Essay on Labour Supply in Transition Economies

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Abstract

This study highlights the factors that influence individual hours of work decision in five transition economies. Employing the modified Heckman estimation procedure the study finds positive and modest wage elasticities of labour supply in all the countries reviewed. This finding is consistent with stylized fact that those countries which inherited high labor force participation rates are relatively insensitive to changes in the wage rates.

Apart from wages such factors as age, marital status, type of settlement, employee occupation, educational attainment, the presence of children and non-labour income are found to explain significantly labour supply behavior in the countries studied.

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Introduction

Since the mid XX century labour supply has become one of the leading and most visited branches of labour economics. Such persistent interest in studying individual labour supply decision-making process has been fueled by the notion that all working age individuals go through such decision-making and they greatly influence individuals' everyday lives. Research has put forth a variety of approaches for modeling labour supply behavior incorporating numerous factors that affect individuals' and households' labour supply and consumption choices. These factors include, for example, the notion of lifecycle consumption optimization, taxation of income and welfare transfers among others rendering labour supply models more complex and difficult to solve.

The theory has identified three key issues in examining the responses of labour supply to changes in wages (Hindricks and Myles, 2006): (i) potential conflict between income and substitution effects; (ii) complexities of budget constraints emerging as a result of the different tax-and-transfer programs; and, (iii) the impact of labour contracts on labour participation decision. Most of the models seem to converge to the conclusion that the sign of the income effect is ambiguous in contrast to the substitution effect which is always negative. Therefore, the extant theoretical models are inconclusive in predicting the responses of hours of labour supplied to changes in the wage rate[1].

[1] See, for instance, Pencavel (1986), Killingsworth (2000), Blundell and MaCrudy (1999), Cahuc and Zylberberger (2008), to name a few.

Since in practice, each individual faces various tax-and-transfer programs most of the budget constraints are inherently non-convex or possess many kinks. These further complicate the analysis by creating multiple solutions to the individual's decision to supply labour. In cases when the individuals cannot choose the hours of working time freely, that is, when her supply of hours is fixed by the labour contracts, the decision to participate in labour force becomes of particular interest rather than the hours of work supplied. The extant empirical results in labour supply literature for developed and transition economies suggest relatively low sensitivity of labour supply to changes in the wage rates.

This thesis studies the sensitivity of hours of work supplied to changes in the wage rates in five transition economies, namely, Albania, Bulgaria, Serbia, Tajikistan and Uzbekistan. To the best of my knowledge, most of the previous studies in transition economies concentrated on labour force participation decision. Therefore, this study provides new evidence on the labour supply and contributes to forming a more complete picture of labour market processes in transition economies.

The remainder of the thesis is structured as follows: The first chapter (literature review) starts from the discussion of neoclassical static labour supply model extensively used in labour supply literature. Then it is extended by discussion of dynamic model of labour supply for a single individual. This part of the chapter is concluded by providing short overview of recently developed search and matching models of labour supply behavior that are rapidly becoming the workhorse in theoretical and applied research.

The second part of chapter one reviews some of common approaches to modeling labour supply decisions that are applied in empirical studies. This part starts from the discussion of functional forms employed in constructing labour supply functions. Then some of estimation techniques to estimate labour supply function will be discussed. Among those are the instrumental-variable, maximum likelihood and difference-in-difference estimation techniques. The second part is concluded by providing an overview of recent empirical research and its results.

Chapter two provides a methodology for empirical specifications and estimations, as well as the discussion of sample data employed in order to estimate labour supply elasticity during this study. As it will be apparent this study makes use of the Heckman to-step estimation approach (Heckit procedure). The complications, namely sample selection bias, measurement errors in work hours and endogeneity of the wages are encountered and mitigated in the analysis.

Chapter 3 provides findings of a study along with their discussion. The study estimates labour supply functions of five transition economies, namely, Albania, Bulgaria, Serbia, Tajikistan and Uzbekistan.

Chapter 1

Literature Review

Part I

Neoclassical Model of Labour Supply

1.1 Static Labour Supply Model

Labour supply estimates differ greatly across economic studies, depending on the theoretical framework and estimation strategy used. In order to keep this investigation comparable to other findings, both the theoretical model for the labour supply decision and estimation strategy are precisely defined.

The analysis employed in this study is based on principles of partial equilibrium neoclassical model of labour supply which guides most economists' analyses and is extensively discussed by papers of Pencavel (1986), Heckman and Killingsworth (1986), Blundell and MaCurdy (1999). An individual is endowed with fixed block of time H, which can be divided between hours worked in the labour market, h, and hours spent in other activities, l:

$$H = l + h$$

Her demand for leisure is simply what is left over after market sales of h. That is,

$$l = H - h$$

An individual is assumed to possess a well-behaved (quasi-concave, continuous, real-valued) utility function which is defined over her consumption of commodities, C, and her leisure activities, l:

$$U \equiv U[C, (l \equiv H - h), \delta]$$

In this formulation, C, represents a composite commodity and, δ, stands for individual specific characteristics unseen to an economist. The individual derives utility from consumption of commodities and leisure (which is assumed to be a normal good), and disutility from working. Disutility from working is offset by the wage rate that the individual earns and represents the opportunity cost of leisure.

Individual income consists from the wage, w, that she earns by providing her labour supply and a non-labour income, I. This non-labour income includes all income acquired outside of the labour market including investment income, transfer income, and even gains deriving from undeclared or illegal activities. Then the individual's budget constraint is summarized by the following expression:

$$C \leq wh + I$$

That can be alternatively expressed as:

$$C + wl \leq wH + I$$

Expressed in this way we arrive at the standard concepts of the theory of consumer. The right-hand side of the budget constraint includes the full value of individual's endowments - "full income", - which includes the stock of time available and all other sources of income. The individual purchases the consumption goods and leisure with her full income and the wage appears to correspond equally to the price and the opportunity cost of leisure. Let Y denote full income, so that:

$$Y = wH + I$$

Then the individual's utility maximization problem is given by:

$$\max_{\{C,l\}} \; : \; U = U(C, l, \delta) \qquad (1.1)$$
$$s.t. \; : \; C + wl \leq Y$$

The solution of the problem (1.1) results in the following first order conditions:

$$\frac{\partial U(\cdot)}{\partial C} = \mu \qquad \text{and} \qquad \frac{\partial U(\cdot)}{\partial l} = \mu w$$

where μ is a marginal utility of income. The solution involves finding of the optimal hours of consumption, C^*, and leisure, l^*, which solves the following equation:

$$\frac{\partial U(C^*, l^*, \delta)/\partial l}{\partial U(C^*, l^*, \delta)/\partial C} = w \qquad \text{with} \qquad C^* + wl^* = Y^* \qquad (1.2)$$

Figure 1 below shows the graphical illustration of this solution. Line AB represents the individual budget constraint. The distance OB is the full income of the individual and whereas AH shows the non-wage income coming from non-labour market activities. The optimal solution is located at the tangency point, E, of the individual indifference curve and her budget constraint. The slope of the budget line represents the wage, w, offered by the labour market.

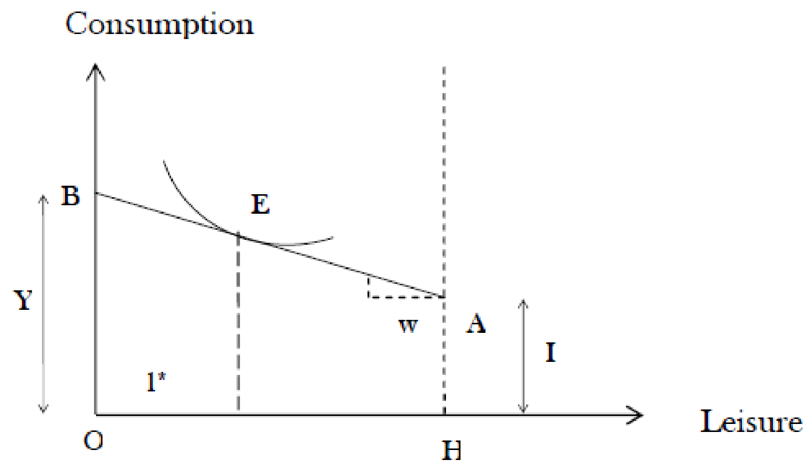

Figure 1. Consumption-leisure tradeoff

Note the following features of Figure 1. For the relation (1.2) to describe the optimal solution to individual's problem point E has to lie to the left of point A where the individual supplies zero hours of work. The individual supplies positive amount of labour hours only if the following condition is satisfied:

$$\left(\frac{\partial U/\partial l}{\partial U/\partial C}\right)_A < w$$

The wage rate such that:

$$-\frac{\partial U(I,H,\delta)/\partial l}{\partial U(I,H,\delta)/\partial C} = w^R$$

is the reservation wage below which the individual will not work and represented by the marginal rate of substitution at point A.

In accordance with the model, the individual reservation wage depends on the shape of the utility function and on non-labour income, I, and determines the conditions for the participation in the labour market. Increases in non-labour income and the condition that leisure is a normal good increase the reservation wage and discourage individual from the entry in the labour market.

The solution of the first-order conditions gives the ordinary demand functions:

$$C^* = C(w, Y, \delta) \quad \text{and} \quad l^* = l(w, Y, \delta)$$

Using the Slutsky equation and the definition of the full income in terms of I we can derive how the demand for leisure changes as the wage rate changes:

$$\frac{\partial l^*}{\partial w} = \frac{\partial l}{\partial w} + \frac{\partial l}{\partial I}(H - l) > 0 \quad \text{iff leisure is a normal good}$$

The Slutsky equation reveals that a change in the demand for leisure as a result of change in wage is the sum of negative and positive terms. Therefore, the result is ambiguous in sign. That is, the change in the wage rate either can increase or reduce the supply of labour (Varian, 1992). More specifically, an increase in the wage rate increases the supply of labour since leisure becomes more expensive. At the same time, since the increase in wage makes the individual more rich, she can increase her demand for leisure. Hence the sign of the income effect is positive. This result makes the response of the labour supply to changes in the wage rate ambiguous.

Alternatively, the model can be a bit modified in order to derive the Slutsky equation in terms of elasticities. Using the definition of the hours of work supplied, $h = H - l$, along with the definition of the full income in terms of I to derive the labour supply function:

$$h^* = h(w, I, \delta)$$

Substituting labour supply function into the Slutsky equation we obtain the responsiveness of the ordinary labour supply function to the changes in the wage rate:

$$\frac{\partial h^*}{\partial w} = \frac{\partial h}{\partial w} + \frac{\partial h}{\partial I} h$$

Multiplying the Slutsky equation through by w/h and the last term by I/I we obtain:

$$\frac{\partial h^*}{\partial w}\frac{w}{h} = \frac{\partial h}{\partial w}\frac{w}{h} + \frac{\partial h}{\partial I} h \frac{w}{h}\frac{I}{I} \Longrightarrow \eta_w^{h^*} = \eta_w^C + \eta_w^U \left(\frac{wh}{I}\right)$$

Hence, the wage elasticity of the ordinary supply of labour, $\eta_w^{h^*}$, equals the wage elasticity of the compensated labour supply, $\eta_w^{h^*}$, plus the corresponding elasticity of the non-compensated labour supply, η_w^U, multiplied by the proportion of total earnings relative to non-labour income, wh/I. That is, the Slutsky equation shows that the wage elasticity of the labour supply is to be interpreted as the sum of two effects. The substitution effect, represented by the wage elasticity of compensated labour supply and income effect, represented by the term, $\eta_w^U(wh/I)$. Note that the substitution effect is necessarily negative as opposed to the income effect which is positive if leisure is a normal good. This confirms the result that income and substitution effect operate in the opposite directions.

Supplementary issues: complex budget constraints and hours-choice constraint

The canonical model presented above leaves out many elements of the reality that may play an important part in the decision to supply labour. For instance, the presence of income taxes (mainly progressive) and the differences between the remuneration for the overtime and normal hours make the individual budget constraint piecewise linear rather than linear as shown above. Since in practice, each individual faces various tax-and-transfer programs most of the budget constraints are inherently non-convex or possess many kinks. These further may complicate the analysis by creating multiple solutions to the individual's decision to supply labour. There are two common approaches to solve the problem of non-linearity of the budget constraints which are associated with the construction of the piecewise linear approximations and differentiable relations. The principle of the piecewise linear approximation lies in the construction of the piecewise linear function that recounts the brackets making up tax schedules. The construction of the smooth differentiable relations allows summarizing the tax rates implied by bracketed schedules. The construction of the piecewise-linear functions is well illustrated by Hausman's (1983) paper on labour supply with taxes. For the construction of differentiable relations see paper of MaCurdy (1990).

Another element that may alter the foregoing discussion comes from a relative absence of freedom of choice in the number of hours worked. The model does not assume that some individual's may face quantity restrictions in labour supply in a sense, that the provision of the optimal hours of labour may not be possible for some reasons. In reality, the amount of working hours supplied is fixed by the contractual agreements between the employer and employee. This can be explained by the fact, that firms provide a sort of insurance to the workers, who are risk averse, by stabilizing the wages. More specifically, when the workers are more risk averse than firms and have limited access to financial markets, firms may be in a position to partly insure them against income fluctuations (Blanchard and Fischer, 1989). Hence labour contracts usually specify the wage to be paid as well as the minimum requirements of working hours supplied for one year ahead. Then, it is inappropriate to analyze how the amount of hours of work supplied will change as the marginal wage changes, since in this case, the individual is confronted with the decision to participate in the labour force at all. Since higher wage implies lower benefits, those individual's which actively participate in the government transfer programs and receive large benefits may decide not to join workforce if the wages are decreased. In this case there is no conflict between income and substitution effect and the reduction in wages strictly reduces the participation in the labour force (Hindricks and Myles, 2006). From empirical standpoint this result has a certain importance, since it implies that global labour supply maybe very sensitive to changes in wages even if the labour supply at the intensive margin is not. Indeed, as empirical literature suggests the elasticity of labour supply is slight but the participation decision is extremely sensitive to changes in various incentives, especially fiscal ones, which suppliers are faced with. This point was emphasized by Heckman (1993), who noted that global labour supply behavior may follow the fluctuations in the participation rate, rather than hours of work.

Some issues are worth considering further. First of all, it is essential that the results provided by the theory will vary across various groups of agents if one attempts to apply empirical analysis. That is, it is important to acknowledge that the responses across females and males, moreover, married and non-married will be different.

Secondly, the standard model of labour supply illustrates how a single individual will respond to changes in wages. However, in order for the model to be more realistic, one can adapt it for the case of household rather than a single consumer. In this case, the household model may contain more than one family worker. This further will facilitate the analysis, by creating additional income effects, and may result in the different conclusions with regard to the decision to supply labour as wage changes. See the analysis of the household labour supply with more than one income earner in Aarson and French (2002), Blundell and Walker (1982, 1986), Blundlell and MaCrudy (1999), Blundell,Walker and Bourguignon (1988), Donni (2000), Haan and Uhlendorff(2007), Hausman and Ruud (1984), Looney and Singhal (2005), and Sickles and Yazbeck (1998).

Finally, the one has to bear in mind that some factors as fixed costs (such as child-care, transportation costs and the presence of the dependent relatives) have a direct impact on labour supply and labour participation of the individual. Fixed costs of work influence the trade-off between work and non-work and reduce the effectiveness of wage increases at the point of participation or at low hours as an encouragement to work (Blundell, 1992). The presence of fixed costs means that labour market participation of those for whom the fixed cost is sunk is likely to be decided on rather differently from participant's choices over increasing or decreasing hours of work.

Finally, static model can be modified to include dynamics. In this case the intertemporal choice and the effect of savings in creating further income effects may become of importance. The last point needs to be developed further and its discussion is given below.

1.2 Life Cycle Model of Labour Supply

Realization of the fact that in making labour supply decisions individuals take into account their future needs has led to development of the lifecycle labour supply models. From the early years of the independent life, individuals make plans for their entire life for purposes of income-smoothing and insurance purposes. They attend schools early in life in expectation of higher pays in future; accumulate savings while in the labour force in order to be able to sustain themselves or their dependents when they are out of work.

The dynamic model of labour supply has been paid a lot of attention for the last 30 years and has been discussed by an array of papers. It seems that Lucas and Rapping (1970) were the first authors to use an explicit dynamic model in order to explain the short- and long-run fluctuations in labour supply (Card, 1990). Currently, the dynamic model of labour supply can be found in papers of Blundell(1990), Blundlell and MaCrudy (1999), Browning, Deaton and Irish (1985), Card (1990), Heckman (1974), MaCurdy (1983, 1985, 1990), Pencavel (1986), Zillak and Kneisner (1999, 2004).

The dynamic model of labour supply can be described in two ways. The first approach uses the discrete-time version of the individual labour supply. In the second case, it is the continuous[1].

Basic setting

Let us assume that an individual lives for two periods t and $t+1$ and he has no initial wealth. Moreover, the individual faces no uncertainty about the future wages and interest rate. For simplicity, we may assume that the individual preferences over consumption and labour supply in two periods are represented by the logarithmic utility function of the following form:

$$
\begin{aligned}
U &= \sum_{t=1}^{2} e^{-\rho t} U(C_t, h_t) = \ln C_1 + b \ln (H - l_1) + e^{-\rho t} \left[\ln C_2 + b \ln (H - l_2)\right] = \\
&= \ln C_1 + b \ln h_1 + e^{-\rho t} \left[\ln C_2 + b \ln h_2\right] \qquad (1.3)
\end{aligned}
$$

[1] The continuous version of the intertemporal labour supply is mostly given by the papers on Real Business Cycle models developed by Kydland and Prescott (1982), Long and Plosser (1983), Prescott (1986), and papers of Hall (1971, 1981), Barro (1981), Aschauer (1988) , and Baxter and King (1993) who studied the effects of fiscal policy on an optimizing equilibrium framework. In order to discuss the major results of the models mentioned above, one has to discuss the whole general equilibrium framework, which goes beyond the discussions of the current paper. Therefore, the full continuous-time version of the intertemporal labour supply is not included here.

where C_1, C_2 represent consumption in the first and second period, respectively; $(H - l_1)$, $(H - l_2)$, labour supply in the first and the second period, respectively; ρ is the individual's discount rate. The individual's intertemporal budget constraint is given by:

$$C_1 + \frac{1}{(1+r)}C_2 = w_1h_1 + \frac{1}{(1+r)}w_2h_2 \qquad (1.4)$$

where r is the interest rate. The individual's problem is then summarized by:

$$\begin{aligned} \max_{\{C_1,C_2,h_1,h_2\}} &: \sum_{t=1}^{2} e^{-\rho t}U(C_t, h_t) \\ s.t. &: C_1 + \frac{1}{(1+r)}C_2 = w_1h_1 + \frac{1}{(1+r)}w_2h_2 \end{aligned}$$

The first-order conditions are given by:

$$\frac{1}{C_1} = \lambda \quad \text{and} \quad \frac{e^{-\rho t}}{C_2} = \frac{1}{1+r} \qquad (1.5)$$

$$-\frac{b}{h_1} = \lambda W_1 \quad \text{and} \quad -\frac{e^{-\rho t}}{h_2} = \frac{1}{1+r}\lambda W_2 \qquad (1.6)$$

Since we are interested in the changes of the labour supply we will pay attention only to the first-order conditions (6). Equalizing both conditions to each other via λ we obtain the following result:

$$-\frac{b}{h_1W_1} = -\frac{be^{-\rho t}(1+r)}{h_2W_2} \Longrightarrow \frac{h_1}{h_2} = \frac{1}{e^{-\rho t}(1+r)}\frac{W_2}{W_1} \qquad (1.7)$$

The equation (1.7) shows one of the key results of the intertemporal labour supply – intertemporal substitution in labour supply. According to the equation (1.7), if the wage rate in period t rises relative to the wage rate in period $t+1$, the individual will respond by increasing the labour supply in the first period relative to the second period. Since we have adopted logarithmic functional form, the elasticity of substitution between leisure in two periods is equal to 1.

Additional implications of the equation (1.7) state, that as the interest rate rises, the first-period labour supply rises relative to the second period labour supply. This is quite simple to infer, since a rise in the interest rate attracts working more today and saving relative to working tomorrow.

Dynamic labour supply model under certainty

Construction of the lifecycle models depend on how future is viewed in terms of certainty of the wages and the other types of income. One approach is to assume that the consumers can perfectly control the level of their lifetime wealth, implying that they are certain about their future and they know what they are going to do and how much income they will make.

Generally, a dynamic model of labour supply, starting in the period t, is characterized by the time-separable utility function defined over the consumption, C_t, and hours of labour supply, h_t, of the individual in each of a sequence of periods $t = 1, 2, \ldots$:

$$U = \sum_{t=1}^{\tau} \beta_t U(C_t, h_t, x_t) \qquad (1.8)$$

where, C_t, denotes a Hicks' composite commodity of all market goods, h_t, is hours of work, and x_t is a vector of tastes shifter variables at age t. The individual discounts the future utility by using the appropriate rate of time preference, ρ. Hence the corresponding time discounting is given by $\beta \equiv (1+\rho)^{-1}$. It is assumed that the individual faces the inter-temporal budget constraint of the following form:

$$A_{t+1} = (1 + r_{t+1})(A_t + w_t h_t - C_t) \qquad (1.9)$$

where A_{t+1} represents the real value of assets of the individual at the beginning of period $t+1$; r_{t+1} is the real rate of return between the period t and $t+1$; w_t is the real wage rate at period t.

An alternative way to the see the individual's budget constraint is to assume that at the beginning of each period t, the individual possesses some initial stock of assets A_t^0. Moreover, at the end of the same period the individual is left with the stock of assets A_t^*. The individual's saving function is represented by the difference:

$$S_t \equiv A_t^* - A_t^0 = w_t h_t - C_t \qquad (1.10)$$

Equation (1.10) represents the individual's period t budget constraint, which says that savings, S_t, must equal labour earnings, $w_t h_t$, minus the expenditure on goods, C_t.

Assuming that each dollar of assets held at the end of period t earns a rate of interest equal to r_{t+1} at the beginning of period $t+1$, property income earned on assets equals:

$$Y_{t+1} = r_{t+1} + A_t^* \qquad (1.11)$$

So the problem of the consumer can be summarized by the functional equation formulation of the dynamic programming. So an individual chooses the labour supply, consumption, and assets $(A_t^*, A_{t+1}^*, \ldots)$ according to the value function:

$$V(A_t^*, t) = \max_{\{C_t, h_t, A_t^*\}} [U(C_t, h_t, x_t) + \beta V(A_{t+1}, t+1) \qquad (1.12)$$

subject to the budget constraint (1.10) and the first-order difference equations:

$$\begin{aligned} S_t &\equiv A_t^* - A_t^0 = w_t h_t - C_t \\ A_{t+1} &\equiv (1 + r_{t+1}) A_t^* \end{aligned} \qquad (1.13)$$

Note that expression (1.13) indicates that the endowment of tangible wealth in assets at the beginning of period $t+1$ equals the wealth held at the end of period t, plus property income earned at the beginning of period $t+1$.

The first-order conditions are given by:

$$\frac{\partial U_t}{\partial C_t} = \lambda_t \qquad (1.14)$$

$$-\frac{\partial U_t}{\partial h_t} = \lambda_t w_t \qquad (1.15)$$

$$\lambda_t = \beta(1 + r_{t+1})\lambda_{t+1} \qquad (1.16)$$

where the equations (1.14) and (1.15) are the usual interior solutions to the consumer utility maximization problem, and mimic the static first-order conditions. Whereas the equation (1.16) is the marginal value of wealth which is derived by the straight application of the envelope theorem, $\partial V_{t+1}/\partial A_t^* \equiv (1 + r_{t+1})\lambda_{t+1}$. Equation (1.16) – Euler equation for λ_t - is the key device in analyzing the intertemporal labour supply behavior of the individual (Blundell and MaCurdy, 1999). This equation determines the rule for the allocation of wealth across the periods. In this formulation, the individual chooses savings such that the marginal utility of wealth in period t is equal to the discounted value of the marginal utility of wealth in the subsequent period $t+1$.

The first-order conditions give the demand-for-consumption and the hours-of-labour supply functions:

$$C_t = C(\lambda_t, w_t, x_t) \quad \text{and} \quad h_t = h(\lambda_t, w_t, x_t) \tag{1.17}$$

These are commonly referred to as Frisch functions (Blundell and MaCurdy, 1999). These functions decompose consumption and labour supply decisions into components observed in the current period, x and w, and λ, which can be expressed as a function of initial assets, lifetime wages, interest rates, rates of time preference and tastes, and therefore summarizes all the relevant information from all other periods. Variables such as future wealth, wages, or personal characteristics affect consumption and labour supply only indirectly, through the value of λ_t. Thus, λ_t serves the role of sufficient statistic.

The Marshallian, Hicksian and Frisch functions comprise three types of the labour supply functions. The difference between the three is that the Marshallian function holds income constant, the Hicksian utility constant, whereas the Frisch function holds the marginal utility of wealth constant. The elasticity of the Frisch function can be computed similarly to the previous Marshallian and Hicksian labour supply functions.

Dynamic labour supply model under uncertainty

The dynamic model of labour supply under uncertainty is very similar to the one under certainty except for some minor changes in the Euler equation and the formulation of the individual's maximization problem:

$$
\begin{aligned}
V(A_t^*, t) &= \max_{\{C_t, h_t, A_t^*\}} [U(C_t, h_t, x_t) + \beta E_t V(A_{t+1}, t+1) \qquad (1.18) \\
s.t. &: \quad S_t \equiv A_t^* - A_t^0 = w_t h_t - C_t \\
A_{t+1} &\equiv (1 + r_{t+1})\, A_t^*
\end{aligned}
$$

So according to the above maximization problem, the individual's objective function is simply the expectation of (12), conditional on the current information. The first-order conditions are given by (MaCurdy, 1985):

$$
\frac{\partial U_t}{\partial C_t} = \lambda_t, \quad -\frac{\partial U_t}{\partial h_t} = \lambda_t w_t \quad \text{and} \quad \lambda_t = \beta E_t (1 + r_{t+1}) \lambda_{t+1} \qquad (1.19)
$$

The first two expressions are similar to the ones provided by the model under the certainty. Whereas the Euler equation for λ_t has been modified, and reflects the fact that λ_{t+1} is a random variable the realization of which starts at period $t+1$. Since prices and resources/wealth are uncertain in the future, in each period the individual revises her decision to demand consumption and supply labour in accordance with the acquired information on unanticipated shocks (MaCurdy, 1983). Thus, "... individual sets his saving policy so that the expectation of next period's marginal utility of wealth is revised by the full amount of the unanticipated elements; in other words, the consumer revises the means of all future values of λ to account for all forecasting errors when they are realized" (Blundell and MaCurdy, 1999).

The Euler equation (1.19) implies a stochastic process for λ. To derive it we first write:

$$\ln \lambda_t = E_{t-1} \ln \lambda_{t-1} + \epsilon_t^* \Longrightarrow E_{t-1}(\lambda_t) = \exp[E_{t-1}(\ln \lambda_t) E_{t-1}(\exp \epsilon_t^*)] \Longrightarrow$$
$$\Longrightarrow \lambda_t = \frac{E_{t-1}(\lambda_t) \exp \epsilon_t^*}{E_{t-1}(\exp \epsilon_t^*)}$$

Substituting the expression for $E_{t-1}(\lambda_t)$ implied by the equation (1.19) into the last expression gives:

$$\lambda_t = \frac{\lambda_{t-1} \exp \epsilon_t^*}{E_{t-1}(\exp \epsilon_t^*) \beta (1 + r_t)}$$

Taking logs from the both sides yields:

$$\ln \lambda_t = b_t^* + \ln \lambda_{t-1} + \epsilon_t^*, \qquad \text{where} \qquad b_t^* = -\ln \beta(1 + r_t) - \ln [E_{t-1}(\exp \epsilon_t^*)]$$

As can be seen, the value of b_t^* depends on the values of the discount rate, interest rate and the forecast error term. Substituting repeatedly we obtain:

$$\ln \lambda_t = \sum_{j=1}^{t} b_j^* + \ln \lambda_0 + \sum_{j=1}^{t} \epsilon_j^* \qquad (1.20)$$

Merging the last expression with the first-order conditions for the consumption and labour supply we get:

$$\frac{\partial U_t}{\partial C_t} = \lambda_t, \qquad -\frac{\partial U_t}{\partial h_t} = \lambda_t w_t, \qquad \text{and} \qquad \ln \lambda_t = \sum_{j=1}^{t} b_j^* + \ln \lambda_0 + \sum_{j=1}^{t} \epsilon_j^* \qquad (1.21)$$

These conditions describe the behavior of a consumer under uncertainty. According to these conditions, an individual at the beginning of the period sets the initial value of λ_0 to include all the available information. As the time passes, the individual reacts to the changes in λ by revising his expectations in accordance with the equation (1.20). In order to determine his optimal consumption and labour supply at each stage, the individual needs and information on his current wage rate along with the updated λ.

1.3 General Lessons from Static and Dynamic Models of Labour Supply

The analysis of the static model has revealed that it is important to emphasize the following issues in attempting to discover the impact of changes in wages on labour supply:

- The conflict between the income and substitution effects
- The complexities and non-convexities in the budget constraints
- The role of the labour contracts in the decision to supply labour

Unfortunately, the theory is unable to provide definite answers to the three key issues. This indicates on the importance of the empirical research in order to arrive to some clear conclusions with regard to the three issues discussed above.

Turning our attention to the dynamic model we see that the decision to supply labour depends on intertemporal elasticity of substitution and the Euler equation for the marginal utility of wealth which captures the corresponding information from all other periods. However, some features missing in the dynamic model are worth considering. First of all, it is the imposition of some simplifying assumptions among which are time-separable utility function and a non-stochastic interest rate. The complications with the dynamic model may arise if we relax one of these assumptions. For instance, assume that an individual's wage is a function of human capital that this person chooses to obtain by training or education. Then in this case the wage is endogenous and is solely determined by the individual's training or education decision.

Moreover, some individuals supply labour for the sake of saving the earned income for future periods, where the relative value of non-work activity is higher (such as retirement, economic recession, periods of family formation and periods of ill-health). This indicates that two identical individuals will supply different levels of labour reflecting their different expectations of future needs. Therefore, a person who is more insecure in the coming future and whose future financial needs are much higher will supply more labour (Blundell, 1992).

Finally, as has been discussed above, the individual's decision to supply labour strongly depends on her intertemporal elasticity of substitution. That is her response to an anticipated change in the real wage in one period, holding all future real wages constant and maintaining the marginal utility of income. The theory has revealed that a fall in the real wage for one period would reduce labour supply during that period in the knowledge that it is a one-off change. However, a wage change is usually neither temporary nor anticipated, and marginal utility cannot be maintained since wage decreases reduce wealth and therefore reduce marginal utility. Therefore the dynamic model has to be supplemented with an empirical analysis.

A note on search and matching models of labour economics

Neoclassical model of labour supply is one of many models that are practiced in order to explain labour behavior in the labour market. Although, the discussion that follows is beyond the scope of current thesis some brief discussion of recent trends in labour market research is in order.

Recently labour economics has witnessed a large amount of theoretical and applied research on search and matching models of labour market. In 2010 Diamond, Pissaridies and Mortensen have been awarded the Nobel Prize in

Economics for their contribution in search and matching model of unemployment.

Indeed, the search and matching model has become the workhorse for labour market issues in macroeconomics (Lubik, 2009). Its framework provides a rationale for the existence of equilibrium unemployment, such that workers who would be willing to work for the prevailing wage cannot find a job. By focusing on the search and matching aspect, that is, workers searching for jobs, firms searching for workers, and both sides being matched with each other, the model also provides a description of employment flows in an economy. Moreover, the search and matching model is tractable enough to be integrated into standard macroeconomic models as an alternative to the perfectly competitive Walrasian labour market model.

The search and matching model takes into account the heterogeneity of labour services and describes the matching process of workers and firms. Matching theory is used to describe the formation of new jobs and was evolved from an earlier framework of searching theory. The search model of unemployment consists from three building blocks, which separately describe various aspects of the labour market. The first element of the model describes the wage setting process, whereas the second describes the decisions of the firm on number of vacancies to open. The third element analyses the interaction between unemployed workers and vacancies and how jobs are created. Merging two elements of the model results in one of the key elements of search-matching model, - the Beveridge curve, - which represents the relationship between unemployment and the job vacancy rate. This baseline framework then helps to determine how the equilibrium unemployment rate is affected by economic fundamentals, such as workers' bargaining power, recruiting costs, productivity, and matching frictions.

Search and matching models became the main tool for macroeconomic evaluation of new and existing labour market policies (For instance, see Davidson and Woodbury (1993), Cole and Rogerson (1999), den Haan et. al. (2000), Yashiv (2004)). However, the results of these models were criticized for not accurately capturing the responses of individuals to changes in government policy (see Hansen and Heckman, 1996) and for being unable to match key labour market statistics, chiefly the volatility of unemployment and job vacancies (Shimer, 2005).

Part II

Econometrics of Labour Supply

1.4 Introduction

"The labour supply is probably the area of labour economics in which the greatest number of empirical studies has been carried out over the last twenty years" (Cahuc and Zylberberg, 2008). Indeed, labour supply has been most visited branches of labour economics and the econometrics of labour supply is a separate study on its own right. This section provides some basic insights into the econometrics of labour supply. For a very comprehensive and thorough treatment of empirical aspects of labour supply consult Blundell and MaCurdy (1999).

The conventional methods of the individual's utility maximization problem result in the following labour supply function:

$$h = h(w, I, u) \qquad (1.22)$$

where u is some error term reflecting the characteristics unobserved by an econometrician. The one can re-interpret w and I variables as after-tax variables and treat the function h as describing hours-of-work behavior even in the presence of nonlinearity in the budget constraint. Hence the key purpose of the most empirical research is to estimate the parameters of the function h.

The economic theory can sometimes suggest the functional form of economic relationship. Some of the most common forms of the empirical specifications of the functions are the linear, double log, the semi-log, the reciprocal, and the polynomial functions. For instance, one of the advantages of the double-log form is that the slope parameters represent elasticities. The semi-log is appropriate when the dependent variable grows at about a constant rate over time. This section briefly reviews some of the empirical static labour supply specifications that are commonly used in the empirical research[2].

[2] For more comprehensive review of the labour supply specifications see Stern (1986), and

1.5 Basic Empirical Specifications of Labour Supply

One of the most common static labour supply specifications are given by:

$$\ln h = \beta_1 \ln w + \beta_2 Q + \epsilon \qquad (1.23)$$

$$h = \beta_1 \ln w + \beta_2 Q + e \qquad (1.24)$$

where, β_1, β_2, are the parameters, Q is the vector of controls and e and ϵ are the stochastic terms unobservable by an economist. Studies often use alternative specifications for the vector of controls given by $\beta_2 Q$. The parameter β_1 corresponds to the substitution effect related with the response of the labour supply to variations in wages. An interpretation of this substitution effect is dependent on the set of the controls included and which of those controls are treated as exogenous. Studies also suggest various alternative specifications for the wages, such as after-tax wages or non-linear functions of wage rates. Additivity between the log wage and the other vector of controls implies strong restrictions on preferences which are reviewed below.

Specifications of static preferences

Using specification (1.22) it is possible to illustrate the discussion on the preference restriction. One of the prototype specifications of the labour supply is given by:

$$\ln h = \beta_1 \ln w + \beta_2 I + \rho \qquad (1.25)$$

where as previously, h denotes the labour supply, w wages, I non-labour income, and ρ represents observed and unobserved heterogeneity, β_1, β_2 are

Blundell and MaCurdy, (1999). Most of this section is due to the sources given above.

the parameters. In this form, the labour supply specification allows a single parameter for each of the wage, income and heterogeneity terms. Specification (1.25) is similar to the specification (1,23), where the one has to substitute the vector of controls $\beta_2 Q$ by $\beta_2 I + \rho$.

However, this form places some strong restrictions on the preferences among which are: (i) the restriction on the sign of the wage response, which must be the same over all hours' choices; and (ii) the restriction on non-labour income response, which must establish the degree whether leisure is a normal, inferior or luxury good.

Typically the specification of the direct or indirect utility determines the restrictions placed on the preferences. As can be seen from the labour supply specification (25), it assumes the additivity between wage and non-labour income along with the constancy of the wage elasticity for all hours' choices. These restrictions are mirrored in the following form of the indirect utility function:

$$V(w, I) = \frac{w^{\beta_1+1}}{\beta_1+1} - \frac{e^{-\beta_2 I}}{-\beta_2 e^{-\rho}}$$

Numerous alternative specifications of this type are quite popular in empirical research and the relationship among these specifications and the restriction placed on preferences help to compare studies.

Returning to the discussion of the basic labour supply specifications the common static specification comprises the estimation of the expression (1.22) with the controls set:

$$\beta_2 Q = \rho X + \beta_2 I \qquad (1.26)$$

where X is the vector of taste shifters and I is non-labour income, and

β_2 measures the Marshallian wage elasticity. The estimation of this model requires the instrumental-variable techniques, which accounts the endogeneity of the wage arising from unobservable characteristics influencing wages, labour supply or from the stochastic term (measurement error).

Specifications for Frisch functions

This section follows some of the basic Frisch specifications proposed by Blundell and MaCurdy (1999). In order to create a Frisch labour supply function of the form:

$$\ln h = \beta_1 \ln w + \beta_1 Q + \epsilon \qquad (1.27)$$

Blundell and MaCurdy(1999) suggest to assume the following form of the utility function for period t:

$$U_t = G(C_t, X_t) - \Phi_t \left(h_t\right)^{\sigma}, \qquad \text{with} \qquad \sigma > 1 \qquad (1.28)$$

where G is monotonically increasing function of consumption, C, Φ is a function of the consumer characteristics and σ is a time-invariant parameter common across the consumers. The function Φ takes the following form:

$$\Phi_t = \exp(-X_t \rho^* - v_t^*), \qquad \text{with} \qquad \sigma > 1 \qquad (1.29)$$

where ρ^* is a vector of preference parameter and v_t^* imitates the contribution of unmeasured characteristics.

Allowing an interior optimum, the Frisch labour supply function takes the form of the specification (1.27) with the vector of controls:

$$\begin{aligned} \beta_2 Q_t &= F_t + \rho X_t \qquad (1.30) \\ \text{with} \;\; F_t &= \beta_3(\ln \lambda_t - \ln \sigma), \beta_3 = \frac{1}{\sigma - 1}, \rho = \beta_3 \rho^* \text{ and } \;\; \epsilon_t = \beta_3 v_t^* \end{aligned}$$

By assuming that all b_t^* in the stochastic path equation for λ are constant for all the individuals at all times, and by substituting this condition into expression (1.30) we obtain:

$$\beta_2 Q_t = F_0 + b_t + \rho X_t \qquad \text{with} \qquad b = \beta_3 b^* \qquad (1.31)$$

The error term e now comprises all the forecast error terms. In this specification the important controls include X, age and individual impact of F_0. Taking the first-order differences of the expression (1.27) we obtain:

$$\Delta \ln h_t = b + \rho \Delta X_t + \beta_3 \Delta \ln w_t + \Delta e_t \qquad (1.32)$$

"Given the availability of instruments for the change in wage, one can fit this equation on panel data to yield an estimate of β_3" (Blundell and MaCurdy, 1999, p-1600). In this specification β_3 corresponds to the inter-temporal substitution elasticity which reflects wage elasticity of the Frisch labour supply function. This elasticity keeps the marginal utility of wealth constant and shows how the labour supply responds to the changes in wages induced by movements along an individual's wage profile.

In general, it is important to precisely identify the set of variables that explain labour supply in order to see what type of elasticity the model employed allows estimating. Having set out the needed ingredients of the labour supply equations (25 and 27), the one can go on and estimate them with appropriate estimation techniques.

1.6 Empirical Estimation Methods

In general, estimating basic labour supply equation by ordinary least squares (OLS) method leads to biased results since it does not take into account the individual participation decision (Cahuc and Zylberberg, 2008). In cases, when we want to estimate labour supply elasticities, we need to estimate jointly the decision on participation in the labour and on the number of hours of work. This procedure requires the estimation of the predicted wages for those individuals who do not participate in the labour force.

Furthermore, when the economic theory suggests some non-linear functional specification the OLS method is inappropriate until the functional form is transformed into the linear regression framework. However, the care has to be taken of how the disturbance turn enters the functional.

There are some situations, when the values of the explanatory variables are reported with measurement errors. This leads to biased and inconsistent parameter estimates. One method of obtaining consistent OLS parameter estimates is to replace the explanatory variable subject to measurement error with another variable, which is the instrumental variable that is highly correlated with the original explanatory variable but is independent of the error term. This is often difficult to fulfill and somewhat arbitrary.

Third, if the dependent variable is a binary variable (such as employed or unemployed) OLS regression could yield incongruous predictions greater than 1 or less than 0. Also, the regression would violate the assumption of no heteroscedasticity because of the discrete nature of the dependent variable. In this case it is appropriate to use either probit or logit methods of estimation.

Finally, when we are dealing with simultaneous-equation models, where the dependent variable in one model is also the explanatory model in the other model, the OLS estimation of the structural equations results in simultaneousequations bias (i.e. biased and inconsistent parameter estimates). In this case either indirect least squares or two-stage least squares methods must be employed.

Today, labour economists mostly utilize structural approaches to modeling labour supply functions. Common methods include maximum likelihood, instrumental variable and difference-in-difference to list a few (see Blundell and MaCurdy, 1999).

Maximum likelihood

One of the important directions in modeling labour supply behavior has been analysis of tax and welfare policies' effect on labour supply decisions. Basic models of labour supply have already been discussed. As we know from the above discussion, different marginal tax rates are normally applied in the various income brackets under personal income taxation the budget constraint is no longer linear. In general, two approaches are applied for modeling the tax induced nonlinearity: piecewise-linear functions and smooth differentiable relations. In both cases maximum likelihood estimation approach provides solution to the above type labour supply problems.

Maximum likelihood and convex differential constraints with full participation

The convex budget constraint is a straight line joining any two points is associated with a feasible position, that is an after tax net income less than or equal to the net income along the budget line. Maximum-likelihood method provides convenient tool for estimation of labour-supply models with a tax schedule that produces a convex budget set. Such estimation approach, in contrast to the other estimation methods such as instrumental-variable method (discussed below), does not require exclusion restrictions to identify parameters of the model. These exclusion restrictions are often difficult to justify, and therefore, many researchers choose maximum likelihood estimation method to avoid making such questionable exclusion restrictions.

However, it does not necessarily imply that the maximum likelihood procedures are restriction free. It does require the gross wage variable and the other income variable to be free from measurement error and to be independent of unobserved heterogeneity.

In order to illustrate how maximum likelihood estimation works, consider the following commonly applied linear empirical specification for labour supply model (see, Hausman, 1981):

$$h = h(w, y, v) = \beta_0 + \beta_1 w + \beta_2 y + \beta_3 Z + v = \hat{h} + v \tag{1.33}$$

Where β_is are the coefficients (parameters), Z is the vector of labour supply determinants which are observed by an econometrician, v is the disturbance term which reflects the contribution of heterogeneity of preferences with $v \approx f_v$, where f_v denotes the marginal density of v. This specification is common across the labour supply models using the piecewise-linear approach. In conjunction with this specification, analyses also presume measurement error in hours of work possessing the classical linear functional form:

$$h^* = h^*(h, \epsilon) = h + \epsilon$$

where $\epsilon \approx f_\epsilon$, with ϵ and v independent. The measurement error component ϵ represents reporting error that contaminates observations on h for individuals who work.

Assuming no measurement error and by changing v to actual hours h using relation (33) yields the likelihood function for h:

$$f^h(h) = \frac{dv}{dh} f_v(h - \beta_v - \beta_3 Z - \beta_1 w - \beta_2 y) \qquad (1.34)$$

where the Jacobian term is:

$$\frac{dv}{dh} = 1 + (\beta_1 - \beta_2 h) W^2 \frac{\partial \tau'}{\partial I} \qquad (1.35)$$

Maximizing (1.34) yields maximum-likelihood estimates for the parameters of the labour supply function h, which provide the information needed to evaluate work disincentive effects of taxation.

If hours are indeed contaminated by additive measurement error, then the likelihood function for observed hours $h^* = h + \epsilon$ is given by:

$$f_{h^*}(h^*) = \int_0^{\text{max hours}} f_\epsilon(h^* - h) f_h(h) dh \qquad (1.36)$$

For the above likelihood function (1.36) to be a properly-defined the Jacobian (1.35) must be non-negative. Violation of this condition implies that the density function for h is negative, which obviously cannot be the case. Relation (1.34) indicates that this non-negativity condition translates into the property:

$$\frac{\partial h^S}{\partial w} - \frac{\partial h^S}{\partial y} h \geq - \left(\frac{\partial \tau}{\partial I} W^2 \right)^{-1} \leq 0 \qquad (1.37)$$

where $h^S(= f)$ refers to the labour supply function. Only if the above equation holds then derived maximum likelihood estimations have an economic meaning. This conditionality in its turn requires absence of measurement error; otherwise the evaluation of equation (1.36) would result in a non-positive value which causes the overall log likelihood function to approach minus infinitywhich clearly cannot represent a maximum. Since maximum likelihood procedures assume the validity of such restrictions when calculating estimates of the coefficients of h^S, the resulting estimated labour supply function can be expected to exhibit compensated substitution effects that obey inequality (1.37) over a very wide range of hours, wages, and incomes.

Maximum likelihood and convex piecewise-linear constraints with full participation

Piecewise-linear constraints are specific form of convex sets that consists of several linear segments, each associated with a given marginal tax rate and earnings threshold. Such constraints are associated multi-bracket tax schedules such as progressive personal income tax. When individual's income reaches certain threshold level then he or she jumps to the linear segment that is associated with higher tax rate. In case of such budget constraints, change-in-variables techniques implemented in conventional maximum likelihood do not apply due to the non-existence of the Jacobian term over certain segments of the sample space over which the functional relationships characterizing hours-of-work decisions are not differentiable.

A different approach is applied for deriving labour supply model subject to the piecewise-linear constraint. The basic idea is to perform maximum likelihood estimation for each segment or kink point of the multi-segment budget constraint which will yield optimal labour supply and consumption choices (bundles). Then in the next step one needs to determine the segment or the kink on which the person locates which automatically will point at optimal labour supply and consumption decision parameters, determined earlier separately for each segment. Specifically, consider the following budget constraint facing the individual (Figure 2).

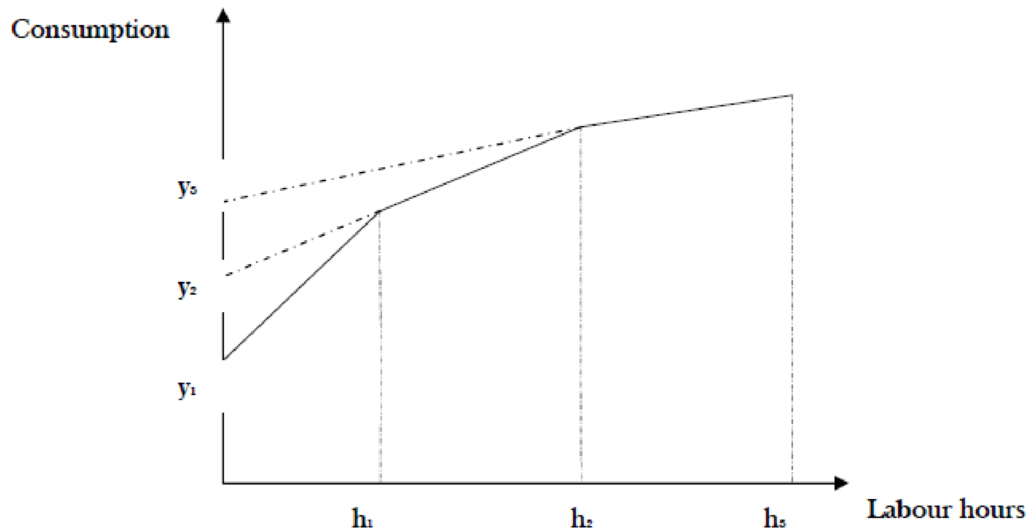

Figure 2

In order to locate the kinks and slopes of the budget constraint for the individual, the one has to possess information on the individual's gross wage rate, non-labour income, hours of work and the tax schedule. Then according to Blundell and MaCurdy (1999), the hours of work at which kinks occur are given by the following expression:

$$h_i = \frac{Y_i - I + D}{W}$$

where I, represent the non-labour income, D are the deductions, Y is the taxable income for the segment i, and W is the gross wage. As before, the slope of each segment is given by the marginal wage for that segment:

$$w_i = (1 - t_i)W$$

with t_i denoting the marginal tax rate for the segment i.

The intercept of the budget line at zero hours of work – the virtual income - is given by the following expression:

$$y_1 = Y + I - \tau(I - D)$$

where the tax function $\tau(\cdot)$ is evaluated at the zero taxable income. Having this intercept value, the virtual incomes corresponding to the successive budget segments can be estimated by repeated application of the following expression:

$$y_i = y_{i-1} + (w_{i-1} - w_i)h_{i-1}$$

As a result, having a convex budget constraint, the individual's utility maximization problem amounts to maximizing $U(C, h)$ subject to:

$$\begin{aligned} C &= y_1 \quad \text{if} \quad h = 0 \\ &= w_1 h + y_1 \quad \text{if} \quad H_0 < h < H_1 \\ &= w_2 h + y_2 \quad \text{if} \quad H_1 < h < H_2 \\ &= w_3 h + y_3 \quad \text{if} \quad H_2 < h < \overline{H} \end{aligned}$$

Mathematically the above procedures can be illustrated as follows:

$$\begin{aligned} C &= y_1 \quad \text{if} \quad h = 0 \\ &= w_1 h + y_1 \quad \text{if} \quad H_0 < h < H_1 \\ &= w_2 h + y_2 \quad \text{if} \quad H_1 < h < H_2 \qquad (1.38) \\ &= w_3 h + y_3 \quad \text{if} \quad H_2 < h < \overline{H} \end{aligned}$$

In the first step, optimal labour supply and consumption choice is determined for each segment or a kink. This step yields the solution:

$$
\begin{aligned}
h &= 0 \quad \text{if} \quad h = 0 \quad \text{Lower limit} \\
&= f(w_1, y_1, v) \quad \text{if} \quad 0 < h < H_1 \quad \text{Segment 1} \\
&= H_1 \quad \text{if} \quad h = H_1 \quad \text{Kink 1} \\
&= f(w_2, y_2, v) \quad \text{if} \quad H_1 < h < H_2 \quad \text{Segment 2} \\
&= H_2 \quad \text{if} \quad h = H_2 \quad \text{Kink 2} \\
&= f(w_3, y_3, v) \quad \text{if} \quad H_2 < h < \overline{H} \quad \text{Segment 3} \\
&= \overline{H} \quad \text{if} \quad h = \overline{H} \quad \text{Kink 3 = upper limit}
\end{aligned} \tag{1.39}
$$

Then, in the next step, we determine the segment or the kink on which the person locates. The following relations characterize this solution choice:

$$
\begin{array}{llcll}
\text{if} & f(w_1, y_1, v) & \leq & 0 \quad 0 & \\
& \text{if} \quad H_0 & = & f(w_1, y_1, v) < H_1 & \text{Segment 1} \\
\text{if} & f(w_2, y_2, v) & \leq & H_1 < f(w_1, y_1, v) & \text{Kink 1} \\
& \text{if} \quad H_1 & < & f(w_2, y_2, v) < H_2 & \text{Segment 2} \\
\text{if} & f(w_3, y_3, v) & \leq & H_2 < f(w_2, y_2, v) & \text{Kink 2} \\
& \text{if} \quad H_2 & < & f(w_3, y_3, v) < \overline{H} & \text{Segment 3} \\
\text{if} & f(w_3, y_3, v) & \geq & \overline{H} &
\end{array} \tag{1.40}
$$

Values of h and C determined in the second step will represent the utility-maximizing solution for entire labour supply model.

Maximum likelihood with accounting for fixed costs of participation

In certain cases there might be costs associated with engaging in employment activities such as cost transportation that must be paid for irrespective of amount of work done and such costs may vary across individuals. Such costs are referred as fixed costs. It is clear that individuals will consider working only when the wages they receive is sufficiently higher than the fixed costs. In presence of such fixed costs the budget constraints are non-convex, which rule out application of simple maximization procedures. Labour supply model with fixed costs can be derived as follows:

Suppose F denotes fixed monetary costs associated with work, and then non-labour income, Y, in the above budget constraints is replaced by:

$$\begin{array}{cccc} Y-F & \text{if} & h > & 0 \\ Y & \text{if} & h = & 0 \end{array} \qquad (1.41)$$

F is partially unobservable and varies across individuals. Hence, the budget constraint is not continuous as it jumps down by F whenever the individual chooses to work.

As one can see there are two regimes that illustrate the individual's behavior, namely: working and not working. Maximization problem is solved by finding the maximum utility $U(C, h, v)$ under each regime and then one of them is chosen as the optimal solution. In the case of no-work regime, the solution is straightforward which yields:

$$U[Y - \tau(Y - D)], 0, v] \qquad \text{with} \qquad h = 0$$

The solution for the other regime can be found by applying maximum likelihood estimation with piecewise-linear constraints approach. With the labour supply function $f(w, y, v)$ solution for h will be as in (41), where the virtual income y now subtracts fixed costs F. Then one needs to compute maximum utility for each possible hours choice, employing the indirect utility function $V(w_j, y_j, v)$ for all segments and direct utility function at kink points j. An individual chooses to work whenever the following inequality is satisfied:

$$V^*(w, y, v) \geq U[Y - \tau(Y - D), 0, v] \qquad (1.42)$$

and chooses not to work otherwise.

Since desired hours of work increase with v, the above critical value will generally be increasing in v as well, implying that greater propensity to work is the higher fixed costs should be no-work regime to prevail.

Maximum likelihood: accounting for missing wages

In certain cases, particularly in case of no-work regime gross wage W is not observed and, therefore, the budget constraint cannot be derived, which implies that W must be endogenized. This can be accomplished by the simple function:

$$W = W(Z) + \eta \qquad (1.43)$$

where Z represents all observable variables that determine W and η is the unobservable wage component.

In the no-work regime, one of two situations can occur: (i) fixed costs are sufficiently high for any given v and η, or (ii) if this fixed-cost threshold falls below the lowest admissible value for F (i.e., $F^* \leq F$), then desired hours are sufficiently low with$v < v^* = v^*(\eta)$ for any η. The probability of such event taking place is:

$$l_0 = \int_{-\alpha}^{\alpha} \int_{-\alpha}^{v^*} \int_{F^*}^{\alpha} f_{v\eta F}\left(v, \eta, F\right) dF dv d\eta \qquad (1.44)$$

where $f_{v\eta F}$ is joint density of (v, η, F). For the work regime, the likelihood function takes the following form:

$$\begin{aligned} l_1 \quad = \quad & \sum_{j=1}^{3} \int_{v_j}^{\overline{v}_j} \int_0^{F^*} f_2[(h^* - f_j), v, (W - W(z)), F] dF dv + \\ & + \sum_{j=1}^{2} \int_{\overline{v}_i}^{\underline{v}_{j+1}} \int_0^{F^*} f_1[(h^* - H_j), v, (W - W(z)), F] dF dv + \qquad (1.45) \\ & + \int_{\overline{v}_s}^{\infty} \int_0^{F^*} f_1[\left(h^* - \overline{H}\right), v, (W - W(z)), F] dF dv \end{aligned}$$

where $\underline{v}_j$ solves the equation $f(w_j, y_j, \underline{v}_j) = H_{j-1}$

$\overline{v}_j$ solves the equation

$$f(w_j, y_j, \overline{v}_j) = H_j \qquad (1.46)$$

f_1 and f_2 denote the distribution of (ϵ, v, η, F) and $(\epsilon + v, v, \eta, F)$

Define $P_E = 1$ if the individual works and 0 otherwise. Then the likelihood function for an individual is given by:

$$l = {l_1}^{P_E} {l_0}^{1-P_E} \qquad (1.47)$$

Estimation of this likelihood functions is carried out by maximizing the sum of log likelihoods across individuals.

Instrumental-variable

Instrumental variable estimation has since long been a standard econometric technique for dealing with endogeneity and selection issues in general, and for non-experimental policy evaluation in particular. Basic idea of the instrument-variable estimation method is to identify a set of variables, which do not appear directly in the model being considered, but are capable of predicting the endogenous variables included in it. Such variables are referred as "instrumental variables" and they causally affect the variable that they predict but do not have a direct causal effect on the outcome variables (variables that are being determined by the endogenous variables predicted by the instrument variables).

In context of the labour supply analysis the following the semi-log specification of labour supply model illustrates how the instrumental-variable estimation can be employed for labour supply analysis.

$$h = f(w, y, v) = \mu + \gamma Z + \alpha \ln w + \beta y + v$$

where μ, α, γ, and β are parameters, Z is a vector of observed determinants of labour supply such as age, family size, education, and v is a structural disturbance that captures unobserved factors that influence labour supply decisions. Entering the marginal after-tax wage w in a natural log allows it to represent a hybrid of an uncompensated substitution effect and elasticity. The coefficient β, on the other hand, represents to an income effect.

In the above specification of the labour supply w and y are defined as endogenous. However, non-linearity of budget constraint under progressive income taxation with multiple brackets, implies that there is another endogenous variable not included in the labour supply equation that predicts the above two endogenous variables. That variable is marginal tax rate, which due to its endogeneity (individuals might choose their labour supply behavior depending on the marginal tax rate they face) contaminates the net wage w and virtual income y. Thus, marginal tax rate can be used as instrument variable.

In order to illustrate how the above instrumental variable predicts the net wage and virtual income variables we modify the above presented labour supply equation for presence of errors in hours of work and wage measurement, which is the often case. Suppose h^* and W^* denote observed hours of work and wages, respectively. Actual and observed hours are related to each other via function $h^*(h, \epsilon)$, where ϵ is error component. Suppose the reporting error is given by the multiplicative structure:

$$h^* = h^*(h, \epsilon) = he^{\epsilon} \qquad \text{with} \qquad W^* = \frac{E}{h^*}$$

where ϵ is distributed independently of h and v, and the distribution of the measurement error component ϵ satisfies the moment condition $E(e^{\epsilon}) = 1$, implying that h^* and h have the same expected value. $W = E/h$ represents the true hourly wage rate. This formulation presumes not only measurement error in hours, but also the existence of reporting error in hourly wage rates due to its construction.

Modification of the original labour supply equation yields the following:

$$h = \overline{\mu} + \gamma Z + \alpha lnw^* + \beta y + u$$

where $\ln w^* = \ln \epsilon^*(E/h^*) + \ln \epsilon^*(1 - \tau^{'}), \widetilde{\mu} = \mu - (\alpha \sigma_{\epsilon_w^2}/2)$ and $u = v + \alpha[\epsilon + (\sigma_{\epsilon_w^2}/2)] + (h^* - h) = v + \alpha[\epsilon + (\sigma_{\epsilon_w^2}/2)] + h(e^{\epsilon - 1})$

$\ln w^*$ represents the natural logarithm of the after-tax wage rate evaluated at observed hours and it depends on the marginal tax rate $\tau^{'}$, which is a candidate for the instrumental variable. The disturbance u possesses a zero mean since $E(\epsilon) = -\sigma_{\epsilon_w^2}, E(e^{\epsilon}) = 1$,error ϵ is distributed independently of all endogenous components determining h, including the heterogeneity disturbance v.

Since marginal tax rate $\tau^{'}$ enters labour supply model as known parameters it is independent of measurement error ϵ and is orthogonal to the structural disturbance v. Thus, marginal tax rate $\tau^{'}$ satisfies all necessary conditions and qualifies as instrumental variable and can be used for estimating the parameters determining substitution and income effects.

After identifying the instrumental variable one can proceed to estimation of the labour supply model. Main purpose for employing instrumental variable is to eliminate the correlation between endogenous variables in the model and the structural disturbances v. Otherwise both OLS and weighted least squares estimation results will biased and inconsistent.

Instrumental variable estimation is performed using two-stage least squares (2SLS) technique. In the first stage, 2SLS finds the portions of the endogenous and exogenous variables that can be attributed to the instruments. This stage involves estimating OLS regression of each variable in the model on the set of instruments. The second stage is a regression of the original equation, with all of the variables replaced by the fitted values from the first-stage regressions.

Natural experiment

Natural experiment and/or difference-in-difference are commonly used empirical estimation techniques in economics. The basic idea of this approach is to compare two groups, one of which experienced a specific policy change, while the other one with similar characteristics was unaffected by this policy change. The latter group is often referred as a control group. Difference in Difference approach normally requires placing structural restrictions in order to separate existing population (or part of the population) into two distinct groups

A simple natural experiment can be constructed as follows: Suppose y_{it} measures outcome of a specific policy for a group, consisting of individuals,$i = 1, \ldots, N$ with these individuals observed over a sample horizon that, for simplicity, consists of only two periods $j = t-1$, where $t-1$ is period before the implementation of the policy instrument and period t which is after. Let δ_{ij} be an indicator that equals 1 if the policy change was operative for individual i in period t, and 0 otherwise. Suppose those who experience the policy change react to the change according to a parameter γ. A framework for estimating γ expressed in terms of a conventional fixed-effect model takes the form:

$$y_{ij} = \gamma\delta_{ij} + \eta_i + m_j + \epsilon_{ij} \qquad (1.48)$$

where η_i is a time-invariant effect unique to individual i, m_j is a time effect common to all individuals in period j, and ϵ_{ij} is an individual time-varying error distributed independently across individuals and independently of all η_i and m_j.

In order estimate a consistent estimate of γ in (1.48) we differentiate relation (1.48) over time to obtain:

$$\Delta_j y_{ij} = \gamma\Delta_j\delta_{ij} + \mu_j + \Delta_j\epsilon_{ij} \qquad (1.49)$$

where $\Delta_j y_{ij} = y_{ij} - y_{i(j-1)}$ and $\mu_j = \Delta_j m_j$. The operator Δ_j differences an individual's observation across periods, and μ_t is a parameter representing the difference in common time effects.

At this point we need to assign two groups with e representing the individuals who experienced the policy change (experimental) and group c representing individuals who encountered no policy change (control group). Then we can easily derive estimator for γ, namely $\widehat{\gamma}$ by applying least squares technique to (1.49) which yields:

$$\widehat{\gamma} = \Delta_t\overline{y}^e - \Delta_t\overline{y}^c, \qquad \widehat{\mu} = \Delta_t\overline{y}^c \qquad (1.50)$$

Where $\Delta_t \overline{y}^k = \overline{y}_t^k - \overline{y}_{t-1}^k$, $k = e, c$ and $\overline{y}_j^k = \left(\sum_{i \in k} y_{ij}\right) / N_k$, $k = e, c$ and $\overline{y}_j^k$ is the average outcome for group k.

The estimator $\widehat{\gamma}$ in (50) is known as the difference-in-difference estimator. Now based on the estimator $\widehat{\gamma}$ one can evaluate if the policy change affected the individuals being considered. However, in order to obtain a behaviorally meaningful estimator two structural restrictions have to in place while carrying out the natural experiment.

Restriction 1: Time effects in (1.48) must be common across experimental and control groups.

Restriction 2: The composition of both experimental and control groups must remain stable before and after the policy change.

Structural dynamic models

Since its development a number extensions have been made into the standard inter-temporal model. Among these extensions issue of participation and human capital building deserves particular attention. Individuals make decisions on their participation in labour force depending on their past, current, and future income. They might decide not to participate or withdraw, which is particularly relevant for the analysis of female labour supply and retirement decisions. The models presented so far fail to provide sufficient explanation on how individuals decide on their participation in labour force.

The other extension considers mechanisms through which individuals can affect their wage growth through human capital building, which can take form of trainings, additional schooling and simple accumulation of work experience.

The standard dynamic labour supply model with participation

A dynamic labour supply model with participation can be constructed with help of simplifying assumption that individuals can only choose between working and not working (participation and not participation). Specific feature of such participation model is that it incorporates a special dummy variable that equal 1 if the individual participates in labour force, 0 otherwise. The optimization problem for participation faced by an individual takes the form:

$$\max_{\{P_t\}} V_t(P_t, A_t, W_t, Z_t) \qquad (1.51)$$

where P_t is a dummy variable, V_t is the period-t value function, A_t - beginning-period assets, W_t denotes period-t earnings from participation, and Z_t designates all non-wage variables relevant for lifecycle decision making that are not controlled by the decision maker. Asset accumulation constraint is defined by:

$$A_{t+1} = (1 + r_t)(A_t - C_t + W_t P_t + Y_t) \qquad (1.52)$$

where r_t is the return on assets, and Y_t is a component of Z_t representing income not attributable to earning or returns on assets. The above problem is solved by deriving value functions for each time period being considered of the:

$$V_t(P_t, A_t, W_t, Z_t) = V_t^p = P_t V_t^1 + (1 - P_t)\, V_t^0 = V_t^p(A_t, W_t, Z_t) \qquad (1.53)$$

where first order conditions are:

$$
\begin{aligned}
V_t^1 &= \max_{\{C_t\}}\{U(1, C_t, Z_t) + \\
&\quad +kE_t[(\max V_{t+1}^p[(1+r)(A_t - C_t + W_t + Y_t)W_{t+1}, Z_{t+1})]\} \qquad (1.54) \\
V_t^1 &= \max_{\{C_t\}}\{U(0, C_t, Z_t) + \\
&\quad +kE_t[(\max V_{t+1}^p[(1+r)(A_t - C_t + Y_t)W_{t+1}, Z_{t+1})]\}
\end{aligned}
$$

where E_t denotes the consumer's expectation about variables W_{t+1} and Z_{t+1} conditional on information i_t at time t, which includes W_t and Z_t. The term k is a discount rate. The value function in the last period τ is:

$$V_\tau^p = P_\tau V_\tau^1 + (1 - P_\tau)V_\tau^0 = V_\tau^p(A_\tau, W_\tau, Z_\tau) \qquad (1.55)$$

$$
\text{where} \quad
\begin{aligned}
V_\tau^1 &= \max_{\{C_\tau\}} U(1, C_\tau, Z_\tau) \qquad \text{s.t.} : C_\tau = A_\tau + Y_\tau \qquad (1.56) \\
V_\tau^0 &= \max_{\{C_\tau\}} U(0, C_\tau, Z_\tau) \qquad \text{s.t.} : C_\tau = A_\tau + Y_\tau \qquad (1.57)
\end{aligned}
$$

Formulations for value functions and optimal choices are then derived by solving the above value functions recursively using backward induction.

Labour supply models with learning by doing

The labour supply model that incorporates learning-by-doing is based on assumption that wage rates grows with experience. More one has work experience higher his or her wage is likely to be. Noteworthy feature of such models is that it does not have to accommodate for investments in human capital, as the simple state of being in employment generates returns in form of higher wages. Learning-by-doing type model was first developed by Heckman (1971, 1976) and later has been refined by the other researchers.

Learning by doing with participation

Two main components of the conventional learning by doing models are as follows:

$$K_{t+1} = G(K_t, P_t) \qquad (1.58)$$

where experience capital K_t depends positively on past participation through a dynamic equation. Wages depend positively on K_t according to the function:

$$W_t = W_t(K_t, \eta_t) \qquad (1.59)$$

where η_t represents the unobservable component of wages, implying that work not only brings immediate returns, but also increases future wages by increasing experience capital, η_t represents the wage error.

The solution to the individual's participation problem follows closely that of the standard dynamic labour supply model with participation. In each period, the individual makes a labour supply decision to maximize his or her utility given accumulated work experience. It is clear that learning by doing introduces a trade-off between the increase in utility that can be achieved by reducing work hours and the increase in future productivity that can be achieved from learning on the job. This implies that the wage alone is no longer the appropriate measure of the return to working. An additional valuation term must be included to account for increases in future wages which result from the accumulation of experience capital while working.

Learning by doing with continuous hours choices

Empirical evidence indicates that in a learning-by-doing type labour supply models the number of hours of work itself is an important determinant of wage growth. The above presented equation for experience capital needs to be modified to incorporate continuous hours choices as follows:

$$K_{t+1} = G(H_t, K_t) \tag{1.60}$$

where H_t is hours of work in period t, and G is an increasing function of H_t. Choices over hours and consumption are made by maximizing equation:

$$\begin{aligned} V(A_t, W_t, K_t, \eta_t, X_t) &= \max_{\{C_t, L_t\}} \{U(C_t, L_t, X_t) + \\ &\quad + kE_t[V(A_{t+1}, W_{t+1}, K_{t+1}, \eta_{t+1}, X_{t+1})]\} \end{aligned} \tag{1.61}$$

The first order conditions for the allocation of time generalize to account for the role of experience capital. Assuming an interior solution for this continuous hours problem we have:

$$U_L(C_t, L_t, X_t) = \lambda_t W_t + kE_t[\Gamma_{t+1}\left(\frac{\partial G}{\partial H_t}\right)] \tag{1.62}$$

$$\Gamma_t = \lambda_t H_t \left(\frac{\partial W}{\partial K_t}\right) + kE_t[\Gamma_{t+1}\left(\frac{\partial G}{\partial K_t}\right)] \tag{1.63}$$

where $\lambda_t = \partial V_t / \partial A_t = \partial U_t / \partial C_t$ and $\Gamma_t = \partial V_t / \partial A_t$

As one can see now the value of work is no longer just the wage, but now includes the return to experience capital. Thus, all future wages and implied work decisions should be included in determining the value of work.

Labour supply models with human capital

Impact of investment in human capital on level of wages is similar to the impact of the learning by doing: individual's human capital, namely skills and knowledge, has a direct effect on the determination of individual's wages. As in case of the learning by doing models enhancements in human capital can result in higher wages in future. However, the human capital model differs from learning-by-doing model in one aspect; namely, the former considers investments in human capital.

Human capital models with participation

In such set up, in each period an individual must choose between participation in work, P_t, and participation in human capital investment, P_t^*, and leisure L_t. The wage, W_t, is determined as a function of human capital, K_t, according to the function, $W_t = W_t(K_t, \eta_t)$ where K_t depends on past investment decisions and accumulates according to the dynamic equation:

$$K_{t+1} = G(K_t, P_t^*) \qquad (1.64)$$

The problem is, in principle, more complicated now because the individual must choose among three activities. However, this problem can be solved by reinterpreting the discrete hours choices as options over the four states characterized by the four possible values combinations of P_t and P_t^*.

Human capital models with continuous hours choices

With introduction of the third option, namely investment in human capital, in the continuous hours-of-work problem individuals have to choose how much time in each period to spend in three activities: leisure L_t, hours of work H_t, and human capital investment S_t. Their choice problem is to choose L_t and C_t:

$$V(A_t, W_t, K_t, \eta_t, X_t) = \max_{\{C_t, L_t\}} \{U(C_t, L_t, X_t) + +kE_t[V(A_{t+1}, W_{t+1}, K_{t+1}, \eta_{t+1}, X_{t+1})]\} \quad (1.65)$$

subject to the human capital equations $K_{t+1} = G(K_t, S_t)$, the asset accumulation conditions and $L_t + H_t + S_t = T$. This results in two additional conditions:

$$U_L(C_t, L_t, X_t) = kE_t[\Gamma_{t+1}\left(\frac{\partial G}{\partial S_t}\right)] \quad (1.66)$$

$$\Gamma_t = \lambda_t H_t \left(\frac{\partial W}{\partial K_t}\right) + kE_t[\Gamma_{t+1}\left(\frac{\partial G}{\partial K_t}\right)] \quad (1.67)$$

Given these expressions, the marginal utility of leisure still equals λ times the wage rate, the marginal rate of substitution between consumption and leisure still equals W, and the Euler equation for consumption continues to hold.

Time must be allocated among three types of activities while satisfying the above 2 conditions, which imply that rate the return to training must equal the return to leisure which equals the return to work. The return to training depends on the marginal value of a unit of human capital, Γ, and the above Euler equation determines its time path. Thus, levels of both leisure and training must be selected to equate their marginal values with λ times the wage – remaining number of hours then will be spent at work.

Part III

Empirical Findings for Models of Labour Supply

The empirical evidence on labour supply can be found in the results of the empirical surveys and the econometric estimates of labour supply functions. Most of the surveys on labour supply models have usually come to the conclusion that labour supply is insensitive to changes in wages. The results of this kind point on the fact that labour supply does not vary significantly with the wage rates. Hence, if these conclusions were correct then labour supply curve has to be nearly vertical. In terms of the theory the survey results indicate to an income effect that almost entirely offsets the substitution effect. On the other hand, the above discussion has hinted that the responses of the different groups of agents to the wage changes may vary. This section provides an overview of the key findings of some recent empirical research of labour supply. It considers both static and intertemporal setting and focuses on the studies of labour supply in developed and transition economies.

Hausman (1981) was among the first who has provided a thorough discussion of static labour supply model with taxes along with estimation techniques needed to estimate labour supply responses to income tax changes. In his paper, Hausman (1981) estimates the effect of taxation and transfers on the labour supply of a sub-sample of husbands, wives, and female family heads that have children under the age of eighteen from the 1975 US Panel Study of Income Dynamics (PSID), treating the husband as the primary earner and the wife as the secondary earner. His sample size consists of 1085 individuals employed of age 25-55 years. Hausman's model assumes linear labour supply specification with non-convex piecewise-linear budget constraint. The wage coefficient is considered to be constant across individuals, in contrast to virtual income coefficient which varies. Econometric estimation is made by maximum-likelihood approach and allows for variations in preferences. For prime-age males, Hausman finds that the uncompensated labour supply elasticity is closer to zero.

In contrast, he finds the substantial income elasticity among husbands. Since the wage and income variables from the convex and non-convex budget sets are similar, Hausman concludes that for estimation purposes it is probably reasonable to smooth the non-convexities created by the earned income credit, social security taxes, and the standard deduction. In contrast to husbands, the magnitude of the uncompensated and income elasticities is substantial among wives. Besides the convex and non-convex cases, Hausman also assumes an explicit specification allowing the inclusion of the fixed costs of working for wives. The obtained estimates of the wage elasticities are midway between those of husbands and those of wives.

General results obtained by Hausman indicate that income taxation does discourage labour supply. Moreover, the higher marginal tax rate lead to greater reduction in labour supply, in contrast to the reduction in tax burden, which leads to increase in labour supply.

Blomquist's (1983) estimation of labour supply functions is similar to Hausman's approach (1981). Blomquist estimates labour supply functions for Swedish males, using 1974 Swedish Level of Living Survey conducted by the Swedish Institute for Social Research. His sample size consists of 688 employed and married males of age 25-55 years. He assumes linear labour supply specification with piecewise-linear analysis with a convex budget set to account for the highly progressive Swedish income tax. Similar to Hausman's estimation, the wage coefficient is considered to be constant across individuals, in contrast to virtual income coefficient which is allowed to vary. Estimation by maximum-likelihood yielded the estimates of -0.03 for income elasticity, 0.11 for wage elasticity and 0.08 for uncompensated wage elasticity.

MaCurdy (1983) estimates intertemporal labour supply model with taxes. He uses the data from the 1972-1975 Pre-enrollment and the Monthly Labour

Supply Files of the Denver Income Maintenance Experiment for 121 married prime-aged males. MaCurdy uses two-stage instrumental variable technique in order to estimate marginal rate of substitution functions, monotonic transformations and the income and substitution effects. His estimates of the substitution and income effects are larger compared to the previous studies of the intertemporal labour supply with taxes[3]. The instrumental variable estimation technique yields the uncompensated wage elasticity in a range of 0.31-0.7 and the income elasticity in a range of -0.28 and -0.16. MaCurdy also finds that the family size influences the inter-period allocation of resources. More specifically, he finds that as the number of children in the family increases the husbands is induced to increase the supply of labour, hence, more resources are allocated to the periods with more children.

Blundell et al. (1988) estimate generalized version of the Stone-Geary labour supply. They use data from the 1980 British Family Expenditure Survey for 1400 married women. Estimation by maximum-likelihood approach allowing for random preferences yielded relatively low uncompensated wage elasticities, in contrast to the compensated elasticities, which were found to be quite large. Moreover, these compensated elasticities were positive across a wide range of demographic groups.

MaCurdy et al. (1990) use the data from the 1975 Michigan PSID in order to analyze the labour supply of 1017 married males of age 25-55 years. They analyze linear labour supply specification with piecewise-linear and differentiable budget constraints. The analysis shows that the maximum-likelihood estimation technique with non-linear budget sets implicitly relies on the satisfaction of inequality constraints that translate into behaviorally meaningful restrictions. These constraints arise from the requirement to create a well-defined statistical model, and not as a consequence of economic theory. MaCurdy, Green and

[3]See Cain and Watts (1973) and Borjas and Heckman (1979)

Harry further present the empirical results which suggest that the disparate results found in the literature on the males' labour supply are stemming from the implicit constraints.

Triest (1990) analyses the sensitivity of Hausman's estimates to changes in model specification. By using a 1983 sub sample of the PSID, the author estimates the various variants of Hausman's model. He uses the linear labour supply specification with the linear measurement error. Triest employs the maximum-likelihood approach allowing the heterogeneity in preference separately, measurement error separately, and both heterogeneity and measurement error included in addition to instrumental variables estimation assuming only heterogeneity. The estimates across model specifications indicate that the supply of labour for prime-aged married men is relatively invariant to the net wage and virtual income. However, in contrast to Hausman's results, Triest finds no virtual income effect. The net wage elasticities are positive and larger than those obtained by Hausman. The results for females have shown to be more sensitive to the labour supply specification. Net wage elasticities resulting from a censored estimator are similar to those of Hausman.

An interesting paper is given by Mokhtari and Gregory (1993). They estimate the effects of consumer-market shortage on Soviet labour supply. The authors use micro data from interviews with 2793 Soviet emigrants to the US conducted under the auspices of the Soviet Interview Project in the early 1980s. The paper uses two settings of the labour supply specification: the first setting includes the quantity constrains associated with the consumer-market shortages; and, the second setting excludes the quantity constraints in order to evaluate the effect of the elimination of the quantity constraints on hours of work in a planned socialist economy. The estimation by maximum likelihood (Logit) of Soviet labour supply produces negative uncompensated wage elasticities. The negativity of the uncompensated wage elasticities indicates that workers facing quantity constraints react more strongly to wage increases than workers who do not face quantity constraints. The overall conclusion from the study is that the removal of the consumer-market shortages is expected to raise aggregate hours of work in the Soviet economy.

Friedberg (1995) analyzes data from the United States March Current Population Survey. She considers the linear functional specification and employs a convex budget set with the piecewise-linear budget constraint in order to study a progressive taxes and the social security earnings test. Estimation is by maximum-likelihood method. Freidberg uses the Heckman sample selection technique in order to predict non-participant wages in the labour supply equation. The estimates result in a compensated wage elasticity of 1.12, an uncompensated wage elasticity of 0.36, and an income elasticity of -0.76.

Eissa and Liebman (1996) examine the impact of Tax Reform Act of 1986 (TRA86) on the labour force participation and hours of work of single women with children. They find that between 1984-1986 and 1988-1990, single women with children increased their relative LFP by up to 2.8 percentage points. Additional finding also showed no change in the relative hours worked by single women with children who were already in the labour force.

Garsia and Jose Squarez (2002) estimate four models of married female labour supply using the data from the 1994 Spanish section of the European Household Panel which is carried out in Spain by the Instituto Nacional de Estadistica. The empirical analysis is based on a sample of married women who are living with their husbands and are not the household head. The sample size consists of 2586 observations. The analysis is restricted to couples between 16 and 65 years old. They specify four alternative models, which differ with regard to the hypothesis about the optimization error and/or the likelihood contribution of non-workers. Garsia and Jose Squarez follows Hausman's approach in estimating the four models using the maximum-likelihood approach with piecewise-linear budget constraints. The results obtained for the four models suggest that the effects of wages and non-labour income on the labour supply of Spanish married women depend on the specification used. The model which has both preference and optimization errors and allows for both voluntarily and involuntarily unemployed females desiring to participate seems to better fit the evidence for Spanish married women.

Bhattarai and Wisniewski (2002) use British Household Panel Survey to explore characteristics of the UK labour market with special emphasis on explanation of the existing wage inequalities, determinants of participation and variation in the magnitude of hours of labour supplied among individuals. They explain up to 92 percent of variance in the wage rates from the supply side. Accuracy of the model is accounted by a variety of factors relevant to the labour market, such as gender gaps, marital status, on and off the job training, fluency in English and regional characteristics. They find that the psychological profile of an individual has a very big influence over his decision on whether to participate, but once he joined the labour force his personal beliefs and opinions have no further impact on the probability of finding a job. They also find that the chance of being employed once participating depends mainly on the local labour market conditions.

Kalb (2002) estimates labour supply models for four subgroups of the Australian population: couples with and without children, single men, single women, and sole parents. Kalb assumes linear functional form with income taxation, fixed costs and missing wages, as well as non-convex budget set. The maximum-likelihood method is employed to estimate linear labour supply function. The obtained results suggest that preference for labour supply highest for people who are in their 30's with a high education level. Moreover, the education levels are found to be more important for women than for men and the preference for labour supply is lower for women with children, in particular when the children are young.

Ziliak and Kneisner (2004) estimate the incentive effects of income taxation in an intertemporal model of consumption and labour supply that relaxes the standard assumption of strong separability within periods. They use data on 1980-1999 male heads of household from the US PSID, which spans the major recent federal tax reforms in the United States from the Economic Recovery Tax Act of 1981 to the Taxpayer Relief Act of 1997. The analysis is restricted to males between 25-60 years old. The estimation was conducted following MaCurdy's (1983) two-stage instrumental variable technique. The model permitted identification of both within-period preference parameters and lifecycle preference parameters such as the inter-temporal substitution elasticity. The estimates by the two-stage estimation methods yielded the compensated net wage elasticity of 0.3, the intertemporal substitution elasticity of -0.96, and the Frisch elasticities of 0.1 and 0.5. The results pointed that consumption and hours worked are direct complements in utility, and both increase with an increase in the after-tax share and with a compensated increase in the net wage. Further, the obtained estimates of the Frisch elasticities of consumption and labour supply with respect to the after-tax wage are indicated on the significant inter-temporal smoothing of utility.

Ziliak and Kniesner (2005) use Panel Study of Income Dynamics 1979–98 to identify the tax effects on work incentives and consumption and to estimate the incentive effects of income taxation in a life-cycle model of consumption and labour supply without intra-temporal strong separability. They find that consumption and hours worked are direct complements in utility; both increase with a compensated increase in the net wage. The compensated net wage elasticity is about 0.3, nearly double estimates for U.S. men from a linear labour supply specification. Estimated intertemporal elasticities indicate significant intertemporal smoothing of utility. The estimated marginal welfare cost of government revenue is 6%–20%, which is about half the estimated welfare cost when additivity between consumption and leisure is incorrectly imposed.

Tondani (2006) estimates the elasticities of the labour supply for four categories of Italian workers: married men, married women, unmarried men, and unmarried women. He uses the micro data from the 2002 Survey of Households' Income and Wealth (SHIW) provided by the Bank of Italy. Tondani assumes the linear functional specification with the piecewise-linear budget constraint. The sample size consists of 21144 individuals 13536 of which receive income benefits. The analysis is restricted to the individuals between 19 and 60 years old. The estimates of the wage and income elasticities by Tobit technique suggest that hours of work are positively related to after tax labour income and negatively related to virtual income. Female labour supply is more sensitive than that of males to an increase in net wage.

Blundell et al. (2008) use British panel data collected over the period of 1990-2002 to investigate single women's labour supply changes in response to three British 1990s in-work benefits reforms. They use 1992, 1995 Family Credit (FC) reforms and 1999 Working Families' Tax Credit reform to identify changes in labour supply. They find that 1992 and 1995 FC reforms had small hours of work effects in contrast to WFTC reform which led to a significant increase in single mothers' hours of work. The mechanism by which the labour supply adjustments were made occurred largely through job changes rather than hours changes with the same employer. They have shown that adjustments in hours of work are made primarily by movements between jobs, and found little evidence of systematic labour supply–induced hours movements within jobs. Therefore, the analysis showed that responses were greater among those who said that they are unconstrained as well as among those who were constrained but stated that they would like to move in the direction suggested by the incentives. Thus, a labour supply model could emerge in which hours adjustments are largely made by moving between workplaces.

Aguero and Marks (2008) study the relationship between children and labour force participation for women in Latin America. They use cross-sectional data from the Demographic and Health Surveys (DHS) in Peru (conducted in 1996), Guatemala (1998), Colombia (1995), Bolivia (1994 and 1998), Nicaragua (1998), and the Dominican Republic (1996) to study the impact of fertility on female labour force participation of women. The results from the study provide little support for the belief that the rise in female labour force participation in Latin America can be attributed to declining family sizes. Instead, the findings suggest that rising labour force participation rates among women in Latin America are closely associated with the empowerment of women. Finally, the study suggests that policies focusing solely on family planning are unlikely to increase female labour force participation in Latin America.

Ali Khan and Khan (2009) study the factors that influence the decision of Pakistani married women to participate in labour force activities. They employ International Food Program Research Institute (IFPRI) survey data to run probit model on 3911 observations. The finding of the study suggest that such factors as female age, education, household poverty, family size, number of daughters over 15 years of age, husband's unemployment and low income, and rural locality have a significant positive effect on labour force participation of married women. On the other hand, ownership of assets by the household, per capita income, being a nuclear family, number of infants, number of sons over 15 years of age, and husband's education have shown a negative effect. Poverty in an overall perspective is found to be the major determinant of the labour force participation of married women.

Colonna and Marcassa (2011) use micro data from the EU-SILC, the Community Statistics on Income and Living Conditions to estimate a structural labour supply model for women and use the estimated parameters to simulate the effects of alternative revenue-neutral tax systems. They find that the participation rate of married women is positively correlated to their husbands' income and show that a high tax schedule together with tax credits and transfers raise the burden of two-earner households, generating disincentives to work. Moreover, the findings of the study suggest that joint taxation implies a drop in the participation rate. Conversely, working tax credit and gender-based taxation boost it, with the effects of the former concentrated on low educated women.

In contrast to the empirical literature on developed countries, the empirical evidence of the behavior of labour supply in transition economies is relatively scarce. Moreover, most of the empirical estimation was focused on the choices at the extensive margin, which is the labour force participation decision. The explanation for the studies of labour force participation rather than optimal hours of work is found in the presence of the labour contracts and incompleteness of data on wages, non-labour income and other determinants of labour supply in the transition economies.

Saget (1999) uses 1992 data to estimate a labour force participation model for 720 Hungarian prime-aged females. The estimations result in labour force participation rate of 1.81, a value which is relatively high compared to other studies of labour force participation.

Chase (1995) compares labour force participation of Czech and Slovak married women (between 20 and 69 years of age) before (in 1984) and after (in 1993) the change of the political regime and the division of Czechoslovakia. Chase finds that the wage semi-elasticity of labour force participation changed from 0.54 to zero for the Czech and from 0.49 to 0.63 for the Slovak married women between the two years.

An interesting paper was provided by Slinko (1999) who estimated the Russian labour supply function in order to explain why the individuals faced with chronic wage arrears continued to spend certain amount of their time at their state jobs. She estimates log-linear labour supply function by Tobit estimation technique. The data is provided by the 1998 Russian Longitudinal Monitoring Survey by Carolina Population center at the University of North Carolina at Chapel Hill. The survey includes 10677 interviews. The sample size of the data considered 4047 individuals of which 111 were on maternity leave. The estimated model reports positive uncompensated wage and cross-wage elasticities, negative income elasticities and indicates on the need of including Russia-specific factors, as wage arrears and unpaid leaves into the model.

Ivanova et al. (2005) use micro-level data to examine the employment effect of introduction of a flat income tax in Russia in 2001. The main finding of this paper is that while revenues increased, these increases in revenues were the results of the better compliance, while the total labour supply effect was relatively limited.

Bic'akova et al. (2008) estimate the wage elasticity of the labour force participation in Czech Republic. The study uses Heckman selection to employment approach to estimate the standard static labour supply function with taxes. The data used originates from the Czech Household Income Survey for the year 2002 and covers 19003 individuals in 7973 households. Bic'akova et al. (2008) estimates two models of labour supply behavior. The first model excludes any tax and benefits system variables and produces uncompensated wage elasticities of 0.16 and 0.02 for females and males, respectively. The second model takes into account tax and benefit system of the Czech Republic and its estimation results in the semi-elasticities of 0.06 and 0.01 for women and men, respectively.

Pastore and Verashchagina (2008) investigate the determinants of female labour force participation in 1996 and 2001 using the data from the Belarusian Household Survey. They use the Heckman two-step procedure to estimate the sensitivity of female labour force participation rates to changes in wages. They find that elasticities of female participation to wages were low (approximately 0.45 in 1996 and 0.41 in 2001). Moreover they find that, women in low-income households had much lower than average participation rates. At the same time, the findings suggest that the elasticity of female labour supply with respect to the own wage were much higher for the low-paid groups of women.

Staehr (2008) estimates the employment and welfare effects of flat personal income taxation in Estonia. He finds that economic incentives affect the participation decisions of the individuals, but not the number of hours worked by individuals already working.

As it was noted, research on labour supply in transition economies is in its early stages. In order to further discuss the issues of labour supply in other transition economies, and investigate specifics of these economies compared to other developed and developing economies, this study further analyses the labour supply in three other transitions economies. This is the first attempt to analyze labour markets of these economies and provides comprehensive sensitivity analysis of labour supply on wage changes. The results of the study can be used in important public policy discussions, where determination of wages and controlling employment are key issues. Especially during the anti-crisis period, where more than two-thirds of developing economies reduced their individual income taxes only because of employment issues. Thus, the results of the study maybe important and crucial in economic development and labour market program design processes.

Chapter 2

Methodology

Labour supply estimations have been implemented by many empirical studies and the results of these studies greatly vary. The differences in these results come from the differences in controls that have been chosen and estimation approaches taken. Pencavel (1986), Blundell and MaCurdy (1999), and Killingworth (1983, 2000) propose a variety of approaches to modeling labour supply. Clear distinction between different methodologies must be explicitly identified, as the results can vary greatly.

Across labour supply literature, several complications during estimations of labour supply functions arise. These mainly include: (i) Sample selection bias, which arises when labour supply decisions cannot be observed for individuals with higher reservation wages; and, (ii) endogeneity of wages and income, arising from correlation between unobserved person-specific factors with observable wage variables.

The approach chosen in this study follows Heckman two-step procedure and used to mitigate the above mentioned problems. Econometric treatments of the complications are as follows: sample selection requires specific methods for censoring data estimation, hence Heckman procedure is employed and endogeneity is tackled with instrumented explanatory variable (i.e. log of average wages in the local labour market for specific gender/education group)[1].

2.1 Heckman Procedure Estimation

Following Heckman (1974) labour supply regression is estimated on a sample where the probability of selection into the sample is correlated with the realized value of the dependent variable. Consequently, the sample of workers is censored as participation can be observed only for those with lower reservation wages[2].

Assume that work hours are represented by the following structural labour supply equation:

$$\log h_i = \alpha_0 + \alpha_1 \log w_i + \alpha_2 X_i + \varepsilon_i \qquad (2.1)$$

where X is a vector that includes observable taste variables affecting labour hours, while ε_i stands for "unobserved tastes" for work. Thus, variable of the primary interest from the empirical specification is α_1.

The OLS estimates of (2.1), conducted over subsample of workers will be biased. The ultimate goal is to obtain unbiased estimates of the wage elasticity. Note that work hours for each particular individual will be positive if:

$$\log h_i > 0 \Longrightarrow \varepsilon_i > -\alpha_0 - \alpha_1 \log w_i - \gamma_2 X_i \qquad (2.2)$$

[1] I would like to thank Professor Lorenzo Cappellari from Università Cattolica in Milan for his valuable suggestions and thorough assistance in the choice of the instrument for tackling endogeneity problem.

[2] In general, Heckman estimation procedure is a bit different since it specifies a system of equations, namely, hours equation (h = f(w, X)) and wage equation, w = g(Z). Since, the wage rate is unseen for those who are not in employment; the one can predict wages for these unobserved individuals in accordance with a system of equations: 1) wage equation; 2) selection to employment equation. Once the predicted wages have been obtained, their values are imputed into labour force participation (LFP) equation to estimate the wage sensitivity of LFP. The approach taken in this thesis uses a bit modified Heckman equation and is discussed below.

Hence, the presence of a particular person in the subsample of workers is conditional on observable controls of $\log w_i$ and X and determined by: 1) either high unobserved tastes for work ε_i or (2.2) high unobserved wage-earning ability which permits to match the reservation wage with the market one. It is assumed that that the error term from (2.1) is independent and normally distributed across individuals.

As long as condition (2.2) must be satisfied, it can be verified that the expectation of the error term from (2.1) does not equal zero, leading to biased estimates if simple OLS is used.

$$
\begin{aligned}
E(\varepsilon_i \quad | \quad \log h_i > 0) &= E(\varepsilon_i \mid \varepsilon_i > -\alpha_0 - \alpha_1 \log w_i - \gamma_2 X_i) = \\
&= \frac{\varphi\left[\left(-\alpha_0 - \alpha_1 \log w_i - \gamma_2 X_i\right)/\sigma_\varepsilon\right]}{(1-\Phi)\left[\left(-\alpha_0 - \alpha_1 \log w_i - \gamma_2 X_i\right)/\sigma_\varepsilon\right]} = \lambda_i \qquad [2.3]
\end{aligned}
$$

where Φ is a standard normal cumulative distribution function, φ is the standard normal density function, and λ_i, represents inverse Mills ratio which varies across observations. Hence, taking into account (2.3), the equation of labour supply over the sample of participants takes the following form:

$$
\log h_i = \alpha_0 + \alpha_1 \log w_i + \alpha_2 X_i + \lambda_i + \varepsilon_i^{'} \qquad (2.4)
$$

which is the augmented labour supply equation.

Note that the wage rate in equation (2.1) is assumed to be endogenous and correlated with the error term due to unobservable individual effects via productivity and preferences (Mroz, 1987). The assumption that individual wages are exogenous has been regarded as implausible in most previous literature. There have been plenty of arguments in favor of endogeneity of wages in labor supply. The main one is that unobserved heterogeneity across agents may affect both somebody's preference for work and his or her productivity, and, hence, wages. Another argument against exogeneity of wages is that jobs may come in wage-hour packages. Thus wages may not be determined independently from hours. One can also say that individuals may be able to influence their earnings through investment in their human capital. In all these cases the error term in the labor supply is to be correlated with observed wages which in turn renders parameter estimates biased and inconsistent. Although there are common specification tests (eg. Hausman, 1978) that could be used to determine the presence of endogeneity, this study does not provide them as the prevailing belief in literature is wages are endogenous.

The most challenging part of addressing endogeneity is finding suitable instruments, eg. variables that are correlated with endogenous wages but not with labor supply. A common instrument for wages is union membership (Blanchflower and Bryson, 2010), but it seems that it is not appropriate in this study case. Rare membership aside, trade unions do not have substantial bargaining power in most transition economies and it is certainly true in post Soviet countries. Their functions are reduced to specific social benefits, like admission to preferred health care, vacations, etc. Instead this study opts to use average wages in local markets for specific gender/education group. Average wages mitigate the endogeneity of individual productivity and capture the effect of expected wages on somebody's labor supply. The term local labor market implies different stratum in a country. Hence, a person, say Uzbek female, with higher education and residing in Tashkent city (capital of Uzbekistan) faces different average wage rate compared to Uzbek female with higher education in Samarkand city. Complete list of regions for each country can be found in the appendix.

Considering issues above, the following system of equations has been used to estimate wage sensitivity of labour hours:

$$\begin{aligned} \text{employment equation} &: \Pr(EMP = 1 \mid Z) = \Phi\left(\beta_0 - \beta_1 Z_i + \mu_i\right) \\ \text{hours of work equation} &: \log h_i = \alpha_0 + \alpha_1 \log w_i + \alpha_2 X_i + \lambda_i + \varepsilon_i^{'}, \text{if } EMP = 1 \end{aligned}$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution function. Selection bias problem can be tackled by Heckit procedure: (i) estimation of probit equation by maximum likelihood for employment equation gives a selection correction variable (namely, the inverse Mills ratio); (ii) estimation of the labour supply with the inverse Mills ratio from the first stage gives unbiased estimator. The study assumes that error terms are independent across individuals and jointly normally distributed with zero means, variances σ_μ^2 and σ_ϵ^2 and correlation coefficient $\rho_{\mu\varepsilon}$.

Hence, in the first stage the probit model for employment is estimated which defines how various characteristics affect the decision to participate in employment. These characteristics include such factors as the level of education, age, sex, marital status, other income, number of children in the family and type of settlement. The second stage involves the estimation of the sensitivity of work hours to changes in the wage rate (the variable of primary interest) and other variables as occupation, other income (gives an indicator of the income effect) and degree of urbanization.

Finally, all the standard errors of the coefficients from the model of hours of work are bootstrapped to account for the fact that the study uses an instrumented wage variable in the estimations.

2.2 Data and Variables

The data used in this study originates from various sources. The samples are restricted to all working ages which include all individuals of $16 - 64$ ages year old that are engaged in employment. Students, pensioners and individuals employed by informal sector are excluded from the analysis.

For Albania the study employs Albanian Living Standards Measurement Survey (LSMS) conducted by the World Bank in 2005. Albanian LSMS is retrospective questionnaire which covers labour market issues at both individual and household level. The data estimated is a cross-section and was gathered for nearly 17500 individuals from 5400 households which reflect the characteristics of the total Albanian labour force.

To estimate sensitivity of labour supply to changes in wages in Bulgaria and Serbia the study employs cross -section LSMSs for Bulgaria and Serbia conducted by the World Bank in 2003 for the former and latter, respectively. For Bulgaria the study estimates wage elasticity of labour supply for 8168 individual respondents. For Serbia the sample covers 8027 individuals.

The 2009 LSMS for Tajikistan is a panel survey of 1,500 households and contains information on 10069 individuals.

Finally, the estimation of labour supply wage elasticity in Uzbekistan is based on micro-data collected by the GIZ in Uzbekistan and "Expert Fikri" for 2011.The survey is cross-section and covers 1000 individuals representing 13 regions of Uzbekistan.

Although, the surveys conducted contained fairly large samples, complete information on wages, labour supply hours, and other individual specific characteristics are not available for all the respondents in the samples. Still, these indicators serve as relevant variables in the labour supply models in this analysis.

The descriptive statistics on the variables of primary interest, namely weekly hours of work and net monthly wages, are provided in table 1.

Table 1. Weekly hours of work and net monthly wage rates

Variable	Observations	Mean	Standard deviation
	Albania		
Hours of work	5803	43.46	13.39
Wage rate	3972	224,185.7	373036
	Bulgaria		
Hours of work	3750	40.45	11.36
Wage rate	2590	219.323	171.30
	Serbia		
Hours of work	3466	37.07	17.70
Wage rate	2514	10,502.11	8392.16
	Tajikistan		
Hours of work	2678	41.71	17.41
Wage rate	2123	396.96	553.0331
	Uzbekistan		
Hours of work	373	43.11	14.36
Wage rate	311	311,158.1	11000

Although volatile, the reported hours of work in all countries under the analysis range around 37-44 hours per week, which is a standard range in most of the transition economies. Composition of wages in the analyzed sample of countries suggests that on average net monthly pay for Albanian individual amounts to 224,185 Lek, 219.32 Lev for Bulgarian individual, 10502.11 Serbian Dinars for Serbian individual, 369.96 Somoni for Tajik individual, and

311,158 Uzbek Soums for Uzbek individual, respectively[3]. Expressed in Euro terms, monthly salaries in all of the above countries are relatively low in accordance with international standards and clustered around 100 Euros in Bulgaria, Serbia, Tajikistan and Uzbekistan. Albania in comparison to 4 countries on average is found to possess higher monthly wages in amount of 1590,3 Euros per month.

The set of explanatory variables for the Heckman selection to employment equation model includes[4]:

- Age and age squared: The mean age rates in the samples vary in range of 26-41 years for all countries under the study.

- Gender: Dummy for gender takes on value of zero if male and one for female. Males comprise the majority of respondents for Balkan countries (around 51 percent) whereas females comprise the majority of respondents in Central Asian countries (around 51 percent). One of the possible explanations is found in the fact that very large proportion of Central Asian male population works abroad and were absent during the surveys.

- Marital status: Dummy variable that assigns the value on one for married individuals as well as for partners living together. Zero value is assigned to individuals who are single, divorced or widowers. That is, in this analysis term "married" is expanded to include those who have permanent partners living together without civil registration since such relationships in many ways resemble normal families. In accordance, with the data the majority of populations in samples are reportedly married (range 51 - 68 percent).

[3] Information on net earnings across respondents in estimation samples varied since some respondents reported their net earnings on monthly, daily, and weekly basis. In this study all weekly reported wages have been multiplied by 4 (average number of weeks), all daily reported wages have been multiplied by 22 working days in order to arrive to a measure of monthly net earnings. This study estimates monthly work hours by multiplying weekly average work hours by 4 for all working respondents in the estimation sample. Then net hourly wage is calculated by dividing the reported monthly wage with estimated monthly work hours.

[4] The description of this set of explanatory variables can be found in appendix.

Note the remarkable differences in marital status between Balkan and Central Asian countries. In general, the proportion of married individuals in Balkan states is substantially lower as compared to Central Asian states. This again can be explained by cultural and religious traditions prevalent in oriental and western societies.

- Education: Variables that are reflected by dummies for the highest degree that a person possessed. Education dummies are broken down into five categories consisting from: Individuals with graduate, postgraduate and undergraduate diplomas (higher education), individuals that possess from $2-5$ years of vocational education (vocational education), individuals with general secondary education, individuals possessing the level of primary education, and individuals without any educational attainment. In general vast majority of respondents in Albania have primary education (60.61 percent), in Bulgaria vocational education (39,85 percent), in Serbia secondary and vocational education (36.67 percent and 38.01 percent, respectively), in Tajikistan secondary education (40.13 percent) and, in Uzbekistan secondary and vocational education (40.5 percent and 35.53 percent, respectively). Note that in all countries under the study level of higher education among the respondents is relatively low (around 7 percent in general).

- Type of settlement is represented by dummies one for urban settlement and zero for rural. More than 50 percent of respondents in Balkan states are found to reside in urban residence in contrast to more than 50 percent of rural population (rural residence includes such settlements as villages, towns, etc.) residing in Central Asian countries. This is not surprising since Central Asian countries are characterized by larger agrarian sectors as compared to Balkan states.

- Other income: The measure of other income includes non-labour income acquired outside of the labour market and includes all capital gains, transfer income as well as income coming from informal sector activities. It is interesting to note the remarkable differences between the possessions of other non-labour income in countries under the analysis. For instance, in Serbia and Bulgaria nearly 100 percent of individuals reported that they have other income sources besides labour income. The picture becomes more striking when these statistics are compared to Uzbekistan and Albania, where more than 70% of individuals reported to have no other income besides labour income. In case of Albania, this can be explained that since the country possesses relatively high wage rates among the population there is no need to finding other income sources. In contrast, in Uzbekistan the wage rates are relatively low and it is difficult to believe that somehow population survives without other income sources. One of the explanations for this result is that a large proportion of Uzbek population is somehow involved in informal market activities and does not report earnings coming from informal market in order to avoid tax payments.

- Number of children: This study utilizes information on the presence of children in a household which is sufficient information for purposes of analyzing impact of having children on labour supply decisions. It is expected that the presence of children below the school age decreases the probability of employment for adults.

The set of explanatory variables for the hours of work equation in addition to some of the regressors listed above includes:

- Occupation represented by dummies for the various categories. These categories include such sectors as public sector, self-employment, public works programs, state owned enterprises and NGOs. The study of LSMSs along with Uzbek survey revealed that most of the workers in the samples, except Uzbekistan, are involved in private sector activities. In Uzbekistan the proportion of individuals involved in public sector activities is highest among other sectors of occupation.

For a complete description of this set of explanatory variables see Appendix.

Chapter 3

Findings from the Study

Tables A1.1-A1.5, A2.1-A2.5 present the results from modified Heckman selection procedure and results of the probit model estimated at means of the variables. Prior to discussing the results it is important to review the steps that have been followed throughout estimations procedure:

In order to eliminate the selection bias Heckman two-stage procedure was employed. To overcome endogeneity of wages with respect to labour supply wage rates were proxied by average wages for local labour market for specific gender/education/settlement group.

Heckman two-step procedure eliminates the selection bias that arises when individuals with higher reservation wages are unobserved. Following the logic of Lacroix and Fortin (1992), individual specific-factors that affect the decision to be employed (i.e. regressors in the selection equation) are: age, gender, type of settlement, marital status, educational attainment, other income and number of children in a household.

The structural equation for hours of work includes variables that affect the decision on number of hours supplied and includes such variables as after-tax wage rate, degree of urbanization, occupation and other income (representing the income effect).

The results indicate that the null hypothesis of no correlation in unobservables between the selection equation and hours of work equation is rejected. The correlation coefficient is negative and suggests that unobservables determining employment decision (that is, ability and motivation) are negatively correlated with unobservables that determine hours of work. It is shown by the Wald test that provides the basis for testing whether the estimated correlation coefficient is statistically different from zero and follows χ^2 distribution. Hence, the use of Heckman estimation procedure is justified by the presence of the selection bias and inverse Mills ratio has to be included into hours of work equation.

Now we turn to an examination of the estimated coefficients for the selection and structural models. All estimated models conform to a broadly similar specification and differ only in the nature of regional controls used.

3.1 Albania

The selection equation reveals how changes in various factors affect the employment decision. The age effects are reasonably well determined and conform to prior expectations on positive relation between the age and employment. For instance, older individuals are, on average almost 22 percentage points more likely to be employed relative to those in the younger age group. Looking at the marginal effects from probit model estimations, we can infer that the probability that individual is employed increases by 0.05 percent as an individual gets one year older.

In accordance with estimation results females, on average and ceteris paribus, are less inclined to work than males. The probability that an individual is employed increases if a person is a male.

Marital status is also important, with individuals more likely to be employed compared to single ones. The marginal effect for marital status shows that the probability that individual is employed increases by 0.06 percent for married individuals.

The location variable is also important, since it reflects that people residing in urban areas, on average, are considerably less likely to be employed. That is, if a person has the urban residence then the probability that this individual is employed falls by 0.12 percent.

The selection equation shows that families with children of ages under 6 years on average are less likely to be employed. In contrast the presence of children of ages between 7-17 years old in a family does not seem to significantly affect the probability of being employed. This is perhaps not surprising since children in this age group will have started their primary schooling, hence freeing parents to engage in employment.

Turning our attention to educational attainment, we can see that employment, on average and ceteris paribus, increases with higher educational levels. The marginal effects show that employment probability increases with higher levels of educational attainment.

Finally, non-labour income, namely all sources of income other than the wage rate, negatively affect employment of individuals in Albania. In accordance with the results of the selection model, a one percent increase in non-labour income reduces the probability of being employed by 0.009 percent. This implies that responses among Albanian population to changes in non-labour income are relatively small. One plausible explanation to this result is that the majority of Albanian respondents in a sample did not possess other sources of income except the wages. Thence, the reliance of Albanian individuals from the sample on non-labour earnings may expected to be relatively low.

The structural equation provides evidence on sensitivity of hours of work to changes in various factors. The results show that wage elasticity of hours of work is relatively modest. Specifically, a 10 percent increase in the wage rate increases the number of hours supplied by 1.1 percentage points. This finding indicates that changes in hours of work are nearly insensitive to changes in the wage rates.

Whether a person resides in urban or rural areas of Albania, on average, does not seem to affect the decision on number working hours as the coefficient of settlement is insignificant.

Finally, it can be confirmed that individuals employed in public works programs and NGOs, on average, supply more labour hours as compared to individuals engaged in government sector activities.

3.2 Bulgaria

The results from Bulgarian selection equation are similar to those obtained for Albania. The estimated age effects are as anticipated with older individuals more likely to be employed than younger counterparts. The marginal effects from probit estimations indicate that a one year increase in the age increases the probability of being employed by 0.05 percentage points.

Married individuals are more likely to be employed, whereas the presence of dependent (under school age) children in a household reduces the probability of parents being employed. In particular, increase in one dependent child within a family reduces the probability of being employed by 0.04 percentage points.

The results also show that Bulgarian females, ceteris paribus, work less than males with probability of being employed increasing among masculine population.

Similar to Albania, persons residing in rural areas are more likely to be employed as compared to those residing in urban areas. One of the plausible explanation to this result is that job search is less complicated and lengthy in the rural areas as compared to urban areas. On the other hand, findings from the structural equation indicate that in general workers in larger cities,on average and ceteris paribus, work more hours in comparison to individuals employed in the regions.

The probability of being employed increases with educational attainment. The results show that individuals with higher educational levels are more likely to be employed.

Non-labour income negatively affects the probability of being employed creating a discouraging income effect. Thence, a one percent increase in non-labour income reduces the probability that Bulgarian person is employed by 0.09 percent. The magnitude of the income effect is not large, although theoretical predictions are in line. In contrast to the selection equation, findings from the structural equation show that the presence of non-labour earnings in a family insignificantly affects the number of work hours.

The structural equation presents findings on the wage elasticity of labour hours in Bulgaria. In accordance with these results, the impact of the wage rate on hours of work decision is insignificant.

Lastly, workers in public works programs and private sector are found to supply more labour hours as compared to individuals working in the government sector.

3.3 Serbia

The estimation of the selection equation for Serbia produces a positive relationship between the age and employment. Probit results suggest that the probability of being employed increases by 0.06 percent for older individuals. As is expected males are, on average and ceteris paribus, found to be more inclined to work with probability of being employed increasing if a person is a male.

In accordance with the results from the selection equation, rural residence increases the probability of being employed. Nevertheless, the results from the structural equation reflect significant and positive influence of urban residence on hours work. Specifically, workers in the urban areas are, on average, found to work longer hours opposite to their rural associates.

Marital status is found to affect positively the probability of being employed implying that married individuals are more likely to be employed. This result is in line with results documented in the standard literature. In contrast, the presence of dependent children (of any age group) in a household is found to affect insignificantly employment probability in Serbia. This result is surprising since it is expected that individuals looking after their children are less likely to be employed.

Coefficients of educational attainment clearly indicate on the advantages of higher education, particularly Ph.D., MA and BA degrees, over lower educational attainments. The probability of being employed increases by 0.32 percentage points if a person possesses higher education level.

As expected, non-labour income and employment probability are negatively related. The findings suggest that the presence of non-labour income reduces the probability of being employed by 0.07 percent. The structural equation produces slightly (the result is only significant at 10 percent level of significance) negative impact of non-labour income on work hours.

The found wage sensitivity of 0.03 percent is smallest among all countries in the study. This implies that a 10 percent increase in the wage rate increases hours of labour supplied by 0.3 percentage points.

Only public sector is found to be significant and positively related with labour hours. The results show that public sector employees typically supply more labour hours as compared to other sectors of the economy. This finding is not surprising since the one would expect workers employed by public sector to spend more hours of work in their workplaces.

3.4 Tajikistan

The estimated age effects conform to a similar pattern to that in other countries, with the estimated employment effects higher for the older age category.

No independent effect on employment is registered for a married individuals, with coefficients of marital status being insignificant for all three levels of significance.

In regard to the household structure variables, the number of dependent children in the household exerts no independent effect on probability of being employed. The age structure for the dependent children reveal that the presence of older children reduces the probability of being employed in Tajikistan.

There is also a strong regional aspect to the pattern of employment with individuals resident in the urban areas being less likely to be employed in comparison to those residing in the rural areas. Therefore, the individuals in urban settlements are considerably less likely to be employed in the formal labor market.

The absence of the primary education is found to negatively affect the probability of being employed in the labour market in Tajikistan. On average, the probability of being in employment increases with higher educational attainment. The marginal effects show that the probability that an individual is employed increases if a person possesses higher education.

The presence of non-labour income is found to affect labour hours but not the probability of being employed. Findings show that the increase in the level of non-labour income reduces work hours in Tajikistan.

The estimated effect of the wage rates on hours of labour supplied are positive and well determined. However, the magnitude of the wage elasticity suggests that, on average, labour hours are nearly insensitive to changes in the wage rates.

Again, employees engaged in public works program and self-employment are found to work longer hours as compared to public sector workers.

3.5 Uzbekistan

The age effects are again reasonably well determined and in line with prior expectations on positive relation between the age and employment. The probit equation reporting the marginal effects for Uzbekistan shows that the probability that individual is employed increases by 0.09 percent as the individual gets one year older.

Males, on average are more likely to be employed than females. This conforms the expectations that men, on average and ceteris paribus, work more hours the same wage rate than women do. This finding can be explained by traditional values in Uzbek society where males are considered as main "breadwinners" who carry main responsibility for well-being of their households.

Employment, on average, increases with higher educational levels. The marginal effects show that the probability that an individual is employed increases with the level of educational attainment. Specifically, the individuals with higher education are more likely to be employed. In contrast, the individuals with lower educational levels do not have a lot of opportunities in the formal labour market. This finding highly contrasts the positions of white and blue collar employees in Uzbekistan.

Finally, the study surprisingly finds that such factors as the presence of non-labour income, marital status, type of settlement, and the number of children in a family are relatively unimportant in the decisions of Uzbek individuals to supply labour. Marital status of the individual, being statistically insignificant at all the three levels of significance, is found to explain little of the variation in the Uzbek labor supply behavior. This is quite interesting result, since the one would expect that the motive for supplying more work hours among married individuals should be higher as compared to the single ones. However, the dominance of the men' role in Uzbek tradition can partially explain such effect.

Structural equation provides the evidence on the wage sensitivity of the number of Uzbek labour hours along with various factors. The wage elasticity of the hours of work is relatively modest, though, highest among all other countries under the study.

Whether a person resides in the urban or rural areas of Uzbekistan, on average, seems to affect the number of work hours as the coefficient of settlement is significant. The results show that people who reside in urban areas are inclined to work more hours as compared to those living in the rural areas.

Finally, the supply of labour hours increases mostly with self-employment, and falls if the individual is involved into farming.

3.6 Summary from the Results

The summary of results focuses on the estimated selection and structural models. In general, these models provide reasonably good fits to the relevant data, with pseudo-R^2 values ranging from a low of 0.19 in Tajikistan to a high of

0.38 in Serbia. It is clear from the foregoing that while there is a number of common findings across countries there is also some conflict in the results in terms of both magnitude and sign. The purpose of this section is to bring together commonalities and to identify key issues of difference.

Individual characteristics

In all countries reviewed, older individuals are more likely, on average and ceteris paribus, to be employed in formal labor markets than their younger counterparts. The lower probability of being employed among young individuals may be attributable to increased participation in education and/or increased engagement in informal labor market activity.

The effect of marital status on probability of being employed yields more conflict across the selected countries, with married individuals, on average and ceteris paribus, more likely to be employed relative to single ones in Albania, Bulgaria and Serbia but less likely to be so in Tajikistan and Uzbekistan.

Across all the countries studied, males are more likely to be employed in the formal market than females.

The level of education is found to be a significant determinant of probability of being employed in all the countries under the study. In accordance with the findings, individuals with higher levels of education are more likely to be employed as compared to those with lower educational attainment.

Household characteristics

The number of children in the household provided a mixed set of results. The number of dependent children below school ages reduced, ceteris paribus, probability of being employed only in Albania and Bulgaria and exerted no independent influence in all other countries. In contrast, the presence of children above school ages (between 7 and 17 years) affected negatively the probability of being employed in Bulgaria and Tajikistan. In general it can be concluded, that the presence of children in the household significantly affects employment in Albania, Bulgaria and Tajikistan with no effects in Serbia and Uzbekistan.

In accordance with the findings from the selection equation, the presence of non-labour income in a household is found to create a discouraging employment effect in all Balkan states and exert no effect in Central Asian countries. On the contrary, the results from the structural equation indicate that non-labour income negatively affects work hours in Serbia and Uzbekistan with no significant effect in Albania, Serbia and Tajikistan.

Location and environment

There is a strong location influence on the probability of being employed and labour hours in a number of countries. The findings show that, on average, the residence in rural areas increases the probability of being employed in all countries except Uzbekistan, where coefficient of settlement type was found insignificant. Thence, the incidence of being employed is found to be lower in urban areas. In contrast, the results from the structural equation show that individuals residing in urban areas, on average, supply more labour hours in all the countries reviewed except for Uzbekistan where the coefficient of settlement is found to be insignificant.

Across occupations, employees working in the public sectors of Bulgaria, Serbia, and Tajikistan are found to supply more labour hours than workers in other sectors of occupation. In contrast,in Albania and Uzbekistan the supply of labour hours increases if individuals are in engaged in the private sector activities and public work programs.

The estimates in regard to the wage offers are unambiguously positive in all cases and are well determined. The wage elasticities are largest and most elastic in Uzbekistan. The more modest elasticities are recorded in Albania, Serbia and Tajikistan. The coefficient of wage elasticity for Bulgaria was found to be insignificant. In general, the results obtained from this study are compatible with estimates obtained in more developed labor markets. It is evident that wages have an impact on the individual labor hours decision in all of these countries but this effect may be relatively modest.

The findings of this study are consistent with stylized fact that countries which inherited high labour force participation rates tend to be less sensitive to changes in the wage rates. Similar results were provided by most of the studies in transition economies[1].

[1] See Staehr (2008), Bicakova (2008), and Paci & Reilly (2004)

Chapter 4

Afterword

The purpose of this study was to analyze the sensitivity of labour supply to changes in the wage rates in five transition economies, namely, Albania, Bulgaria, Serbia, Tajikistan and Uzbekistan. To the best of my knowledge, this is the first study of labor supply that uses hours of work instead of labor force participation choices for transition countries. So far, it has been the empirical research on developed countries that concentrated on studying the effects of wage changes on the hours of labour supplied. In general, empirical results reported positive substitution effects while the income effect was found always negative. Although there is a range of estimates for each group of population (single and married men, unmarried and married women), some general conclusions still can be made.

The estimated elasticities for males (both single and married) were reported to be the lowest and the only ones that have ever been estimated to be negative. Hence, most males worked full time and their hours of work decisions were modestly affected by the wage changes. Thus, the labor supply curve of most males is nearly inelastic. This finding was explained by the prevalence of labour contracts exogenously constraining men's choice of the number of work hours. In contrast to the wage sensitivity of males, the wage elasticities of single females were found to be the largest among all groups. These results are likely driven by the unattractiveness of entering the labor force since it usually implied the loss of many welfare benefits. The labor elasticity of married females was reported to be in between that of males and single females. In case of the married females the part-time work, on contrary, is found to be an attractive option since it provides flexibility in hours of work.

In contrast to empirical literature in developed countries, empirical evidence of the labour supply behavior in transition economies is relatively scarce. The majority of empirical investigations, in comparison to those of developed countries, studies the sensitivity of labour force participation decisions to changes in the wage rates. The justification for approaching labour supply from an extensive margin stems from incompleteness of data from employment surveys in the transition economies. The findings from these studies suggest that women are more sensitive to wage and non-labour income changes in contrast to men. The negative impact of non-labour income (which mostly includes various benefits from social assistance programs) has been shown to have a dramatic discouraging influence on female participation rates. In general, the wage elasticities for the labor force participation have been found to be modest but larger than for the hours of work.

This study provided further evidence of the labour supply behavior in transition economies by estimating the sensitivity of hours of work to changes in the wage rates and other determinants of labour supply using data from three Balkan and two Central Asian countries. The empirical analysis entailed two steps using the modified Heckman approach. In the first step Heckman two-stage procedure was applied to handle the selection bias problem. The second step involved estimation of augmented labour hours equation which included the measure of aggregate wages (to correct for possible endogeneity problem) along with inverse Mills ratio. Estimations have been carried out by employing micro-data from various employment surveys for each country separately.

The findings from the study showed that, on average, the hours of work in four out of five countries included in this study were positively related to the wage rates. The wage elasticities were found to be positive and modest, ranging from 0.03 in Serbia to 0.25 in Uzbekistan. This result is in line with previous labour supply literature which suggests limited sensitivity of labour supply to changes in the wage rates in countries which have retained high labour force participation rates.

In regard to the other determinants, the following set of control variables turned out to be significant explanatory factors: age, marital status, type of settlement, employee occupation, educational attainment, the presence of children and non-labour income.

Finally, it seems that the next natural step in this research is to use different specifications of the proxy employed in the augmented hours of work equation. Examination of alternative proxies for wages seems to be a promising avenue to pursue with respect to addressing possible endogeneity problems. In spite of these concerns, however, it is felt that the approach adopted by this study has provided some useful and important insights into labour supply behavior in the selected transition economies.

Appendix A

Heckman Selection Model

Table A1.1: Heckman selection model for Albania

Variable	Structural equation		Selection equation	
	Coefficient	Bootstrapped standard error	Coefficient	Bootstrapped standard error
Log of wage	.1112**	.0484		
Settlement	.1307***	.0379	-.5418***	.0706
Other income	-.01297	.0126	-.0386*	.0198
Occupation				
Government or public sector and army	-.0645	.0388		
Self-employed and private enterprise/company	.1391***	.0367		
Public works programs	.2074***	.0427		
State owned enterprise	.0046	.0449		
NGOs or humanitarian organizations	.1608**	.0818		
Private individuals	.1264***	.0438		
Age			.2117***	.0109
Age^2			-.0026***	.0001
Gender			-.5199***	.0603
Marital status			.2661***	.0896
Educational attainment				
No education			-2.983***	.3105
8-9 years of schooling and secondary education			.2730***	.0789
Vocational education 2-5 years			.5965***	.0867
Undergraduate degree			1.0718***	.1067
Postgraduate and graduate degree			1.1030**	.5073
Number of children 6 years old and younger			-.1231***	.0436
Number of children 7-17 years old			.0122	.0263
Inverse Mills ratio	-.1822	.0446		
Correlation between the error terms in structural and selection equations	-.4280			
Wald test: χ_i^2	193.88 (.0000)			
Observations	3430			
Cencored observations	2390			

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively.

Table A1.2: Heckman selection model for Bulgaria

Variable	Structural equation		Selection equation	
	Coefficient	Bootstrapped standard error	Coefficient	Bootstrapped standard error
Log of wage	.0204	.0170		
Settlement	.0412*	.0212	-.5593***	.0436
Other income	-.0059	.0049	-.0921***	.0167
Occupation				
Government or public sector and army	.0607***	.0194		
Self-employed and private enterprise/company	.1656***	.0180		
Public works programs	.1698***	.0183		
Private individuals	.1385***	.0452		
Age			.1494***	.0054
Age^2			-.0017***	.0001
Gender			-.2503***	.0355
Marital status			.3622***	.0389
Educational attainment				
No education			.1587	.4772
Primary education			.6609	.4654
Secondary education			.8730**	.4604
Vocational education			1.2905***	.4597
Higher education			1.5142***	.4633
Number of children 6 years old and younger			-.0242	.0367
Number of children 7-17 years old			-.0853***	.0231
Inverse Mills ratio	-.1830	.0275		
Correlation between the error terms in structural and selection equations	-.5194			
Wald test: χ_i^2	263.09 (.0000)			
Observations	8003			
Cencored observations	4353			

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively.

Table A1.3: Heckman selection model for Serbia

Variable	Structural equation		Selection equation	
	Coefficient	Bootstrapped standard error	Coefficient	Bootstrapped standard error
Log of wage	.0310**	.0152		
Settlement	.0420	.0282	-.4151***	.0349
Other income	-.0315*	.0172	-.1256***	.0283
Occupation				
Government or state owned enterprise	-.0892***	.0203		
Self-employed and private enterprise/company	.0623	.1205		
Mixed	-.0301	.0686		
Age			.1705***	.0059
Age^2			-.0019***	.0001
Gender			-.4606***	.0330
Marital status			.2124***	.0434
Educational attainment				
No education			.0609	.0822
Secondary education			.2395***	.0624
Vocational education			.2036***	.0392
Higher education			.5872***	.0787
Number of children 6 years old and younger			-.0487	.0324
Number of children 7-17 years old			-.0509**	.0216
Inverse Mills ratio	-.3120	.0477		
Correlation between the error terms in structural and selection equations	-.513			
Wald test: χ_i^2	55.30 (.0000)			
Observations	8027			
Cencored observations	4682			

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively.

Table A1.4: Heckman selection model for Tajikistan

Variable	Structural equation		Selection equation	
	Coefficient	Bootstrapped standard error	Coefficient	Bootstrapped standard error
Log of wage	.0466***	.0158		
Settlement	.0948***	.0312	-.1962***	.0484
Other income	-.0412***	.0116	.0280	.0191
Occupation				
Government or public sector and army	.1032**	.0448		
Self-employed and private enterprise/company	.2765***	.0337		
Public works program	.4758***	.0692		
State owned enterprise	.1024*	.0573		
NGOs or humanitarian organizations	.2624***	.0754		
Private individuals	.1567***	.0418		
Age			.1779***	.0092
Age^2			-.0021***	.0001
Gender			-.6346***	.0444
Marital status			-.0308	.0587
Educational attainment				
No education			-4.026***	.3035
Primary education			.1158	.1348
Secondary education			.2551*	.1355
Vocational education			.4454***	.1434
Higher education			.6975***	.1511
Number of children 6 years old and younger			-.0037	.0157
Number of children 7-17 years old			.0117	.0143
Inverse Mills ratio	-.0765	.0386		
Correlation between the error terms in structural and selection equations	-.149			
Wald test: χ^2_i	115.58 (.0000)			
Observations	6564			
Cencored observations	4906			

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively.

Table A1.5: Heckman selection model for Uzbekistan

Variable	Structural equation		Selection equation	
	Coefficient	Bootstrapped standard error	Coefficient	Bootstrapped standard error
Log of wage	.2544***	.0943		
Settlement	.0819**	.0386	-.1075	.1077
Other income	.0419	.0483	-.0795	.1152
Occupation				
Self-employed	.1214***	.04285		
Private enterprise/company	.0313	.0534		
Farming	-.5793**	.2675		
NGOs or humanitarian organizations	.1795	.0501		
Age			.0956***	.0384
Age^2			-.0019***	.0005
Gender			.6119***	.1025
Marital status			-.1699	.1492
Educational attainment				
No education			-.3514	1.6022
8-9 years of schooling and secondary education			-.0107	.0789
Vocational education			.0927	.1147
Higher education			.3441**	.1674
Number of children 6 years old and younger			.0052	.0539
Number of children 7-17 years old			.0586	.0461
Inverse Mills ratio	-.0709	.0952		
Correlation between the error terms in structural and selection equations	-.1901			
Wald test: χ_i^2	36.39 (.0000)			
Observations	730			
Cencored observations	378			

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively.

Appendix B

Probit Model

Table A2.1: Marginal effects from probit model for Albania

Variable	Marginal effect	Standard error
Age	.0501***	.00205
Age^2	-.0006***	.00002
Gender	-.1255***	.01415
Settlement	-.1298***	.01596
Marital status	.0646***	.02172
Educational attainment		
No education	NA	NA
8-9 years of schooling and secondary education	.0671***	.02182
Vocational education 2-5 years	.1707***	.02812
Undergraduate degree	.3492***	.04135
Postgraduate and graduate degree	.3729***	.14138
Other income	-.0094**	.00457
Number of children 6 years old and younger	-.0308***	.01020
Number of children 7-17 years old	.0032	.00612
Log likelihood value	-1325.4296	
Pseudo R^2	.3656	
Sample size	3430	

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively

Table A2.2: Marginal effects from probit model for Bulgaria

Variable	Marginal effect	Standard error
Age	.0551***	.00238
Age^2	-.0006***	.000025
Gender	-.1187***	.01354
Settlement	-.2259***	.01556
Marital status	.1311***	.01579
Educational attainment		
No education	-.2023	.12346
Primary education	.0055	.13519
Secondary education	.0379	.13285
Vocational education	.1978	.12835
Higher education	.2651**	.11614
Other income	-.0327***	.00672
Number of children 6 years old and younger	-.0381**	.01564
Number of children 7-17 years old	-.0173*	.01039
Log likelihood value	-3690.7589	
Pseudo R^2	.2240	
Sample size	6869	

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively

Table A2.3: Marginal effects from probit model for Serbia

Variable	Marginal effect	Standard error
Age	.0633***	.00173
Age^2	-.0007***	.00002
Gender	-.1434***	.0108
Settlement	-.0768***	.0114
Marital status	.0955***	.0137
Educational attainment		
No education	.0307	.03138
Secondary education	.1297***	.02625
Vocational education	.0976***	.0136
Higher education	.3168***	.03474
Other income	-.0668***	.00888
Number of children 6 years old and younger	.0061	.00974
Number of children 7-17 years old	-.0074	.00701
Log likelihood value	-3205.0791	
Pseudo R^2	.3893	
Sample size	8027	

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively

Table A2.4: Marginal effects from probit model for Tajikistan

Variable	Marginal effect	Standard error
Age	.0593***	.00301
Age^2	-.0007***	.0000
Gender	-.2382***	.0149
Settlement	-.0641***	.01662
Marital status	-.0001	.01983
Educational attainment		
No education	NA	NA
Primary education	.0206	.04931
Secondary education	.0498	.04753
Vocational education	.1340**	.05618
Higher education	.2378***	.05774
Other income	-.0121*	.00683
Number of children 6 years old and younger	-.0012	.00549
Number of children 7-17 years old	.0097*	.00529
Log likelihood value	-2414.4391	
Pseudo R^2	.1948	
Sample size	4598	

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively

Table A2.5: Marginal effects from probit model for Uzbekistan

Variable	Marginal effect	Standard error
Age	.0379***	.0139
Age^2	-.0008***	.0002
Gender	.2398***	.0387
Settlement	-.0427	.0417
Marital status	.0676	.0555
Educational attainment		
No education	-.1350	.1667
8-9 years of schooling and secondary education	.0042	.0757
Vocational education	.0369	.0465
Higher education	.1365**	.0623
Other income	-.0316	.0427
Number of children 6 years old and younger	.0021	.0205
Number of children 7-17 years old	.0233	.0185
Log likelihood value	-430.9227	
Pseudo R^2	.1476	
Sample size	730	

Notes: ***, **, * - Statistical significance at one, five, and ten percent, respectively

Appendix C

Individual and Household Characteristics

Table A3.1: Individual and household characteristics in Albania

Characteristics	Percent
Total	100
Age	
Less than 20 years	35.91
Between 20-30 years	15.42
Between 30-40 years	12.33
Between 40-50 years	15.98
Between 50-60 years	8.74
Over 60 years	11.62
Gender	
Male	50.36
Female	49.64
Marital Status	
Married and/or living together	58.17
Single, divorced, and/or widower	41.82
Household composition	
Children 6 years old and younger	9.47
Children of 7-17 years old	22.12
Adults	68.41
Settlement	
Urban	51.47
Rural	48.53

Table A3.2: Level of education in Albania

Education	Percent
Total	100
No education	1.94
Primary education	60.61
Secondary education	17.06
Vocational education	13.04
Higher education	7.35

Table A3.3: Sector of activity in Albania

Occupation	Percent
Government or public sector and army	40.08
Self-employed and private enterprise/company	54.79
Public works program	0.23
State owned enterprises	3.40
NGOs or humanitarian organizations	1.49

Table A3.4: Non-labour income descriptive statistics in Albania

Variable	Observations	Mean	Standard deviation	Min	Max
Non-labour income	17302	400,259.9	4643977	0	4,000,000.00
Percent of individuals reported to have no other income = 79.34 %					
Percent of individuals reported to have other income = 20.66%					

Table A3.5: Individual and household characteristics in Bulgaria

Characteristics	Percent
Total	100
Age	
Less than 20 years	20.27
Between 20-30 years	13.15
Between 30-40 years	13.6
Between 40-50 years	13.24
Between 50-60 years	14.52
Over 60 years	23.93
Gender	
Male	48.34
Female	51.66
Marital Status	
Married and/or living together	51.87
Single, divorced, and/or widower	48.13
Household composition	
Children 6 years old and younger	5.46
Children of 7-17 years old	12.21
Adults	82.33
Settlement	
Urban	68.99
Rural	31.01

Table A3.6: Level of education in Bulgaria

Education	Percent
Total	100
No education	6.59
Primary education	11.79
Secondary education	25.78
Vocational education	39.85
Higher education	16

Table A3.7: Sector of activity in Bulgaria

Occupation	Percent
Government or public sector and army	25.95
Self-employed and private enterprise/company	68.93
Public works program	2.72
Private individual	3.41

Table A3.8: Non-labour income descriptive statistics in Bulgaria

Variable	Observations	Mean	Standard deviation	Min	Max
Non-labour income	8168	2392.42	3596.16	0	129391.8
Percent of individuals reported to have no other income = 1.97 %					
Percent of individuals reported to have other income = 98.03%					

Table A3.9: Individual and household characteristics in Serbia

Characteristics	Percent
Total	100
Age	
Less than 20 years	20.18
Between 20-30 years	14.27
Between 30-40 years	12.52
Between 40-50 years	14.16
Between 50-60 years	14.15
Over 60 years	24.72
Gender	
Male	51.46
Female	48.54
Marital Status	
Married and/or living together	54.08
Single, divorced, and/or widower	45.92
Household composition	
Children 6 years old and younger	5.39
Children of 7-17 years old	12.4
Adults	82.21
Settlement	
Urban	51.46
Rural	48.54

Table A3.10: Level of education in Serbia

Education	Percent
Total	100
No education	13.09
Primary education	38.01
Secondary education	6.77
Vocational education	36.67
Higher education	4.64

Table A3.11: Sector of activity in Serbia

Occupation	Percent
Government or public sector and army	37.10
Self-employed and private enterprise/company	59.51
Mixed	2.39
Private individual	1.01

Table A3.12: Non-labour income descriptive statistics in Serbia

Variable	Observations	Mean	Standard deviation	Min	Max
Non-labour income	8027	32030.43	20647.28	890.49	256241.5
Percent of individuals reported to have no other income = 0 %					
Percent of individuals reported to have other income = 100%					

Table A3.13: Individual and household characteristics in Tajikistan

Characteristics	Percent
Total	100
Age	
Less than 20 years	47.23
Between 20-30 years	19.05
Between 30-40 years	10.75
Between 40-50 years	10.29
Between 50-60 years	6.75
Over 60 years	5.93
Gender	
Male	51.04
Female	48.96
Marital Status	
Married and/or living together	61.51
Single, divorced, and/or widower	38.49
Household composition	
Children 6 years old and younger	14.89
Children of 7-17 years old	24.6
Adults	60.51
Settlement	
Urban	29.45
Rural	70.55

Table A3.14: Level of education in Tajikistan

Education	Percent
Total	100
No education	9.41
Primary education	34.18
Secondary education	40.13
Vocational education	8.41
Higher education	7.87

Table A3.15: Sector of activity in Tajikistan

Occupation	Percent
Government or public sector and army	17.13
Self-employed and private enterprise/company	29.09
Public works program	0.60
State owned enterprises	9.30
NGOs or humanitarian organizations	2.89
Private individual	41.0

Table A3.16: Non-labour income descriptive statistics in Tajikistan

Variable	Observations	Mean	Standard deviation	Min	Max
Non-labour income	10112	161.45	332.97	0	5763
Percent of individuals reported to have no other income = 35.08 %					
Percent of individuals reported to have other income = 64.92%					

Table A3.17: Individual and household characteristics in Uzbekistan

Characteristics	Percent
Total	100
Age	
Less than 20 years	15.94
Between 20-30 years	31.23
Between 30-40 years	19.99
Between 40-50 years	16.71
Between 50-60 years	12.85
Over 60 years	3.28
Gender	
Male	49.92
Female	50.08
Marital Status	
Married and/or living together	68.03
Single, divorced, and/or widower	31.97
Household composition	
Children 6 years old and younger	48.4
Children of 7-17 years old	54.5
Settlement	
Urban	42
Rural	58
Other income	
Possesses other income	31.8
Does not possess other income	68.2

Table A3.18: Level of education in Uzbekistan

Education	Percent
Total	100
No education	0.58
Primary education	10.92
Secondary education	40.50
Vocational education	35.53
Higher education	12.28

Table A3.19: Sector of activity in Uzbekistan

Occupation	Percent
Government or public sector and army	40.26
Private enterprise/company	25.60
Farming	1.97
Self-employed	29.76
NGOs or humanitarian organizations	0.22
No answer	2.19

Table A3.20: Name of districts

Albania	Bulgaria	Serbia	Tajikistan	Uzbekistan
Berat	Blagoevgrad	Belgrade	Dushanbe(city)	Andijan
Bulqize	Bourgas	Vojvodina	RRS	Bukhara
Delvine	Dobrich	West Serbia	Sugd	Djizzak
Devoll	Haskovo	Šumadija I	Khatlon	Fergana
Diber	Gabrova	Pomoravlje	GBAO	Kashkadarya
Durresi	Kardjali	East Serbia		Khorezm
Elbasani	Kjustendil	South-east		Namangan
Fier	Lovech	Serbia		Navoi
Gramsh	Montana			Republic of
gjirokaster	Pazardjik			Karakalpakistan
Has	Pernik			Samarkand
Kavaje	Pleven			Surkhandarya
Kolonje	Plovdiv			Tashkent (city)
Korce	Razgrad			Tashkent
Kruje	Russe			
Kucove	Shumen			
Kukes	Silistra			
Kurbin	Sliven			
Lezhe	Smoljan			
Librazhd	Sofia (city)			
Lushnje	Sofia			
Malsi e	Stara Zagora			
madhe	Targovishte			
Mallakaster	Tarnova			
Mat	Varna			
Mirdite	Veliko			
Peqin	Vidin			
Permet	Vratza			
Pogradec	Yambol			
Puke				
Sarande				
Skrapar				
Shkoder				
Tepelene				
Tirane				
Tropoje				
Vlore				

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