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EVIDENCE ON THE EFFECTS OF PAYROLL TAX CHANGES ON WAGE GROWTH AND PRICE INFLATION: A REVIEW AND RECONCILIATION

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Evidence on the Effects of Payroll Tax Changes on Wage Growth and Price Inflation: A Review and Reconciliation

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The social security payroll tax rate is scheduled to increase by almost one percent each on employees and employers between now and 1990. One of the major elements of the recently adopted social security package was an acceleration of the timing of this increase.[1] A number of economists have recommended that as an anti-inflationary policy scheduled increases be avoided or even that the current rates be rolled back. (See, for example: Crandall, 1978; and the widely adopted macro text, Gordon, 1981.)

The rationale for these proposals is stated by Okun and Perry (1978, p. 13):

> On both empirical and analytical grounds, most economists conclude that payroll taxes levied on _employers_ are passed on to the consumer in the form of higher product prices, just like other elements in the business costs of labor compensation.

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[1]In 1984 the social security (OASDHI) tax rate is 7.0 percent on both employees and employers with a one-year credit of 0.3 percent offsetting the employees' portion. The tax base is the first $37,800 of earned income (the "taxable maximum"). The OASDHI rate is now scheduled to increase to 7.05 percent in 1985, 7.15 percent in 1986, 7.51 percent in 1988, and 7.65 percent in 1990. The taxable maximum will increase each year with the growth in average earnings.

The story is that while employee payroll tax increases reduce net wages, employer tax increases are not shifted backwards to lower nominal wages (or slower growth) due to institutional rigidities. Thus unit labor costs go up and profit margins are maintained by increasing prices. But neither the theory nor the evidence are as clear as Okun and Perry assert.

Most of the theoretical analysis of payroll tax effects does conclude that labor, not capital, bears the tax in <u>real</u> terms (for example: Feldstein, 1974) but does not distinguish between backward shifting via reduced nominal compensation or forward shifting via increased prices. Brittain (1972, p. 44) is very explicit on this:

> Neither this analysis nor the statistical case presented later takes a position in the debate between those who think labor pays the tax and those who think consumers pay it . . .[S]uch a distinction is analytically impossible.

This theoretical ambiguity, or impossibility, means that how payroll tax increases affect wages, prices and profits is an empirical question.

Not only is the empirical evidence on the direction of shift of the employers' share mixed, but all of the macro studies consistent with Okun and Perry's conclusion make an important error in the measurement of the crucial payroll tax variable. This paper develops a corrected measure of payroll tax changes. When that measure is used to reestimate equations based on two of the apparently conflicting studies, the results converge and suggest that a substantial portion of the employer tax is backward shifted. This evidence greatly weakens the payroll tax-inflation link.[2]

EXISTING EVIDENCE

An increase in payroll taxes can result in decreased nominal labor earnings, decreased profits, or increased product prices.[3] Any single equation estimation can isolate only one of these three effects and will not distinguish between the other two. As noted, the classic study by Brittain (1972) analyzed cross-country differences in real wages, but was expressly unable to distinguish between nominal wage differences and price differences. None of the studies which use a real wage measure (e.g. Vroman, 1972; Leuthold, 1972) can be used to get at the crucial inflation issue. Most other authors focus on the effects of payroll tax changes on nominal wages and infer the residual is

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[2]Moreover, when the potential inflationary impact of alternatives to the payroll tax is considered, the prospects for slowing inflation with payroll tax rollbacks become very questionable. Hagens and Hambor (1980) provide a theoretical framework for examining the price and output effects of payroll tax alternatives (income taxes, debt finance, etc.) and then simulate a number of policy substitutions using macro forecasting models. For the inflation potential of the income tax alternative see Auld (1977).

[3]These possibilities are not exhaustive. It is also possible for <u>horizontal</u> shifting to affect wages outside the taxed sector, or wages above the taxable maximum. This can be accomplished by mobility of labor or by other wage-wage links such as the "comparability" studies used to set federal salaries. Shifting to other taxes is also possible, e.g., decreased wages will decrease wage earners' <u>income</u> taxes, or decreased profits will decrease corporate income taxes.

shifted forward to prices--but they cannot rule out an efect on profits.[4] The two recent micro studies of payroll tax effects (Hamermesh, 1979; Neubig, 1980) both have good theoretical underpinnings for their models of wage differences, but offer very inconclusive evidence on the crucial inflation question. Both studies in effect test whether payroll taxes disturb the vertical earnings contours of those below the taxable maximum compared to those above the taxable maximum, and therefore do not capture any across the board backshifting to all labor.

Hamermesh (1979) is a cross-sectional study of hourly earnings differences with respect to an average effective OASDHI tax variable, which is the statutory rate for those below the taxable maximum and the statutory rate times the taxable maximum divided by annual earnings for those above. (See Appendix A.1 for a summary report of the data, specifications, and results of this study.) There are a number of important problems with his method and interpretation. First, all of the variation in his tax measure comes from earnings above the taxable maximum (and the survey questions on earnings and hours worked are used to construct the dependent wage variable). He recognizes the strong possibility for simultaneity bias and accordingly interprets his ordinary

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[4]Unfortunately, the study which does attempt separate estimates of an effect on profits (Baily, 1980) and the two studies which present direct estimates of inflation effects (Frye and Gordon, 1981; and Gordon, 1982) all err in measuring the tax variable as explained below.

least squares estimate of 36% backshifting as an upper bound. Second (Neubig, 1980, p. 38),

> Hamermesh reported his estimates from cross-sectional data as being estimates of long-run parameters. This assumes the existence of an equilibrium state in which individuals have had time to adjust fully to their present status. Large changes in both the tax rate and taxable maximum immediately prior to the period estimated make the assumption of an equilibrium state questionable.

Another problem is his use of wages as opposed to total compensation as the dependent variable. This fails to capture any backshifting via reduced non-wage compensation. (See Neubig, 1980, pp. 36-40 for a thorough critique of the Hamermesh study.)

Neubig (1980) is a longitudinal study of wage changes with respect to changes in the marginal combined employee plus employer OASDHI tax rate (the statutory rate for those below the taxable maximum and zero for those above). (See Appendix A.2.) His choice of marginal as opposed to average payroll tax rates was pragmatic. Even though his theory suggests that both rates affect wage growth, the high colinearity of average and marginal rates (they are identical for those below the earnings maximum) precludes specification of both. Also, his specification includes a separate dummy variable for each year-to-year change period. Thus his method does not capture any economy-wide effects of changes in the payroll tax on average wages. Instead he is only measuring changes in the <u>relative</u> wages of four groups: those who stay below the taxable maximum between adjacent years; those who stay above; those who move below; and, those who move above. Furthermore, most of the variation in his payroll tax measure comes from the move below and move above groups. These are very small and very special groups--those near the taxable maximum, those who change jobs, those who make choices or who are affected by other changes which alter their hours worked or wage rate.[5] If these changes are not captured by other explanatory variables, there is a problem of simultaneous determination of wage change and tax change.

The macro-time series studies of payroll tax effects differ in many ways: periods covered; quarterly versus annual data; sources and construction techniques for the variables; form of the estimating equations. The general

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[5]Those who stay below the taxable maximum have their marginal rate change by the change in the statutory rate (26% of the white males in his sample are in this group). Those who stay above the taxable maximum have a zero marginal rate in both periods and a zero change (61% of his sample). Those who move above the maximum see a decrease from the prior year's statutory rate to the current year's zero (6% of his sample). Those who move below the taxable maximum have an increase from zero to the current year's rate (7% of his sample). Thus fully 61% of his sample (the stay above group) have a zero change in their marginal payroll tax rate. Further, since the statutory tax rate changed only three times in the nine periods studied (+0.8% in 1968-1969, +0.8% in 1970-1971, and +1.3% in 1972-1973) two-thirds of the observations for the next largest group (the stay below group) are also zeros. Thus most of the non-zero changes in marginal payroll tax rates are for those who move above the taxable maximum (with an average change in the marginal payroll tax rate of -10.6%) and those who move below (average change of +10.9%). To emphasize that these may be individuals in very special circumstances, 4% of the sample moved below in the three years when the taxable maximum fell relative to economy-wide wages, and 2% moved above in the three years when the taxable maximum rose relative to economy-wide wages (p. 72).

technique is to add a payroll tax measure to a set of Phillips curve variables and estimate something like:[6] $\dot{\text{Compensation}} = \alpha + \beta\,(\text{Tax } \dot{\text{measure}}) + \gamma\,(\text{Phillips curve variables}) + \varepsilon$. To standardize the presentation of the earlier studies using the notation of the present study, let $\beta = 1$ represent the (Okun-Perry) hypothesis that employer tax changes go fully into increased nominal compensation costs and let $\beta = 0$ represent the competing hypothesis of full backshifting to labor. (See Appendix B.) A summary of the key earlier studies follows.

Perry (1970) is primarily devoted to exploring alternative unemployment measures in wage change equations, but he also includes a tax change variable. (See Appendix A.3.) He uses quarterly data and estimates that compensation is increased by more than the change in taxes ($\beta = 1.4$, s.e. = 0.4). This study finds β significantly different from zero, but, as explained below, Perry mismeasures social security to include all contributions for social insurance.

Gordon (1971) is another study primarily of alternative labor market variables which also includes tax measures. (See Appendix A.4.) He uses quarterly data and estimates that tax increases stay in increased employer costs after one quarter ($\beta = 1.0$, s.e. = 0.3). He dismisses as implausible his unconstrained estimates of lagged effects, then ends up

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[6] The dot notation represents a percentage change:

$$\dot{X} \equiv ((X - X_{-1})/X_{-1}) * 100.$$

constraining his coefficients to sum to full back shift to reduced compensation ($\Sigma\beta = 0$) after 4 quarters. The variable which he calls "social security" includes other contributions for social insurance, and he also makes several other errors in specifying or interpreting tax effects.

Vroman (1974) finds, using quarterly data, a wide range of estimates for alternative variable definitions and alternative lengths of the lag between tax change and wage change. (See Appendix A.5.) For lags of two, three, or four quarters his estimates are around $\beta = 0.7$ (s.e. = 0.4). His tax variable is constructed for the manufacturing sector only, but here again includes all employer contributions for social insurance--not just social security.

Hagens and Hambor (1980) use annual data and estimate substantial backshifting of social security taxes ($\beta = 0.4$, s.e. = 0.3). (See Appendix A.6.) The Hagens-Hambor study is one of those which serve as the basis for the re-estimates presented below.

Halpern and Munnell (1980) use quarterly data and estimate complete backshifting of employer social security taxes after six quarters for both the manufacturing ($\Sigma\beta = -0.8$, s.e. = 0.6) and private nonagricultural ($\Sigma\beta = 0$, s.e. = 0.5) sectors. (See Appendix A.7.)

It is noteworthy that these two studies (Hagens and Hambor, 1980; and Halpern and Munnell, 1980) which find the greatest amount of backshifting are the ones which measure only social security taxes for only the sector corresponding to their dependent variable.

Baily (1980) uses annual data to generate point estimates of almost no backshifting ($\beta = 0.9$, s.e. = 0.9). (See Appendix A.8.) Recall that the other recent study using annual data (Hagens and Hambor, 1980) estimated substantial backshifting. Since the two studies differ in so many respects--tax variable definitions, dependent variable definition and measurement, other variables specified, and sample period--the empirical section of this paper will narrow the sources of difference by using common variable definitions and the same sample period.[7]

Frye and Gordon (1981) present estimates of a reduced form *price* inflation equation using quarterly data. They estimate that after five quarters "half of all changes in the effective tax rate, which includes both employer and employee shares, is shifted forward in prices [p. 291]." (See Appendix A.9.) Since this is a reduced form estimate, the coefficient is not a structural shift estimate but includes the effect of the wage-price spiral. Also, having wages in the denominator of the effective tax rate makes the coefficient particularly sensitive to misspecification of wage

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[7]In their own attempts to explain the divergent results, Bailey points to the simultaneity bias from the contemporaneous price inflation term in Hagens' and Hambor's work, while John Hambor counters (in private conversations) that current price inflation belongs in the structural wage equation and that Baily's estimate of the tax effect is thus a reduced form effect which includes the wage-price multiplier.

change determinants. This might explain why in a follow-up study (Gordon, 1982) which substitutes unemployment variables for the output variables used in Frye and Gordon, the estimated inflationary effects are reduced substantially--the new wage equations have most payroll tax changes passed backwards to reduced wages after five quarters ($\Sigma\beta$ = 0.4, s.e. = 0.6). (See Appendix A.10.) Note that in both these studies what is called "social security" is really the more inclusive "total contributions for social insurance," and that the denominator of the effective tax rate variable does not include employer contributions for social insurance nor other labor income.

THE TAX MEASURE

In most of the macro studies of payroll tax effects the authors are careful to construct or select as a dependent variable an index of hourly compensation which excludes the government sector and usually the farm sector. But Perry (1970), Gordon (1971), Baily (1980), Frye and Gordon (1981), and Gordon (1982) are not as careful in constructing the tax variable. Generally their effective tax rate is the ratio of the National Income Accounts' measures for "Total (or employer only) Contributions for Social Insurance" to "Total Wages, Salaries, and (in some cases) Supplements." There are problems with both the <u>sectors</u> covered and with the <u>types</u> of contributions for social insurance included. The government sector is special because federal civilian employees are not covered by social security,[8] federal military employees were covered starting only in 1957, and state and local employees have optional coverage--options which have changed over time. Similarly, the farm sector is special because of incomplete and changed coverage. The self-employed have had changed coverage and a special rate which has varied between 132 percent and 150 percent of the employee's OASDHI tax rate.[9] Because of these features and because the dependent variable is private, non-farm compensation, I believe that the studies using an all-sectors total contributions ratio tax variable are seriously in error. Accordingly, the tax variable used in this paper is adjusted to remove the government, farm, and self-employed sectors.

I also narrow the types of social insurance contributions to only social security (OASDHI), railroad retirement, and unemployment insurance contributions. Removing the government sector already eliminates the potential problem of treating government civilian employees retirement contributions (federal, state and local) as a payroll tax or as similar in impact to social security taxes. Also excluded in

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[8]Starting in 1984, however, all newly hired federal employees will be covered.

[9]Gordon (1971), Baily (1980), Frye and Gordon (1981), and Gordon (1982) commit the additional error of including the taxes of the self-employed in the numerator of their effective tax rate variable without including the income of the self-employed in the denominator.

the current analysis, but included in the NIA total are workers' compensation paid to government administered funds,[10] veterans life insurance, cash sickness compensation, and supplemental medical insurance.

In the empirical analysis of this paper, private, nonfarm employer contributions for social security are treated separately from unemployment insurance contributions. In any given year social security coverage and rates uniformly apply across firms, but unemployment tax rates vary widely across states and across firms with different experience ratings. These and other differences may lead to different effects on wage growth or price inflation. Also, at issue for policy purposes is the scheduled change in social security tax rates, not unemployment or other contributions for social insurance.

For a number of reasons the authors of the macro time-series studies of payroll tax effects choose an average effective tax rate variable as opposed to the statutory OASDHI rate: this permits the inclusion of other (non-wage) labor income as well as income above the taxable maximum in the effective tax base; in some years the OASDHI statutory tax base is changed--either by increases in the taxable maximum or by changes in the sectoral coverage of social

[10]About 70 percent of total workers' compensation goes to privately-administered funds and is already excluded from the NIA contributions measure (Price, 1980). Also the government-private mix has changed over time.

security; and, there has been little variation over time in the statutory rate. The use of an effective tax rate variable has two important problems. First, this forces the theoretically different effects of rate changes and base changes to be statistically the same.[11] Second, since the denominator of the effective tax rate is closely related to the dependent compensation variable, there is the possibility of simultaneity bias which might be confused with an effect of taxes on compensation. In the empirical work which follows, the statutory OASDHI rate is examined as an alternative to the effective rate.

[11]Increases in the taxable maximum will raise the taxes of high earners only, and since the amount of taxable earnings is used to calculate future benefits, will raise expected benefits for those affected. Increases in tax rates are more of a pure tax since with a given benefit formula there is no change in future benefits. Increases in tax rates should also affect high and low earners differently. For those below the taxable maximum a higher tax rate results in an income loss (at the same number of hours supplied) which should encourage work effort, but a decrease in the net wage which should discourage effort. For those above the taxable maximum there is only the income effect without the opposing substitution effect. This point is made in MacRae and MacRae, (1976).

EMPIRICAL ANALYSIS

This section presents estimates of annual wage growth equations for the 1954-1979 time period using the improved measure of private nonfarm employer payroll tax changes. The robustness of the tax effect estimate is examined by using two different dependent variables and two different forms of the wage growth equation--a price-wage model and a wage-wage model. With a price-wage specification Hagens and Hambor (1980) found substantial backshifting of payroll tax changes. But, Baily (1980), using a wage-wage specification, found little or no backshifting. By running both models with common variable definitions and a common time period, this apparent disagreement can be attributed to the overly inclusive sectoral and contribution-type coverage of Baily's tax variable.

Dependent Variables: The desired dependent variable is an index of private, nonfarm hourly labor compensation. The measure should include non-wage compensation. There are two imperfect approximations for the desired index. The first is the BLS index of private nonfarm wages, salaries and supplements (IWSSNF). Unfortunately this is actually the ratio of one index for total compensation (adjusted for overtime and interindustry shifts) divided by another index for total hours worked (U.S. Department of Labor, 1980, pp. 203-208). The second measure (IAHESNF) starts with the BLS index of adjusted private nonfarm average hourly earnings and then adds in supplements by multiplying by the ratio of aggregate private nonfarm wages, salaries and supplements to aggregate private nonfarm wages and salaries.[12]

Phillips Curve Variables: The price-wage specification includes lagged values of price inflation to represent inflationary expectations. Specifically, the annual rate of inflation in the GNP deflator[13] is lagged one-quarter ($\dot{P}_{-(1/4)}$) and five-quarters ($\dot{P}_{-(5/4)}$).[14]

On the theory that wage setting depends most importantly on recent wage growth in other firms or industries, the wage-wage specification includes two lagged values of the dependent variable. The lagged value of the CPI inflation rate[15] is included measured as a residual from

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[12]The IWSSNF is Baily's (1980) compensation measure, except for a difference in treatment of the self-employed--here excluded. The IAHESNF is similar to the construct of Hagens and Hambor (1980) except that they did not include payroll taxes in the supplements adjustment and thus have a net of tax compensation measure. See Appendix B.

[13]Additional estimates with a CPI inflation measure yielded much the same tax effects as those reported and are not presented.

[14]These are annual rates of inflation calculated to end in the third quarter of the current year and the third quarter of the prior year. In their estimates Hagens and Hambor had the contemporaneous rate of price inflation (and price inflation lagged one year). I believe that specification is particularly prone to simultaneity bias where the current rate of price inflation depends on the current rate of wage growth. The extra one-quarter lag on the price inflation terms is intended to reduce such bias.

[15]Additional estimates with a GNP deflator yielded slightly greater backshifting of payroll taxes but are not presented here.

three years of change in the dependent variable ($R\dot{C}PI_{-1}$).[16]

The unemployment measure in both models is the difference between the aggregate unemployment rate and the natural rate of unemployment ($U-U^N$).[17]

Thus the basic specifications are (with C = compensation index, and t = effective employer tax rate):[18]

$$\dot{C} = \alpha + \beta(1/\dot{(}1-t)) + \lambda_1(U-U^N) + \lambda_2\dot{P}_{-(1/4)} + \lambda_3\dot{P}_{-(5/4)} + \varepsilon$$

$$\dot{C} = \alpha + \beta(1/\dot{(}1-t)) + \lambda_1(U-U^N) + \lambda_2\dot{C}_{-1} + \lambda_3\dot{C}_{-2} + \lambda_4 R\dot{C}PI_{-1} + \varepsilon$$

Tax variables: The tax variables are described in detail elsewhere in the paper. The transformation of the

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[16] For each of the dependent compensation ($\dot{C}$) variables the variable RCPI was obtained as the residual from the regression:

$$\dot{CPI} = a + b\dot{C} + c\dot{C}_{-1} + d\dot{C}_{-2} + R\dot{C}PI$$

Baily (1980, p. 35) justifies this as follows: "[T]he wage-wage feedback process should be given as much scope as possible, with the feedback of prices and wages playing a secondary role....Thus [RCPI] consists of 'wage-purged' changes in the cost of living."

[17] The natural rate of unemployment is that presented in Gordon (1982). A variety of alternative measures and transformations of the unemployment rate did not markedly affect the coefficient of the tax variable and are not presented.

[18] Not included here are dummy variables for the Kennedy-Johnson guidepost period and for the Nixon controls period. Hagens and Hambor (1980) included these variables while Baily (1980) did not. My own preliminary estimates included these variables but the coefficients were always insignificant and frequently changed sign across specifications.

effective tax rate (t) to (1/(1-t)) yields β as an estimate of the fraction by which tax increases raise employer compensation costs. Thus a value of β = 1.0 represents the hypothesis that employer payroll taxes go entirely to increased prices or decreased profits, while a value of β = 0 represents the competing hypothesis of full backshift to labor. (See Appendix B.)

Results: Table 1 presents the tax shift coefficients for several alternative tax variables (rows) for the two basic models and the two dependent variables (columns).

The tax variable in row (1) is the measure of which I am critical--the ratio of total employer contributions for social insurance from all sectors (ECSI) to total wages, salaries and supplements from all sectors (WSS). Note that with this measure payroll tax changes appear to go mostly into increased nominal compensation.

The tax variable in row (2) narrows the types of taxes to only employer contributions for social security (OASDHI, here denoted SS) and railroad retirement (RR), and narrows the sectors covered for both taxes and compensation to private nonfarm (NF). The method for constructing this tax measure is described in Appendix C. Here the point estimates suggest that half or more of employer taxes are shifted backwards.[19] (Appendix D presents the complete equations for

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[19]Estimates (not shown) for social security alone (SSNF), without railroad retirement, resulted in shifting coefficients very similar to those in Table 1.

Table 1: TAX SHIFT COEFFICIENTS FOR EMPLOYER PAYROLL TAXES[a]

	TAX RATE VARIABLE(S)[b]	MODEL AND DEPENDENT VARIABLE[c]			
		PRICE-WAGE		WAGE-WAGE	
		IAHESNF (1)	IWSSNF (2)	IAHESNF (3)	IWSSNF (4)
(1)	ECSI/WSS	.89	.67	.64	1.04
		(.59)	(.54)	(.67)	(.99)
(2)	SSRRNF/WSSNF	.42	.47	-.15	.33
		(.66)	(.60)	(.72)	(1.08)
(3)	SSRRNF/WSSNF	.46	.48	-.10	.37
		(.60)	(.59)	(.70)	(1.10)
	UI/WSSNF	2.27	1.14	1.62	1.14
		(.92)	(.90)	(1.11)	(1.85)
(4)	Statutory OASDHI	.40	-.16	-.28	-.80
		(.61)	(.55)	(.69)	(.97)

[a]Standard errors are shown in parentheses.

[b]In rows (1), (2), and (3) the tax variable in the estimating equations is the annual percentage change in the inverse of one minus the indicated effective tax rate. This yields 1.0 as no backshift and zero as full backshift. See Appendix B Case I. For the statutory tax rate in row (4) the variable in the estimating equations is the annual percentage change in one plus the tax rate. This yields the same value of zero for full backshift but only 0.76 for no backshift. See Appendix B Case IIB.

[c]The basic specifications and compensation indexes are defined in the text. The dependent variables are the annual percentage changes in the indicated compensation indexes.

this tax variable in the four specifications.) Note that with the properly narrowed tax measure the wage-wage model based on Baily (1980) shows even more backshift to reduced nominal compensation than does the price-wage model based on Hagens and Hambor (1980).

In row (3) the effective SSRRNF/WSSNF tax rate variable is accompanied by the effective employer rate of unemployment insurance (plus railroad unemployment insurance) taxes: UI/WSSNF. The large coefficients on the UI variable suggest that nominal compensation goes up by at least the full amount of changes in unemployment insurance rates. Note that the coefficients for the social security plus railroad retirement tax rate (SSRRNF/WSSNF) in row (3) are quite close to those in row (2) which excludes the UI variable.

The difference between the estimated effects of social security taxes and unemployment taxes in row (3) provides one possible explanation for the difference between shifting coefficients in rows (1) and (2). The numerator of the crude NIA ratio (ECSI/WSS) used by most authors may well be pooling social security--with a small effect on compensation--with other contributions, like UI, having much larger effects. Experimentation with other effective tax rates suggests that the difference is also partly attributable to the inclusion of the government and farm sectors in the wages, salaries, and supplements of the denominator.

Row (4) of Table 1 presents the estimated shifting effects of the statutory OASDHI employer payroll tax rate.

This measure indicates even more backshifting than does the effective rate variable in row (2)--considerably more for the IWSSNF dependent variable in columns (2) and (4).[20] This result is important since the statutory OASDHI rate is exactly the variable which would be manipulated in the proposed policy attempt to slow inflation.

Not shown here are a number of specifications which included one and two year lagged values of the tax variable. While the estimates of the same year tax effect continue to show half or more backshifting, the estimates of the lagged effects vary widely in magnitude and sign across the two dependent variables. While these results are puzzling, I believe that since social security tax rate and base changes are announced well in advance, there is strong justification for including only the contemporaneous tax change variable.

CONCLUSION

The relatively large standard errors on tax shift coefficients in Table 1 mean that formal significance tests would reject neither of the competing hypotheses: that changes in the employer's share of social security taxes are

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[20]Equations with an additional variable measuring the growth of the statutory OASDHI taxable maximum base caused the OASDHI rate variable to show slightly more backshifting than row (4). A number of two-stage and instrumental variable specifications with the statutory rate and base used as exogenous predictors of the effective rate yielded similar results.

nominally borne by employers ($\beta = 1.0$), or are borne by employees ($\beta = 0$). But the purpose of this exercise is not to present conclusive evidence of backshifting, rather to invite skepticism of others' results which imply no backshifting. The measure of "social security" used in those studies which showed the least backshifting--the greatest likelihood of tax changes affecting prices--is not social security but the more inclusive "total contributions for social insurance." The total contributions measure is shown here to overstate the amount by which social security tax changes increase nominal compensation. The potential for social security tax rollbacks to slow inflation is thus highly speculative.

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Appendix A.1

Research Summary of Hamermesh (1979)

Title: Daniel S. Hamermesh, "New Estimates of the Incidence of the Payroll Tax," Southern Economic Journal 45:4 (April 1979), pp. 1208-1219.

Data: Micro Cross Section, Michigan Panel Study of Income Dynamics, 1973 (with lagged variables to 1967), White Males Continuously employed.

Dependent Variable: The natural log of hourly earnings (annual earnings divided by hours), does not include supplements.

Tax Variable: The average effective employer's tax rate--the statutory rate for those below the taxable earnings maximum or the maximum tax divided by annual earnings for those above--current and six lagged values.

Other Variables: Intelligence test score; SMSA size dummies; occupation dummies; hours worked; years of experience; years of experience squared.

Results: At most, 36% of employer tax shifted back to reduced wages in the long run. (In the notation of Appendix B: $\Sigma\beta = .64$) But only 5% backshifting was found when predicted earnings were used in the tax variable calculation ($\Sigma\beta = .95$), and no backshifting was found with a maximum likelihood procedure ($\Sigma\beta = 1.0$).

Appendix A.2

Research Summary of Neubig (1980)

Title: Thomas S. Neubig, "The Social Security Payroll Tax Effect on Wage Growth," (Ph.D. dissertation, the University of Michigan, 1980). For a summary see 1981 Proceedings of the National Tax Association - Tax Institute of America, pp. 196-201.

Data: Micro Longitudinal, Michigan Panel Study of Income Dynamics, 1968-1977, private sector male workers (his model was not identified for married women) with 500 hours or more of work in any two adjacent years. a/

Dependent Variable: The first difference of the natural log of hourly earnings (annual earnings divided by hours) in adjacent years, does not include supplements.

Tax Variable: The year-to-year change in the marginal combined (employee plus employer) social security payroll tax rate. The marginal payroll tax rate is the statutory rate for those with earnings below the taxable earnings maximum and zero for those above.

Other Variables: The change in the marginal income tax rate; the fraction of full time hours worked; the fraction of hours worked times the number of years of labor force experience; dummy variables for changes in union status, health status, and residence in the South; and separate dummy variables for each of the year-to-year change periods.

Results: b/ No backshifting of the employer's portion and some (insignificant) evidence of forward shifting of the employee's portion to prices or to capital. For white males he estimates what in the notation of Appendix B is $\beta^* - .5 = .27$ (s.e. = .13). This translates into my $\beta = +1.60$ (s.e. = .27). Qualitatively similar results obtain for black males.

a/ These and other restrictions yield two-thirds of his sample over the taxable maximum in any given year, while for the population of all workers subject to social security taxes more than two-thirds are under the taxable maximum in the same years.

b/ Due to simultaneous determination of changes in wages, hours, and tax rates, he employs a two-stage procedure with the payroll tax and income tax variables predicted in the first stage.

Appendix A.3

Research Summary of Perry (1970)

Title: George L. Perry, "Changing Labor Markets and Inflation," Brookings Papers on Economic Activity 1970:3, pp. 411-448.

Data: Macro Time-Series, Quarterly 1953:1-1968:4.

Dependent Variable: The four-quarter rate of change in private, nonfarm compensation per man hour adjusted for age-sex composition, overtime, and inter-industry shifts.

Tax Variable: The four-quarter rate of change in the inverse of one minus the ratio of employer's contributions for social insurance to total compensation.

Other Variables: Lagged CPI inflation rate; various unemployment measures; a measure of secondary worker employment; dummy variables for Kennedy-Johnson guideposts.

Results: Compensation increases by even more than the increase in employer taxes ($\beta = 1.4$, s.e. = 0.4). (Refer to Appendix B, Case I).

Appendix A.4

Research Summary of Gordon (1971)

Title: Robert J. Gordon, "Inflation in Recession and Recovery," Brooking's Papers on Economic Activity 1971:1, pp. 105-166.

Data: Macro Time-Series, Quarterly 1954:1-1970:4.

Dependent Variable: The quarter-to-quarter rate of change in private nonfarm hourly compensation--an index of "straight-time private nonfarm average hourly earnings adjusted for changes in industry mix" times the ratio of total compensation of employees to wage and salary income.

Tax Variables: The quarter-to-quarter[a/] rate of change in the inverse of one minus the effective employer payroll tax rate--measured as "one-half of federal plus state and local social security tax revenue divided by wage and salary payments."[b/] The quarter-to-quarter rate of change in the inverse of one minus the effective employee payroll plus income tax rate. The employee payroll tax rate is equivalent to the employer rate. The income tax rate is "federal plus state and local tax and nontax payments divided by personal income."[c/]

Other Variables: A variety of alternative measures of excess labor demand; lagged changes in the personal consumption deflator and the difference between the nonfarm private deflator and the personal consumption deflator.

Results: In the current period, all of changes in employer taxes increase compensation ($\beta = 1.0$, s.e. = 0.3).[d/]

a/ This creates a problem in using his results to predict the effects of social security which changes only once a year and only in the first quarter.

b/ There are a number of errors in this measure. His interpretation of the coefficient would require that the denominator include supplements--both employer contributions for social insurance and other (non-wage) labor income. (This means that Gordon's estimates do not correspond exactly to β as defined in Appendix B, Case I.) While he says "social security" he actually uses "total receipts of contributions for social insurance." In addition to the sectoral and contributions type problems with this measure stressed in the body of this paper, this makes his 50% division between employer and personal contributions wrong. Also, the contributions of the self-employed are included in the numerator of the effective tax rate but the income of the self-employed is not in the wages and salaries demominator.

c/ Note that personal tax and nontax payments include property taxes as well as a variety of minor fees. Further note that in addition to wages and salaries, personal income includes transfer payments and property income (other than corporate retentions), but excludes contributions for social insurance.

d/ Unconstrained lags on the employer tax measure yield shifting estimates which sum to more than full backshifting after 5 quarters ($\Sigma\beta = -1.5$) and then no backshifting ($\Sigma\beta = 1.0$) after 14 quarters. Other estimates are constrained to sum to full backshifting after 4 quarters ($\Sigma\beta = 0$).

Appendix A.5

Research Summary of Vroman (1974)

Title: Wayne Vroman, "Employer Payroll Taxes and Money Wage Behavior," Applied Economics 6 (1974), pp. 189-204.

Data: Macro Time-Series, Quarterly 1956:1-1969:4.

Dependent Variables: Four-quarter rates of change in the ratio of total wage and salary payments to total hours in manufacturing, and in a BLS fixed-weight index of production workers straight time hourly earnings. These measures do not include supplements.[a]

Tax Variable: Four-quarter change in hourly manufacturing employer payroll taxes as a percent of lagged hourly wage and salary payments. Derived from an annual tax series allocated quarterly with wages. In alternative specifications this variable is entered contemporaneously and with lags of 1, 2, 3, 4 or 5 quarters.

Other Variables: Four-quarter rate of change in labor income other than wages or employer payroll taxes (with alternative lags like the tax variable); four-quarter rate of change in the CPI lagged one quarter; four-quarter change in after tax corporate profits as percent of owner equity; unemployment rate; guidepost period dummies.

Results: A wide range of estimates. The average of the coefficients for the specifications with tax variable lags of 2 to 4 quarters indicates 30% of employer tax changes shifted back to reduced wage growth. (In the notation of Appendix B, $\beta' = -0.3$ or $\beta = 0.7$, s.e. = 0.4).

a/ The potential for bias and difficulties in interpreting tax shift coefficients are enhanced by the inclusion of other labor income as a right-hand-side variable.

Appendix A.6

Research Summary of Hagens and Hambor (1980)

Title: John Hagens and John Hambor, "The Macroeconomic Effects of a Payroll Tax Rollback," *Eastern Economic Journal* 6:1 (January 1980), pp. 21-32.

Data: Macro *Time-Series*, *Annual* 1954-1976.

Dependent Variable: Percentage change in private nonfarm wages, salaries and supplements *net* of employee and employer payroll taxes (constructed from an index of adjusted private nonfarm wages, and aggregates for wages, salaries, supplements and taxes).

Tax Variable(s): Percentage change in one plus the *combined* (employee plus employer) effective tax rate (both shares divided by private wages salaries and supplements *net* of payroll taxes) current and two lagged values. They have social security taxes and unemployment taxes both together and separately.

Other Variables: The rate of unemployment minus the natural rate of unemployment (to represent demand pressures on wage growth); dummy variables for Kennedy-Johnson guidepost period; dummy variables for Nixon price controls period; the *current* change in the GNP deflator and the lagged change in the GNP deflator.[a]

Results: They estimate substantial backshifting of combined (employee plus employer) tax changes. In the notation of Appendix B this is Case IVB and their shifting coefficients are $\beta^{*\prime}$. After one year they get $\beta^{*\prime} = -.82$ (s.e. = .14) which translates into $\beta = .37$ (s.e. = .29); after two years they get even more backshifting, $\Sigma\beta^{*\prime} = -1.25$ or $\Sigma\beta = -.52$; in the third year there is some unshifting so that $\Sigma\beta^{*\prime} = -.89$ or $\Sigma\beta = .23$.[b]

a/ The specification of a contemporaneous price inflation variable has a potential for simultaneity bias (reverse causation) since current price inflation may in turn depend on current wage growth. The current inflation rate is included as a measure of inflationary expectations brought to the wage setting process, but given the lag in measuring and publishing inflation figures and given the fact that wage setting goes on throughout the year, the use of an end-of--the-year inflation measure is questionable.

b/ Since they use an effective tax rate, the denominator of which is very close to being the dependent variable, the possiblity of a spurious negative correlation--overstating backshift--exists. Two alternative specifications suggest that this bias is not great: when the statutory social security tax rate is used very similar shifting coefficients are obtained; and, when the statutory tax rate and the taxable maximum are used as instruments to predict the effective tax rate similar results are also obtained.

Appendix A.7

Research Summary of Halpern and Munnell (1980)

Title: Janice H. Halpern and Alicia H. Munnell, "The Inflationary Impact of Increases in the Social Security Payroll Tax," New England Economic Review (March/April 1980) pp. 23-34.

Data: Macro Time-Series, Quarterly 1954:1-1978:4.

Dependent Variables: Four-quarter rate of change in wages, salaries and supplements net of employer payroll taxes (constructed from an index of sectoral average hourly earnings and aggregates for wages and salaries and other labor income). Separate series for manufacturing (1954:1-1978:4) and for private nonagricultural sector (1965:1-1978:4).

Tax Variables: Four-quarter rate of change in one plus the effective employer tax rate (constructed) current and five lagged values. The denominator of the tax rate is wages, salaries, and supplements net of employer social insurance contributions. Separate variables for social security taxes and other employer's taxes. Different tax variables corresponding to the manufacturing and private non-agricultural sectors.

Other Variables: The inverse of the unemployment rate; guideposts dummies; Nixon controls dummies; four quarter rate of change in the personal consumption deflator - current and lagged values.

Results: Complete backshifting (or more) of employer tax changes to reduced wage growth after 6 quarters. In the notation of Appendix B this is Case III: for manufacturing $\Sigma\beta' = -1.77$ or $\Sigma\beta = -.77$ (s.e. = .57); for private non-agricultural $\Sigma\beta' = -1.04$ or $\Sigma\beta = -.04$ (s.e. = .54).a/

a/ Even though the specifications are very similar, there are a number of explanations for the fact that Halpern and Munnell estimate more backshifting with quarterly data than do Hagens and Hambor with annual data. First, by allowing only six quarters of lagged tax effects, they truncate the counter-intuitive unshifting which takes place when up to three years are included. Second, the endogeneity bias from having wages in the denominator of the tax variable has to be greater with the increased volatility of quarterly data (especially since the "true" tax rate changes only once a year). Third, the potential for reverse causation bias from using current inflation should be greater with quarterly data. (See text footnotes 7 and 14).

Appendix A.8

Research Summary of Baily (1980)

Title: Martin Neil Baily, "Inflation and Social Security Financing," prepared for the National Commission on Social Security (The Brookings Institution, June 1980).

Data: Macro Times Series, Annual 1954-1978.

Dependent Variable: Rate of change [a] in an index of compensation per hour, inclusive of supplements, for the nonfarm business sector. This is actually the ratio of one index for total compensation (adjusted for overtime and inter-industry changes) divided by another index for total hours worked.

Tax Variables: The rate of change in one plus "the ratio of social insurance taxes paid by employers and the self-employed to total compensation" (p. 39, emphasis supplied).[b]

Other Variables: The natural log of the unemployment rate for adult males; the dependent variable lagged one and two years; the rate of change in the consumer price index lagged one year and measured as a residual from three years of change in the dependent variable (see text footnote 16).

Results: Most all of employer plus self-employed tax changes stay in increased compensation and are not shifted backwards (β = .91, s.e. = .91. See Appendix B, Case IIA). [c]

a/ He uses the first difference in the natural log which is quite close to percentage changes for small changes.

b/ This definition leaves some question as to whether the denominator is net of employer taxes (Cn in the notation of appendix B), but on page 33 his derivation of the shifting coefficient does come from an effective tax rate defined with respect to Cn. Note also that the self-employed taxes are included in the numerator but the income of the self-employed is not included in the denominator of this effective tax rate.

c/ Essentially the same results obtain for specifications which use: the lagged layoff rate instead of the unemployment rate; the statutory payroll tax rate and the taxable maximum as instrumental variables for predicting the tax rate; or average hourly earnings as the dependent variable instead of total compensation. Baily also presents some estimates of the effect of payroll tax changes on the rate of return to capital. When only the current tax change variable is specified, the estimated effect on profits is very close to zero. But when the current and two-lagged values of payroll tax changes are specified, some of his estimates are of a cumulative 50% to 60% negative (though insignificant) effect on profits. While this evidence is mixed and the estimates are imprecise, this does represent a useful and interesting attempt to look past wages and prices to profits for a payroll tax effect.

Appendix A.9

Research Summary of Frye and Gordon (1981)

Title: Jon Frye and Robert J. Gordon, "Government Intervention in the Inflation Process: The Econometrics of 'Self-Inflicted' Wounds," American Economic Review 71:2 (May 1981), pp. 288-294. For a longer version with essentially the same results see Jon Frye and Robert J. Gordon, "The Variance and Acceleration of Inflation in the 1970's: Alternative Explanatory Models and Methods," National Bureau of Economic Research Working Paper No. 551 (September 1980).

Data: Macro Time-Series, Quarterly 1954:2-1980:2.

Dependent Variable: The quarter-to-quarter rate of change in the fixed weight GNP price deflator.

Tax Variables: The quarter-to-quarter rate of change in the inverse of one minus the ratio of total combined (employee plus employer plus self-employed) contributions for social insurance to total wages and salaries (not including supplements)--current and four lagged values.[a/]

Other Variables: Lagged inflation rate; dummy variables for Nixon controls; the ratio of output to "natural" output--as a level and rate of change; a measure of relative food and energy prices; the deviation of productivity from trend; the effective exchange rate; and the effective minimum wage rate.

Results: 54% of increases in combined employee and employer taxes are passed forward as price increase within five quarters ($t=2.98$). This is a reduced form estimate and thus includes the effect of the wage price multiplier and the structural effect on prices. If this were a structural estimate, and if the tax variable were properly specified, and if we assume that there is no effect on profits this estimate would correspond roughly to $\Sigma\beta = 1.0$, in the notation of Appendix B.

a/ The authors' interpretation of the shifting coefficient would require that the tax rate denominator include supplements as well as the income of the self-employed.

Appendix A.10

Research Summary of Gordon (1982)

Title: Robert J. Gordon, "Inflation, Flexibile Exchange Rates and the Natural Rate of Unemployment," in Martin N. Baily (ed.), Workers, Jobs, and Inflation (Washington, D.C.: Brookings Institution, 1982).

Data: Macro Time-Series, Quarterly 1954:2-1980:4.

Dependent Variables: The quarter-to-quarter rate of change in the fixed weight GNP price deflator; the quarter-to-quarter rate of change in the fixed weight average hourly earnings index, this does not include supplements.

Tax Variables: The quarter-to-quarter rate of change in the inverse of one minus the ratio of total combined (employee plus employer plus self-employed) contributions for social insurance to total wages and salaries (not including supplements)--current and four lagged values.a/

Other Variables: Lagged price inflation and/or lagged wage change; weighted unemployment rate - as a level and rate of change (this replaces the ratio of output to "natural" output in the Frye and Gordon study); a measure of relative food and energy prices; the deviation of productivity from trend; the effective exchange rate; the effective minimum wage rate; and dummy variables for Nixon controls.

Results: For his reduced form price inflation equation (identical to Frye and Gordon except for unemployment variables instead of output variables) he gets 27% of increases in combined taxes passed forward. But for his structural price inflation equation (with lagged wages instead of lagged prices) he gets only 13% forward shifting. His wage change equations yield estimates of 27% to 35% backward shifting. None of these estimated shifting coefficients is significantly different from zero. His (proportedly structural) wage change equation yields substantial backward shifting. In the notation of Appendix B, he estimates $\Sigma\beta^* - .5 = -.32$ (s.e. = .27) which translates into $\Sigma\beta = .37$ (s.e. = .56).

a/ Gordon's interpretation of the shifting coefficient would require that the tax rate denominator include supplements as well as the income of the self-employed.

Appendix B

Comparison of Shifting Coefficients

This appendix derives the tax shift coefficient used in the present study (Case I) and then shows how different choices of a denominator for the effective tax rate (Case II), of a dependent variable (Case III), or of a numerator for the effective tax rate (Case IV) can be transformed into the reference case. This is not an exhaustive presentation of all of the mixtures of different choices made in the actual studies which were summarized in Appendix A. This appendix does not derive the shifting coefficients in the two micro studies (Hamermesh, 1979, and Neubig, 1980) nor Vroman (1974) but those authors' own interpretations can be accepted and thus transformed into the reference case.

Let $C = Cn + Tr$

$Cn = W + OLI$

$W = Wn + Te$

where, with all variables measured per unit of labor,

$C \equiv$ gross compensation ("wages, salaries and supplements")

$Tr \equiv$ employer payroll taxes

$Cn \equiv$ compensation net of employer payroll taxes

$W \equiv$ wages and salaries

$OLI \equiv$ other labor income (non-wage compensation)

$Te \equiv$ employee payroll taxes

$Wn \equiv$ wage net of employee payroll taxes

$Tr + OLI \equiv$ "supplements"

Case I: In the present study, the estimating equations are of the form:

$$\dot{C} = \alpha + \beta\ (\dot{1}/(1-t)) + \gamma\ \text{(Phillips curve variables)} + \varepsilon$$

where the effective tax rate is defined as

$$t = Tr/C$$

The coefficient of the tax measure is the partial relationship between the dependent variable and the tax variable:

$$\beta = \partial \dot{C} / \partial\ (\dot{1/(1-t)})$$

Since $C = Cn + Tr$

$$C = Cn + C(Tr/C)$$

$$C = Cn + Ct$$

then $C = Cn(1/(1-t))$

and $\dot{C} = \dot{Cn} + (\dot{1/(1-t)})$

For a given change in Tr and the associated $(\dot{1/(1-t)})$, (and controlling for the other things--Phillips curve variables--which might change C) if workers are made whole (no backshift) all of the change goes to $\dot{C}$, and $\dot{Cn} = 0$, so $\beta = 1$. While if firms are made whole (full backshift) all of the change goes to $\dot{Cn}$, and $\dot{C} = 0$, so $\beta = 0$.

Case IIA: In some of the studies the denominator of the effective tax rate measure is net of employer taxes:

$$t' = Tr / Cn$$

In this case the proper transformation to get a shifting coefficient is $(1 \dot{+} t')$.

Since $\quad C = Cn + Tr$

$$C = Cn + Cn(Tr/Cn)$$

$$C = Cn(1+t')$$

$$\dot{C} = \dot{Cn} + (1\dot{+}t')$$

Because $(1+t')$ is identical to $(1/(1-t))$, with this tax measure the shifting coefficient is again $\beta = 1.0$ for no backshift and $\beta = 0$ for full backshift.

Case IIB: When the statutory tax rate is specified a similar transformation is appropriate. Here define --

$W' \equiv$ taxable wages

$OLI' \equiv$ other labor income plus non-taxable wages

$s \equiv$ statutory employer tax rate $= Tr/W'$

with the other variables previously defined.

Since $\quad C = W' + Tr + OLI'$

then $\quad C = W' + sW' + OLI'$

and $\quad C = W'(1+s) + OLI'$

To translate this into rates of change, define here $\dot{X} \equiv dX/X$.

(In the empirical section of the paper the discrete changes in X are defined in percentage terms, but this continuous definition is more convenient here.)

So $\dot{C} = dC/C = ((1+s)dW' + W'd(1+s) + dOLI')/C$

$$\dot{C} = \frac{(1+s)W'}{C}\dot{W}' + \frac{(1+s)W'}{C}(1\dot{+}s) + \frac{OLI'}{C}\dot{OLI}$$

Here the tax shift coefficient will be

$$\beta'' = \partial\dot{C} / \partial(1\dot{+}s)$$

If for a given tax change there is full backshift then $\dot{C} = 0$ and $\beta'' = 0$. But if workers completely avoid the tax (no backshift) then $\dot{W}' = \dot{OLI}' = 0$ and

$$\beta'' = (1+s)W'/C$$

The average value of (1+s)W'/C for the period from 1954 to 1977 is 0.76.[a]

a/ This is calculated as one plus the statutory OASDHI employers' tax rate times the ratio of non-farm non-government wages and salaries to non-farm non-government wages salaries and supplements from the National Income Accounts times the ratio of taxable wages and salaries to total wages and salaries in covered employment from Social Security Bulletin, Annual Statistical Supplement, 1977-79 (U.S.G.P.O., 1980) p. 85.

Case III: In other studies the dependent variable is net of employer taxes, Cn. Here the tax shift coefficient will be $\beta' = \partial \dot{Cn} / \partial(1 \dot{+} t')$

Since $\dot{Cn} = \dot{C} - (1 \dot{+} t')$ (From above)

then for a given tax change if workers are made whole (no backshift) then $\dot{Cn} = 0$ and $\beta' = 0$. While if $\dot{C} = 0$ (full backshift) then $\beta' = -1$. It follows that $\beta' = \beta - 1$. Related to this are studies which use average hourly earnings (W) as a dependent variable. Here the same (β') is estimated only if any change in Cn is reflected entirely in W and not in other labor income (OLI). But this specification would fail to capture any backshifting via reduced non-wage compensation. Note that since non-wage compensation is not subject to the payroll tax, an increase in the payroll tax rate makes non-wage compensation relatively more atractive for both employer and employee.

Case IV: Another variant is to combine employee and employer taxes and to estimate the combined effect on compensation of changing both. When the tax variable includes only social security and railroad retirement contributions, which have exact parity between employee and employer contributions, then the estimated effects of one share or both shares will differ by roughly a factor of two.

Case IVA: For a model with C as the dependent variable and with

$$t^* = (Te+Tr)/C = 2Tr/C = 2t$$

as the tax rate the appropriate form of the tax variable is $(1/(\dot{1-t^*}))$. The coefficient,

$$\beta^* = \partial\dot{C}/\partial(1/\dot{(}1-t^*))$$

will be equal to 1.0 for no backshift of both shares and zero for full backshift of both shares. The relationship between β^* and β, our reference coefficient for the employer tax share only, is

$$\beta^* = \beta\,\frac{1}{2}\;\frac{(1-2t)}{(1-t)}$$

To see this again define $\dot{X} = dX/X$.

So, $$(1/\dot{(}1-t) = \frac{d(1/(1-t))}{1/(1-t)}$$

(quotient rule) $$= \frac{dt/(1-t)^2}{1/(1-t)}$$

$$= \frac{dt}{1-t}$$

Similarly $$(1/\dot{(}1-2t)) = \frac{2dt}{1-2t}$$

Thus the ratio $$\frac{(1/\dot{(}1-t)}{(1/\dot{(}1-2t)} = \frac{1}{2}\;\frac{(1-2t)}{(1-t)}$$

The average value of the adjustment fraction $\left(\frac{1}{2}\,\frac{(1-2t)}{(1-t)}\right)$ for the 1954 to 1979 sample period is .48.

<u>Case IVB</u>: For a model with $(Wn \dot{+} OLI)$ as the dependent variable and with

$$t^{*\prime} = (Te+Tr)/(Wn+OLI)$$

as the tax rate, the appropriate form of the tax variable is $(1\dot{+}t^{*\prime})$. The coefficient,

$$\beta^{*\prime} = \partial(Wn + \dot{O}LI)/\partial(1\dot{+}t^{*\prime})$$

will be equal to zero for no backshift of <u>both</u> shares and -1.0 for full backshift of both shares. The relationship between $\beta^{*\prime}$ and the previously defined coefficients is

$$\beta^{*\prime} = \beta^{*} - 1 = .48\beta - 1.$$

Appendix C

Tax Variable Construction

The adjustment of the National Income Accounts (NIA) data to remove the government and farm sectors extends a method developed by John Hagens after the publication of his paper with John Hambor (1980) which used various ratios of NIA aggregates to narrow the sectoral coverage of their tax variables. Unpublished Social Security Administration estimates were obtained for OASDHI taxable wages for farm workers, federal civilian employees (a tiny fraction are covered), military members, and state and local government employees. (The federal civilian series starts in 1957, so the 1953-1956 numbers were extrapolated from 1957 as proportions of the corresponding NIA totals for federal civilian wages and salaries.) The total of taxable wages from these sectors is then multiplied by the statutory OASDHI tax rate for each year to yield a dollar tax amount, shown here in column (1) of Table C.1. This amount is then subtracted from the NIA totals for employer OASDHI taxes (column (2)) plus employers' contributions to railroad retirement insurance (column (3)) to yield an amount for private nonfarm social security and railroad retirement taxes (SSRRNF, shown in column (4)). The denominator in the effective tax rate variables is accordingly the NIA total for private nonfarm wages, salaries and supplements (WSSNF, column (5)).

Table C.1

Amounts Used in Tax Variables Construction

(in billions of dollars)

	Farm & Government Employer OASDHI Taxes (Unpublished SSA Data)	Total Employer OASDHI Taxes (NIA)	Total Employer Railroad Retirement Contributions (NIA)	SSRRNF (2)+(3)-(1)	WSSNF=Total Non-Farm Non-Government Wages, Salaries & Supplements (NIA)
	(1)	(2)	(3)	(4)	(5)
1953	0.055	1.882	0.312	2.139	171.337
1954	0.081	2.458	0.294	2.671	169.716
1955	0.145	2.825	0.308	2.989	184.253
1956	0.216	3.043	0.316	3.143	200.252
1957	0.397	3.673	0.304	3.580	210.364
1958	0.463	3.657	0.265	3.459	208.509
1959	0.571	4.556	0.287	4.272	227.539
1960	0.748	5.632	0.297	5.181	239.132
1961	0.728	5.700	0.275	5.247	243.987
1962	0.831	6.262	0.289	5.684	261.229
1963	0.980	7.464	0.287	6.771	274.722
1964	1.047	7.846	0.305	7.104	294.373
1965	1.120	8.330	0.326	7.536	317.611
1966	1.722	12.053	0.363	10.694	350.631
1967	1.878	13.411	0.402	11.935	373.517
1968	2.154	15.243	0.438	13.527	410.740
1969	2.557	17.884	0.464	15.791	453.105
1970	2.768	18.524	0.517	16.273	478.807
1971	3.160	20.621	0.535	17.996	507.799
1972	3.586	23.333	0.567	20.314	560.373
1973	4.515	30.429	0.766	26.680	629.390
1974	5.102	34.566	1.131	30.595	689.913
1975	5.707	36.100	1.124	31.517	723.716
1976	6.145	40.059	1.255	35.169	811.058
1977	6.586	44.253	1.384	39.051	909.133
1978	7.471	51.522	1.456	45.507	1034.880
1979	8.408	60.648	1.671	53.911	1173.270

APPENDIX D

Complete Regression Results for the SSRRNF Tax Variable (Equation numbers correspond to columns in Table 1)

Equation (1), $\bar{R}^2$ = .91, D.W. = 1.70:

$$\dot{\text{IAHESNF}} = \underset{(.27)}{2.28} + \underset{(.66)}{.42}\ (1/(1-(\text{SSRRNF}/\dot{\text{WSSNF}})))$$

$$\underset{(.13)}{-.29}\ (U-U^N) + \underset{(.10)}{.46}\ \dot{P}_{-(1/4)} + \underset{(.12)}{.44}\ \dot{P}_{-(5/4)}$$

Equation (2), $\bar{R}^2$ = .93, D.W. = 2.76:

$$\dot{\text{IWSSNF}} = \underset{(.24)}{2.42} + \underset{(.60)}{.47}\ (1/1(1-(\text{SSRRNF}/\dot{\text{WSSNF}})))$$

$$\underset{(.12)}{-.33}\ (U-U^N) + \underset{(.09)}{.67}\ \dot{P}_{-(1/4)} + \underset{(.11)}{.22}\ \dot{P}_{-(5/4)}$$

Equation (3), $\bar{R}^2$ = .90, D.W. = 2.13:

$$\dot{\text{IAHESNF}} = \underset{(.47)}{-.59}\ \underset{(.72)}{-.15}\ (1/(1-(\text{SSRRNF}/\dot{\text{WSSNF}})))$$

$$\underset{(.13)}{-.59}\ (U-U^N) + \underset{(.15)}{.85}\ \dot{\text{IAHESNF}}_{-1} + \underset{(.17)}{.28}\ \dot{\text{IAHESNF}}_{-2} + \underset{(.11)}{.41}\ \text{RC}\dot{\text{P}}\text{IA}_{-1}$$

Equation (4), $\bar{R}^2$ = .77, D.W. = 2.03:

$$\dot{\text{IWSSNF}} = \underset{(.76)}{-.70} + \underset{(1.08)}{+.33}\ (1/(1-(\text{SSRRNF}/\dot{\text{WSSNF}})))$$

$$\underset{(.21)}{-.71}\ (U-U^N) + \underset{(.17)}{.79}\ \dot{\text{IWSSNF}}_{-1} + \underset{(.18)}{.35}\ \dot{\text{IWSSNF}}_{-2} + \underset{(.23)}{.54}\ \text{RC}\dot{\text{P}}\text{IW}_{-1}$$