TAXATION AND LABOUR SUPPLY: EVIDENCE FROM JAMAICA

by

Dillon Alleyne
Dalleyne@uwimona.edu.Jm

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Introduction

In the light of the reform of tax systems in developing countries in the 1990's the impact of taxation on labour supply has gained considerable importance. In Jamaica, in particular, following the 'supply-side'[1] approach to tax reform, tax rates were reduced with very little empirical evidence about the relationship between taxes and their effects on labour supply. Thus the magnitude of the tax break required to generate a certain level of productivity is unknown. Part of the reason for this lack of information might be due to the proposition that structural unemployment in many developing countries and the growing importance of the informal sector, with global competition, makes the effect of productivity gains due to changes in tax rates a matter of small importance (see Gary Fields, 1987).

The impact may also be assumed small since the taxpaying population may not be able to vary its labour supply significantly. In Jamaica this group would constitute most of the pay as you earn (PAYE) taxpayers. Another reason why this issue has not been investigated is that in many developing countries, there has been a gradual movement from direct to indirect taxes, with indirect taxes contributing to the bulk of revenue and in some countries direct taxes have been abandoned altogether. In the Jamaican case, however, direct taxes have remained an integral part of the tax

[1] See Roy Bahl, "The Political Economy of the Jamaican Tax Reform" In Tax Reform in Developing Countries, Malcolm Gillis (ed) Duke University Press, Durnham, Londom, 1989.

system with the share of direct tax revenue to total revenue ranging from between 36 and 38 percent between fiscal years 1994/95 and 1996/97.

Rochjadi and Leuthold (1994, p.332) point out that due to the lack of suitable cross-sectional labour market data in developing countries, the analysis of the labour supply in developing countries has been largely qualitative [2]. This study is similar to theirs for Indonesia, by applying econometric techniques to a cross-sectional data set to investigate the response of hours worked to the effective tax rate for different income groups. The labour supply elasticity estimates are computed as the expected percentage change in labour supply for a 1% change in the disposable wage rate controlling for gender, area and levels of education. The results suggest that the response of labour supply to taxes is progressive as incomes rise. In addition, the response of females is smaller than that of males which is contrary to the general result that males are less able to vary their labour effort. The elasticity estimates tended to be much higher that that found by Rochjadi and Leuthold(1994) for Indonesia. These results also suggest that the compensated elasticities are sufficiently large to merit further analysis.

This study utilises the special 1993 Survey of Living Conditions (SLC) module which asked respondents about their income from primary and secondary employment, the hours worked and a number of socio economic variables such as age, education and gender. This paper is made up of 5 sections. Section II outlines the model which informs the analysis, Section III describes the data , Section IV reports the results which are compared with other studies and Section V provides a summary and conclusion.

Section II

Following Rochjadi and Leuthold (1994,p.335) the model begins with the assumption that for individuals there is a trade off between the utility of consumption and that of leisure. Individuals however, are constrained by their endowments and the limitation of income which is equal to the sum earned income from primary and secondary jobs. We assume that the second source of income is informal and may not be subject to taxes. Thus there may be a tendency to pursue informal activities when taxes are very high.

The utility function for an individual is assumed to follow the constant elasticity of substitution (CES) form such that,

$$U=(\delta Y^{-\alpha} + (1-\delta)L^{-\alpha})^{-1/\alpha} \ldots\ldots.(1)$$

where δ and α are parameters from the CES function , Y is income, and L is the hours of leisure. The elasticity of substitution between income and leisure , z is a function of α , and is defined as $1/(1+\alpha)$. We assume that $z>0$, which implies that

[2] Studies of this kind represent those by Miracle and Bruce (1970) and Miracle (1976). An early exception is the study by Pranab Bardhan (1979) in which he examined through the tools of econometrics, labour supply behaviour in a poor agrarian economy.

$\alpha > -1$. In the model utility of the individual is maximised subject to the constraint of income and time. The income constraint is,

$$Y = wH + N - T \ldots\ldots\ldots\ldots(2)$$

where w is the standard hourly wage rate, H is hours of market work, N wage income from sources other than main employment and T is the tax liability. The statutory tax rate in Jamaica is proportional but the effective rate is progressive to a point in the income distribution then becomes regressive (See Alleyne, 1992; Bahl, 1992; GOJ Emolument Survey, 1993). Since we are interested in the effective tax rate, this can be approximated by ,

$$T = t(wH + N) \ldots\ldots\ldots\ldots(3)$$

Where t is the individual effective tax rate. Using equation (3), equation (2) can be written as,

$$Y = w(1-t)\,H + N(1-t) \ldots(4)$$

where w(1-t) is the after tax wage W and N(1-t) is the non-primary labour income I. We can write the equation compactly as,

$$Y = WH + I \ldots\ldots\ldots\ldots\ldots\ldots(4a)$$

The time constraint is

$$e = H + L \ldots\ldots\ldots\ldots\ldots\ldots(4b)$$

where e is the total endowment of time in a year. Maximising equation (1) subject to the after tax income (4) and the time endowment (4b), yields after arranging and taking logs,

$$Ln(L/Y) = -z\ln a - z\ln W \ldots\ldots\ldots\ldots(5)$$

Since z is positive, equation (5) states that the leisure-income ratio is negatively related to the parameter ($\delta/1-\delta$), defined as 'a', which is assumed to vary across households reflecting differences in preferences for consumption and leisure, and the disposable wage rate W.

Appendix A shows the derivation of the uncompensated and compensated elasticities of labour supply. The uncompensated elasticity is given as,

$$\varepsilon_{HW} = (za^{-z}W^{1-z}I)\,/(We - a^{-z}W^{1-z}I) - ((1-z)a^{-z}W^{1-z})\,/\,(1+a^{-z}W^{1-z}) \ldots(6)$$

Since the change in income is not controlled for equation (6) is interpreted as the uncompensated elasticity. The sign on (6) is ambiguous unless specific values for each parameter and variable are inserted. The compensated elasticity can be derived by taking the income effect into account and this is given as ,

$$\varepsilon_{HW comp} = \varepsilon_{HW} + (a^{-z}W^{1-z})\,/(1+a^{-z}W^{1-z}) \ldots\ldots\ldots\ldots(7)$$

While the sign on (6) six is ambiguous, the sign on (7) is always positive. These formulas involve parameters that can be estimated from equation (5).

Section III. The Model and Estimation

To estimate equation (5) it is assumed that the utility parameter, a, varies across households (Rochjadi and Leuthold, 1994), thus;

$lna = D_0 + D_{1i}X_i$ ....(8)

where X_i represent various demographic factors such as age, sex, education, area of residence and the number of children less than six years of age in a household. The model was also disaggregated to determine the separate effects of taxes on gender. Substituting (8) into (5) gives the equation to be estimated.

$Ln(L/Y) = B_0 + B_1 Age + B_2 Gender + B_3 Education + B_4 Area + B_5 Child6 + B_6 lnW + u$,....(10)

where $B_0 = -zD_0$, $B_i = -zD_{1i}$, i=1....5, and $B_6 = -z$.

Two problems arise in using OLS to estimate equation (10). The net wage rate which appears as an explanatory variable in the labour supply function is endogenous because it depends on the hours worked and so is correlated with the disturbance term. Wales and Woodland (1979, p.83) argue that this must be accounted for in order to get consistent estimates of the parameters.

The second problem arises because although a person may be observed on a given segment of a piecewise-linear constraint, this is the sum of his utility maximising position plus a random disturbance. Thus for some persons the after tax wage may not be correctly specified especially if the errors are large.

The usual approach to this problem is to treat the budget constraint as piecewise linear and use mathematical programming to solve the optimisation problem. A two step procedure is usually employed, where in the first step the utility maximising segment of the budget constraint is located and in the second the labour supply function is estimated by an appropriate maximum likelihood procedure (See Wales and Woodland, 1979 and Hausman 1981).[3] Rochjadi and Leuthold (1994, p.336), in addressing this problem, pointed out that for the Indonesian model, the correct but more complicated procedure provided elasticities close to the OLS method. Only the OLS method was applied in this initial stage of our analysis.

The data for this analysis was a subsample of the special 1993 SLC data set which had 3078 observations after dropping persons who did not report income.[4] Of these, 1885 were males and 1193 were females. The sample included government employees both from statutory bodies and the civil service and persons from the private sector. Only 196 public sector workers were in the sample.

Table I: Effective Tax Rate by Income Category Group(SJmn)

Income category	Income	Tax Deducted	Effective Tax Rate
S18,408-S24,999.99	407	13	3.2%
S25,000-49,999.99	2,616	182	7.0%
S50,000-74,999.99	2,763	319	11.5%
S75,000-99,999,99	2,017	265	13.1%
S100,000-149,999.99	4,724	708	15.0%
S150,000-199,999.99	3,525	586	16.6%
S200,000-249,999.99	2,491	404	16.9%
S250,000-499,999.99	6,066	1,131	18.6%
S500,000-S999,999.99	3,356	629	18.7%
S1,000,000 or more	1,934	247	12.8%
Total	30,109	4,489	14.9%

Source: Table 5, Emoluments PAYE Survey. Tax Analysis and Statistical Branch of the Revenue Board, 12 Ocean Boulevard, Kingston Jamaica.1993

[3] Wales and Woodland (1979) have carefully outlined this procedure, using Monte carlo simulations to support their analysis.

[4]. Theoretically this may not be correct because there may be systematic factor which explain why some persons are not reporting wages. To drop these persons may imply selectivity bias (See Heckman, 1979)

The SLC survey did not include taxes paid , however, in 1993, a survey of PAYE workers in the private and public sector was conducted [5]and the effective tax rates were computed for various income groups. These effective rates included allowances received and social security contributions paid by workers.

Table I shows the effective marginal tax rates at different income levels.

The tax reform which took place in 1986 was to reduce the number of allowances illegally claimed by taxpayers. The Emoluments Survey (1993,p.9) reports that although there has been a shift away from taxable wages to non-taxable allowances, the tax structure continued to be progressive overall. Thus the effective tax rate rose continuously to 18.7 percent in the income group $500,000-$999,999.99 (Table I).

The table also shows a significant fall in effective rates to 12.8 percent in the highest income group, while the average rate was 14.8 percent. One of the reasons for this decline was that high income employees benefited more from allowances that were not taxed than low income earners.

These are the effective rates as opposed to the statutory rates computed by Rochjadi and Leuthold (1994,p.340) and these rates, better reflect the actual tax burden of each income group. This is particularly important in Jamaica where besides the income tax, there is the education tax and a variety of other taxes and deductions. In additional there is a significant amount of avoidance within the PAYE system and the statutory rate would grossly exaggerate the tax burden (Alleyne 1992, Bahl and Murray, 1986). The tax system in 1993 was proportional at 25% with a threshold level of $18,408.

[5] Government of Jamaica. Emoluments PAYE Survey , 1993. Tax Analysis and Statistical Branch of, The Revenue Board,12 Ocean Boulevard, Kingston, Jamaica.

In the sub sample of households selected, were persons with jobs and those who had jobs but were not working. The overall weekly earnings was $J955.0 dollars with a standard deviation of 1288.8 and the overall weekly hours worked varied by gender. The weekly hours worked for the overall sample was 36 with a standard deviation of 16.1 while hours worked for males and females were 38.1 and 33.7 with standard deviations of 15.4 and 16.9 respectively.

Table II shows the mean weekly earnings by school last attended and there is definitely a link between weekly earnings and school type. Table III shows the distribution of earnings by gender and hours worked. Notwithstanding, the fact that females worked fewer hours the data suggest that males receive on average higher rewards than females hence the rationale for splitting the sample across gender. Average weekly earnings also varied by hours of work as is expected. In Table IV it is noted that average hourly earnings vary by age with the highest hourly wage of $41.8 going to persons in age group 45-49 years.

The dependent variable was computed as the log of the ratio of leisure to after tax income.

Table II: Educational Attainment by Weekly Earnings

Type of School Attended	Mean Weekly Earnings	Cases
Primary	858.9	326
All Age School G1-6	785.1	344
All Age School G7-9	1164.1	820
New Secondary	834.7	823
Comprehensive	1004.1	31
Secondary High	1091.5	229
Technical	1097.4	57
Vocational/Agricultural	1340.4	57
University	3766.0	44
Other post-Secondary	1829.6	109
None	498.9	35

Table III: Weekly Earnings by Gender and Hours of Work

	Mean	cases
Gender:		
Female	829.5	1193
Male	1036.0	1885
Number of Hours of Work per Week		
10-24	403.6	8
25-34	931.9	446
35-44	1026.8	940
44-59	1224.7	747
60+	1696.6	176

Table IV: Age by Average Hourly Earnings

Age group	Mean Hourly Earnings	cases
< 20	18.1	250
20-24	23.4	488
25-29	24.3	450
30-34	32.5	416
35-39	33.5	387
40-44	32.5	278
45-49	41.8	200
50-54	28.8	134
55-59	23.7	123
60-64	23.7	125

Since hours of leisure was not reported, leisure was computed as the annual number of hours available per year minus the hours worked in a year including primary and secondary income sources. This difference was divided by the after tax income which was computed as gross income minus a worker's tax liability.

The hourly wage rate, on the other hand, was computed as gross wage income from primary sources divided by the hours of work to obtain the hourly wage. This was then multiplied by (1-t) to get the after tax wage rate for each individual.

The demographic variables in the data set include age, gender, area and the number of children in a family (Child6) less than six years old. An alternative formulation used experience and the square of experience rather than age to capture non linearities between leisure and experience. The variable education was represented by dummy variables as follows:

Educ1=1 if a person went to a primary or an all age school education and 0 otherwise.

Educ2= 1 if a person went to a New Secondary, Comprehensive or Secondary High School and 0 otherwise.

Edu3=1 if a person had a technical, university or other post secondary training and 0 otherwise.

The omitted category was those who did not report any formal education.

Area and gender were also represented by dummy variables as follows:

Area=1 if Kingston ano St. Andrew and 0 otherwise.

Gender = 1 if male and 0 if female.

Part IV: The Regression and Other Results

The model was first estimated on the entire sample using two separate formulations and then the regressions were run separately for males and females. The results of the OLS estimates are shown in Table V. The table shows that the $\bar{R}^2$ varied between .48 and .53 and the F values are also reported.

Table V: Ordinary Least Squares Estimation Results

Group Area	Constant	Ln W	Age	experne	expSQ	Gender	Educ1	educ2	educ3	Child6	
Overall Sample	1.33	-.85	-.002	-	-	-.244	.06	-.03	-.09	0.17	-.16
t-ratio	(16.8)	(-53.2)	(-2.12)	-	-	(-8.34)	(1.18)	(-.54)	(-1.3)	(1.23)	(-5.14)
Overall Sample	1.39	-.83	-	-.02	.0003	-.243	.06	-.03	-.09	0.15	-.17
t-ratio	(19.4)	(-51.9)	-	(-9.6)	(8.6)	(-8.4)	(1.27)	(-6.0)	(-1.4)	(1.14)	(-5.45)
Male	1.10	-.83	.037	-	-		.03	-.01	-.08	-.003	-.18
	(-2.67)	(-43.2)	(-2.67)	-	-		(.52)	(-.26)	(-.86)	(-.19)	(-4.43)
Female	1.29	-.87	.0002	-	-		.08	-.05	-.09	.04	-.14
t-ratio	(9.54)	(31.19)	(.118)	-	-		(.94)	(-.65)	(-.92)	(2.02)	(-2.8)

$\bar{R}^2$=.51 F=415.7 N=3073,
$\bar{R}^2$=.53 F=390.0 N=3073,
$\bar{R}^2$=.53 F=307.1 N=1883,
$\bar{R}^2$=.48 F=160.8 N=1189

The overall results show that the coefficients of the demographic variables have the expected signs. Older workers and male workers consume less leisure than younger and female workers and age is significant in all cases except for females. Experience and the square of experience are highly significant.

In all cases, the education coefficients are no different from zero at the usual 5% level of significance. In addition, persons with the first category of education consumed more leisure than the other two. Children tend to promote less leisure among men but more in women but only the coefficient for females is significant at the 5% level.

The results also suggest that workers in urban areas consume more leisure than their rural counterparts or persons from other towns. These findings were also consistent with those found made by Rochjadi and Leuthold (1994, p.341) hereafter referred to as RL.

The sign of the coefficient of lnW has the expected negative sign in all cases and is significantly different from zero. The negative of this coefficient provides and estimate of z, defined before as a measure of substitutability between income and leisure. For the two overall formulations the coefficients are z = .85 and .83 respectively. The RL (1994,p.341) study got an estimate of .81 which was not very different. The fact that z is not equal to zero or infinity implies that income and leisure are neither perfect substitutes nor complements. In addition, since z is not equal to one then the CES function does not represent the Cobb Douglas form.

Tables VI-VIII present the results from the uncompensated and compensated elasticities for the overall sample and for males and females respectively. In the case of the overall sample, the uncompensated elasticities varied between -.06 and -.14 except for one income group for which it rose to 6.20, but the observations here were very small. For the RL study, the range was between -.02 and -.06. For the compensated elasticities, the range of our results was between .54 and .85 except for one case of 5.22. In the RL study the range was between .33 to .58.

When the sample was split by gender it was observed that the uncompensated elasticity for males ranged from -.03 to -.16 and for the RL study it ranged from -.02 to -.16. For the compensated elasticity the study found that the range was from .59 to .94 and for developed countries the range was -.08 to .20[6]. In the RL study, the range was between .31 and .55.

For females the compensated elasticity ranged from .49 to 1.05, for developed countries it was -.11 to 2.72 and the RL study found it to be between .37 to 1.22. Clearly, there is similarity of the female results with other studies.

[6] See Hausman (1985); Auerbach and Feldstein (1985) for a discussion of these estimates for developed countries.

The main finding is that the elasticity for males is generally lower than that of females, [7] which is usually the opposite elsewhere. Also the elasticity estimates for males and females show a generally progressive structure as incomes increase.

Section V: Summary and Conclusion

This study sought to assess the impact of taxes on labour supply. The elasticity estimates suggest that the impact is sufficiently large to be studied. The response of females is much larger than their male counterparts. In addition, the impact is much larger at higher income groups across gender. This study focused primarily on workers within the PAYE system and may not have relevance for those workers whose taxes depend on voluntary compliance and whose hours of work are not fixed institutionally. Further work in this area should consider labour supply from the pint of view of the family, even though taxes are levied on an individual basis, in which case the results may be different.

[7] This trend is clearly so at least up to the tax rate of 15%.

Table VI:Estimated Elasticities for the Whole sample

Number of Cases	Marginal tax rate	ε_{HWcomp}	ε_{HW}
1038	0	.54	-.08
1011	7.0	.63	-.10
465	11.5	.69	-.11
200	13.1	.83	-.14
226	15.0	.76	-.12
67	16.6	.85	-.06
30	16.9	.84	-.10
30	18.6	.81	-.14
7	18.7	5.22	6.20
3	12.8	.83	-.14

Table VII. Elasticity Estimates for Males

Number of Cases	Marginal tax rate	ε_{HWcomp}	ε_{HW}
545	0	.59	-.10
662	7.0	.65	-.11
299	11.5	.70	-.12
127	13.1	.79	-.06
153	15.0	.76	-.14
52	16.6	.78	-.14
22	16.9	.85	-.09
16	18.6	.80	-.16
5	18.7	.94	-.03
3	12.8	.81	-.16

Table VIII:Elasicity Estimates for Females

Number of Cases	Marginal tax rate	ε_{HWcomp}	ε_{HW}
493	0	.49	-.07
349	7.0	.59	-.08
166	11.5	.66	-.09
73	13.1	.74	-.10
72	15.0	.75	-.11
15	16.6	1.05	-.14
8	16.9	.81	-.12
14	18.6	.83	-.12
2	18.7	.84	-.12
0	12.8	-	-

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Appendix A

The impact of a change in the disposable wage on hours work can be got by computing the elasticity of hours work with respect to W. Solving (6) for H independently of Y and substituting from (4a) gives,

$$H = (e - a^{-z}W^{-z}I) / (1 + a^{-z}W^{1-z}) \ldots\text{(a)}$$

Hours of work depend on time endowment, the after-tax wage, the nonprimary income level and the utility parameters. Differentiating equation (a) with respect to W and employing the standard elasticity definition $\partial H/\partial W * W/H$ leads to ,

$$\varepsilon_{HW} = (za^{-z}W^{1-z}I) / (We - a^{-z}W^{1-z}I) - ((1-z)a^{-z}W^{1-z}) / (1 + a^{-z}W^{1-z}) \ldots\text{(b)}$$

This is the uncompensated elasticity since income change is not controlled for. The compensated elasticity takes the income effect into account, by taking the elasticity form of the Slutsky equation for hours of work. Thus,

$$\varepsilon_{HWcomp} = \varepsilon_{HW} - W\partial H/\partial I \ldots\ldots\ldots\text{©}$$

Where ε_{HWcomp} is the compensated elasticity of hours worked with respect to wage changes. Differentiating (a) for a change in I and substituting gives,

$$\varepsilon_{HWcomp} = \varepsilon_{HW} + (a^{-z}W^{1-z}) / (1 + a^{-z}W^{1-z}) \ldots\text{(d)}$$

whose sign is positive.