A model of the informal economy with an application to Ukraine

Simon Commander[1], Natalia Isachenkova[2] and Yulia Rodionova[3]

Abstract

The size of the informal economy has grown sharply in many transition countries, particularly in the Former Soviet Union. The structure of labour compensation inherited from central planning seems especially important in explaining this growth. Using a panel dataset on individuals and households from the Ukraine Longitudinal Monitoring Surveys (ULMS) for 2003 and 2004, our paper first quantifies the size of the Ukraine informal economy. We then write down a model of an economy with both state and private sectors and formal and informal work. All sectors can employ both full- or part-time workers. Private firms can choose whether to be formal - and pay payroll taxes - or stay informal, subject to some probability of detection for evading payroll tax The setting allows us to derive the impact of changes in benefits, as well as output demand shocks and detection rates, on the allocation of employment across different labour market states. Predictions from our model are then tested econometrically using the ULMS panel dataset.

Keywords: informal sector, labour mobility, Ukraine

JEL Classification: J2

This version: June 2008[4]

[1] EBRD and London Business School. Corresponding author. E-mail: commanders@ebrd.com
[2] Kingston University *London*, UK.
[3] University College London.
[4] We are grateful to Suren Basov, Randolph Bruno, Xiao Chen, Stanislav Kolenikov, Alexander Muravyev, Sophia Rabe-Hesketh, Andrei Tolstopiatenko and Tolga Yuret for comments and suggestions. Earlier drafts of the paper were presented at an IZA-EBRD Conference on Labour Market Dynamics, Role of Institutions and Internal Labour Markets, held at the University of

1 Introduction

A significant informal economy is a characteristic of many developing countries. In recent years, there has been a strong growth in the size of the informal economy in most transition countries. Attempts to estimate the size have mostly been based on electricity consumption and money demand functions. For example, Schneider and Enste (2000) pull together evidence using physical inputs that suggest that by 1995, the informal economy accounted for between 35-44% of GDP in the Former Soviet Union (FSU) and between 21-33% in Central and Eastern Europe. If most transition economies are indeed developing economies, then the rapid growth in the size of the informal sector may simply reflect convergence. However, it may also reflect some of the particular institutional and other features of the transition economies. Given that the size of the informal economy not only has implications for growth and investment – informal sector firms tend to remain relatively small scale and associated job creation may be biased towards those with low set up costs, scale and productivity – but also for the ability of governments to continue to raise revenues and provide public goods, the origins and dynamics of the informal sector are of evident interest from a public policy perspective.

Attempts to understand why there has been such growth in the informal economy have mostly emphasized the role of public policy. In particular, high payroll tax rates will have raised the incentive for creating informal jobs. In addition, where the business environment has been problematic informal sectors have tended to be relatively large. Yet in the transition economies, it is interesting to note that cross-country estimates of the size of the informal economy find no robust association between size and the extent of reform, where the latter is clearly highly correlated with the quality of the business environment. This suggests that the size of the informal economy is not simply an issue for the early or slow reformers.

While models of the informal sector tend to be organised around two distinct sectors – formal and informal - a feature of many transition economies has been that multiple job-holding has also been prevalent. Existing research suggests that multiple job-holding has resulted from a combination of control regimes in state sector firms, the structure of compensation and the level of outside opportunities – particularly unemployment benefits – made available to separated workers[5].

This paper investigates the extent of informal employment in Ukraine and the relevance to its growth of the inherited structure of labour compensation . Using unique individual and household data from the Ukraine Longitudinal Monitoring Surveys (ULMS) for 2003 and 2004, we first quantify the size of the informal economy and describe transitions of workers between its formal, informal and formal/informal sectors. We find – using the ULMS – that in Ukraine the share of employment in the informal sector has jumped from around 10 -16% in 1991 to between 17-23% in 2004. This share is far higher if people involved in agricultural production for their own use are also considered.

Second, based on an analytical model of an economy with state and private sectors and incorporating formal, informal and full and part-time work, we study the impact on the reallocation of labour of changes in non-monetary compensation, the

---

Bologna, May 5-8 2005 and to seminar participants at EBRD, London Business School and Oxford University. We thank EBRD and UK DFID for support

[5]For example, Rein, Friedman and Worgotter (1997)

financing of non-monetary benefits and the probability of being detected evading payroll tax. Panel data from the ULMS are then used to test the predictions from our model. Employing state-of-the-art econometrics, such as mixed logit, we estimate the effects of social benefits on the static allocation of labour across the three sectors. In addition, we analyse the dynamics using multinomial logit for transitions of workers between the sectors, which conditions on the detection probability, involuntary temporary unemployment, and occupation. Our overall conclusion points to the important attaching role social benefits play in determining the mix of formal/informal sector employment.

The paper is organised as follows. In Section 2, we quantify informal sector in Ukraine using various employment measures. Section 3 explores two versions of a simple theoretical model of the informal sector and formulates hypotheses for empirical testing. Section 4 gives a brief description of the econometric approach and reports estimation results. Section 5 concludes.

2 The informal sector: evidence from Ukraine

Existing measures of the size of the informal economy in Ukraine have been based on physical inputs data. They indicate not only that a large informal sector came into existence near the start of transition but that it has continued to expand. For example, Johnson et al (1998) estimated that informal activity accounted for around 16% of GDP in 1989/90, rising to over 47% by 1994/95. Lacko (1999) had a yet higher estimate of around 54% at the latter date. Schneider (2005) places the informal sector share of GDP at around 53/54% in 2001-2003. In short, Ukraine in the 1990s appears to have had one of the sharpest rates of increase in the informal economy. Explanations for why this has been the case have mostly emphasised the slow and partial nature of reforms and the continuing high level of payroll taxation. Indeed, throughout the transition, the payroll tax rate has remained above 40%.Yet, aggregate measures give little or no sense of what constitutes the informal economy and how that may have changed over time. These issues can only be adequately addressed with household data containing observations over time.

The ULMS dataset comprises two distinct rounds and is a representative sample of Ukrainian households. The first round was implemented for 4056 households and 8641 individuals in 2003 with a retrospective questionnaire covering some – but not all – questions for the years, 1986, 1991, 1997-2001 and 2003. A second round was completed in late 2004 and covered nearly 3500 households and included 7201 individuals. The reference period for the second round was 2003 and 2004[6]. From this dataset we are able to put together a number of estimates of the size of the informal economy – as measured by shares of total employment - for 1991, 1997, 2003 and 2004. *Table 1* provides these estimates. The first column - Measure 1 - reports the share of employment in informal activity outside of agriculture. This

[6] The ULMS provides extensive information on households' income and expenditure, as well as information on individuals relating to employment, working hours, earnings, non-monetary benefits and other components of income.

includes individuals with an unregistered job, those who are self employed or have a second job or are involved in occasional supplementary work. The second column - Measure 2 - gives the share augmented by individuals involved in non-agricultural household production and sale of agricultural goods on a secondary basis. The third column - Measure 3 - further augments by including all individuals involved in agricultural production for their own use.

Not surprisingly the size of the informal economy is significantly affected by whether agriculture is included. In the latter case, informal employment accounted for over 66% of employment at its peak in 2004. By contrast, when excluding individuals involved in agricultural activity, the informal economy share dropped to 17%. While there is evidence of some decline in this measure between 1997 and 2003, the share is roughly constant between 1997 and 2004. Because agriculture is largely an untaxed part of the economy in most developing countries, we focus our attention on the second - and significantly lower - measure which includes only those with secondary agricultural output for sale. This measure gives an informal employment share of 16% in 1991 rising to 26% in 1997. The share falls substantially in 2003 before rising again to 23% in 2004.

Table 1: Ukraine: informal sector employment in 1991, 1997, 2003 & 2004 (% of all working)

	1991	1997	2003	2004
Measure1	10	17	13	17
Measure2	16	26	16	23
Measure3	50	65	58	66

Turning to employment distributions across formal and informal sectors, in 1997 nearly three quarters were in formal sector jobs alone. A further 20% were only employed in informal work and about 6% participated in both formal and informal work. By 2003/4, formal employment remained roughly constant at between 75-80% while the share of informal employment ranged between 7-15% The share of job holders in both sectors was between 9-12%.

Table 2 provides transition matrices across these various employment states for 2003/2004, calculated for those individuals present in both periods.

Table 2: Transition matrix for 2003/ 2004 (%)

N obs = 2824	Formal only	Formal / Informal	Informal only
Formal only	90	6	4
Formal/Informal	45	35	20
Informal only	28	4	68

It can be seen that 90% of individuals with formal employment did not change status. Between 4-6% moved to either informal or multiple job holding. In the case of multiple job holders there was a clear tendency for them to move into the formal sector but a significant share also into informal activity

As regards compensation, particularly the use of non-monetary benefits – such as housing subsidy, health and child care and other services – by state and privatised firms, the ULMS data indicate that in both 2003 and 2004 around 36% of individuals in the sample were in receipt of social benefits or non-monetary compensation. Further, more than 50% of multiple jobholders received social benefits.

3 A model of the informal economy

We take the economy to be populated by three types of firms: state, private formal and private informal firms. All types can employ both full-time and part-time labour. We now outline each type of firm's problem.

3.1 State sector firms

Full-time employees in the state sector receive monetary wages and also non-monetary or social benefits. Part-time employees receive only non-monetary benefits. State firms pay payroll taxes for their full-time employees but not for their part-time ones. Part-time employees working in the state sector can also work in the private sector and receive a wage. That wage will, however, be discounted by the probability of detection for not paying taxes, if they work informally.

We model state- or insider- run firms by analogy with trade unions[7]. In the transition context, they have often been modelled as either maximizing wages, or maximizing utility with respect to both wage and employment, subject to a zero constraint on profits. In the Ukrainian context, we assume that , instead of maximizing wages, state-owned firms maximize employment (i.e., they prefer not to fire existing workers) setting wages consistent with their employment objective. This can be modelled as the state firm picking the largest full-time employment possible subject to a zero-profit constraint. We denote the subsequent analysis of this case as Model I. Clearly, the resulting wage-employment combination is inefficient. Alternatively, state-owned firms can be assumed to pick a combination of employment and wages to maximize rents subject to a zero-profit constraint. In

[7] Handbook of Labor Economics, Chapter 18.

this case, the wage-employment solution will be efficient. We denote the corresponding analysis as Model II. Throughout, we assume that the state (formal) sector is populated by identically skilled risk-neutral workers, who potentially could combine formal sector employment with informal sector employment (we denote these workers formal/informal)[8].

The utility of the state firm is given by:

$$U\left(N_f^S, N_p^S, w^S\right) = N_f^S w^S\left(1-\tau_0\right) + N_p^S\left(\theta w_p^I\left(1-\varphi\right) + \left(1-\theta\right) w_p^F\left(1-\tau_0\right)\right) + Mb \qquad (1)$$

where;

θ = share of part-time employees who work in the informal private sector;

b = social or non-monetary benefits provided by the state sector;

N_f^S = full-time employment in the state sector;

N_p^S = part-time employment in the state sector;

w^S = state sector wage;

τ_0 = payroll tax paid on full-time state sector employees;

φ = probability of detection when not paying taxes;

w_p^I = part-time wages in the informal private sector and,

w_p^F = part-time wages in the formal private sector.

In the absence of labour market rigidities, for both full- and part-time employment in the state sector to be positive, we need the following conditions for wages to hold:

$$w^S\left(1-\tau_0\right) \quad = \quad \theta w_p^I\left(1-\varphi\right) + \left(1-\theta\right) w_p^F\left(1-\tau_0\right) \qquad (2)$$

for part-time employment in both formal and informal sectors to be positive, we need

$$w_p^I\left(1-\varphi\right) = w_p^F\left(1-\tau_0\right) \qquad (3)$$

We also suppose that the state sector's total employment is fixed at M - in other words, the state sector does not hire or fire, it only moves workers between full-time and part-time employment.

$$N_f^S + N_p^S = M \qquad (4)$$

With a quadratic production function[9] and assuming substitutability of part-time for full-time labour - albeit with some efficiency loss $\delta \in [0,1]$ - the firm's zero-profit constraint can be written as:

[8] Friebel and Guriev (2005) study the effect of employer concentration on the attaching role of social benefits and regional worker mobility.

[9] We use a quadratic production function as it satisfies the assumptions we make about the two types of labor (full- and part-time) being close substitutes and decreasing returns to scale

$$p\sqrt{N_f^S(1-\delta)+M} = M(1-s)b + N_f^S w^S(1+\tau) \quad (5)$$

where s = subsidy rate provided by the government to cover the cost of providing social or non-monetary benefits and τ = the rate of payroll tax that the firm pays on its full-time employees.

Model I:

Solving for the state sector's full-time labour supply N_f^S (and imposing an additional constraint that the slope of the LHS at the solution point is less than the slope of the RHS), we get:

$$p\sqrt{N_f^S(1-\delta)+M} = M(1-s)b + N_f^S w^S(1+\tau) \quad (6)$$

$$\frac{p(1-\delta)}{2\sqrt{N_f^S(1-\delta)+M}} < w^S(1+\tau) \quad (7)$$

The second constraint can be written as:

$$N_f^S > \left(\frac{p(1-\delta)}{2w^S(1+\tau)}\right)^2 * \frac{1}{1-\delta} - \frac{M}{(1-\delta)} \quad (8)$$

Then solving for N_f^S; we can find part-time state sector employment N_p^S from

$$N_p^S = M - N_f^S \quad (9)$$

We also have the condition for wages that

$$w^S(1-\tau_0) = w_p^I(1-\varphi) = w_p^F(1-\tau_0) \quad (10)$$

This gives us the supply of part-time labour to the private sector.

3.2 Private sector firms

Private firms can choose whether to be in the formal sector and pay payroll taxes or be in the informal sector by comparing the relative pay-offs to both states, V^F and V^I. While private informal firms do not pay payroll tax but face the probability of being detected - φ, with the corresponding fine F - private formal sector firms pay the payroll tax on both full- and part-time labour. Both private informal and formal firms maximize profit subject to the supply of part-time labour, the wage parity condition, and the condition for equilibrium in the market for part-time labour:

$$N_p^I + N_p^F = N_p^S \quad (11)$$

We assume that the constraint on the supply of full-time labour for private firms is not binding.

3.2.1 Informal private sector

If the firm chooses to be informal, it receives an expected payoff of

$$V^I = \max[(1-\varphi)(N_p^I + N_f^I)\{p\sqrt{N_f^I + (b)N_p^I} - w_f^I N_f^I - w_p^I N_p^I\} - (1-(1-\varphi)^{N_p^I + N_f^I})F \quad (12)$$

The firm faces the following optimization problem:

$$Max[(1-\varphi)\{p\sqrt{N_f^I + (b)N_p^I} - w_f^I N_f^I - w_p^I N_p^I\}] - (1-(1-\varphi))F \quad (13)$$

with respect to $(N_f^I, N_p^I, w_f^I, w_p^I)$ and subject to $((6),(8),(9))$.

3.2.2 Formal private sector

If the firm chooses to be formal, its payoff is given by:

$$V^F = \max[\, p\sqrt{N_f^F + (b)N_p^F} - w_f^F N_f^F (1+\tau) - w_p^F N_p^F \,] \quad (14)$$

The firm maximizes profit

$$Max[\, p\sqrt{N_f^F + (b)N_p^F} - w_f^F N_f^F (1+\tau) - w_p^F N_p^F \,] \quad (15)$$

with respect to $N_f^F, N_p^F, w_f^F, w_p^F$ and subject to the constraints given by $((6),(8),(9))$.

3.3 Model I: Comparative statics

Deriving the first order conditions, we can now sign the effect of a change in subsidies (s), benefits (b), payroll tax rate (τ), detection probability (φ) and prices (p) on employment in the various sectors and states.

Table 3: Comparative statics

N	***S***	***b***	***m***	**T**	**φ**	***p***
N_f^S	+	-	+	-	+	+
N_f^I	+	-	-	+	-	+
N_p^I	-	+	+	+	-	-
N_f^F	+	-	-	-	+	+
N_p^F	-	+	+	-	+	-

We can see from this exercise that an increase in subsidy financing for social benefits raises full-time employment in the state sector, the informal and formal private sectors while clearly reducing formal/informal work. An increase in social benefits works in the opposite direction. By contrast, an increase in the tax rate unambiguously raises part-time work in the state and the informal sectors, i.e., formal/informal work. An increase in the detection probability, as expected, lowers part-time activity in the informal sector.

Model II:

The strategy of employment maximization underpinning Model I is inefficient. We now assume that workers maximize rents (in our case of linear utility, the total wage bill) with respect to wages and full-time (formal sector only) employment, subject to a zero-profit constraint. In this case, the optimization problem of the state sector firm looks as follows:

$$\begin{aligned} &Max \\ &U\left(N_f^S, N_p^S, w^S\right) = N_f^S w^S\left(1-\tau_0\right) + N_p^S\left(\theta w_p^I\left(1-\varphi\right) + \left(1-\theta\right) w_p^F\left(1-\tau_0\right)\right) + Mb \\ &w.r.t.\left(N_f^S, w^S\right) \end{aligned} \tag{16}$$

$$\begin{aligned} &subject \quad to \\ &p\sqrt{N_f^S(1-\delta)+M} = M(1-s)b + N_f^S w^S(1+\tau) \end{aligned} \tag{17}$$

Graphically, condition (17) could be represented in the space $\left(N_f^S, w^S\right)$ as a set of inverted U-shaped lines.

The efficient combination of $\left(N_f^S, w^S\right)$ will be found at the point where $MRS = MRT$:

$$MRT = \frac{dw^S}{dN_f^S} = -\frac{\pi_{N_f^S}}{\pi_{w^S}} = -\frac{\frac{p(1-\delta)}{2\sqrt{N_f^S(1-\delta)+M}} - w^S(1+\tau)}{N_f^S(1+\tau)} = \frac{w^S(1+\tau) - \frac{p(1-\delta)}{2\sqrt{N_f^S(1-\delta)+M}}}{N_f^S(1+\tau)} \tag{18}$$

$$MRS = \frac{dw^S}{dN_f^S} = -\frac{U_{N_f^S}}{U_{w^S}} = -\frac{w^S\left(1-\tau_0\right) - \left(\theta w_p^I(1-\varphi) + (1-\theta) w_p^F\left(1-\tau_0\right)\right)}{N_f^S\left(1-\tau_0\right)} \tag{19}$$

$$Sign(MRS) = - \quad sign\left\{w^S\left(1-\tau_0\right) - \left(\theta w_p^I\left(1-\varphi\right) + \left(1-\theta\right) w_p^F\left(1-\tau_0\right)\right)\right\} \tag{20}$$

Case 1: The net wage in the formal sector is assumed to be greater than the expected wage in the formal/informal sector

$$w^S\left(1-\tau_0\right) > \left(\theta w_p^I\left(1-\varphi\right) + \left(1-\theta\right) w_p^F\left(1-\tau_0\right)\right) \tag{21}$$

Here, the indifference curves of the state firm insiders are negatively sloped. The optimal tangency point $\left(N_f^S, w^S\right)^{OPT}$ will lie to the right of the zero-slope point of the iso-profit (zero-profit) curve. The formal sector firm is in the diminishing marginal product part of the iso-quant. The value of the marginal product is less than the marginal (wage) cost.

Case 2: The net wage in the formal sector is less than the expected wage in the formal/informal sector.

$$w^S(1-\tau_0) < \left(\theta w_p^I(1-\varphi) + (1-\theta) w_p^F(1-\tau_0)\right) \tag{22}$$

In this case, the indifference curves are positively sloped. The optimal tangency point $\left(N_f^S, w^S\right)^{OPT}$ will lie to the left of the zero-slope point of the iso-profit (zero-profit) curve. The formal sector firm is in the increasing marginal product part of the iso-quant. The value of the marginal product is greater than the marginal (wage) cost.

Case 3: The net wage in the formal sector equals the expected wage in the formal/informal sector

$$w^S(1-\tau_0) = \theta w_p^I(1-\varphi) + (1-\theta) w_p^F(1-\tau_0) \tag{23}$$

The indifference curves of the state firm insiders are horizontal. The optimal tangency point $\left(N_f^S, w^S\right)^{OPT}$ will be at the zero-slope point of the iso-profit (zero-profit) curve. Here the value of the marginal product is equal to the marginal (wage) cost.

These three possible outcomes have different implications for our main question of interest - the impact of social benefits on formal vs. formal/informal vs. informal sector employment.

Consider **Case 1**: as social benefits increase from b_0 to $b_1 > b_0$, the zero-profit curve shifts down, and the optimum $\left(N_f^S, w^S\right)^{OPT}$ shifts in, resulting in lower wages and lower formal sector employment and higher formal/informal employment. We call this property the "attaching" property of social benefits, in the sense that, despite lower expected wages in the formal/informal sector, a higher level of social benefits leads to an inflow of workers into that sector.
A higher subsidy would have an opposite effect to that of an increase in benefits, leading to higher formal sector employment. A positive shock to aggregate demand (higher p) would also lead to higher formal sector employment, but higher wages as well.

Table 4: Comparative statics 2

N	s	b	m	τ	φ	p
N_f^S	+	-	+	-	+	+
N_f^I	+	-	-	+	-	+
N_p^I	-	+	+	+	-	-
N_f^F	+	-	-	-	+	+
N_p^F	-	+	+	-	+	-

However, **Cases 2 and 3** produce drastically different results. In Case 2, as social

benefits increase and the zero-profit curve shifts down, the optimal point $\left(N_f^S, w^S\right)^{OPT}$ shifts down to the right of the old optimum, so that formal sector employment is higher, while formal sector wages are lower than before and. formal/informal employment decreases. Higher prices bring about lower formal sector employment but also higher wages. Case 3 offers much the same results[10].

To sum up, the effect of social benefits on formal/informal employment is dependent upon the ratio of the net wage in the formal to the expected wage in the formal/informal sectors being more or less than unity. The impact of a subsidy increase is opposite to that of the increase in benefits, in all cases.

As in Model I, we have assumed that workers in the formal/informal sector (those who want to have multiple jobs in both sectors) can find employment there. However, as these workers are substitutes (with some efficiency loss) for those who are employed in the informal sector only, the inflow of workers from the formal to the formal/informal sector will reduce informal sector employment, as well as expected wages in the formal/informal and informal sectors. [11]

4 Testing the model with Ukrainian data

We now test the model's predictions and, in particular, the propositions regarding the impact of changes in the structure and financing of compensation on labour allocation. We use micro data exploiting information on employment by sector, first, in a mixed multinomial logit model of sector choice that integrates correlated errors arising from repeated measurements on workers, and, second, in a standard multinomial logit, looking at the stayer-mover structure, which allows for individual heterogeneity by capturing the effects of past choices of sector for work.

4.1 Empirics: mixed multinomial logit estimation of sector choice

The revealed choice between J alternative sectors for work y_{it} is observed for individual worker *i* on occasion *t.* The choice set contains just three alternatives. These are, being employed in the informal sector, being employed in the formal sector, or holding multiple jobs in the formal/informal (mixed) sector. Associated with each alternative sector *j* is a probability of being employed in this sector *j*, π_{it}^{j}. In our paper, predictors of labour allocation (sector choice) include the economic and socio-demographic characteristics of individual *i* and contextual factors, which operate on the firm and sector levels. The predictors reside in a matrix of explanatory variables $X_{it} = (x_{it}^{1}, \ldots, x_{it}^{J})$, with x_{it}^{j} being a column vector associated with the probability π_{it}^{j}.

We use an extension of the multinomial logit model, where the response

[10] Detailed results available on request.

[11] As for the shift from the formal/informal and the formal into the informal sector, we do not model it explicitly but we expect social benefits to play an attaching role there in the two former sectors. We also expect a higher subsidy to social benefits and a positive shock to aggregate demand to have a similar effect.

probabilities π_{it}^{j} depend on the nonlinear transformations of the linear function $X_{it}\beta_j + u_i$, and where arising from heterogeneity between individuals, individual-specific random intercepts u_i account for intra-individual correlation caused by multiple observations for individual *i*. With a predictor vector $x_{it}{}^{j}$ that includes a constant term, and with the last among $j = 1,...,J$ alternatives as the reference category, the conditional probability of a particular choice *j* can be written as follows:

$$\Pr\left(y_{it} = j \mid X_{it}, u_i\right) = \pi_{it}^{j} = \frac{\exp\left(\alpha_j + X_{it}\beta_j + u_i\right)}{\sum_{k=1}^{J-1}\exp\left(\alpha_j + X_{it}\beta_k + u_i\right)} \qquad (24)$$

The effect of x_{im} (the *m*th characteristic for individual *i*) on the logit of choice *j* relative to choice *k* (i.e. on the log-odds) is obtained as the contrast $\beta_{jm} - \beta_{km}$. The random effects u_i are assumed to be independent and identically distributed according to a normal distribution. Note that in our specification, the vector u_i allows for random variation in intrinsic preferences across individuals with respect to their choice of employment sector choice but remains constant over time and between alternatives for work.

In Model II above, the effect of social benefits depends on the ratio of expected formal to formal/informal wages in both sign and magnitude. The sign is dependent upon the wage ratio being more or less than unity. To test this proposition, we add to the model an interaction variable between the wage ratio dummy and the social benefits variable, taking the value of one if the relative wage is greater than one[12]. We would expect to see a negatively-signed coefficient on this interaction variable. We also include a second interaction term that is constructed as the product of the predicted wage ratio and the benefits variable. This second interaction term is expected to show the impact of changes in the wage ratio on the relative magnitude of the effect of social benefits on sector choice.

Alternatively, our conjecture based on the conclusions from Model I is that work in the formal/informal sector will be positively influenced by the provision of social benefits and subsidies to benefits, and whether workers have experienced compulsory leave (temporary lay-offs) – an indicator for the level of activity in the firm[13]. It therefore implies that the first interaction term discussed above will be insignificant.

We now use a panel sub-sample of the ULMS that contains information for all the variables for 6160 observations in 2003 and 2004. The regression coefficients represent log-odds ratios. A positive coefficient for an independent variable implies higher odds of observing an individual being in the destination sector *j* rather than in the sector that is taken as the reference category.

[12] Note, that benefits variable that enters the interaction terms is measured on a continuous scale.
[13] It is a proxy for an aggregate demand shock.

Table 5. Estimation of the sector choice model using mixed logit

Dependent variable: Log Odds **Reference category: Work in Formal/Informal Sector**	**Work in Formal Sector**	**Work in Informal Sector**
Independent variables:		
<u>Worker characteristics</u> (Socio-economic controls):		
Age	0.0345	-0.062*
	(0.027)	(0.037)
Age squared	-0.001*	0.001
	(0.000)	(0.001)
Female	0.167*	0.318**
	(0.086)	(0.142)
Education (relative to Education1 = diploma of high school (general secondary))		
Education2 (incomplete professional higher)	-0.826*	-0.994
	(0.467)	(0.637)
Education3 (bachelors, masters, candidates)	0.434	-0.421
	(0.450)	(0.651)
Education4 (all the other: grades 1-6, grades 7-9, grades 10-11, PTU diplomas …)	-0.414*	-0.525*
	(0.248)	(0.275)
Settlement type (relative to Village) - Included as continuous variable	0.477***	0.330***
	(0.033)	(0.043)
PGT (small settlement of town type)		
Small or medium-sized town		
Large city		
Capital city		
Location (Oblast) dummies	Not included	Not included
<u>Employer characteristics and wage differences across sectors</u>:		
Social benefits (relative to Benefits_group1 = No social benefits)		
Benefits16_group2 (1 or 2 benefits, count of benefits1-6)	1.280***	-1.665***
	(0.272)	(0.382)
Benefits16_group3 (3 benefits)	1.268***	-3.011***
	(0.385)	(0.560)
Benefits16_group4 (4-6 benefits)	1.150**	-3.190***
	(0.501)	(0.899)
Subsidy to benefits dummy	-0.004	-2.047***
	(0.173)	(0.342)
Predicted formal sector wage/ Predicted formal/informal sector wage	1.241***	0.841*
	(0.430)	(0.480)
Benefits × (Predicted formal sector wage/ Predicted formal/informal sector wage)	-0.322	-0.247
	(0.197)	(0.295)
Dummy =1 if (Predicted formal sector wage/ Predicted formal/informal sector wage)>1	dropped	dropped
Benefits × Wage Ratio Dummy	-0.614***	-0.794***
	(0.160)	(0.262)
Compulsory leave	Not included	Not included
Employer size (relative to Employer size 1 = 1-9 employees, ie micro firms)	Not included	Not included
Employer_size 2 (10-49 people)		

Employer_size 3 (50-249 people)		
Employer_size 4 (250 people and more)		
Year dummy for 2004	0.771***	1.701***
	(0.064)	(0.048)
Constant	-1544.943***	-3406.27***
	(127.488)	(95.465)
Variance of random intercepts	3.573 (0.387)	
No. of observations	6160	6160

Reported: coefficients (log odds ratios), robust standard errors in parentheses.

Significance levels: * - 10%, ** - 5%, *** - 1%.
Weighted by sample (population) weights.

As can be seen from Table 5, all three social benefits dummies are positive and significant. This result is robust to various specifications, suggesting that non-monetary benefits are an important factor affecting sector choice. The preference for being in the formal sector over the formal/informal sector is positively related to benefits per se. However, the total effect of social benefits also depends on the wage ratio between formal and formal/informal sectors, as illustrated by the negative significant coefficient on the interaction variable of benefits and the wage ratio dummy. As predicted by Model II, wage ratios greater than unity are associated with a higher level of benefits leading to the formal/informal sector being chosen with a larger probability. To explore this prediction further, we compute the economic effects for the benefits and the benefits-wage ratio dummy interactions. Available statistical software that handles quantification of such effects is restricted to binary logit models[14], so we estimate a binary logit for choice as an approximation of the first equation in Table 5, and compute the total effect of benefits on the probability to be in the mixed formal/informal sector. Because the available tools[15] only permit to quantify the effects of a dummy-by-dummy interaction, we estimate a specification where the dummy for each group of benefits enters with its own separate interaction with the wage ratio dummy. The estimation results are in Table 2.1 of Appendix 2. They are consistent with and complement the mixed logit results presented in Table 5[16]. Of particular interest are the total effects of each of the benefits groups and the effect of subsidy. We find that while all benefit dummies are positive and significant, for benefits16_group2 and benefits16_group4 the interaction dummies are insignificant. However, in the case of having three benefits, both benefits16_group3 and the interaction are significant, implying the following economic effect: for the wage ratio dummy equal to zero, the benefits16_group3 dummy decreases the probability to choose the formal/informal sector by 7 per cent, while for the wage ratio dummy equal

[14] Note that in the mixed logit framework, such effects are nonlinear and depend on the realised values of the other covariates (Mitchell and Chen (2005)).
[15] Mitchell and Chen (2005).
[16] Wage ratio and wage ratio interacted with continuous benefits are excluded from the specification in Appendix 2 because of multicollinearity.

to one, the benefits16_group3 dummy actually increases this probability by 1 per cent. Graphically this is illustrated in Figure 2.1 of Appendix 2. This result supports the prediction from Model II. We conclude that social benefits play an "attaching" role in the mixed (formal/informal) sector, thus also influencing the composition of the purely informal sector and formal employment. Subsidy to benefits is insignificant for the formal sector work alternative[17], but tends to reduce informal employment. A higher predicted relative formal wage increases the probability of working in the formal sector. Overall, these results tend to support the predictions of Model II, which assumes joint maximization with respect to employment and wages, rather than those of Model I, which supposes maximization with respect to employment only[18].

4.2 Multinomial logit analysis of inter-sector transitions

To capture the extent to which individual workers differ in their sectoral allocations given their previous employment sectors, we estimate a series of standard multinomial logits for inter-sector transitions. In the standard multinomial logit model for a given sector, the observed response categories are mutually exclusive and exhaustive, describing possible switches to the alternative sectors. A worker's response represents their realised move (or the absence of a move). The probability of the *j*th type of switch y_i is

$$\Pr\left(y_i = j \mid X_i\right) = \pi_i^j = \frac{\exp\left(\alpha_j + X_i \beta_j\right)}{\sum_{k=1}^{J-1} \exp\left(\alpha_j + X_i \beta_k\right)}$$ i

Our conjectures about the signs of the coefficients follow from the two models described earlier. If we take the left-hand side variable (say, starting from formal (equal to one) and moving to informal (equal to 3)) as a change in sectoral status over time, then in fact what we estimate in this section is the probability of a particular difference in the value of sector choice variable. We can then argue that using the differences of the independent variables on the right-hand side in the above estimation equation will allow us to transfer the predictions of the model[19] from the comparative statics case to the transition case. We therefore

[17] In the regression in Appendix 2, subsidy to benefits actually turns out to be positive and significant. Figure 2.2 shows the economic effect of subsidy. In particular, at the median level of the other covariates, subsidy raises the probability of being in the formal sector by 4 per cent,

[18] Compulsory leave was always insignificant and was dropped. Employer size was not included due to endogeneity concerns, as data limitations precluded the inclusion of lagged variables.

[19] It has to be noted that the model presents the case of inter-sector, but not inter-firm, transitions. In other words, workers keep their jobs in the formal sector firm and take up an additional job in the informal sector outside the firm, which shifts them into the mixed formal/informal sector without changing their main employment firm. We checked whether this assumption is satisfied in our sample. Indeed, it turns out to be the case: out of 154 movers from formal to formal/informal only 3 changed main jobs (firms) in 2004. However, even if it was not the case, we could easily get around this by assuming not a single formal firm, but a measure one of identical insider-dominated firms.

hypothesise that the likelihood of switching into the informal sector will be decreasing in the size of the firm (which is a proxy for the probability of detection in payroll tax evasion), and increasing in predicted relative wages in the informal sector, while the likelihood of switching into the formal/informal sector will be affected by the social benefits (positively for high enough formal salary according to Model II and positively always according to Model I) and by subsidy (with an effect opposite to that of benefits).

We now use ULMS data on individuals with complete records for 2003-2004 on their employment status and socio-demographic characteristics. We then combine the micro data on workers with information about the firm, such as size. Answers to the survey questions about respondents' economic activity, including their employment status, enable us to ascertain each individual's specific sector of employment in 2003 and 2004 and construct our dependent variable of inter-sector transition with three response categories. Alternative employment sectors are defined in terms of three mutually exclusive categories that distinguish a formal sector, an informal sector, and a mixed formal-informal sector. The sample selection procedures yield a cross-section of 2528 individuals with complete records. *Table 3.1* in Appendix 3 provides the respective transition rates. Based on worker employment sector status in 2003, we split the full sample into three samples used in estimation: (i) a sample of 2047 workers who stay within the formal sector, or move out of the formal sector into the formal-informal sector or into the informal sector, (ii) a sample of 320 workers that either remain employed in the formal-informal sector or move to work solely in the formal sector or solely in the informal sector, and (iii) a sample of 161 individuals who either remain within the informal sector or switch jobs for a different sector.[20]

Table 3.2 in the Appendix 3 presents results pertaining to transitions of: (i) movers from the formal sector (Panel A); (ii) movers from the formal-informal sector (Panel B); and (iii) movers from the informal sector (Panel C). Each multinomial logit model incorporates a three-regime specification distinguishing between those who have not moved (the reference category) and those who have moved sectors. The regression coefficients represent log-odds ratios. A positive coefficient for an independent variable implies an increased odds of observing an individual being in the destination sector *j* rather than in the sector that is taken as the reference category. The default category are males, with diplomas of high school (or general secondary education), who are village residents, employed in 2003 by micro-firms, who have not experienced temporary lay-offs and who self-report being in managerial or professional occupations.

Turning to our results regarding movement from the formal sector (Panel A in *Table 3.2*), males are more likely to leave the formal sector altogether for the informal sector. Town and city residents are less likely to move from the formal into the formal-informal sector, but the impact of the degree of urbanisation, as measured by settlement type, on the likelihood of transition is non-linear. As

[20] Note, however, that our data contain a very small number of departures from the informal sector for the other two sectors over the examined years 2003 and 2004 .As such, we cannot estimate a logit model for the informal sector with the data available. Results are consequently omitted for the infornal sector from Table 3.2.

expected, there is a significant occupation effect on transition, where individuals in less skilled occupations are more likely to move from the formal sector and take up jobs in the formal-informal sector or in the informal sector. The impact of establishment size (measured by its employment) seems to show that those employed by larger firms are less likely to move out of the formal sector into the formal-informal sector. In our analysis, firm size serves as a proxy for the probability of detection by the tax authorities. The result is therefore consistent with a higher detection probability reducing informal employment, as predicted by the model.

Over and above the impact of these factors, the model points to the relevance of social benefits and wage differences for inter-sector moves. We note that among those who hold jobs in the formal sector, enjoying greater benefits increases the chances of their taking an additional job in the formal-informal sector but decreases the likelihood of moving out of the formal sector completely and taking up a job in the informal sector. But both interaction terms between benefits and predicted wages, are insignificant, suggesting that the most complete story about the role of benefits and wage differences in influencing transition from this sector can be told by the main effects of these variables.

Repeating the multinomial logit fitting for transitions of workers from the formal-informal sector (Panel B in Table 3.2), we observe that those who live in larger cities are more likely to move into the formal sector, but residents of smaller or medium-sized towns appear more likely to go over to the informal sector. In contrast, individuals living in PGT (small settlements of town type) tend to stay within the formal-informal sector. Those individuals with jobs in the formal-informal sector, who have been temporarily laid-off, are more likely to move to the informal sector. With respect to skills, formal-informal sector workers with higher skills, such as plant operators, appear to have an improved likelihood of transiting into the formal sector. Allied to this is the finding that being a worker with higher skills makes them less likely to move into the informal sector. The probability of detection of payroll tax evasion, as identified by the establishment size, seems to have a significant and negative effect on moves into the informal sector. Compared with micro-firms, workers employed by larger establishments, are less likely to move into the informal sector. The presence of non-monetary benefits, as well as presence of a subsidy to benefits, makes the likelihood of leaving for an informal sector job less likely. We also find that a higher ratio of the predicted formal sector wage over the predicted informal-formal sector wage is negatively associated with the propensity to participate only in the informal sector. However, as is the case in the model for transitions from the formal sector, the interaction terms are insignificant.

5 Conclusion

The growth of an informal economy has been a feature of many transition countries. This paper looks particularly at the case of Ukraine. Relying on the data from the ULMS, we started by estimating the size and composition of the informal sector over the period from 1991-2004, and tried to shed some light on individual and firm-level factors behind employment choices through a novel analytical model of the firm-level utility maximization by insiders. Our approach, while building up on the standard models of trade unions' behaviour, brings in a number of original features that describe an economy with a strong inheritance from the planned economy, such as the importance of non-monetary benefits in workers' compensation, labour hoarding in the form of unpaid temporary compulsory leave and state subsidies to benefits. When the model's predictions are tested on the ULMS panel data using mixed multinomial logit, we find that, in terms of labour allocation among formal, mixed (formal/informal) and informal sectors at a given point of time, non-monetary compensation plays an attaching role in the mixed formal/informal sector for a high enough predicted formal/mixed wage ratio. Our findings confirm, if only at the sectoral level, previous results by Commander et al. (1997), Friebel and Guriev (2005) on the important worker-attaching role of social benefits at the firm level. We also find for the static case of the model that the empirical results point to the joint maximization of the firm's utility with respect to both employment and wages. In the dynamic setting, the results from a multinomial logit analysis of transitions between sectors again suggest the same important attaching role of non-monetary benefits. However, the optimization problem here tends to be with respect to employment only. This is one puzzle that merits further analysis. One possible explanation for this could be the underlying optimization policy of firms from which transitions take place. For the mover starting in the formal sector, her decision to make a transition may reflect the response to her current firm's policy to optimize with respect to employment, not wages, in other words, with her starting employer possibly engaging in labour hoarding. Finally, our results have implications for policies aiming at improving efficiency of labour allocation in transition countries. Although our findings relate to Ukraine, we suspect that they may generalize beyond its borders, in particular to the other countries of the Former Soviet Union.

References

Bernabe, Sabine, (1999), 'A profile of informal employment: the case of Georgia', International Labour Office, Geneva.

Clarke, Simon, (2002), "Market and Institutional Determinants of Wage Differentiation in Russia", Industrial and Labour Relations Review, Vol.55, No.4 (July).

Commander, Simon and Yulia Rodionova, (2005), "The informal sector in Ukraine: its size, structure and dynamics", EBRD and London Business School, mimeo.

Commander, Simon and Andrei Tolstopiatenko (1997), "A model of the informal economy in transition", World Bank, mimeo.

Commander, Simon and Mark Schankerman, (1997), "Enterprise Restructuring and Social Benefits", Economics of Transition, 5, 1, 1-24.

Commander, Simon, Qimiao Fan and Mark Schaffer (eds), (1997), "Enterprise Restructuring and Economic Policy in Russia", The World Bank, Washington DC.

Friebel, Guido and Sergei Guriev, (2005), "Attaching Workers through In-Kind Payments: Theory and Evidence from Russia", World Bank Economic Review.

Gaddy, Clifford and Barry Ickes, (1998), "To Restructure or Not to Restructure: Informal Activities and Enterprise Behaviour in Transition", Brookings Institution and Pennsylvania State University, February, mimeo

Handbook of Labour Economics, Chapter 18.

Johnson, Simon, Daniel Kaufman and Andrei Schleifer, (1997), "The Unofficial Economy in Transition", Brookings Papers on Economic Activity, 2, December

Krstic, Gorana, (2003), "Empirical aspects of the formal and informal labour market in the Federal Republic of Yugoslavia", PhD, University of Sussex

Lacko, Maria, (2000), "Hidden economy – an unknown quantity?", Economics of Transition, 8, 117-149.

Mitchell and Chen, (2005), "Visualizing main effects and interactions for binary logit models", The Stata Journal, **5**, Number 1, pp. 64–82

Rabe-Hesketh, Sophia and Anders Skrondal, (2006), "Multilevel modelling of complex survey data", Journal of Royal Statistical Society Association, **169**, *Part* 4, *pp*. 805–82.Rein, Martin, Barry L. Friedman and Andreas Worgotter, (1997), "Enterprise and Social Benefits After Communism", Cambridge University Press, Cambridge.

Schneider, F and D. Enste, (2000), "Shadow Economies: Size, Causes and Consequences", Journal of Economic Literature, 38, 77-114

Yoon, Yang-Ro, Barry Reilly, Gorana Krstic, Sabine Bernabe, (2003), "A study of informal labour market activity in the CIS-7", World Bank, mimeo

Appendix 1

Table 1.1: Description of variables

Variable name	Variable description
Worker characteristics	
socio-demographics and measures of access to, and level of education; previous unemployment, occupation	
Age	Age of respondent, in years
Female	Dummy = 1 for female respondent
Settlement Type (reference category Village)	
PGT (small settlement of town type)	Dummy = 1 if respondent lives in PGT
Small or medium-sized town	Dummy = 1 if respondent lives in small or medium-sized town
Large city	Dummy = 1 if respondent lives in a large city
Capital city	Dummy = 1 if respondent lives in the capital city
Education (reference category Education1 = diploma of high school /general secondary education)	
Education2	Dummy = 1 if respondent has incomplete professional higher education, or bachelors, masters, or candidate of sciences degree
Education3	Dummy = 1 if respondent has completed grades 1-6, 7-9, 10-11 or received a PTU diploma
Previous unemployment (ie whether was temporarily laid off)	
Compulsory leave	Dummy = 1 if respondent experienced compulsory leave in the current employment
Occupation / Job Type (reference category "being manager or professional")	
Technician	Dummy = 1 if respondent works as technician
Clerks	Dummy = 1 if respondent works as clerk
Service worker	Dummy = 1 if respondent works as service worker
Skilled agricultural worker	Dummy = 1 if respondent works as skilled agricultural worker
Artisan	Dummy = 1 if respondent works as artisan
Plant operator	Dummy = 1 if respondent works as plant operator
Elementary occupation	Dummy = 1 if respondent has an elementary occupation
Armed Forces	Dummy = 1 if respondent serves in armed forces

(continued on next page)

Table 1.1: *cont.*

Variable name	Variable description
Employer characteristics and wage differences across sectors	
Social benefits (reference category Benefits_group1 = No social benefits)	
Benefits16_group2 (1 or 2 benefits, count of benefs1-6)	Dummy = 1 if respondent receives one or two types of benefits
Benefits16_group3 (3 benefits)	Dummy = 1 if respondent receives three types of benefits
Benefits16_group4 (4-6 benefits)	Dummy = 1 if respondent receives four to six types of benefits
Subsidy to benefits	Dummy = 1 if the enterprise belongs to budgetary enterprise, state enterprise, local municipal enterprise or state or collective farm???
Employer size (reference category Employer size 1 = 1-9 employees (micro firms)	
Employer_size 2 10-49 people	Dummy = 1 if the enterprise has 10 to 49 employees
Employer_size 3 50-249 people	Dummy = 1 if the enterprise has 50 to2 49 employees
Employer_size 4 250 people and more	Dummy = 1 if the enterprise has >250 employees
Ratio of predicted formal sector wage to predicted formal/informal sector wage	Ratio of predicted wages constructed using Heckman estimation.
Wage Ratio Dummy	Dummy =1 if (Predicted formal sector wage/ Predicted formal/informal sector wage) >1
Benefits x (Predicted formal sector wage/ Predicted formal/informal sector wage)	Benefits variable treated as continuous times the Ratio of predicted wages constructed using Heckman estimation.
Benefits ×Wage Ratio Dummy	Benefits variable treated as continuous times Wage Ratio Dummy
Employment sector	Categorical variable = 1 if respondent has formal employment, = 2 if respondent has both formal and informal employment, = 3 if respondent has informal employment only.

Table 1.2: Descriptive statistics

Variables	Mean	StD	Median	
Age	40.0	12.2	41	Overall
	40.2	12.4	41	2003
	39.9	11.9	41	2004
Wage ratio : Ratio of predicted formal sector wage to predicted formal/informal sector wage	0.8	0.5	0.6	Overall
	0.7	0.4	0.7	2003
	0.8	0.6	0.6	2004
Wage ratio × benefits	2.0	1.7	1.6	Overall
	1.9	1.3	1.7	2003
	2.0	2.0	1.5	2004
Wage ratio dummy	0.2	0.4	0.0	Overall
	0.1	0.3	0	2003
	0.2	0.4	0	2004
Benefits × Wage ratio dummy	0.4	1.0	0	Overall
	0.3	0.9	0	2003
	0.5	1.1	0	2004
Gender	0.5	0.5	0	Overall
	0.5	0.5	0	2003
	0.5	0.5	0	2004
Subsidy_(to)_benefits	0.6	0.5	1	Overall
	0.6	0.5	1	2003
	0.5	0.5	1	2004
Benefits_cat == 1	0.2	0.4	0	Overall
	0.2	0.4	0	2003
	0.3	0.4	0	2004
Benefits_cat == 2	0.2	0.4	0	Overall
	0.2	0.4	0	2003
	0.2	0.4	0	2004
Benefits_cat == 3	0.3	0.5	0	Overall
	0.4	0.5	0	2003
	0.3	0.5	0	2004
Benefits_cat == 4	0.2	0.4	0	Overall
	0.2	0.4	0	2003
	0.2	0.4	0	2004
Employer size	2.69	1.11	na	Overall
	2.57	1.14	na	2003
	2.63	1.12	na	2004

Sample frequencies for the settlement type variable.

Village	PGT	Small town	Medium-sized town	Large town	Capital city	
0.26	0.13	0.01	0.12	0.24	0.24	Overall
0.28	0.13	0.02	0.10	0.23	0.24	2003
0.24	0.14	0.01	0.13	0.25	0.24	2004

Appendix 2

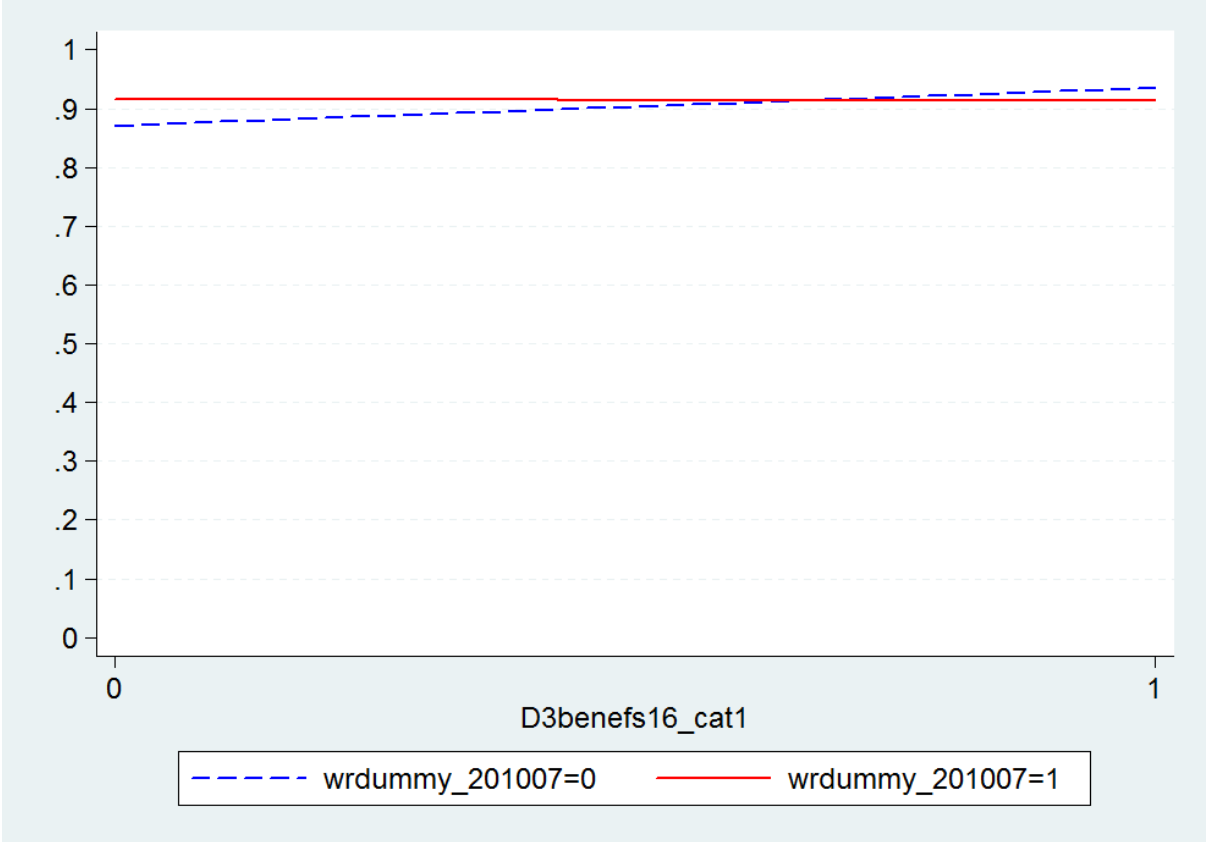
Table 2.1: Logit regression of Pr(Formal): formal=1 with dummies for benefits groups and Wage Ratio Dummy times_Benefits group interactions.

```
. xi3: logit transp3_logitF  D3benefs16_cat1  wrdummy_201007   wrdummy_201007_D3
D2benefs16_cat1  D4benefs16_cat1   wrdummy_201007_D2 wrdummy_201007_D4 age_new
age_newsq gender i.education subsidy_ben    rur_urb  year if wratio_201007>0.1&
wratio_201007<5.1  [pw=weight_pool]
i.education       _Ieducation_1-4     (naturally coded; _Ieducation_1 omitted)

(sum of wgt is   2.6858e+07)
Iteration 0:   log pseudolikelihood = -1952.5092
Iteration 4:   log pseudolikelihood = -1765.2442
Logistic regression                               Number of obs   =       5498
                                                  Wald chi2(16)   =     253.60
                                                  Prob > chi2     =     0.0000
Log pseudolikelihood = -1765.2442                 Pseudo R2       =     0.0959
------------------------------------------------------------------------------
             |               Robust
transp3_lo~F |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D3benefs16~1 |   .7514825   .1462926     5.14   0.000     .4647543    1.038211
wrdummy_20~7 |   .4037377    .226992     1.78   0.075    -.0411584    .8486337
wrdummy_20~3 |  -.5690444   .2849377    -2.00   0.046    -1.127512   -.0105767
D2benefs16~1 |   .9400076   .1779198     5.28   0.000     .5912912    1.288724
D4benefs16~1 |   .6533107   .1687437     3.87   0.000     .3225791    .9840424
wrdummy_20~2 |  -.4525677   .3643416    -1.24   0.214    -1.166664    .2615287
wrdummy_20~4 |   .4146545   .4177981     0.99   0.321    -.4042146    1.233524
     age_new |  -.0920214   .0270024    -3.41   0.001    -.1449452   -.0390977
   age_newsq |   .0010066   .0003251     3.10   0.002     .0003694    .0016438
      gender |   .1278728   .0979566     1.31   0.192    -.0641185    .3198641
_Ieducatio~2 |  -.0667999   .3554784    -0.19   0.851    -.7635248     .629925
_Ieducatio~3 |  -.0538314   .3260348    -0.17   0.869    -.6928479    .5851851
_Ieducatio~4 |  -.1908176    .128006    -1.49   0.136    -.4417048    .0600695
 subsidy_ben |    .368447   .1110028     3.32   0.001     .1508854    .5860086
     rur_urb |   .3470429    .027521    12.61   0.000     .2931026    .4009831
        year |   .2576863   .0996462     2.59   0.010     .0623834    .4529893
       _cons |  -514.1267   199.6049    -2.58   0.010    -905.3452   -122.9083
------------------------------------------------------------------------------

.    xi3:    viblicc    transp3_logitF       D3benefs16_cat1       wrdummy_201007
wrdummy_201007_D3     D2benefs16_cat1     D4benefs16_cat1       wrdummy_201007_D2
wrdummy_201007_D4 age_new age_newsq gender i.education subsidy_ben      rur_urb
year, gen(cc98) graph
i.education       _Ieducation_1-4     (naturally coded; _Ieducation_1 omitted)
Saving covariate contribution as cc98


Percentiles for Covariate Contribution
     P1    P10    P20    P30    P40    P50    P60    P70    P80    P90    P99
  482.5    483  483.3  483.6    484  484.2  484.5  484.8  485.1  485.5    486


. vibligraph , b0(-482.339) b1(.761) b2(.477) b12(-.792) ccat(484.248)
ccmin(483.271) ccmax(485.078)x1name(D3benefs16_cat1) x2name(wrdummy_201007)
```

Changes in Pr(Formal)accounting for the total effect of the D3Benefs16_cat1, wage ratio dummy and their interaction

```
**For CC=484.2479248047** (median)
         |   D3benefs16_cat1
wrdummy_201007 |  0         1
---------+--------------------
       0 |  0.87 (A)   0.94 (B)   (B-A) =  0.07
       1 |  0.92 (C)   0.91 (D)   (D-C) = -0.01
                     (D-C) minus (B-A) = -0.08
```

Figure 2.1: Pr(*F*) by x1 (D3benefs16_cat = 1 if benefs16=3) and x2 (wage ratio dummy) accounting for x1x2 when other covariates take median values



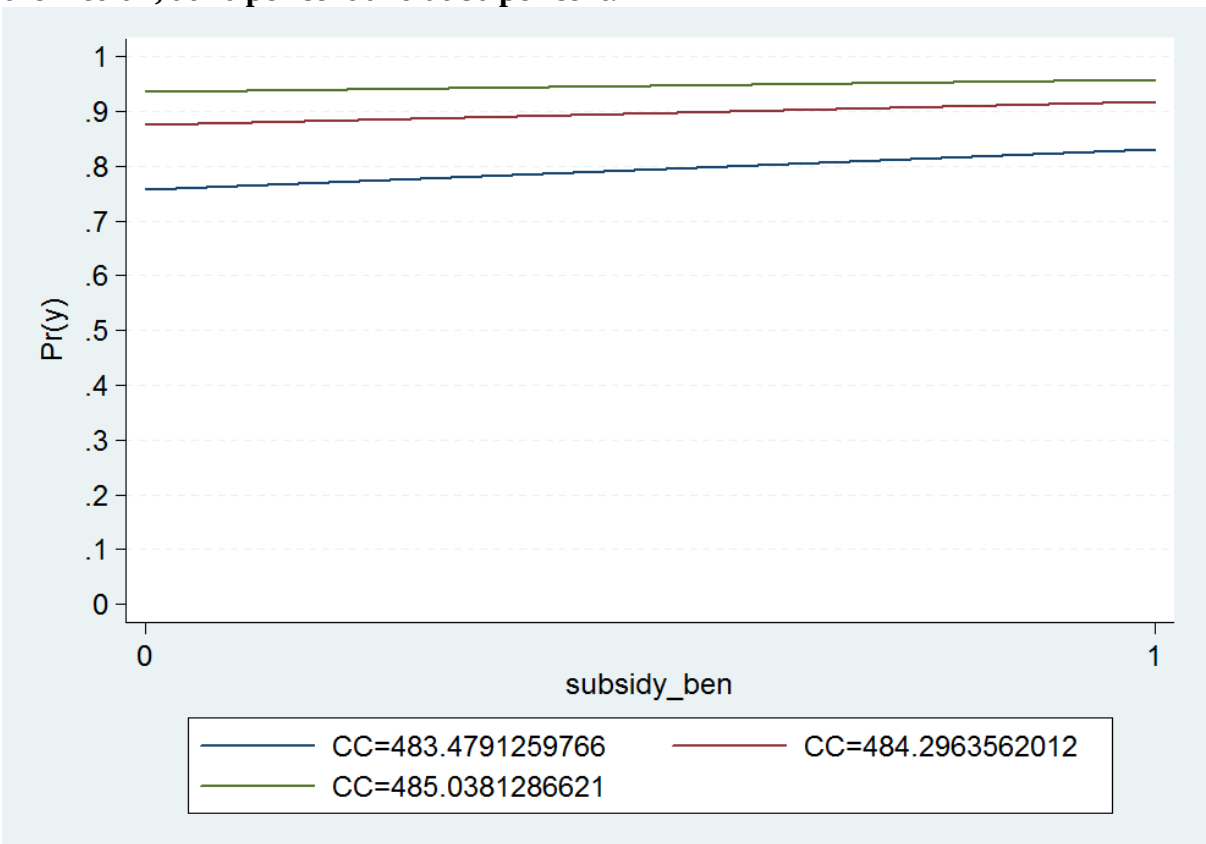
Quantifying the effects of a subsidy for different values of other covariates

```
. xi3: viblmcc transp3_logitF subsidy_ben D3benefs16_cat1  wrdummy_201007
wrdummy_201007_D3  D2benefs16_cat1  D4benefs16_cat1   wrdummy_201007_D2
wrdummy_201007_D4 age_new age_newsq gender i.education     rur_urb  year,
gen(cc991) graph
i.education       _Ieducation_1-4     (naturally coded; _Ieducation_1 omitted)
Saving covariate contribution as cc991

Percentiles for Covariate Contribution
     P1    P10    P20    P30    P40    P50    P60    P70    P80    P90    P99
  482.6  483.2  483.5  483.7    484  484.3  484.6  484.9    485  485.3  485.8
. viblmgraph , b0(-482.339) b1(.46) ccat(483.479 484.296 485.038) xmin(0)
xmax(1) xname(subsidy_ben)
```

Change in the Pr(Formal) for different values of covariates

```
**For CC=483.4791259766**
   subsidy_ben
  0          1
--------------------
 0.76 (A)   0.83 (B)   (B-A) =  0.07

**For CC=484.2963562012** (median)
   subsidy_ben
  0          1
--------------------
 0.88 (A)   0.92 (B)   (B-A) =  0.04

**For CC=485.0381286621**
   subsidy_ben
  0          1
--------------------
 0.94 (A)   0.96 (B)   (B-A) =  0.02
```

Figure 2.2: Pr(*Formal*) by Subsidy to benefits when other covariates are at the median, at 20 per cent and at 80 per cent.



Appendix 3

Table 3.1: Inter-sector Transition Rates for the Full Sample

	Frequency	Per cent
From Formal Sector	2047	
Stayers	1848	73.10%
Movers to Formal/Informal	127	5.02%
Movers to Informal	72	2.85%
From Formal/Informal Sector	320	
Stayers	108	4.27%
Movers to Formal	141	5.58%
Movers to Informal	71	2.81%
From Informal Sector	161	
Stayers	110	4.35%
Movers to Formal	42	1.66%
Movers to Formal/Informal	9	0.36%
Total	2528	100%

Table 3.2: Results from a Standard Multinomial Logit Analysis of Transitions

Panel A: Reference category: Start in FORMAL	**Transitions from Formal to Formal/Informal sector** $log(P_{I\text{-}F} / P_F)$	**Transitions from Formal to Informal sector** $log(P_I / P_F)$
Worker characteristics ***Socio-demographics; access to, and level of education; previous unemployment, occupation.***		
Age	0.050	-0.040
	(0.038)	(0.047)
Age squared	-0.001	0.001
	(0.000)	(0.001)
Female	0.061	**-0.516***
	(0.233)	(0.285)
Access to education, or access to land leading to a possibility of generating income from horticultural activities and suchlike(?), proxied by Settlement Type (relative to Village)		
PGT (small settlement of town type)	**-1.674*****	-0.042
	(0.422)	(0.507)
Small or medium-sized town	**-0.842*****	-0.804
	(0.309)	(0.614)
Large city	**-1.491*****	-0.282
	(0.333)	(0.391)
Capital city	**-1.096*****	-0.296
	(0.319)	(0.384)
Education (relative to Education1 = diploma of high school /gen. secondary)		
Education2 (incomplete professional higher, bachelors, masters, candidates)	-0.747	-0.664
	(0.594)	(0.924)
Education3 (all the other: grades 1-6, 7-9, 10-11, PTU diplomas)	-0.010	0.003
	(0.271)	(0.357)
Previous unemployment (ie whether was temporarily laid off)		
Compulsory leave	-0.469	-0.290
	(0.377)	(0.588)
Occupation / Job Type (relative to being manager or professional)		
Technician	0.450	-0.561
	(0.339)	(0.830)
Clerks	-0.024	0.917
	(0.523)	(0.674)
Service worker	0.354	**1.690*****
	(0.527)	(0.519)
Skilled agricultural worker	0.789	-0.329
	(0.524)	(1.160)
Artisan	0.069	0.826
	(0.385)	(0.551)
Plant operator	0.168	0.917
	(0.547)	(0.813)
Elementary occupation	**0.577***	**1.335****
	(0.336)	(0.544)
Armed Forces	**-31.756*****	**-30.946*****
	(0.401)	(0.560)

(continued on next page)

Table 3.2: Results from standard ML *cont.*

Panel A: Reference category: Start in FORMAL	$log(P_{I\text{-}F} / P_F)$	$log(P_I / P_F)$
Employer characteristics and wage differences across sectors		
Social benefits (relative to Benefits_group1 = No social benefits)		
Benefits16_group2 (1 or 2 benefits, count of benefs1-6)	**1.566*** **	**-1.108** **
	(0.529)	(0.475)
Benefits16_group3 (3 benefits)	**1.285** **	**-1.627*** **
	(0.652)	(0.542)
Benefits16_group4 (4-6 benefits)	0.998	**-1.749** **
	(0.828)	(0.698)
Subsidy to benefits dummy	-0.240	-0.501
	(0.241)	(0.337)
Employer size (relative to Employer size 1 = 1-9 employees, ie micro firms)		
Employer_size 2 10-49 people	**-0.825** **	0.086
	(0.339)	(0.384)
Employer_size 3 50-249 people	**-0.951*** **	0.380
	(0.354)	(0.439)
Employer_size 4 250 people and more	**-1.273*** **	-0.119
	(0.402)	(0.457)
Predicted formal sector wage/ Predicted formal/informal sector wage	0.113	-0.327
	(0.781)	(0.570)
Dummy =1 if (Predicted formal sector wage/ Predicted formal/informal sector wage)>1	1.360	-0.126
	(1.300)	(1.030)
Benefits × (Predicted formal sector wage/ Predicted formal/informal sector wage)	-0.173	-0.028
	(0.352)	(0.267)
Benefits × Wage Ratio Dummy	-0.591	0.431
	(0.524)	(0.396)
Constant	**-3.013*** **	-1.353
	(0.965)	(0.991)
No. of observations	2047	

Table 3.2: Results from standard ML *cont.*

Panel B: Reference category: Start in FORMAL / INFORMAL	**Transitions from Formal/Informal to Formal sector**	**Transitions from Formal/Informal to Informal sector**
	$log(P_F/P_{I\text{-}F})$	$log(P_I/P_{I\text{-}F})$
Worker characteristics		
Socio-demographics; access to, and level of education; previous unemployment, occupation…		
Age	-0.075	0.041
	(0.053)	(0.078)
Age squared	0.001	-0.001
	(0.001)	(0.001)
Female	0.242	0.604
	(0.329)	(0.481)
Access to education, or access to land leading to a possibility of generating income from horticultural activities and suchlike (?), proxied by Settlement Type (relative to Village)		
PGT (small settlement of town type)	0.601	**-2.356***
	(0.549)	(1.394)
Small or medium-sized town	0.758	**2.533****
	(0.663)	(1.157)
Large city	**1.141****	-1.129
	(0.495)	(0.945)
Capital city	**1.681*****	-0.022
	(0.505)	(0.937)
Education (relative to Education1 = diploma of high school /gen. secondary)		
Education2 (incomplete professional higher, bachelors, masters, candidates)	-0.111	1.855
	(0.759)	(1.475)
Education3 (all the other: grades 1-6, grades 7-9, grades 10-11, PTU diplomas)	-0.057	0.566
	(0.406)	(0.638)
Previous unemployment (ie whether was laid off)		
Compulsory leave	-0.093	**2.318****
	(0.520)	(1.097)
Occupation / Job Type (relative to being manager or professional)		
Technician	-0.352	**-39.128*****
	(0.485)	(1.187)
Clerks	-0.303	-0.685
	(0.658)	(1.682)
Service worker	0.971	-1.040
	(0.712)	(0.863)
Skilled agricultural worker	-0.205	-0.985
	(0.620)	(0.758)
Artisan	0.430	0.033
	(0.607)	(1.694)
Plant operator	**2.315*****	0.431
	(0.851)	(1.294)
Elementary occupation	-0.595	0.535
	(0.529)	(0.665)
Armed Forces	NA	NA
	NA	NA

(continued on next page)

Table 3.2: Results from standard ML *cont.*

Panel B: Reference category: Start in FORMAL / INFORMAL	$log(P_F/P_{I\text{-}F})$	$log(P_I/P_{I\text{-}F})$
Employer characteristics and wage differences across sectors		
Social benefits (relative to Benefits_group1 = No social benefits)		
Benefits16_group2 (1 or 2 benefits, count of benefs1-6)	-0.197	-1.493
	(0.838)	(1.467)
Benefits16_group3 (3 benefits)	-0.386	**-4.842****
	(1.199)	(2.384)
Benefits16_group4 (4-6 benefits)	-0.609	**-6.300***
	(1.719)	(3.363)
Subsidy to benefits dummy	0.448	**-1.595***
	(0.436)	(0.950)
Employer size (relative to Employer size 1 = 1-9 employees, ie micro firms)		
Employer_size 2 10-49 people	-0.423	**-1.690****
	(0.483)	(0.853)
Employer_size 3 50-249 people	-0.170	**-2.365*****
	(0.487)	(0.830)
Employer_size 4 250 people and more	-0.371	**-39.024*****
	(0.586)	(1.523)
Predicted formal sector wage/ Predicted formal/informal sector wage	-0.786	**-5.241***
	(1.804)	(2.962)
Dummy =1 if (Predicted formal sector wage/ Predicted formal/informal sector wage)>1	-0.485	2.698
	(1.595)	(2.156)
Benefits × (Predicted formal sector wage/ Predicted formal/informal sector wage)	-0.016	2.588
	(0.766)	(1.615)
Benefits × Wage Ratio Dummy	0.513	-1.431
	(0.611)	(1.078)
Constant	1.861	2.220
	(1.393)	(1.894)
No. of observations	320	