.142)	0.7294 (5.948)	0.9342 (9.575)	0.8858 (7.999)	0.7669 (7.232)
Variance of x	-5.9445 (-0.418)			12.794 (0.929)	
Variance of x		17.9645 (1.818)			26.853 (3.072)
Mean x			-21.847 (-3.658)	-24.018 (-3.74)	-25.801 (-4.51)
$\bar{R}^2$	-0.0147	0.0389	0.1784	0.1764	0.2859

4.2 than in Table 4.1.

In Table 4.2 the growth of relative price is negatively related to the nominal GNP tradeoff in equation 4.2 and positively related to the nominal GNP tradeoff in equation 4.5. Neither of these results, however, are statistically significant at any level. The second measure of relative demand, the variance of the growth of relative demand, is positively related to the nominal GNP tradeoff in both equations 4.3 and 4.6. Further, in specification 4.3 the results are statistically significant at the ten percent level and in specification 4.5 the results are significant at the one percent level.

The results presented in Table 4.2 are very similar to those found by Kandil (1991). This is true in spite of the

fact that the equation used to estimate these tradeoffs is slightly different than that used by Kandil. The motivation for the method used to estimate the nominal GNP tradeoffs in this study was to see exactly what caused the different results found in Table 4.1 and Table 4.2.

The results in Table 4.2 are based on a tradeoff measure variable, the response of industry output to nominal GNP changes, which has all changes in relative demand removed. This is because, as explained in Chapter 3, when nominal GNP is used as every industry's demand variable there is no means for changes in relative demand to enter into the calculation of this tradeoff. In direct confrontation to this method, the results in Table 4.1 are based on a the tradeoff estimated using nominal value added by industry. This tradeoff allows for responses to both economy-wide changes in demand and relative changes in demand. This is, nominal value added by industry offers a different demand variable for each industry.

Consequently, it is argued here that Kandil's method of estimating the tradeoff is deficient, and that the results using the method in Table 4.1 are more appropriate to answer at least one of the questions at hand: how do changes in relative demand affect the tradeoff at an industry level? A second piece of evidence supporting the utilization of the method used in Table 4.1 is that the adjusted R^2's are considerably greater in Table 4.1.

The second issue being addressed by this study is the effect the growth of industry relative price has on the size of industry tradeoffs. This issue is not affected by which method is employed to estimate the tradeoffs. Instead, this result seems consistently to support the new-Keynesian predictions. In all subsequent regressions, the results using both methods of estimating the tradeoff will be presented. The results using nominal value added by industry in estimating the tradeoff will be emphasized.

DISAGGREGATING THE RESULTS TEMPORALLY

During the 1970's many economic relationships broke down. As a result, this study is divided into two temporal subsections. The breakpoint for this division is the year 1972. This breakpoint is chosen because, as BMR (1988, p.177) point out, "the early 1970's are often considered a time of major structural change; certainly many empirical macroeconomic relationships broke down."

In Tables 4.3 the dependent variable is the tradeoff by industry estimated using nominal value added by industry as the demand variable for the years 1948 to 1972. These tradeoffs are presented in Table 3.1. The independent variables correspond exactly to those used in Tables 4.1 and 4.2 and come from equations (4.2) through (4.6), except that they are calculated only for the period 1948 to 1972.

The results shown in Table 4.3 are approximately the same as those in Table 4.1. Both measures of the variance

Table 4.3

Determinants of the Response
Of Industry Real Output to Nominal
Industry Shocks; 1948-1972
(Numbers in parenthesis are t-statistics)

Explanatory Variables	4.2	4.3	4.4	4.5	4.6
Constant	0.6808 (14.502)	0.6066 (11.532)	0.5974 (13.833)	0.6915 (15.38)	0.6327 (12.57)
Variance of x	-31.3803 (-4.220)			-28.727 (-4.01)	
Variance of x		-6.3298 (-1.203)			-7.028 (-2.57)
Mean x			-6.9573 (-2.823)	-5.6181 (-2.57)	-4.231 (-2.43)
$\bar{R}^2$	0.2277	0.0077	0.1090	0.2979	0.1214

Table 4.4

Determinants of the Response
Of Industry Real Output to Nominal
Industry Shocks; 1973-1986
(Numbers in parentheses are t-statistics)

Explanatory Variables	4.2	4.3	4.4	4.5	4.6
Constant	0.7471 (13.155)	0.7378 (12.104)	0.6751 (13.525)	0.7295 (13.48)	0.7153 (12.61)
Variance of x	-16.8906 (-4.349)			-9.9150 (-2.220)	
Variance of x		-11.8038 (-3.471)			-7.8938 (-3.255)
Mean of x			-9.7595 (-4.712)	-6.6879 (-2.748)	
$\bar{R}^2$	0.2392	0.1624	0.2711	0.3189	0.2849

of relative demand are still negative, although only the variance of the growth of relative price is statistically significant. Since it is the variance of the growth of relative price that is of more direct interest for comparison of the two theories being studies, the fact that the variance of the growth of relative demand is considered to be of minor importance.

In addition to the results regarding relative demand, the average growth of relative prices is also included as an independent variable. Once again, regardless of the specification, the average growth of relative prices is negatively related to the tradeoff and is statistically significant. This corresponds to the findings of Tables 4.1 and 4.2.

Table 4.4 presents the same equations as were presented in Table 4.3. The only difference is that the sample period is 1973 to 1986. Once again the results with respect to the variance of the growth of relative prices are the same as those presented in Tables 4.1, and 4.3. The average growth of relative price is also still negatively related to the tradeoff and statistically significant. The variance of the growth of relative demand is negatively related to the tradeoff, but is not always statistically significant. For the same reasons that were given for this result in Table 4.3 this result is considered to be of lesser importance.

Tables 4.5 and 4.6 present the temporally disaggregated

regression results for the determinants of the tradeoff, where the tradeoff is estimated using nominal GNP as the demand variable. The results are very similar to those presented in Table 4.2 for the entire time period. The coefficient of average growth of relative price is again always negative and statistically significant, the variance of the growth of relative price is sometimes positively related to the tradeoff and sometimes negatively related to the tradeoff depending upon the specification, but is never statistically significant; and the variance of the growth of relative demand is always positively related to the tradeoff and sometimes statistically significant.

The result of primary significance of Tables 4.3 through 4.6 is that the determinants of the tradeoff have not changed dramatically from the pre-1972 period to the post-1972 period. This result holds regardless of the method used to estimate the tradeoff. This indicates that, at least in the U.S., the factors determining industry tradeoffs have been
fairly constant over a very turbulent time. Further, these results indicate that the findings of this study are not limited to a special set of economic events; instead, they appear to be consistently representative of the U.S. economy.

INDUSTRY SPECIFIC SUPPLY FACTORS

Kandil (1991) introduced the possibility the supply

Table 4.5

Determinants of the Response
Of Industry Real Output to Nominal
Aggregate Shocks; 1948-1972
(Numbers in parentheses are t-statistics)

Explanatory Variables	4.2	4.3	4.4	4.5	4.6
Constant	0.8431 (6.979)	0.6859 (6.009)	0.0935 (8.972)	0.8708 (7.534)	0.7391 (6.712)
Variance of x	-5.1278 (-0.268)			-1.7354 (-0.094)	
Variance of x		26.467 (2.317)			25.8428 (2.384)
Mean x			-14.6221 (-2.623)	-14.6992 (-2.586)	-14.3476 (-2.68)
$\bar{R}^2$	-0.0166	-0.07	0.0935	0.0772	0.1635

Table 4.6

Determinants of the Response
Of Industry Real Output to Nominal
Aggregate Shocks; 1973-1986
(Numbers in parentheses are t-statistics)

Explanatory Variables	4.2	4.3	4.4	4.5	4.6
Constant	1.2478 (7.501)	1.1488 (6.732)	1.2475 (8.638)	1.2086 (7.414)	1.0919 (6.753)
Variance of x	-8.4606 (-0.744)			7.0938 (0.527)	
Variance of x		4.4634 (0.4688)			20.7463 (1.960)
Mean x			-12.7144 (-2.122)	-14.9122 (-2.034)	-19.939 (-2.885)
$\bar{R}^2$	-0.0079	-0.0139	0.0579	0.0456	0.1034

factors in individual industries could affect results such as those presented in Tables 4.1 and 4.2. Kandil states

> ...there are other industry-specific factors that are likely to distinguish the industrial real output to aggregate demand shocks. These factors relate to the general response of characteristics of industries which include differential technological change, economies of scale, supply elasticities, capital intensity, labor productivity and others. Ignoring these factors may have biased my estimates of the response of industrial output to aggregate demand shocks and, in turn, may have affected the accuracy of the relationship implied by the cross section results. (1991, p.483)

While this study differs from Kandil's study in that it is interested in both aggregate shocks and relative shocks to which industries must respond, these industry specific factors may still bias the results. Further, at least one of the variables used by Kandil to represent these supply factors offers yet another means to test the predictions of the two competing theories.

The two industry-specific characteristics that are incorporated into this study are the average growth of compensation per employee by industry (Comp) and the average growth of productivity by industry (Prod). Comp is measured as the average annual growth of compensation per employee in each industry. Prod is defined as the average annual rate of change of the ratio of real gross product per person in each industry. These definitions correspond to those used by Kandil (1991).

The new-Keynesian model's prediction with respect to

Comp differ dramatically from those of the price-misperceptions models. The new-Keynesian model predicts a negative relationship between the tradeoff and Comp. This is because as Comp increases, the firm's marginal cost curve shifts upward. This shift in the firm's marginal cost curve moves the firm away from the point of profit maximization; therefore, the firm's gain in profits from changing price is increased. Consequently, the model predicts that the firm will adjust prices more frequently and that the output response to a nominal shock will be smaller. This relationship is symmetrical.

The price-misperceptions model, on the other hand, predicts a positive relationship between the tradeoff and comp, at least when the firm faces a positive demand shock. The reasoning of the price-misperceptions model is that firms or industries with high Comp are better able to induce more work from the labor force. This may come from the firm's current labor force working more hours or from the firm hiring addition workers. Either of these methods will be more easily facilitated if comp is high. The price-misperceptions model's analysis, however, is accurate only for periods dominated by positive demand shocks.

Both the new-Keynesian and price-misperceptions models offer the same prediction for the prod variable. This prediction is a positive relationship between the tradeoff and prod. The new-Keynesian model argues that in a period

of increasing price, which is true of the sample period used in this study, increasing productivity allows the firm not to raise its own price even when economy-wide prices are increasing. This is the case because as prod increases the firm's marginal cost curve falls. When the firm's marginal cost curve falls there is an incentive, from a profit maximizing point of view, for the firm to lower its relative price, ceteris paribus. By simply maintaining price during a period of rising general prices, the firm is effectively allowing its relative price to fall.

The price-misperceptions model also predicts a positive relationship between the tradeoff and prod. The best means of understanding the logic of this model is through a short example. First, assume that there is an increase in economy-wide price and that the firm must decide if the increase is a relative or economy-wide change in price. If the firm misperceives the price change as relative when it is economy-wide, output will be increased and a positive tradeoff will exist. If at the same time the firm's prod variable increases, the firm will increase output also in response to this supply factor. As a result, the measured tradeoff will be larger as a result of the increased prod because output will have increased more than it would have otherwise. This analysis also holds for a decrease in demand that occurs at the same time as a decrease in productivity.

The two industry-specific supply factors, comp and prod, are added to the explanatory variables used in equations (4.2) through (4.6). Since productivity and industry price growth are highly negatively correlated, in equations where both variables are used, the industry price growth variable will be purged of any correlation with prod and will be called π^r. These results are presented in Table 4.7.

The addition of the compensation and productivity variables does not dramatically effect the results presented in Table 4.1. The average growth of relative price, the absolute value or the measure purged of any correlation with productivity, the variance of the growth rate of relative price, and the variance of the growth of relative demand are negatively related to the tradeoff. The average growth of relative price and the variance of the growth of relative price are also always statistically significant. The variance of the growth rate of relative demand is sometimes statistically significant depending upon the specification.

The two new variables, the average growth of compensation per employee by industry and the average growth of productivity per employee by industry, enhance the equation's explanatory power. This is indicated by the increased adjusted R^2's shown in Table 4.7 compared to those in Table 4.2. Equations 4.7, 4.10, and 4.12 all explain over forty percent of the variation of the tradeoff across

Table 4.7

Further Determinants of the
Response of Industry Real Output
to Nominal Industry Shocks, 1948-1986
(Number in parentheses are t-statistics)

Explanatory Variables	4.7	4.8	4.9	4.10
Constant	0.5533 (10.409)	0.5116 (9.482)	0.4958 (10.098)	0.7379 (13.725)
Variance of x	-12.093 (-2.351)			-16.4445 (-3.441)
Variance of x		-2.6514 (-0.724)		
Mean x				-8.2764 (-3.676)
Mean x^r	-14.6006 (-3.901)	-17.9692 (-4.820)	-19.1624 (-5.755)	
Mean Comp				-0.6683 (-1.542)
Mean Prod	4.0102 (2.215)	4.3326 (2.285)	4.2191 (2.243)	
$\bar{R}^2$	0.4346	0.3827	0.3881	0.4218

Table 4.7 (Continued)

Explanatory Variables	4.11	4.12	4.13
Constant	0.7187 (12.130)	0.5963 (8.825)	0.5455 (7.747)
Variance of x		-13.0642 (-2.499)	
Variance of x	-6.7589 (-1.934)		-3.3289 (-0.880)
Mean x	-10.0636 (-4.371)		
Mean x^r		-13.2402 (-3.337)	-16.8915 (-4.215)
Mean Comp	-0.6796 (-1.462)	-0.4625 (-1.029)	-0.3595 (-0.753)
Mean Prod		4.0952 (2.261)	4.4407 (2.326)
$\overline{R}^2$	0.3407	0.4353	0.3777

industries.

The compensation variable is negatively related to the tradeoff, as predicted by the new-Keynesian model. These results are at best only marginally significant and become almost irrelevant statistically when the productivity measure is included in the same equation. Productivity is positively related to the tradeoff and is statistically significant in all specifications, as predicted by both the new-Keynesian and the price-misperceptions models.

When the mean value for all variables in equation 4.12 are used the average tradeoff is calculated to be .50. When the variance of π is increased by 50%, holding the mean of π at its average across industries, the tradeoff decreases to .47. When the variance of π is decreased by 50%, again holding the mean of π at its average across industries, the tradeoff increases to .53.

The results presented in Table 4.7 continue to provide strong support for the new-Keynesian model and to cast major doubt on the price-misperceptions model. This support comes primarily from the variability of relative price and the mean of relative price. The comp and prod variables offer at best only weak support for the new-Keynesian model and cast only minor doubt on the price-misperceptions model. In spite of this, an interesting finding is that at least the productivity and probably the compensation variable should be included in a properly specified equation attempting to

isolate the determinants of the tradeoff. These results concerning compensation differ considerably from those found by Kandil. Kandil (1991) finds that compensation is positively related to a tradeoff estimated using nominal GNP as the demand variable. (See Chapter 2 for the exact specification) Further, Kandil finds that it is productivity that becomes insignificant when compensation is added to the equation, the exact opposite of what is presented in Table 4.7.

Equation 4.12 is also estimated using the temporally disaggregated data. The results indicate that the comp variable is a more important factor in determining the tradeoff in the post 1972 period. This is probably true because of the pressure wages put on prices in the post 1972 period. These results are presented where 4.12A is the pre-1972 results and 4.12B is the post 1972 results.

In an effort to isolate the reason for the difference between the results presented in Table 4.7 and those found by Kandil, equations 4.7 through 4.13 are re-estimated using the same model used to estimate the tradeoffs except that the demand variable is nominal GNP. These results are presented in Table 4.8.

The results offered in Table 4.8 with respect to compensation and productivity are closer to those presented in Table 4.7 than to those presented by Kandil (1991). This leads one to the conclusion that her results concerning

Table 4.8

Further Determinants of the
Response of Industry Real Output
to Nominal Aggregate Shocks, 1948-1986
(Numbers in parentheses are t-statistics)

Explanatory Variables	4.7	4.8	4.9	4.10
Constant	0.4535 (2.930)	0.3288 (2.324)	0.4825 (3.538)	0.9107 (5.819)
Variance of x	6.1000 (0.407)			12.607 (0.906)
Variance of x		25.6877 (2.676)		
Mean x				-23.798 (-3.629)
Mean x^r	-14.1222 (-1.296)	-23.381 (-2.767)	-11.8211 (-1.017)	
Mean Comp				-0.2862 (-0.227)
Mean Prod	19.638 (3.725)	18.4339 (3.707)	19.5329 (3.738)	
$\overline{R}^2$	0.1803	0.2740	0.1927	0.1620

Table 4.8 (Continued)

Explanatory Variables	4.11	4.12	4.13
Constant	0.7632 (5.072)	0.5261 (2.657)	0.3369 (1.815)
Variance of x		4.4568 (0.291)	
Variance of x	26.8877 (3.029)		25.5265 (2.559)
Mean x	-25.8348 (-4.419)		
Mean x^r		-11.8205 (-1.017)	-23.1252 (-2.189)
Mean Comp	0.0415 (0.035)	-0.7825 (-0.594)	-0.0855 (-0.068)
Mean Prod		19.7621 (3.726)	18.4595 (3.668)
$\bar{R}^2$	0.2728	0.1704	0.2604

compensation and productivity are heavily influenced by her choice of using nominal GNP in estimating the tradeoffs by industry.

Kandil is the first to find it necessary to decompose the demand variable into anticipated and unanticipated portions when estimating the tradeoff. (For a detailed explanation see Chapter 2.) Further, Kandil includes both anticipated and unanticipated energy price shocks in her equation to estimate the tradeoff. Neither of these were found to be necessary by either Lucas and his followers or by BMR, the two primary groups having done studies regarding the tradeoff on an international basis. There seems to be nothing unique about studying the tradeoff on an inter-industry basis that would force such a divergence from the traditional means of estimating the tradeoff. Therefore, the method used by Lucas and BMR is followed in this study.

THE TRADEOFF AND MANUFACTURING INDUSTRIES

In an effort to determine if the most cyclical portion of the economy, manufacturing, behaves differently than the economy as a whole, I now remove all nonmanufacturing industries from the data set. All of the following work will be for manufacturing industries only. There are twenty industries included in this portion of the study.

Table 4.9 presents the results of regressions for equations 4.2 through 4.6 using manufacturing data only. The dependent variable is the tradeoff by industry estimated

Table 4.9

Determinants of the Response
Of Industry Real Output to Nominal
Industry Shocks, Manufacturing Industries; 1948-1986
(Numbers in parentheses are t-statistics)

Explanatory Variables	4.2	4.3	4.4	4.5	4.6
Constant	0.9531 (14.276)	0.6953 (8.984)	0.6911 (12.475)	0.8854 (12.964)	0.6578 (15.451)
Variance of x	-85.3495 (-4.186)			-6.6543 (-3.665)	
Variance of x		8.584 (0.990)			-6.1940 (-1.765)
Mean x			-10.1478 (-2.739)	-6.6543 (-2.194)	-10.6154 (-4.626)
$\bar{R}^2$	0.4524	-0.0010	0.2454	0.5439	0.3270

using industry demand. These results for most independent variables, are not very different from those for the economy as a whole. In fact, the average growth of relative price and the variance of the growth of relative price are both negative and statistically significant for all specifications shown in Table 4.9. Further, equation 4.5 which has both of these variable included explains over fifty percent of the variation of the tradeoff across industries. This adjusted R^2 is larger than any equation presented by BMR in their cross-country study.

The only result which runs counter to the predictions of the new-Keynesian model in Table 4.9 is that the variance of the growth of relative demand is positively related to the tradeoff in one equation, which offers some support to

the price-misperceptions model. This is only weak support, however, because the variable is not statistically significant at any meaningful level when I include the average growth of relative price in either equation. In addition, when the variance of the growth of relative demand is negative and statistically significant the explanatory power of this equation is considerably less than the specification using the variance of the growth of relative price.

ADDING MARKET POWER

In an attempt to address the effects of market power on the tradeoff, various measures of market power have been added to equation 4.5. These measures are available only for manufacturing industries, and the methods used to estimate the measures of market power are detailed in the Appendix. The new-Keynesian model requires the existence of imperfect competition. Because of this, I wish to test the hypothesis that a positive relation exists between the tradeoff by industry and the degree of market power by industry. For a detailed explanation of the reasons for this prediction see Chapter 2.

The results presented in Table 4.10 fall into a large range depending on the measure of market power used in the equation. The only statistically significant coefficient associated with a measure of market power is the CR4 coefficient, and it is negative instead of positive. The

Table 4.10

Determinants of the Response
Of Industry Real Output to Nominal
Industry Shocks, Manufacturing only; 1948-1986
(Numbers in parentheses are t-statistics)

Explanatory Variables	4.51	4.52	4.53	4.54
Constant	0.9214 (5.611)	0.8088 (5.487)	1.0514 (4.317)	1.2727 (7.320)
Variance of $\hat{x}$	-63.382 (-2.752)	-65.6706 (-5.967)	-58.4438 (-2.370)	-79.2693 (-4.461)
Mean x	4.3627 (0.730)	-0.8620 (-0.360)	0.6936 (0.143)	1.8898 (0.507)
Hall	-0.3777 (-1.003)			
DHP		0.5880 (1.652)		
Lebow			-0.3610 (-0.733)	
CR4				-0.0088 (-3.100)
R^2	0.3033	0.7329	0.2968	0.5679

Hall is the measure of market power estimated by Hall (1987).
DHP is the measure of market power estimated by Domowitz, Hubbard, and Petersen (1987).
Lebow is the measure of market power estimated by Lebow (1990).
CR4 is the weighted four firm concentration ratio.

other three measures of market power are all insignificant at the ten percent level and some are positively and some are negatively related to the tradeoff. The only conclusion from these findings is that while it is true the new-Keynesian model requires that imperfect competition exists, there is no systematic relationship between the tradeoff and the level of concentration in an industry. That is, for a

tradeoff to exist, the existence of imperfect competition is sufficient, and the degree of the imperfection is not crucial.

CHAPTER 5

CONCLUSION

This research focuses on an empirical examination of the determinants of the tradeoff between output and prices in U.S. industries. The research is significant in that it offers a test between two competing models: the price-misperceptions model and the new-Keynesian model. The price-misperceptions model offers an explanation of a positive tradeoff that has as its core the variance hypothesis. The variance hypothesis states that the higher the variance of relative price, the more likely firms are to perceive a change in price as a change in relative demand. If the firm perceives a change in price as a change in relative demand, then the firm's optimal response is to change output. On the other hand, if the firm perceives a change in price as a change in economy-wide price, which would be more likely if the variance of economy-wide price is high, then the firm will adjust price and not alter output. Therefore, the price-misperceptions model predicts a positive relation between the tradeoff and the variance of relative price.

The new-Keynesian model offers an explanation of the tradeoff that has at its core the existence of imperfect competition and a menu cost of changing price. In imperfect

competition, the loss to the firm from failure to adjust price in the event of a shift in demand is small. Rigidity of price therefore is near-rational for the firm. Further if there exists a cost of changing price, a fully rational firm will change price only if the gain in profits exceeds the cost of changing price. If all firms change price instantly in the face of any change in demand, then the tradeoff will be zero. If some firms maintain price, due to the menu cost exceeding the gain in profits from changing price, then a positive tradeoff will exist. The new-Keynesian model predicts that the greater the variability of demand in any industry, the more likely the gain in profits to the firm from changing price will exceed the menu cost associated with changing price, and the firm will change price. Therefore, the new-Keynesian model predict that the higher the variance of relative demand, the lower the tradeoff.

The two models also offer different predictions concerning the effect that the mean rate of industry inflation has on the tradeoff. The price-misperceptions model predicts a positive relation between the tradeoff and the mean level of inflation of an industry. The rationale behind this prediction is the that the higher the level of inflation in an industry, the more frequently the firm must determine if the change in price is a change in relative demand or an economy-wide change in price. Because of the

increased frequency of decision making, the number of price changes that are misperceived as changes in relative demand when in fact they are economy-wide changes in price will increase; therefore, the tradeoff will also increase.

The new-Keynesian model predicts that there is a negative relation between the tradeoff and industry inflation. The rationale behind this prediction is that the higher the industry inflation, the further the firm moves from its profit maximizing price if price is maintained. The further the firm is from its profit maximizing price, the greater the loss in profits to the firm because it does not change price; therefore, pressure is being placed on the firm to change price. As a result of this pressure, the frequency of price changes by the firm increases and the tradeoff decreases.

The first step in conducting this study is to estimate the tradeoff by industry. The results of this study are very sensitive to the method used to estimate the tradeoff. The method pioneered in this study uses industry nominal value added as the demand variable in the tradeoff estimation (See Chapter 3). Kandil (1991) uses nominal GNP as the demand variable for all industries when estimating the tradeoff. It is claimed here that the use of industry nominal value added as the demand variable offers some advantages over nominal GNP. First, the use of nominal GNP removes all relative demand factors when estimating the

tradeoff. The use of nominal value added by industry allows changes in relative demand to affect industry output and therefore to affect the tradeoff. As was seen in Chapter 4, this may have a major effect on the results of a study which is intended to isolate the factors which determine the tradeoff. Second, the response of industry demand to a change in nominal GNP may be quite different across industries. If the goal is to come as close as possible to the demand actually faced by the firm, then nominal GNP seems an inferior variable when compared to nominal value added by industry.

The results of Chapter 4 indicate that for regressions with tradeoffs estimated using nominal industry value added as the dependent variable both the variance of the growth of relative price and the mean inflation by industry are statistically significant and negatively related to the tradeoff. These results tend to support the new-Keynesian model and to refute the price-misperceptions model.

However, when the dependent variable is the tradeoff estimated using nominal GNP, as Kandil estimates the tradeoff, the variance of the growth of relative demand is positive and statistically significant. This result supports the price-misperceptions model. In the same specification, the mean level of inflation is negatively related to the tradeoff and statistically significant. This finding supports the new-Keynesian model.

The difference in these results is tied to the difference in variables used to estimate the tradeoff. Since there seems to be theoretical support for estimating the tradeoff using nominal value added by industry, it is these results which receive primary attention. These results support the predictions of the new-Keynesian model and contradict the predictions of the price-misperceptions model. Further, when the variance of the growth of relative price and the mean of industry inflation are included in the same equation, the adjusted R^2 is over 0.4. This indicates that for a cross sectional study the explanatory power of this equation is quite strong.

The results of regression analysis for various other specifications for the determinants of the tradeoff are presented. Temporal disaggregation indicates that the results explained above hold for both the period 1948 to 1972 and for the period 1973 to 1986. In addition, two industry-specific supply variables are added to the independent variables used in equations to isolate the determinants of the tradeoff. These variables are the average growth of compensation per employee and the average growth of productivity per employee.

The two models predict the same relationship between the average growth of productivity per employee. Specifically, a positive relation is predicted. But the models offer differing predictions with respect to the

relation between the tradeoff and the average growth of compensation per employee. The price-misperceptions model predicts a positive relation between the tradeoff and the average growth of compensation per employee. The rationale behind this prediction is that industries that offer high compensation are able to attract additional worker in times of expanding demand; therefore, these industries are able to increase output at a faster rate. The new-Keynesian model predicts a negative relation between the tradeoff and the average growth of compensation per employee. The reason for this prediction is that industries which experience a high level of average growth of compensation per employee have increased incentive to adjust price. This incentive comes from a rising marginal cost curve. As the marginal cost increases, the firm departs from its profit maximizing price if price if maintained; therefore, the greater the average growth of compensation per employee, the greater the incentive to increase the frequency of adjusting price. The increased frequency of adjusting price decreases the tradeoff.

The empirical results support both models' predictions concerning productivity. The coefficient of productivity is positive and statistically significant in all specifications. The coefficient of compensation is negative in all specifications, but is significant only when productivity is not included in the equation. Therefore,

the results concerning the industry-specific supply factors offer some weak evidence in supporting the new-Keynesian model and in contradicting the price-misperceptions model. This evidence comes form the sign on the compensation variable.

The overall conclusion of the evidence presented in this study offers substantial support to the new-Keynesian model. Further, the evidence casts doubt on the predictions made by the price-misperceptions model. These results are based on a cross-industry study of the U.S.. When these results are combined with those of BMR, which are based on a cross-country study, there seems to be an increasing amount of empirical evidence which supports the new-Keynesian model and casts doubt on the price-misperceptions model.

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APPENDIX

APPENDIX

Because the new-Keynesian framework assumes a significant portion of the economy is characterized by less than perfectly competitive markets, market structure and its effect on the tradeoff is central to a new-Keynesian macroeconomics. The new-Keynesian model predicts that the tradeoff and market power measures should vary considerably over the range of market power. In the case of the perfectly competitive firm and the monopoly the tradeoff is expected to be low. This result holds because in both cases there are no impediments to changing price except an explicit cost of changing price. It is market structures which fall in between these two extremes which tend to offer cases where there is an implicit cost to changing price. Specifically, this cost is the possibility of breaking down industry pricing discipline. In Chapter 4 this proposition is tested empirically.

Basic measures of market structure have been developed by industrial organization economists for many years. Three such measures include the Lerner index, the Herfindahl-Hirschman Index (HHI) and the four or eight firm market concentration ratios.

The Lerner index is defined as price minus marginal

cost divided by price. The market concentration ratio is the percentage of total industry sales originated by the leading firms, either the leading four in the case of the four firm concentration ratio or eight in the case of the eight firm concentration ratio. The Lerner index is referred to as a performance oriented approach while the market concentration ratios are referred to as an industry structure approach. Finally, the HHI offers a combination of a performance oriented approach and an industry structure approach. The HHI is calculated by the summing the squared market share of each firm. This method weights more heavily the values for large firms than for small.

The exact measure used between the HHI and the market concentration ratio may be somewhat irrelevant. In support of this argument, Scherer notes that

> ...the correlation between four-firm sales concentration ratios and HHI values published for 437 industries in 1982 was 0.954. An even higher correlation of .992 was obtained when logarithms of the HHI and CR4 (four firm market concentration ratio) values were taken, allowing for the nonlinear relationship...(Scherer 1990, p. 72-73.)

Because of this, the CR4 measure will be used in empirical work in this study requiring one of the two measures.

In 1988, Hall published a new means to estimate market power. In this paper, Hall derived and then applied a new method for testing the equality of price and marginal cost.

It is this equality which defines perfect competition and is always absent in imperfect competition. The specific test, described below, depends crucially on an assumption of constant returns to scale; this is the case because the actual hypothesis tested by this new method is the joint hypothesis of competition and constant returns. Assuming for the moment that decreasing returns to scale is uncommon, this assumption does not invalidate any conclusions of the methods since increasing returns are inherently inconsistent with perfect competition.

Hall states that the "essence of the proposed test is to measure marginal cost as the observed change in cost as output rises or falls from one year to the next. The comparison of movements of inputs with movements in output is at the heart of the calculation." (Hall, p.922) The model will first be developed under the null hypothesis of competition and constant returns. This analysis will then be compared to the alternative hypothesis of market power.

Under the null hypothesis, the firm is assumed to produce output with a production function $\theta F(K,N)$, where K is capital, N is labor and θ is an index of Hicks-neutral technical progress. Nothing is assumed about the capital stock or the firm's investment policy except that the capital stock is chosen prior to a realization of demand and that the pure user cost of capital is zero. This last

assumption is simply assuming that capital wears out over time not with use. Further, the firm is assumed to hire workers in a labor market which is characterized by the fact that the firm can hire additional workers without offering higher wages.

Hall's method makes use of Solow residual technique of estimating the growth rate of productivity. Solow's equation is equation 4A.1 below

$$(4A.1)\ \Delta q_t - \alpha_t \Delta n_t = \theta_t$$

"where Δq is the rate of growth of the output/capital ratio, α is the factor share earned by labor (ratio of compensation wN to total revenue pQ, where w is wages), Δn is the rate of growth of the labor/capital ratio (Δ log[N/K]), and θ is the rate of Hicks-neutral technical progress (Δ log θ)." (Hall, p.923) Solow has recommended estimating the left side of equation (4A.1) in an effort to measure total factor productivity.

The economic value of equation (4A.1) is straightforward according to Hall, "Under competition and constant return, the observed share of labor is an exact measure of the elasticity of the production function." Hall continued, "Once the elasticity is known, the rate of productivity growth can be obtained simply by subtracting the rate of growth of the labor/capital ratio, adjusted by

the elasticity, from the rate of growth of output." (Hall, p.923-24) Solow, using this technique and assuming perfect competition, was able to estimate productivity growth for each separate year. Because the growth rate of productivity is assumed to be comprised of both a long run growth rate, θ, and a random term, u_t, equation (4A.1) becomes

$$(4A.2)\ \Delta q_t - \alpha \Delta n_t = \theta + u_t.$$

Hall then goes on to assert that if a variable Δz_t can be found that is both an important outside determinant of output and employment and is known not to cause shifts in productivity or be influenced by productivity shifts from other sources, then the joint hypothesis of competition and constant returns to scale can be tested. Hall refers to this as his first proposition which states

> Under competition and constant returns to scale, the Solow residual is uncorrelated with all variables known neither to causes of productivity shifts nor to be caused by productivity shifts.
>
> When a convincingly exogenous variable is found to be correlated with the Solow residual, it refutes the joint hypothesis of competition and constant returns....for the case of an instrumental variable Δz that is positively correlated with output and employment, a positive correlation of Δz and the Solow residual is most likely a sign of market power. (Hall, p.924)

Turning to the alternative hypothesis of market power, Hall defines $\mu = p/x$, where p is price, x is marginal cost

defined as wages times the change in labor divided by the change in output, and μ is the markup ratio. Given this, the relationship between these variables can be written in similar form to equation (4A.1). After rearranging terms we have

$$(4A.3)\ \Delta q=\mu\alpha\Delta n.$$

Because in the case of competition μ is equal to one, equations (4A.1) and (4A.3) are identical in this limiting case. In the case of the alternative hypothesis, μ is not limited to a value of one; instead, when market power is present, μ will be greater than one. When the modification of allowing the firm's capital stock to vary over time and for the firm to enjoy technical progress is included equation (4A.3) becomes

$$(4A.4)\ \Delta q=\mu\alpha\Delta n+\theta.$$

According to Hall, equation (4A.4), "expresses the basic idea of the paper" (Hall, p.926) When competition prevails μ is equal to one; marginal cost is equal to price. Since productivity growth is not known but is considered a constant, θ, plus a random disturbance, u_t. The Solow residual under market power is

$$(4A.5)\ \Delta q_t-\alpha\Delta n_t=(\mu_t-1)\alpha\Delta n_t+\theta+u_t.$$

This established Hall's proposition 2

> In the presence of market power, the covariance of an exogenous instrumental variable Δz and the Solow residual is
>
> $$(4A.6)\ cov(\Delta q - \alpha \Delta n_t, \Delta z) = cov[(\mu - 1)\alpha_t \Delta n, \Delta z]\ .$$
>
> ...if the markup ratio, μ_t, is a constant, it is immediately apparent that the covariance will be positive if and only if μ_t exceeds one.[1] (Hall, p.927)

Hall goes on to conclude

> ...the covariance of the Solow residual with the instrument will be close to zero under competition and positive under market power....When productivity rises along with employment in response to an outside force, it is a sign that the firm is not competitive. (Hall, p.928)

The analysis of Hall's work thus far has been limited to his basic model. Since Hall did not limit his work to simply establishing a potential method to estimate markup power, it is now time to review his statistical techniques and report his findings.

Hall's statistical technique was two stage least square estimation with instrumental variables. Hall states of his choice of instruments

> The instrumental variables for the test should

---

[1] Hall goes on to demonstrate that the results shown hold also for cases where μ is variable. See Hall (1988) 927-28 for a detailed explanation.

> cause important movements in employment and output but be uncorrelated with the random fluctuations in productivity growth. Such exogenous variables could operate through product demand or through factor supplies. Lack of correlation with the random element of productivity growth involves two considerations: First, the instrument must not cause movements in productivity, and second, it must not respond to random variations in productivity growth. (Hall, p.932)

Three separate instruments were ultimately chosen by Hall. These variables were military spending, the world oil price and the political party of the president. The political party of the president was included because, "the two political parties have caused differences in rates of expansion of the industries considered here, both, over time and across industries." (Hall, p.933)

The estimation of μ is based upon the assumption of μ be constant is obtained by applying instrumental variable estimation to equation (4A.4). The result is

$$(4A.7)\ \mu = [cov(\Delta q, \Delta z)] / [cov(\alpha \Delta n, \Delta z]\ .$$

The interpretation proposes, "...the result(s) are much enhanced by estimating the reciprocal, $1/\mu$. The reciprocal maps the entire region of values of μ greater than one into the interval from zero to one." (Hall, p.934)

The data Hall uses are all annual data for 26 industries at roughly the two-digit level for the period 1953-1984. In addition, the study includes a seven industry

data set at the one-digit level for the same period. The series used are real value added (in 1982 dollars), net real capital stock, an implicit deflator with indirect business taxes removed, hours of work of all employees, and total compensation divided by the number of workers.

The results of Hall's study can be divided into two sections: those results not assuming constant markups and those assuming constant markups. These results are in tables 4A.1 and 4A.2. Table 4A.1 shows the covariance of each instrument with the Solow residual for the one-digit data set. Table 4A.2 presents the results of the covariance of each instrument with the Solow residual for two-digit industries. Small values are evidence against the null hypothesis of competition and for the alternative hypothesis of market power and increasing returns.

We turn now to the results of primary interest to the study at hand, the estimates of the degree of market power under the assumption of a constant ratio of price to marginal cost. These results are reproduced in tables 4A.3 and 4A.4. According to Hall

> ...the most convenient way to measure the magnitude of market power under the assumption of a constant markup ratio, μ, is to estimate the reciprocal, $1/\mu$, which I will call β. It has the value one under competition and falls short of one to the extent that price exceeds marginal cost....these estimates (contained in tables 4.A3

Table 4A.1

Marginal Significance Levels for One-Digit Industries

Industry	Military Spending	Oil Price	Political Party
Construction	0.327	0.003	0.090
Durable Goods	0.500	0.029	0.357
Nondurable Goods	0.760	0.001	0.256
Transportation and public utilities	0.790	0.009	0.363
Trade	0.270	0.002	0.499
Finance, insurance, and real estate	0.121	0.271	0.198
Services	0.193	0.082	0.430

> and 4A.4) make use of all three instruments together by suing the two-stage least squares estimator. For all seven industries, the estimate of β is significantly less than one, confirming the result of table 4A.1 that the estimates of μ in table 4A.3 range from a little under 2 to a little under 4. That is, of the total value added per unit of sales, only 25-55 percent is marginal cost; the rest is earnings from market power. (Hall, p.939-940)

These results support the new-Keynesian claim that a significant portion of the U.S. economy is characterized by imperfect competition. Hall shows that all seven of the one-digit industries, reproduced in table 4A.1 above, display significant market power. Further, when the more detailed data are used for the 26-industry data set,at least 22 of the 26 industries display market power. Assuming that

Table 4A.2

Marginal Significance Levels: Further Industry Detail

Industry	Military Spending	Oil Price	Political Party
Food and Kindred Products	0.398	0.023	0.265
Tobacco Manufacturers	0.087	0.231	0.366
Textile Mill Products	0.253	0.082	0.170
Apparel and other textile products	0.208	0.614	0.591
Lumber and wood products	0.632	0.250	0.096
Furniture and fixtures	0.043	0.063	0.447
Paper and Allied Products	0.191	0.004	0.271
Printing and publishing	0.068	0.081	0.500
Chemicals and allied products	0.184	0.001	0.291
Petroleum and coal products	0.053	0.001	0.425
Rubber and miscellaneous plastic products	0.285	0.237	0.246
Leather and leather products	0.141	0.494	0.161
Stone, clay and glass products	0.357	0.002	0.379
Primary metals	0.155	0.341	0.221
Fabricated metals	0.265	0.092	0.304
Machinery, except Electrical	0.748	0.065	0.624
Electric and electronic equipment	0.252	0.027	0.038

Industry	Military Spending	Oil Price	Political Party
Instruments and related products	0.478	0.723	0.362
Miscellaneous manufacturing industries	0.452	0.144	0.075
Communication	0.356	0.216	0.674
Electric, gas, and sanitary services	0.440	0.208	0.202
Motor vehicles and equipment	0.369	0.124	0.376
Other transportation Equipment	0.455	0.557	0.669
Transportation	0.022	0.020	0.219
Wholesale Trade	0.270	0.002	0.283
Retail Trade	0.319	0.013	0.596

Table 4A.3

Estimates of Markup Ratio One-Digit Level

Industry	Estimate of Reciprocal, β	Durbin-Watson Statistic	Markup Ratio
Construction	0.455 (0.103)	1.051	2.196
Durable Goods	0.486 (0.111)	1.942	2.058
Nondurable Goods	0.323 (0.102)	2.081	3.096
Transportation and public services	0.313 (0.119)	1.570	3.199
Trade	0.264 (0.109)	1.474	3.791
Finance, insurance and real estate	0.303 (0.167)	1.734	3.300
Services	0.536 (0.187)	1.662	1.864

the new-Keynesian model is correct, that an economy typified by such market power does in fact behave differently than an economy dominated by competition, then there seems to be little doubt that such market power exists, given Hall's evidence.

Domowitz, Hubbard and Petersen (DHP) (1988) offer a second paper using Hall's basic methodology. This methodology deals with measuring price over marginal cost through a new interpretation of the Solow residual. DHP depart from Hall's method in three areas. First, DHP use a

Table 4A.4

Estimates of Markup Ratio: Further Detail

Industry	Estimate of Reciprocal, β	Durbin-Watson Statistic	Markup Ratio
Food and kindred product	0.189 (0.144)	1.301	5.291
Tobacco manufacturers	0.362 (0.388)	1.476	2.766
Textile mill products	1.213 (0.592)	2.384	2.578
Apparel and other textile products	0.555 (0.223)	1.911	0.824
Lumber and wood products	0.555 (0.223)	2.013	1.801
Furniture and fixtures	0.506 (0.118)	1.990	1.977
Paper and allied products	0.269 (0.060)	1.948	3.716
Printing and publishing	0.070 (0.294)	0.961	14.263
Chemicals and allied products	0.050 (0.067)	1.821	20.112
Petroleum and coal products	-0.007 (0.122)	1.432	-139.478
Rubber and miscellaneous plastic products	0.663 (0.249)	2.036	1.508
Leather and leather products	0.476 (0.337)	2.086	2.100
Stone, clay and glass products	0.394 (0.090)	1.885	2.536
Primary metal industries	0.460 (0.100)	2.374	2.172

Industry	Estimate of Reciprocal, β	Durbin-Watson Statistic	Markup Ratio
Fabricated metal products	0.607 (0.232)	2.478	1.649
Machinery, except electrical	0.700 (0.265)	0.992	1.429
Electric and electronic equipment	0.324 (0.175)	2.284	3.086
Instruments and related products	0.716 (0.540)	2.558	1.397
Miscellaneous manufacturing industries	0.223 (0.130)	1.888	4.491
Communication	0.028 (0.998)	1.764	36.313
Electric, gas and sanitary services	0.079 (0.290)	0.389	12.591
Motor vehicles and equipment	0.567 (0.191)	3.218	1.763
Other transportation equipment	1.053 (0.413)	1.679	0.095
Transportation	0.251 (0.196)	2.743	3.976
Wholesale Trade	-0.271 (0.366)	1.076	-3.688
Retail Trade	0.425 (0.109)	2.253	2.355

more disaggregated data set. Specifically, the data set is a panel data set of 284 four-digit S.I.C. manufacturing industries. Second, DHP include materials costs in their calculation of the markup of price over marginal cost. Hall assumed that labor was the only incremental cost of producing output. Finally, DHP examine the possibility that markups vary over the business cycle.[2]

The basic model DHP employ is very similar to that used by Hall. The model's point of departure is equation (4A.8)

$$(4A.8)\ Q_{it}=A_{it}e^{\gamma}K_{it}f(L_{it}/K_{it})$$

where γ represents the rate of Hicks-neutral technical progress and A represents a productivity shock. DHP continue developing the model through equation (4A.9)

$$(4A.9)\ \Delta a=\Delta q_{it}-\alpha_{Lit}\Delta l_{it}-\gamma_{i},$$

where $q=\ln(Q/K)$, $l=\ln(L/K)$, α_L represents the labor share in the value of output, and Δa is the Solow residual. According to DHP

> The Solow derivation assumes that output is valued at marginal cost (MC). Hall's crucial insight is that in the presence of market power, measured total factor productivity (based on the

[2]The variation of markups over the cycle is not of direct interest to the current study and will therefore not be included in the analysis of DHP.

> assumption of perfect competition) will be spuriously procyclical: When firms expand output, they will be able to sell it for more than they pay for the incremental inputs....If price exceeds marginal cost, then the labor share in costs α_{Lt} is equal to $(P/MC)\alpha_L$, where α_L is defined with respect to the value of output (PQ)...(DHP, 1988, p.56)

Given this, DHP modify equation 4A.9 such that

$$(4A.10)\ \Delta q_{it}-\alpha_{Lit}\Delta l_{it}=\gamma_i(1-\beta)+\beta\Delta q_{it}+(1-\beta)\Delta a_{it},$$

where that ratio of price to marginal cost is given by $(1-\beta)_{-1}$. In other words, β is the Learner index.

Equation 4A.10 is very similar to Hall's estimating equation as long as material costs are assumed constant with production.[3] Because this is a very dubious assumption, DHP have developed a model which includes the variation of materials costs when production levels change. Equation (4A.11) is the appropriate equation to be estimated when materials cost vary with output.

$$(4A.11)\ \Delta q_{it}-\alpha_{Lit}\Delta l_{it}-\alpha_{Mit}\Delta m_{it}=\gamma_i(1-\beta^*)+\beta^*\Delta q_{it}+(1-\beta^*)\Delta a_{it}.$$

Where m=ln(M/K) and α_M is the ratio of materials cost to the value of output.

Like Hall, DHP use the instrumental variable technique

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[3]If materials cost do vary with output, then the true markup would be $\beta^*=\beta(1-\alpha_M)$ where α_M is the ratio of materials cost to value of output.

to estimate equation (4A.11). DHP use current and lagged GNP growth, current and lagged rate of growth of real military purchases, and the rate of growth of the relative price of imports as instruments. Table 4A.5 below is reproduced from DHP's paper. According to DHP Table 4A.5 shows

> First, under our assumption that individual productivity shocks are uncorrelated with aggregate fluctuations, the estimated value of the Learner index for all industries on average of about 0.37 indicates that price substantially exceeds marginal cost in U.S. manufacturing. Second, as expected from the inclusion of materials in variable cost, the estimated price-cost margins are significantly lower than the value-added markups studied by Hall. Third, there is little interindustry variation in the estimated price-cost margins among the broad categories in table 4.15--producer and consumer goods, and durable and nondurable goods. (DHP,p.57)

Table 4A.6 is also reproduced from DHP's paper. This table offers estimates of the markup, including materials cost, for 19 two-digit S.I.C industries. The average markup is .359 when the GNP instrument is used and .392 when the military and import price instrument is used. This indicates that regardless of the instrument, the markup greatly exceeds zero. The expected markup if perfect competition existed across these industries would be zero.

Once again, DHP's work, as Hall's work did, demonstrates the existence of imperfect completion in U.S. industries. The DHP results offer additional support to

Table 4A.5

Estimates of Industry Price-Cost Margins

Industry	GNP Instrument		Military and Import Price Instruments		House-man Test
	β^*	R^2	β^*	R^2	
All Industries	0.365 (0.006)	0.877	0.371 (0.009)	0.878	0.76
Producer Goods	0.367 (0.006)	0.882	0.373 (0.009)	0.883	0.81
Consumer Goods	0.360 (0.010)	0.863	0.368 (0.011)	0.864	0.68
Durable Goods	0.380 (0.005)	0.913	0.397 (0.006)	0.919	0.03
Nondurable Goods	0.359 (0.009)	0.865	0.362 (0.012)	0.866	0.89

the new-Keynesian claim that a significant portion of the U.S. economy is characterized by imperfect competition. Assuming that an economy typified by such market power does in fact behave differently than an economy dominated by competition, DHP seem to have shown in Tables 4A.5 and 4A.6 that there is little doubt that there exist sufficient market power in U.S. industries to account for these behavioral differences.

The most recent paper using the method developed by Hall to estimate industry markups is by Lebow (1990). There are two primary areas of interest in Lebow's study. The first is his expanded data set on which Hall's method of

Table 4A.6

Estimates of Industry Price-Cost Margins

Industry	GNP Instrument		Military and Import Price Instruments	
	β^*	R^2	β^*	R^2
Food and kindred products	0.332 (0.025)	0.832	0.344 (0.034)	0.845
Tobacco Products	0.198 (0.068)	0.639	0.372 (0.046)	0.966
Textile Mill Products	0.298 (0.026)	0.836	0.354 (0.034)	0.834
Apparel	0.351 (0.020)	0.859	0.343 (0.026)	0.830
Lumber and Wood Products	0.288 (0.047)	0.858	0.304 (0.052)	0.931
Furniture and Fixtures	0.388 (0.026)	0.940	0.372 (0.025)	0.933
Paper and Allied Products	0.360 (0.009)	0.892	0.374 (0.010)	0.900
Printing and Publishing	0.513 (0.023)	0.920	0.525 (0.029)	0.935
Chemicals and Allied Products	0.379 (0.019)	0.888	0.371 (0.015)	0.902
Petroleum and Coal Products	0.314 (0.018)	0.938	0.335 (0.017)	0.931
Rubber and Miscellaneous Plastic Products	0.402 (0.016)	0.944	0.388 (0.017)	0.942
Leather and Leather Products	0.316 (0.030)	0.889	0.304 (0.020)	0.885
Stone, Clay, and Glass Products	0.428 (0.011)	0.928	0.422 (0.014)	0.919
Primary Metals	0.280 (0.007)	0.890	0.270 (0.008)	0.899

Industry	GNP Instrument		Military and Import Price Instruments	
	β^*	R^2	β^*	R^2
Fabricated Metals	0.373 (0.006)	0.906	0.381 (0.013)	0.914
Machinery, Except Electrical	0.400 (0.006)	0.940	0.405 (0.005)	0.930
Electric Machinery, Electronic Equipment	0.403 (0.008)	0.924	0.419 (0.006)	0.923
Transportation equipment	0.289 (0.014)	0.874	0.320 (0.013)	0.838
Instruments and Related Products	0.508 (0.019)	0.953	0.482 (0.022)	0.956

measuring the markup of price over marginal cost is applied. This data set consists of 446 manufacturing industries. The second is Lebow's estimates of the relationship between the price-marginal cost margin and the covariance of employment and output with real GNP. These two subjects will be considered in turn.

Lebow offers two means of using Hall's method of estimating market power through the use of the Solow residual. The first Lebow estimate is the same as the one estimated by DHP and can be seen in equation (4A.10) above. The second method of estimating price-marginal cost margin is through the use of a translog cost function. With this method, marginal cost is estimated according to the rules of translog cost functions and these estimates enter the price-marginal cost margin. Each of these two different methods along with Hall and DHP's results are show in table 4A.7. As will be seen in chapter 4, each of these estimates will be used in estimations in this paper.

In table 4A.7 Lebow's estimates for both the procyclical productivity measure of markup and the translog cost measure of markup are aggregated to the two-digit S.I.C. level. This aggregation was done through what Lebow refers to as a weighted real value added measure. Lebow notes

Table 4A.7

Estimates of the Price-Marginal Cost Margin

Two-digit Industry	Procyclical Productivity	Translog Cost Function	DHP	Hall
Food and Kindred Products	0.626	0.485	0.332	0.767
Tobacco Products	0.476	0.480	0.198	0.219
Textile Mill Products	0.195	0.289	0.298	0.048
Apparel	0.250	0.279	0.351	0.231
Lumber and Wood Products	0.245	0.184	0.288	0.000
Furniture and Fixtures	0.237	0.234	0.388	0.275
Paper and Allied Products	0.513	0.474	0.360	0.327
Printing and Publishing	0.585	0.516	0.513	0.379
Chemicals and Allied Products	0.704	0.688	0.379	0.705
Petroleum and Coal Products	0.551	0.526	0.314	NA
Rubber and Miscellaneous Products	0.522	0.475	0.402	0.291
Leather and Leather Products	0.424	0.550	0.316	0.371
Stone, Clay and Glass Products	0.422	0.467	0.428	0.448
Primary Metals	0.450	0.377	0.280	0.545
Fabricated Metals	0.438	0.333	0.373	0.281
Machinery, except Electrical	0.517	0.446	0.400	0.281
Electrical Equipment	0.401	0.384	0.403	0.301
Transportation Equipment	0.334	0.304	0.289	0.517
Instruments and Related Products	0.583	0.552	0.508	0.225
Miscellaneous Manufacturing Industries	0.497	0.481	NA	0.342

> My price-marginal cost margin estimates tend to be larger than those of Domowitz et al. and Hall. This difference appears to result from my estimating the price-marginal cost margin at the four-digit industry level, while Domowitz et al. estimate them using a panel of four-digit industries in two-digit subgroups, and Hall carries out the estimation directly on two-digit industries. (Lebow, 1990, p.192)

Lebow also tests the correlation between both of his estimates, the procyclical productivity measure and the translog cost function measure, with each other and with the adjusted concentration ratio. These correlations indicate that the procyclical measure and the translog cost measure are correlated at the .411 level, but the procyclical and translog cost measures are correlated with the adjusted concentration ratio at only .132 and .148 respectively.

In addition to the two additional estimations of the price-marginal cost margin, Lebow's study also offers a methodology and results on examination of the relationship between price-marginal cost margin and the covariance of employment and output with real GNP.

Lebow describes his methodology as follows

> I estimate a single cross-industry equation in which the industry's variability of output or employment (V) is explained by the industry's market power, as well as by other variables thought to be correlated with variability. The dependent variable measures the variability of either employment (the hours of production employees) or production (total industry output). (Lebow, p.179)

The actual equation estimates is

$$(4A.12)\ \Delta \log(series) = a + V\Delta \log GNP,$$

where series is either employment or production.

The results of equation (4A.12) are used in a subsequent regression which includes both of Lebow's measures of market power explained above. An additional measure of market power, the concentration ratio, is also included in these regressions. Also, these regressions are controlled for the magnitude of shocks affecting each industry. Lebow uses "dummy variables to separate durable goods from nondurable and producer goods from consumer goods." (Lebow, p.180) Further, the estimations are controlled also for the size of the industry, the capital intensity of the industry, and the growth rate of total output. This controlled equation was then estimated using instrumental variable estimation.[4]

The results of this estimation offer three interesting results. The first, is "that market power is <u>inversely</u> related to the variability of employment and output..." (Lebow, p.182, emphasis added) Second, the concentration ratio is positively correlated with the variability of production and employment. Lebow, commenting on this result, states, "Since concentration ratios are often

[4]Instrumental variable estimation was necessary here due to potential measurement error problems.

result, states, "Since concentration ratios are often considered to be a measure of market power, as are price-cost margins, the differing correlations of these two variables with employment and output variability are puzzling." (Lebow, p.184) Third, Lebow finds that both the concentration ratio and the price-marginal cost margin are negatively related to the covariance of price and real GNP. Lebow interprets these results as follows

> ...prices are relatively countercyclical in concentrated industries, and this would lead one to predict that output and employment should be more variable in those industries.
>
> The coefficient on PMCM (price-marginal cost margin) is also negative and strongly significant, indicating that industries with higher markups have prices that are more countercyclical. These price results suggest that high markups should be correlated with more variability of output and employment, but as we saw above, the opposite was the case....(Lebow, p.186)

Lebow offers three potential explanations of this paradox. First, there is a possibility that market power is endogenous. In Lebow's words, "it may be that firms in inherently stable industries are more likely to possess market power." (Lebow, p.186) Second, industries with market power "systematically face smaller shocks than do competitive industries." (Lebow, p.186) Third, inventories offer a means to keep price and output constant in the face of fluctuations in demand. Fourth, labor hoarding may make

the price-marginal cost margins a poor measure of market power in the first place. Instead, the price-marginal cost measure of market power may be simply picking up labor hoarding behavior.

Regardless of these explanation, these results offer a substantive area for further research. As is shown in chapter 4, the entire area of market power estimation, particularly those studies that followed Hall's general methodology detailed above, are used as inputs into regression analysis designed to explain the output-inflation tradeoff explained in Chapter 2.

VITA

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