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By: Mirco Tonin

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Mirco Tonin*

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Abstract

The paper investigates the role of the minimum wage in a competitive economy in which there is underreporting of earnings by employed labour. The minimum wage induces higher compliance by some low-productivity workers and transforms a nominally neutral fiscal system into a regressive one. A spike in the wage distribution at the minimum wage level appears and a positive correlation between the size of the spike and the size of the informal economy is predicted and documented using cross-country data for Europe. A further result is that employees whose officially declared earnings appear to be boosted by a minimum wage hike actually experience a decline in their true income. This prediction finds support in an empirical test using the massive increase in the minimum wage that took place in Hungary in 2001 as a quasi-natural experiment.

JEL codes: J38, H26, H32, P2

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"Did you know that more than half of the people nominally employed at the minimum wage earn more, and the only reason for such a declaration is to evade taxes and social security contributions?"¹

(Advertisement in Metro newspaper for the Hungarian government Green Book, 22 September 2006)

1 Introduction

What are the fiscal implications of introducing or increasing the minimum wage? How can we explain the very high spike at the minimum wage level appearing in the wage distribution of some countries? This paper contributes to answering these questions by studying the effects of the interaction between tax evasion and minimum wage legislation.

The minimum wage is the subject of a rich literature and policy debate², mainly focusing on its effect on employment. The traditional view of adverse labour market effects has been challenged (Card and Krueger, 1995) and at present, there is no overwhelming consensus on the issue. Potential beneficial effects of the minimum wage for workers through shifts in the composition of jobs toward good (i.e. high-wage) jobs have also been discussed (Acemoglu, 2001.) This paper highlights another aspect of minimum wage policy that has not been considered so far and shows how an increase in the minimum wage can make affected workers worse off through the "fiscal channel", even if they do not experience adverse labour market effects.

Large efforts have also been devoted to the theoretical and empirical study of tax evasion and the shadow economy³. The study of tax evasion by employed labour is of particular interest as the fiscal imposition on labour in the form of social security contributions (SSC) and personal income tax (PIT) represents the bulk of fiscal revenues in many countries⁴. However, to the best of my knowledge, the effects of the interaction between underreporting

¹"Tudta, hogy a papíron minimálbérért dolgozók több mint fele többet keres annál, és csak azért van minimálbérre bejelentve, hogy kikerülje az adó- és járulékfizetést?" (own translation)

²See Brown (1999) for a review.

³See Andreoni et al. (1998) or Slemrod and Yitzhaki (2002) for surveys on tax evasion and Schneider and Enste (2000) for a survey on the shadow economy.

⁴In EU15 as a whole, labour taxes contributed around 50% of the total tax receipts in 2002 (Eurostat, 2004.)

of earnings and minimum wage legislation have not previously been addressed in a formal model.

Undeclared work is a serious issue in many countries. It is difficult to obtain reliable data on its extension, but raw estimates indicate that the phenomenon is relevant, particularly in transition and developing countries but also in some OECD economies. In a report for the European Commission, the authors stress how the practice of paying “envelope wages” above the officially declared minimum “exists in practically all of the Central and Eastern European countries” (Renooy et al., 2004.) An OECD study of the Baltic countries (OECD, 2003) estimates that in Latvia and Lithuania, 20% of the private-sector employees earn more than what is officially reported⁵. Similar figures have been estimated for Bulgaria (Tomev, 2004.) In Russia, 8% of the employees reported that they received part of their income “under the table” (Petrova, 2005.) The phenomenon is not limited to CEE economies. OECD estimates a 30% shortfall in social security contributions due to undeclared work for Hungary, Mexico and South Korea, and a shortfall above 20% for Italy, Poland, Spain and Turkey⁶ (OECD, 2004.) A World Bank study on labour markets in Eastern Europe and the Former Soviet Union (World Bank, 2005) notices how in several countries in the region “disproportionately high shares of workers cluster on declared wages at or just above the minimum wage (with evidence of additional undeclared incomes above the minimum), creating incentives to sustain a high minimum wage to sustain tax revenue” and calls for further research on this aspect of minimum wage policy. This is indeed the aim of the paper.

A simple model of the labour market is created, where underreporting of earnings is made possible by imperfect detection of tax evasion. The introduction of the minimum wage induces some worker-firm pairs to increase compliance, while pushing others out of the formal labour market into the black economy or into inactivity. The increase in compliance is due to the fact that the minimum wage poses a constraint to reporting behaviour, as agents must choose whether to report nothing or report at least the minimum

⁵The Latvian Central Statistical Office publishes data on earnings under the heading “Gross wage of employed *excluding all kinds of irregular payments* by kind of activity” (italics added.)

⁶In Turkey, firms belonging to the formal sector are estimated to underreport 28% of their wage bill and for around 50% of the employees enrolled in SSK (Social Security Organization), wages reported by employers are at the minimum insurable level (World Bank, 2006.)

wage. When faced with such a restriction, agents may prefer to increase their reporting to the minimum wage level rather than decreasing it to zero. The overall effect when enforcement is not too effective is to unambiguously increase fiscal revenues. The distribution of the fiscal burden is also altered, turning a nominally neutral fiscal regime into a regressive one. Moreover, an otherwise smooth distribution of declared earnings is transformed by the introduction of the minimum wage into a distribution presenting a spike at the minimum wage level.

The model predicts that a minimum wage hike implies a fall in true income for those workers officially earning between the old and the new minimum wage before the hike, even if they keep their job. The massive increase in the minimum wage that took place in Hungary in 2001 provides a natural experiment to test this prediction. Panels derived from the household budget survey for the years 1999-2001 are used to compare consumption, as a proxy for true income, before and after the increase in the minimum wage for households affected by this and for similar but unaffected households. The analysis suggests that the minimum wage hike was indeed effective in squeezing more fiscal revenues from affected households, thus supporting the prediction of the theory.

The model also predicts a positive correlation between the size of the spike at the minimum wage level and the size of the informal economy. Supporting empirical evidence is presented.

The next section discusses some of the related literature. The model is introduced in the third section. In section 4, the various effects of introducing the minimum wage are explored. Section 5 looks at the model implications for the relationship between the spike at the minimum wage and the underground economy. The following section tests one of the model predictions using Hungarian data. In section 7, some evidence about the relationship between the spike and the underground economy is presented. The last section concludes.

2 Related literature

The literature on tax evasion has mainly been focused on personal income tax and the compliance decision by an individual filling the tax declaration form. However, due to the tax withholding and information reporting systems present in many countries, this is not an accurate description for the

case of employed labour. Indeed, the rate of non-compliance for wages and salaries at the stage of filling the tax declaration form is often negligible. For instance, Klepper and Nagin (1989) report a mere 0.1% of non-compliance for wages and salaries at this stage in the US, i.e. lower than for any other income category. Therefore, to study tax evasion by employed labour it is necessary to take into account the interaction between the employer and the employee.

The literature specifically looking at the labour market effects of tax evasion often considers the formal and informal sections of the labour market as separate, with workers and firms being either completely underground or completely compliant with the regulation. Boeri and Garibaldi (2005) are a recent example of this. Fugazza and Jacques (2003) also take this approach in their study on the effect of labour market institutions when there is an underground sector.

Another strand of the literature, in line with the view taken in this paper, considers that workers' compliance with regulation can also be partial. Sandmo (1981) and Cowell (1985) study models where working time can be allocated between the formal and informal sectors. The former is mainly interested in determining the optimal income tax and enforcement, the latter in investigating the effects of fiscal and enforcement parameters on the dimension of the informal sector. Kolm and Nielsen (2005) study a search model with wage bargaining, where the worker and the firm agree on the amount of remuneration not to be reported to the fiscal authorities. They find that both higher taxes and weaker enforcement reduce unemployment. Bargaining between the firm and the workers over the true and reported wage is also assumed by Yaniv (1992) who explores the impact of fiscal and detection parameters on tax evasion and contrasts a withholding and a self-declaration system. However, none of the above mentioned studies considers the impact of minimum wage legislation in an economy with underreporting.

The literature on minimum wage deals extensively with its effects on wage distribution and employment. A spike at the minimum wage level has been observed in several instances (see, for instance, DiNardo et al., 1996, Dickens and Manning, 2004.) Such a spike has been defined as a "puzzle" for several standard types of labour market models (Brown, 1999) and as an "anomalous finding from the standpoint of the standard model of the low wage labor market" (Card and Krueger, 1995, p. 152.) Proposed rationalizations include reductions in non-wage compensation or increases in required effort to offset a binding minimum wage, flatter earnings profiles and adjustments in the

amounts of hours worked. The model presented here proposes an alternative rationale for the observed spike in a perfect competition framework. The positive correlation between the size of the spike at the minimum wage and the estimated size of the informal economy in the data presented in section 7 suggests that the mechanism analysed in this paper indeed contributes to shape the observed distribution of earnings in some countries. Recently, several empirical studies have considered the impact of the minimum wage on other aspects than employment, like fringe benefits (Simon and Kaestner, 2004), prices (Lemos, 2005), profits (Draca et al., 2006.) The impact of the minimum wage on tax evasion has, to the best of my knowledge, never been investigated.

The empirical study of tax evasion or participation in the informal economy by labour is not straightforward. One method is to design specific surveys on these issues. For example, Lemieux et al. (1994) conducted a survey with questions on participation in the underground sector in Quebec city, Canada, and find that underground labour-market activity is concentrated among people at the low end of the income distribution. Another method is based on the comparison of income or labour force participation data from different sources. For instance, Fiorio and D'Amuri (2005) estimate tax evasion in Italy by comparing income from tax forms to survey-based data and find that for employees, evasion is high at lower levels of income, but close to zero at the median.

The method used in this paper is based on the comparison of income and consumption data from household budget surveys. This methodology was pioneered by Pissarides and Weber (1989.) They study underreporting by self-employed in UK by assuming that expenditure on food is correctly reported by all income groups, while income is correctly reported by employees, but underreported by self-employed. Lyssiotou et al. (2004) use a demand system approach to take into account preference heterogeneity. They also focus on tax evasion by self-employed. Tedds (2005) uses a non-parametric approach to address the same question and finds evidence of a non-linear reporting function, with underreporting decreasing as reported self-employment income increases.

The methodology developed by Pissarides and Weber has also been used to study underreporting by private sector employees, using public sector employees as a control group assumed to correctly report income (Besim and Jenkins, 2005.) However, Gorodnichenko and Sabirianova (2006) take the opposite view in their study on bribery in Ukraine. They use the large esti-

mated sectoral gap in reported earnings between the public and the private sector and the absence of an expenditure gap to identify the size of unreported bribes to public officials. The methodology used in this paper to investigate the impact of the minimum wage on underreporting is inspired by this strand of literature. Also in this case are expenditures on food assumed to be correctly reported. There is no need, however, to assume that a group truthfully reports income. The theoretical model makes it possible to characterize the minimum wage hike as a shock to the "underreporting technology" affecting some workers but not others and this variation is exploited to identify the impact of the minimum wage on underreporting.

3 The model without minimum wage

The size of the population is exogenously given and normalized to 1. Every individual has an exogenously given productivity y_i , distributed in the population according to pdf $g(y)$ and cdf $G(y)$ on the support $[\underline{y}, \bar{y}]$, where $\underline{y} \geq 0$. We assume that the labour market is competitive, each firm employs one worker, there is no capital, and production is equal to labour input. Moreover, there is free entry of firms, firms can observe workers' productivity, and workers can move from one firm to another at no cost.

Firms are risk-neutral and maximize expected profits. In an environment without tax evasion, profits for a firm employing a worker with productivity y_i are given by

$$\pi_i = y_i - w_i,$$

where w_i is the gross wage⁷. Firms have an obligation to withhold taxes and social security contributions and transfer them to the authorities. Taxation is at the proportional rate $t \in (0, 1)$. Workers are risk-averse, their (indirect) utility is an increasing function of net income, given by

$$I_i = w_i(1 - t).$$

The wedge between the gross wage paid by the firm and the net wage received by the worker, tw_i , is paid to the fiscal authorities. Free entry of firms implies that in equilibrium, the expected profits are zero which, in turn, in the full compliance case implies that a worker with productivity y_i would receive a

⁷No distinction is made between labour cost and gross wage and the two concepts are considered to be equivalent in the model.

gross wage y_i , from which the firm would deduct taxes ty_i , thereby leaving the worker a net wage $(1 - t)y_i$.

In this economy, however, it is possible to evade taxes and social security contributions by not reporting part or all of the worker's earnings to the authorities. A firm employing a worker with productivity y_i must therefore decide how much of the worker's product to declare to the tax authorities, x_i , and how much to conceal, $y_i - x_i$. If $x_i = y_i$, the firm is fully compliant with the regulations. If $x_i = 0$, the full product is hidden from the authorities and the firm-worker pair operates completely in the black economy. If $x_i \in (0, y_i)$, there is underreporting. A worker-firm pair can thus operate in the formal economy, by declaring a strictly positive income, or be completely in the black market, by declaring nothing. A worker can also decide to be inactive. In this case, income is normalized to 0.

Tax authorities may inspect firms to find out whether they comply with fiscal regulation. We assume there to be an exogenously given probability of an audit being performed $\gamma \in [0, 1]$. Fines are imposed on firms in case tax evasion is detected and, given the assumption of risk-neutral firms and risk-averse workers, there is no incentive for workers and firms to negotiate a different risk-sharing arrangement. However, the fact that an audit is performed does not imply that the authority with certainty discovers the true tax liability, but it may find evidence to impute an income $\hat{y}_i \in [0, y_i]$, where y_i is the true product. For instance, Feinstein (1991) estimates that IRS examiners on average managed to detect only half of the tax evasion in the forms they audited, while Erard (1997) rejects the null hypothesis of perfect detection in his empirical investigation of a model where detection can be either complete or null. For analytical convenience, we assume that the detection technology is such that the probability of finding an imputable product \hat{y}_i is uniform over the interval $[0, y_i]$, i.e. $\hat{y}_i \sim U_{[0, y_i]}$. However, the problem is well defined for any distribution characterized by a differentiable density function.

Given a declaration of x_i and collected evidence of a true tax liability of \hat{y}_i , the tax authority imposes on the firm, in case $\hat{y}_i > x_i$, the payment of $\theta t(\hat{y}_i - x_i)$, consisting of taxes plus an additional fine proportional to the assessed tax evasion, thus $\theta > 1$. In case $\hat{y}_i \leq x_i$, the tax authority cannot prove any tax evasion, so no fine is imposed. Given a true product y_i and a

reported one $x_i \in [0, y_i]$, the expected fine in case of auditing, f_i , is

$$f_i = t\theta \int_{x_i}^{y_i} (\hat{y}_i - x_i)g(\hat{y}_i)d\hat{y}_i, \quad \text{where} \quad g(\hat{y}_i) = \frac{1}{y_i}.$$

Then,

$$f_i = \frac{t\theta}{y_i} \int_{x_i}^{y_i} (\hat{y}_i - x_i)d\hat{y}_i = \frac{t\theta}{2y_i}(y_i - x_i)^2. \quad (1)$$

Notice that a decrease in reported income, x_i , does not increase the probability that any particular level of income is detected, as this probability is given. However, it increases the probability of paying a fine, as a fine is imposed on the difference between detected and reported income, if positive. Given the detection technology, the expected fraction of evaded income, $y_i - x_i$, that is discovered in case of auditing is

$$\frac{1}{y_i - x_i} \left[\frac{1}{y_i} \int_{x_i}^{y_i} (\hat{y}_i - x_i)d\hat{y}_i \right] = \frac{y_i - x_i}{2y_i}, \quad (2)$$

i.e. a fraction corresponding to half the ratio of evaded income over true product. The assumption is thus that it is relatively easy to get away with tax-evasion.

Below, we determine the equilibrium wage and evasion. For convenience, subscripts are suppressed where not necessary.

3.1 Equilibrium without minimum wage

For a firm employing a worker with productivity y , declaring x , and paying a gross wage w , the possible realizations of profits are given by ⁸

$$\pi = \begin{cases} y - w & \text{with probability } 1 - \gamma \\ y - w - f & \text{with probability } \gamma \end{cases},$$

⁸Actually, when an audit is performed, possible realizations of profits are a continuum, due to the stochastic nature of the fine. For expositional convenience, the expected value of the fine is considered.

where f , the expected fine in case an audit is conducted, is given by (1). Therefore, expected profits for the firm are

$$E(\pi) = y - w - \gamma f. \quad (3)$$

Substituting (1) into (3), we get

$$E(\pi) = y - w - \gamma\theta t \frac{1}{y} \frac{1}{2} (y - x)^2. \quad (4)$$

The firm chooses both w and x to maximize its profits.

Income I for a worker employed in a firm paying a gross wage w and declaring to fiscal authorities x is given by

$$I = w - xt. \quad (5)$$

This expression captures the fact that taxes and social security contributions are deducted from the worker's declared gross wage x , not from his true gross wage w . As income is non-stochastic, income maximization corresponds to utility maximization, given the assumption that (indirect) utility only depends on net income.

Free entry implies that firms will compete by offering to workers the package (w, x) which maximizes (5) until the expected profits go to zero. Thus, the wage equation is obtained by equalling the expected profits (4) to zero,

$$w = w(x) = y - \gamma\theta t \frac{1}{y} \frac{1}{2} (y - x)^2. \quad (6)$$

The corresponding income for the worker is given by substituting (6) into (5)

$$I = y - \gamma\theta t \frac{1}{y} \frac{1}{2} (y - x)^2 - xt, \quad (7)$$

and the solution to the reporting decision problem is obtained by maximizing income given by (7), i.e.

$$\max_{x \in [0, y]} y - \gamma\theta t \frac{1}{y} \frac{1}{2} (y - x)^2 - xt. \quad (8)$$

The first-order condition is

$$t - \gamma\theta t \frac{1}{y} (y - x) = 0 \Leftrightarrow x = \left(1 - \frac{1}{\gamma\theta}\right)y.$$

The second-order condition is always satisfied. The boundary condition $x \leq y$ is always satisfied. Notice that full compliance (i.e. $x = y$) does not take place unless $\gamma\theta \rightarrow +\infty$ ⁹. The condition $x \geq 0$ is satisfied if and only if $\gamma\theta \geq 1$. When enforcement is very weak, so that $\gamma\theta < 1$, full evasion will take place, i.e. $x = 0$. To simplify the notation, the two enforcement parameters are summarized by

$$\alpha \equiv \frac{1}{\gamma\theta}.$$

To summarize, the solution to the reporting problem without minimum wage is given by

$$x^* = \begin{cases} (1 - \alpha)y & \text{if } \alpha \leq 1 \\ 0 & \text{if } \alpha > 1 \end{cases} . \quad (9)$$

Thus, the model implies that, irrespective of the specific level of productivity, firms reveal a constant fraction of their production to the fiscal authorities. As $\frac{\partial\alpha}{\partial\gamma} < 0$ and $\frac{\partial\alpha}{\partial\theta} < 0$, in an interior solution, the fraction of production that is evaded decreases as enforcement improves. Substituting (9) into (7), we get the worker's income

$$I^* = \begin{cases} y(1 - t) + \frac{1}{2}\alpha yt & \text{if } \alpha \leq 1 \\ y(1 - \frac{1}{2}\frac{1}{\alpha}t) & \text{if } \alpha > 1 \end{cases} . \quad (10)$$

The expected fraction of concealed production that is discovered in case of auditing is, by substituting $x = (1 - \alpha)y$ into (2), $\frac{1}{2}\alpha$. Thus, for example, in an economy where 30% of the income are concealed, only 15% of the evasion are, on average, detected in case of auditing.

4 Effects of the minimum wage

In this section, we study what are the effects of introducing a minimum monthly wage ϖ , with universal coverage, in the economy described in the previous section. Workers cannot be legally employed at a wage below the minimum, in the sense that their reported gross wage cannot be below the

⁹In Tonin (2006a), it is shown that even with the probability of auditing depending on reported income, i.e. $\gamma = \gamma(x)$, evasion remains at all levels of income as far as $\lim_{x \rightarrow y^-} \gamma(x)\theta < +\infty$. This is due to the fact that as $x \rightarrow y^-$, the expected fine in case of auditing goes quadratically to zero, while the benefit of tax evasion goes linearly to zero.

minimum. The assumption in the model is that the minimum wage is fixed on a monthly basis for full-time work and that no alternative working-time arrangements are available. However, in Tonin (2006a), the model is extended to the case where the minimum wage is fixed on an hourly basis, labour supply can vary across workers and underreporting can involve both hours of work and hourly wage. The results are qualitatively unchanged. In what follows, we focus on the case with partial evasion, i.e. $\alpha \in (0, 1)$ ¹⁰.

4.1 Effects on the distribution

With the introduction of a minimum wage (8) becomes

$$\max_{x \in \{0\} \cup [\varpi, y]} y - \gamma\theta t \frac{1}{y} \frac{1}{2} (y - x)^2 - xt.$$

The only difference is in the choice set which shrinks from $[0, y]$ to $\{0\} \cup [\varpi, y]$. The introduction of the minimum wage divides worker-firm pairs into three categories:

1. High productivity: $y_i > \frac{\varpi}{1-\alpha}$
2. Intermediate productivity: $\varpi \leq y_i \leq \frac{\varpi}{1-\alpha}$
3. Low productivity: $y_i < \varpi$

Worker-firm pairs characterized by high productivity would have declared more than the minimum wage anyway, so they are unaffected by it. The minimum wage is instead a binding constraint for worker-firm pairs that would have declared less in its absence. We first analyse the case of low-productivity workers.

¹⁰For this to be the case, we need $\gamma\theta > 1$. By assumption $\theta > 1$, but γ , the probability of being subject to an audit, may be low, so this condition may seem restrictive. Notice, however, that in this model, an audit is extremely ineffective. As already mentioned if, for instance, 30% of the income are evaded, during an audit on average only 15% of the evaded income are discovered. Thus, more than a full-fledged investigation, an audit should in the present set-up rather be interpreted as a routine check by the fiscal authorities, thus occurring much more frequently than a thorough inquiry.

Low productivity A worker with productivity below the minimum wage, $y_i < \varpi$, can only work in the black market or be inactive. The possibility of a worker paying back part of his wage to the firm is thus excluded. The main results are qualitatively unaffected by this modelling choice. From (10), we get income in case of work in the black market, i.e. full evasion,

$$I_{bm} \equiv y_i \left(1 - t \frac{1}{2\alpha}\right). \quad (11)$$

Income in case of inactivity is assumed to be 0. The labour market status is chosen by comparing income in the two cases, giving the following condition

$$I_{bm} > 0 \Leftrightarrow \alpha > \frac{t}{2}.$$

Then, if $\alpha > \frac{t}{2}$, workers with productivity below the minimum wage work in the black market, otherwise they withdraw from the labour market. Thus, the prediction is that, for a given tax rate, in economies where enforcement is quite effective, i.e. α is low, the minimum wage pushes workers into inactivity and therefore, it has a negative impact on efficiency, as productive labour stays idle. Instead, in economies with not very effective enforcement, the minimum wage has no negative impact on efficiency as workers continue to produce in the black market. Naturally, this is true as far as going completely underground does not entail a drop in productivity.

Intermediate productivity The possibility of declaring the minimum wage and thus, participating in the formal labour market is available for worker-firm pairs whose optimal declaration in case of no minimum wage regulation is less than ϖ , but with productivity above ϖ , i.e.

$$(1 - \alpha)y_i \leq \varpi \leq y_i \Leftrightarrow \varpi \leq y_i \leq \frac{\varpi}{1 - \alpha}. \quad (12)$$

Income in case of declaring ϖ is given by substituting $x = \varpi$ in (7)

$$I_{mw} \equiv y_i(1 - t) + (y_i - \varpi)t - t \frac{1}{\alpha y_i} \frac{1}{2} (y_i - \varpi)^2. \quad (13)$$

Declaring a wage higher than the minimum is never optimal for this group. Moreover, as $I_{mw} > 0$ for productivities satisfying (12), these workers will never go into inactivity. The choice is thus between declaring the minimum

wage or working in the black market and declare 0. The comparison between income in case of declaring the minimum wage and income in the black market as given by (11) gives the following condition

$$I_{mw} \geq I_{bm} \Leftrightarrow y_i \geq \frac{1}{2(1-\alpha)}\varpi \equiv y_{mw}. \quad (14)$$

As the choice between employment at the minimum wage and employment in the black market is only relevant for workers satisfying (12) to determine the behaviour once a minimum wage is introduced, it is necessary to position y_{mw} in the interval $[\varpi, \frac{\varpi}{1-\alpha}]$. The threshold y_{mw} is greater than the minimum wage if and only if $\alpha > \frac{1}{2}$, while it is always the case that $y_{mw} < \frac{\varpi}{1-\alpha}$. Thus, if the degree of underreporting is high, i.e. $\alpha > \frac{1}{2}$, the threshold y_{mw} is internal to the interval defined by condition (12). This implies that some of the workers affected by the minimum wage and with productivity higher than the minimum wage prefer to decrease evasion and declare the minimum, while others prefer to go into the black market. If the degree of underreporting is instead low, i.e. $\alpha \leq \frac{1}{2}$, all workers affected by the minimum wage and with a productivity higher than the minimum wage prefer to increase compliance and declare the minimum.

The results are summarized in the below proposition.

Proposition 1 *The introduction of the minimum wage in an economy with underreporting of earnings induces some workers to increase compliance by increasing declared earnings to the minimum wage level. Workers with high productivity are unaffected. Workers with productivity below the minimum wage work in the black market if enforcement is not too effective, otherwise they withdraw from the labour force.*

The distribution of declared earnings x before the introduction of the minimum wage is given by

$$g_x(x) = \begin{cases} g(\frac{x}{1-\alpha}) & \underline{y}(1-\alpha) < x < \bar{y}(1-\alpha) \\ 0 & otherwise \end{cases},$$

where $g(\cdot)$ is the pdf of the productivity distribution. After the introduction

of the minimum wage, it is given by

$$g_{mw}(x) = \begin{cases} \int_0^{\varpi \max\{\frac{1}{2(1-\alpha)}, 1\}} g(y) dy & \text{if } x = 0 \\ \int_{\frac{x}{1-\alpha}}^{\varpi \max\{\frac{1}{2(1-\alpha)}, 1\}} g(y) dy & \text{if } x = \varpi \\ g\left(\frac{x}{1-\alpha}\right) & \text{if } \varpi < x \leq \bar{y}(1-\alpha) \\ 0 & \text{otherwise} \end{cases} .$$

Thus, a "smooth" distribution of productivity is associated with a "smooth" distribution of declared earnings without a minimum wage. However, with the introduction of the minimum wage, two spikes appear at the minimum wage level and at zero. Thus, we can state the following:

Proposition 2 *In a perfectly competitive labour market with underreporting of earnings, a spike at the minimum wage level appears in the distribution of declared earnings.*

Figure (1) depicts declared income as a function of productivity with and without the minimum wage. Declared income when there is no tax evasion is also plotted as a reference.

4.2 Fiscal effects

The minimum wage divides worker-firm pairs into three categories: those declaring nothing, those declaring the minimum wage, and the unaffected, i.e. those declaring more than the minimum. Here, we first determine payments to fiscal authorities for each category. Then, we use the above analysis of the distribution of declared earnings to find out the effects of the minimum wage on fiscal revenues.

Payments to fiscal authorities Total payments, P , to fiscal authorities include taxes, T , and expected fines, F . For worker-firm pairs not affected by the minimum wage, these quantities are

$$P_1 = \left(1 - \frac{\alpha}{2}\right)ty \begin{cases} \nearrow T_1 = (1 - \alpha)ty \\ \searrow F_1 = \frac{\alpha}{2}ty \end{cases} .$$

Underreporting gives worker-firm pairs with relatively high productivity the opportunity to reduce the "effective"¹¹ tax rate by a factor $\frac{\alpha}{2}$. For worker-firm pairs declaring the minimum wage, fiscal payments are given by

$$P_2 = t\bar{w} + t \frac{1}{2\alpha} \frac{(y - \varpi)^2}{y} \begin{array}{l} \nearrow T_2 = t\varpi \\ \searrow F_2 = \frac{1}{2\alpha} \frac{(y - \varpi)^2}{y} t \end{array} .$$

The remaining category is represented by worker-firm pairs that are either in the black economy (when $\alpha \geq \frac{t}{2}$) or do not participate in the labour market (when $\alpha < \frac{t}{2}$). For workers in the black market, fines are the only type of payment, so that

$$P_3 = F_3 = t \frac{1}{2\alpha} y.$$

Workers who withdraw from the labour market do not contribute to the public finances, so

$$P_4 = F_4 = 0.$$

Notice that $\frac{P_3}{y} \geq \frac{P_2}{y} \geq \frac{P_1}{y}$ in the relevant intervals¹². Expected payments as a portion of income are highest for worker-firm pairs in the black economy and lowest for worker-firm pairs not affected by the minimum wage. Thus, considering expected total payments, it is possible to state the following:

Proposition 3 *The interaction of minimum wage and underreporting transforms a nominally neutral tax system into a regressive one.*

The intuition behind this result is simple: worker-firm pairs try to minimize the share of the product paid to fiscal authorities. The minimum wage is not a binding constraint for high productivity workers who manage to reduce the "effective" tax rate. For instance, if $\alpha = 40\%$, the "effective" tax rate for these workers is 80% of t . For workers with intermediate productivity, the minimum wage is binding. Thus, they are less "successful" in minimizing their "effective" tax rate, even if they still manage to reduce it below t . Low productivity workers are even more constrained, as their only choice is to work in the black market or withdraw from the labour market, and they may

¹¹In the sense of total expected payments to fiscal authorities, including fines, over total product, i.e. $\frac{P}{y}$.

¹²In particular, $\frac{P_2}{y} \geq \frac{P_1}{y} \forall y$, $\frac{P_3}{y} \geq \frac{P_1}{y} \forall y$, $\frac{P_3}{y} \geq \frac{P_2}{y} \Leftrightarrow y \geq \frac{\varpi}{2(1-\alpha)}$. As only workers with productivity $y_i \geq \max(\varpi, \frac{\varpi}{2(1-\alpha)})$ will declare the minimum wage, then $\frac{P_3}{y} \geq \frac{P_2}{y}$ for the relevant interval.

end up facing an "effective" tax rate above t . With $\alpha = 40\%$, for instance, the "effective" tax rate for these workers is indeed 125% of t . Figure (2) shows the effective tax rate as a function of productivity.

Effects of the minimum wage on revenues When workers with productivity below the minimum wage work in the black market, i.e. when $\alpha \geq \frac{t}{2}$, total revenues R are given by

$$\begin{aligned}
 R = & \int_0^{\max(\varpi, \frac{\varpi}{2(1-\alpha)})} t \frac{1}{2\alpha} y g(y) dy + \int_{\max(\varpi, \frac{\varpi}{2(1-\alpha)})}^{\frac{\varpi}{1-\alpha}} [t\bar{w} + t \frac{1}{2\alpha} \frac{(y - \varpi)^2}{y}] g(y) dy + \\
 & + \int_{\frac{\varpi}{1-\alpha}}^{\bar{y}} (1 - \frac{\alpha}{2}) t y g(y) dy. \tag{15}
 \end{aligned}$$

The marginal worker is indifferent between being employed in the black market or declaring the minimum wage if $\alpha > \frac{1}{2}$, while he prefers not to be completely underground if $\frac{t}{2} \leq \alpha \leq \frac{1}{2}$. In the first case, the only effect of a marginal increase in the minimum wage is to extract higher payments from workers declaring it while in the second case, there is the additional effect of pushing worker-firm pairs previously in the official economy into the black market. In both cases, total revenues increase with an increase in the minimum wage, i.e.

$$\frac{\partial R}{\partial \varpi} > 0.$$

When workers with a productivity below the minimum wage withdraw from the labour market, i.e. when $\alpha < \frac{t}{2}$, there is no black market from which to extract fines, and total revenues are given by the last two terms in expression (15). Then,

$$\frac{\partial R}{\partial \varpi} = -t\bar{w}g(\varpi) + \int_{\varpi}^{\frac{\varpi}{1-\alpha}} [1 - \frac{1}{\alpha} \frac{(y - \varpi)}{y}] t g(y) dy.$$

The first term represents the fiscal loss due to the withdrawal of workers from the labour market, the second term the higher payments by workers declaring the minimum wage. The net effect depends on the shape of the distribution. We can then state the following proposition:

Proposition 4 *When underreporting is high, revenues increase with the minimum wage. When underreporting is low, the effect of increasing the minimum wage on revenues depends on the productivity distribution.*

The intuition is straightforward: maximization of workers' net income is equivalent to minimization of transfers to the government. Choice is limited to the possible declaration space $\{0\} \cup [\varpi, +\infty)$. Increasing the minimum wage shrinks the possible declaration space, so that the newly chosen compliance after the increase in the minimum wage cannot make workers better off. When the increase in the minimum wage does not have a negative impact on production, i.e. it does not "shrink the pie", this implies that the government cannot be made worse off, i.e. revenues cannot decrease. This can be counterbalanced by a decrease in revenues due to reduced total production when an increase in the minimum wage pushes low productivity workers out of the labour market.

This implies that countries where underreporting is serious because of limited enforcement capacity can use the minimum wage to boost fiscal revenues, without having to worry too much about the impact on efficiency. As enforcement improves, the minimum wage becomes a less effective fiscal instrument and efficiency issues become more prominent. However, equity issues are also at stake, as the minimum wage increases revenues by extracting more payments from low productivity workers.

The revenue boosting effect of the introduction of a minimum wage can be substantial. In Bulgaria, for instance, social security contribution payments increased by almost 20% in 2003 "[a]s a result from the registration of the labor contracts and the introduction of the minimum insurance income upon principal economic activities and qualification groups of professions, as well as from the improved economic situation" (NSSI).

4.3 The effect of a minimum wage hike on incomes

Here, we characterize the change in income due to a minimum wage hike for different categories of workers. Suppose that in the first period the minimum wage is ϖ_1 , increasing to $\varpi_2 > \varpi_1$ in the second period. The change in income due to the minimum wage hike is $\Delta I = I_2 - I_1$, where I_t is income in period t .

If a worker already operates in the underground market or declares earnings above ϖ_2 in the first period, then he will not change his behaviour after

the minimum wage hike and thus, his income remains unchanged, $\Delta I = 0$. A worker whose official earnings are exactly equal to the minimum wage in the first period, ϖ_1 , may experience an increase in declared earnings to ϖ_2 , with a corresponding income change of

$$\Delta I = -\frac{t}{2\alpha y} (\varpi_2 - \varpi_1) [\varpi_2 + \varpi_1 - 2y(1 - \alpha)] < 0^{13}.$$

Alternatively, his declared earnings may decrease to 0. The income change in this case is given by

$$\Delta I = \frac{t}{2\alpha y} \varpi_1 [\varpi_1 - 2y(1 - \alpha)] < 0^{14,15}.$$

In any case, the minimum wage hike results in an income decline for this type of worker. The last type of worker to analyse is the one with declared earnings between the old and new minimum wage in the first period. Also in this case may declared earning in the second period increase to ϖ_2 , resulting in an income drop given by

$$\Delta I = -\frac{t}{2y\alpha} [y(1 - \alpha) - \varpi_2]^2 < 0,$$

or decrease to 0, with the corresponding income change given by

$$\Delta I = -\frac{yt}{2\alpha} (1 - \alpha)^2 < 0^{16}.$$

Notice that the decline in income for workers declaring ϖ_2 in the second period increases as the distance between the declared income in the first period and ϖ_2 increases. Thus, a worker who in the first period was declaring marginally above the minimum wage ϖ_1 and increases his declaration to ϖ_2 experiences a larger income decline than a worker also declaring ϖ_2 in the second period, but whose declared income in the first period was higher. The

¹³This is due to the fact that workers in this situation have productivity y_i s.t. $(1 - \alpha)y_i \leq \varpi_1 < \varpi_2$.

¹⁴This is due to the fact that workers in this situation have productivity y_i s.t. $\begin{cases} y_i > \varpi_1 & \text{if } \alpha \leq \frac{1}{2} \\ y_i > \frac{\varpi_1}{2(1-\alpha)} & \text{if } \alpha > \frac{1}{2} \end{cases}$.

¹⁵This assumes that workers go underground. If $\alpha < \frac{t}{2}$, so that workers withdraw from the labour market, the decline in income is obvious.

¹⁶See previous note.

income decline is even larger for workers who declared the minimum wage in the first period.

The model thus predicts the following:

- Proposition 5** 1. *As a result of a minimum wage hike, workers whose declared earnings before the hike are between the old and the new minimum wage experience a decline in income. Other workers are unaffected.*
2. *For those workers declaring the new minimum wage after the hike, the decline in income increases with the distance between the new minimum wage and the declared income before the hike.*

The intuition behind these results is similar to that behind the previous proposition. Increasing the minimum wage effectively shrinks the choice set of workers declaring in the previous period between the new and the old minimum wage, making them worse-off.

This prediction of the model will be tested in section 6 using the massive minimum wage hike that took place in Hungary in 2001 as a natural experiment. A difference-in-difference approach is used. The first part of the proposition will be tested by using a "dummy treatment", identifying workers declaring an amount between the new and the old minimum wage before the hike. The second part of the proposition will be tested by using a "continuous treatment", where the distance between the new minimum wage and declared earnings before the hike is used to measure the intensity of treatment.

5 Underground economy and minimum wage spike

Both the size of the spike at the minimum wage and the size of the underground economy relative to the economy as a whole are determined by the interplay of the productivity distribution, the fiscal enforcement parameters as summarized by α , and the minimum wage, ϖ . In this section, we study the link between the size of the underground economy and the size of the spike.

The spike at the minimum wage The size of the spike at the minimum wage is given by

$$S = \int_{\max(\frac{1}{2(1-\alpha)}\varpi, \varpi)}^{\frac{\varpi}{1-a}} g(y)dy.$$

A decrease in enforcement parameters, i.e. an increase in α , induces the minimum wage to be declared by some workers previously declaring more, thereby increasing the size of the spike. If enforcement is sufficiently weak, i.e. if $\frac{1}{2} < \alpha < 1$, an additional effect plays a role, as some workers previously declaring the minimum wage prefer to go into the black economy, thus reducing the size of the spike. In this case

$$\frac{\partial S}{\partial \alpha} > 0 \Leftrightarrow g\left(\frac{\varpi}{1-a}\right) > \frac{1}{2}g\left(\frac{\varpi}{2(1-a)}\right).$$

Assuming that the distribution of productivity is single peaked, the above condition is satisfied if the minimum wage is binding for workers with productivity lower than the mode. If this is the case, the spike is always increasing as α increases.

The effect on the size of the spike of a marginal increase in the minimum wage depends on the interplay between two effects: as ϖ increases, some workers previously declaring the minimum wage are pushed out of the formal labour market, thus decreasing the size of the spike, while some, previously declaring more, declare the minimum wage, thus increasing the size of the spike. Given α , the condition for the size of the spike to increase as the minimum wage increases is

$$\frac{\partial S}{\partial \varpi} > 0 \Leftrightarrow g\left(\frac{\varpi}{1-a}\right) > g(\varpi) \max\left(1-a, \frac{1}{2}\right).$$

Also in this case a single peaked productivity distribution and a minimum wage binding for workers with productivity lower than the mode are sufficient conditions for the spike to increase with the minimum wage.¹⁷

¹⁷The analysis can also be conducted in terms of the size of the spike, relative to the size of the officially employed workforce, where the latter is given by:

$$L = \int_{\max(\frac{1}{2(1-\alpha)}\varpi, \varpi)}^{\bar{y}} g(y)dy.$$

The conditions for the spike relative to the officially employed workforce, $\frac{S}{L}$, to increase with α and ϖ are looser than those for S , as the size of the officially employed workforce decreases with α and ϖ .

The informal economy When workers with a productivity below the minimum wage work in the black market, i.e. when $\alpha \geq \frac{t}{2}$, the size of the underground economy¹⁸ is given by:

$$U = \underbrace{\int_{\underline{y}}^{\max(\frac{1}{2(1-\alpha)}\varpi, \varpi)} yg(y)dy}_{\text{black economy}} + \underbrace{\int_{\max(\frac{1}{2(1-\alpha)}\varpi, \varpi)}^{\frac{\varpi}{1-a}} (y - \varpi)g(y)dy + \alpha \int_{\frac{\varpi}{1-a}}^{\bar{y}} yg(y)dy}_{\text{underreporting}}. \quad (16)$$

A decrease in enforcement, i.e. an increase in α , increases the size of the informal economy as workers unaffected by the minimum wage evade more. Moreover, when enforcement is already low, i.e. $\frac{1}{2} < \alpha < 1$, some workers previously declaring the minimum wage go into the black economy, thereby further increasing informality.

An increase in the minimum wage pushes some workers previously declaring the minimum wage into the black economy, thus increasing informality, but also forces workers continuing to declare the minimum to declare more of their true income, thus reducing informality. Which effect prevails depends on the shape of the productivity distribution.

When workers with productivity below the minimum wage withdraw from the labour market; i.e. when $\alpha < \frac{t}{2}$, there is no black market, thus the size of the underground economy is given by the last two terms in expression (16). Also in this case a decrease in enforcement, i.e. an increase in α , increases the size of the informal economy as workers unaffected by the minimum wage evade more¹⁹. The absolute size of the informal economy decreases with an increase in the minimum wage, as workers declaring the minimum increase their compliance. However, in this case, an increase in the minimum

¹⁸The analysis is done on the size of the informal economy in absolute terms, U . The size of the informal economy relative to the economy as a whole, $\frac{U}{Y}$, or relative to the size of the formal economy, $\frac{U}{Y-U}$, are also of interest. When $\alpha \geq \frac{t}{2}$, the size of the economy is given by $Y = \int_{\underline{y}}^{\bar{y}} yg(y)dy$ and does not depend on α or ϖ . Thus, the derivatives of $U, \frac{U}{Y}, \frac{U}{Y-U}$ w.r.t. α and ϖ all have the same sign.

¹⁹There is a discontinuity in the size of the informal economy at $\alpha = \frac{t}{2}$. When enforcement parameters decrease (i.e. α increases), the size of the informal economy jumps up discretely as workers previously withdrawn from the labour market enter into the black market. This jump goes in the same direction as the derivative, so we can state that the size of the informal economy always increases as enforcement decreases. The same is true if we consider the size of the informal economy relative to the whole economy, $\frac{U}{Y}$, or relative to the formal economy, $\frac{U}{Y-U}$.

wage reduces the size of the economy, that is given by $Y = \int_{\bar{w}}^{\bar{y}} yg(y)dy$. The effect of an increase in the minimum wage on the size of the informal economy relative to the economy as a whole, $\frac{U}{Y}$, or relative to the formal economy, $\frac{U}{Y-U}$, is ambiguous, as it depends on the shape of the productivity distribution.

To summarize:

- Proposition 6**
1. *When enforcement decreases, the size of the informal economy increases, both in absolute terms or relative to the formal economy. Sufficient conditions for the size of the spike at the minimum wage to increase when enforcement decreases are a single peaked productivity distribution combined with a minimum wage binding for workers with productivity lower than the mode or a not too weak enforcement.*
 2. *The effect of an increase in the minimum wage on the size of the informal economy relative to the formal economy is ambiguous. A sufficient condition for the size of the spike at the minimum wage to increase when the minimum wage increases is a single peaked productivity distribution combined with a minimum wage binding for workers with productivity lower than the mode.*

Thus, under mild conditions, the common dependence on α should induce a positive correlation between the spike at the minimum wage and the size of the informal economy. Some evidence on this correlation is presented in section 7.

6 The empirical effect of a minimum wage hike on incomes

In this section, we test Proposition 5 about the decline in true income for workers affected by a minimum wage hike. The massive minimum wage increase that took place in Hungary in 2001 is used as a natural experiment. Hungarian microdata from the household budget survey for the years 1999-2001 are used. The method proposed by Pissarides and Weber (1989) is adapted to a panel framework by comparing the change in food consumption for households affected by the minimum wage hike and similar but unaffected households.

First, the Hungarian context is analysed, looking at the fiscal environment, the relevance of the informal economy, and the minimum wage. Then, the statistical framework is outlined. Finally, the results are presented.

6.1 The Hungarian context

In Hungary, taxation on labour is heavy, also for low paid workers. In the period 2000-2002, the tax wedge on a single person without children earning 2/3 of the average production wage was at around 46%, one of the highest in Europe, with marginal rates above 55% (OECD, 2001 and 2002.) The degree of informality is also high, with evidence of there being underreporting of earnings. For instance, 56% of the households interviewed in a survey claim that in their neighbourhood, employers are declaring the minimum wage to the tax authority, while unofficially paying additional wages (ECONSTAT, 1999.)

The statutory minimum wage²⁰ was significantly increased from 25,500 HUF in 2000 (98 EUR or 90 USD using the average exchange rate for the corresponding year) to 40,000 HUF in 2001 (156 EUR, 140 USD.) As a consequence, the corresponding total monthly payments to the fiscal authorities (PIT and SSC) increased by around 9,000 HUF (36 EUR, 32 USD.)²¹ It is interesting to notice how the hike was decided one-sidedly by the centre-right government, against the opposition of the largest trade union federation. The impact of the minimum wage hike clearly appears in figure (3). The share of full-time employees paid 95%-105% of the minimum wage in firms employing more than five workers jumped from 5% in 2000 to 12.1% in 2001 (Kertesi and Köllő, 2003.)

In their study on the labour market impact of the 2001 minimum wage rise, Kertesi and Köllő (2003) find a high level of compliance with the minimum wage regulation, with only a minor spillover on the wage distribution. They compare the job loss risk of workers earning 90-110% of the minimum

²⁰The statutory minimum wage covers all employment contracts and relates to gross monthly earnings net of overtime pay, shift pay and bonuses for full-time employment. For part-timers, it is proportionally lower, but part-timers only account for a small portion of all employees (3.6% in 2001-2002.) According to the Hungarian UI Exit to Job Survey, 64.7% of the low-wage UI recipients who found a job in April 2001 received a fixed salary, 33.8% were paid an hourly wage and the remaining 1.5% concluded a business contract with the employer (Kertesi and Köllő, 2003.)

²¹Additional details can be found in Tonin (2006b.)

wage in 2001, the treatment group, to that of workers earning 110-125%, the control group, and find a small but significant effect on the quarterly outflow into unemployment²². They find no effect on the flow from employment to non-participation. They also find a 7-8% drop in the job finding probability of low-wage unemployed, defined as those receiving lower than average unemployment benefits, relative to the unskilled as a whole, defined as those with less than secondary education. The conclusion of their study is that “despite the brutal price shock the immediate effect did not seem dramatic”.

6.2 The statistical framework

Reported income, $x_{i,t}$, is observed for household i at time t . Reported income is related to true income, $I_{i,t}$, by the following relationship

$$x_{i,t} = k_{i,t}I_{i,t}, \quad (17)$$

where $0 \leq k_{i,t} \leq 1$.

True income is related to permanent income, $I_{i,t}^P$, by the following relationship

$$I_{i,t} = p_{i,t}I_{i,t}^P, \quad (18)$$

where $p_{i,t} \geq 0$.

By combining (17) and (18) and taking logs, we can write permanent income as a function of reported income:

$$\ln I_{i,t}^P = \ln x_{i,t} - \ln k_{i,t} - \ln p_{i,t}. \quad (19)$$

The relationship between food consumption and permanent income is assumed to be

$$\ln c_{i,t} = Z_{i,t}\alpha + \beta \ln I_{i,t}^P + \varepsilon_{i,t}, \quad (20)$$

where $Z_{i,t}$ is a row vector of household characteristics. The use of food consumption is standard in the literature estimating tax evasion by using household budget survey data. This is due to the fact that food consumption is more precisely recorded than consumption of other types of goods over the

²²For a 25-year old male with five years of tenure, for instance, the estimated quarterly flow is 0.243% for the treated and 0.119% for the control group. At average age and tenure of the control group (40, 7.33), the figures are 0.0168% for the treated and 0.0068% for the control group. The average age and tenure of the treatment group are not very different at 39.2 and 6.67, respectively.

limited time period in which the survey is conducted. Substituting (19) into (20), we can express consumption as a function of reported income

$$\ln c_{i,t} = Z_{i,t}\alpha + \beta \ln x_{i,t} - \beta \ln k_{i,t} - \beta \ln p_{i,t} + \varepsilon_{i,t},$$

and taking first differences we get

$$\Delta \ln c_{i,t} = \Delta Z_{i,t}\alpha + \beta \Delta \ln x_{i,t} - \beta \Delta \ln k_{i,t} - \beta \Delta \ln p_{i,t} + \Delta \varepsilon_{i,t}. \quad (21)$$

As seen in section 4.3, the theory indicates that as a result of a minimum wage hike, workers whose declared earnings before the hike are between the old and the new minimum wage experience a decline in income, while other workers are unaffected. Thus, for the former group of workers, we have

$$\Delta \ln I_{i,t} = \Delta \ln x_{i,t} - \Delta \ln k_{i,t} < 0.$$

In particular, for workers whose official earnings increase to the new minimum after the hike, there is an increase in their compliance with the fiscal regulation, while workers unaffected by the minimum wage hike do not experience a change in their ability to underreport. Thus, labelling the former group as "treated", we have

$$-\Delta \ln k_{i,t} \begin{cases} < 0 & \text{for the "treatment group"} \\ = 0 & \text{for the "control group"} \end{cases}.$$

To identify the shock to the "underreporting technology" due to the minimum wage hike, i.e. $-\Delta \ln k_{i,t}$, we use a difference-in-difference approach. The change in food consumption for households that were affected by the minimum wage hike is contrasted to the change in food consumption for similar but unaffected households. As $\Delta \ln p_{i,t}$ is unobserved, particular care must be taken not to confound the shock to the ability to underreport with other shocks to permanent income related to the minimum wage hike due, for instance, to increased labour market risk.

Specification The basic specification is the following

$$\Delta c_i = \alpha + \gamma * M_i + \beta * TREAT_i + \Delta \varepsilon_i, \quad (22)$$

where Δc_i is the change in food consumption for household i in two consecutive years. M_i is a set of dummies allowing for different trends depending on

the months in which the household is surveyed in two consecutive years. The seasonality displayed by food prices makes it important to compare households that were interviewed in exactly the same month in both years. The exact definition of this and the other variables is provided in the Appendix. The coefficient of interest is β . The exact definition of $TREAT_i$ is provided in what follows. Regressions including additional controls like the change in household income or geographical dummies are also run. The reason for preferring a specification in levels to one in logs is that the shock to underreporting is not proportional to income but is absolute. According to the model, every worker declaring the minimum wage in 2000 and then increasing his declaration to the new minimum in 2001 experiences a decline in his income of around 9,000 HUF, irrespective of differences in the income level that may arise from the availability of other sources of income or heterogeneity in the degree of underreporting.

Data and sample The data are from the Hungarian Household Budget Survey Rotation Panel²³. The sample consists of around 10,000 households. One-third of the sample is rotated in each year. The two-year panels of interest for this study, i.e. 1999-2000 and 2000-2001, contain slightly more than 3,500 households. Notice that households interviewed from 1999 till 2001 appear in both panels, so that around half of the sample is the same in the two panels. The population of interest is considerably reduced by the fact that all adults are retirees in around 40% of the households.

More information about the way the survey is conducted is available in the Appendix. It is worth underlining that surveyors are expected to collect the income data used in this analysis from documentation like tax return sheet or tax certification of employer, whenever it is possible. This makes it more likely that income in the survey corresponds to income reported to the fiscal authorities more than to the, possibly different, true income.

The distribution of earnings in the dataset (see figure 4) clearly presents a spike at the minimum wage level, corresponding to 4-5% in 1999-2000 and increasing to around 14% in 2001. These figures are consistent with LFS data and underline the relevance of the minimum wage hike. Table 1 summarizes

²³The Hungarian Household Budget Survey Rotation Panel is created by the Institute of Economics, Hungarian Academy of Sciences from the original HHBS of the Hungarian Central Statistical Office. The data set is work in progress. Although the IE made every effort to clean the data, it cannot be held liable for any remaining errors.

the labour market status and flows for the whole sample.

6.3 Empirical implementation

A household is considered as treated if at least one of its members has been affected by the minimum wage hike. Two different methods are used to single out these individuals. In the first case, individuals employed in 2000 at a wage between the minimum wage in 2000 and the will-be minimum wage in 2001 are selected. The treatment group is thus only defined on basis of pre-treatment characteristics. In the second case, an additional requirement is imposed: being employed in 2001 at the minimum wage. The reported earnings of these employees are thus actually pushed up by the policy intervention, while in the former case, they were only potentially pushed up. For this reason, the two cases are labelled "actual" and "potential". In both instances, the variable "treatment" is defined as the number of household members conforming to the above mentioned criteria. An alternative definition of treatment is explored for the "actual" case. Instead of simply counting their number, the difference between the minimum wage in 2001 and earnings in 2000 is summed up for all members of the household affected by the hike. The aim of this continuous measure is to capture the intensity of treatment. This definition of treatment is labelled "continuous" as opposed to the "dummy" treatment previously described.

Households in the control group are defined on basis of the presence among their members of individuals earning somewhat more than the 2001 minimum wage. To check for the validity of the control group, a "placebo test" is conducted where the absence of a treatment effect in the pre-policy period is ascertained. This is done by looking at changes in food consumption in the period 1999-2000. Sample size considerations restrict this analysis to the "potential" treatment case.

To ensure comparability, the analysis is always restricted to households that keep a constant composition and whose income is within certain limits. Moreover, to avoid confounding an increase in labour market risk with an increase in compliance with fiscal regulation, only employees with stable positions are considered. The precise definitions of treatment and control groups are provided in what follows.

Potential treatment In this section, the analysis is done on the two panels covering the years 1999-2000 and 2000-2001, respectively. For each two-year

panel, only households that kept a constant composition in the period and that had positive net income below 200,000 HUF in both years are considered. Moreover, we consider only households where at least one member has been employed for the whole period and whose wage in 2000 is between the minimum wage in 2000 and 200% (150%) of the minimum wage in 2001. The sample is restricted in this way to ensure comparability between the treatment and control groups.

Definition of treatment Private sector employees who have been employed for the whole period and who in the year 2000 earns a wage between the minimum wage in the year 2000 (25,500 HUF) and the minimum wage in the year 2001 (40,000 HUF) are considered to be treated. The variable $TREAT_i$ contains the total number of members of household i classified as treated.

Descriptive analysis The treatment and the control group are not ex ante identical along all dimensions. For instance, the mean total net income and income from the main activity at the household level are higher for the treatment than for the control group (see table 2a.), with the notable exception of the smallest control group in the post-treatment period. In this case, mean total net income does not differ significantly from the treatment group, while mean expenditures on food do. However, the considerable overlap in the distribution of household total net income for the treatment and control groups (see figure 8) indicates that the two groups are not too heterogeneous. The same conclusion emerges by comparing the estimated relationship between market food consumption and household total net income for treatment and control groups (see figures 6 and 7.) The estimated Engel curves are indeed quite overlapping in the pre-treatment period.

Results When the 2000-2001 panel is used, the coefficient of the treatment variable is, as predicted, always negative and significant whenever the larger control group is used. When the smaller control group is used, significance is not always achieved (see table 2b.) Besides the basic specification described in (22), regressions including the change in household income, the change in home production of food, the change and level of household income, employee characteristics and geographical dummies are also run.

The validity of the control group is confirmed by the fact that the treatment is never significant in the "placebo test", when the analysis is done using the pre-treatment panel, 1999-2000 (see table 2c.) The change in food consumption does not differ between the treatment and the control group in the pre-policy period, i.e. before the minimum wage hike. After the policy has been implemented, however, the change in food consumption is significantly lower for treated households. The magnitude of the coefficient is also reasonable. Gross reported earnings by "treated" employees on average increased by around 15,000 HUF. According to the model, this should translate into a drop in true income of more than half that quantity, due to increased fiscal payments²⁴. Considering that around a quarter of the income is spent on food consumption, a negative coefficient around 1,500-2,000 HUF is reasonable.

Actual treatment In this case, only the 2000-2001 panel is used. To ensure comparability, also in this case do we only keep in the sample households that kept a constant composition in the period and with a positive net income below 200,000 HUF in both years. Moreover, we only select households with at least one member employed during the whole of 2001 at a wage between 90% and 200% (150%) of the minimum wage in 2001.

Definition of treatment An employee must satisfy two criteria to be considered treated. First, he should work for the whole of 2001 in the private sector and earn a wage around the minimum wage in that year (90%-110% are the thresholds considered.) Moreover, he should have been employed in 2000 at a wage between the old and the new minimum wage (the thresholds are 90% of the minimum wage in 2000 and 110% of the minimum wage in 2001.) In the "dummy treatment", the variable $TREAT_i$ contains the number of household members belonging to this category. In the "continuous treatment", the variable $TREAT_i$ is the sum within household i of the difference between the minimum wage in 2001 and the wage in 2000 for the same people as in the "dummy treatment" with the difference that 100% and not 110% of the minimum wage in 2001 are used as the upper bound.

²⁴Social security contributions rate: 48.5%. Personal income tax marginal rate: 8% until 30,000 HUF, 18% thereafter. Total: 56.5% until 30,000 HUF, 66.5% thereafter. The decrease in expected fines due to increased compliance should be accounted for.

Descriptive analysis The descriptive analysis is limited to the definitions used in the "dummy treatment".

As previously, mean expenditures on food, total net income and income from the main activity at the household level differ between treatment and control groups (see table 3a.) However, the estimated distribution of household total net income (see figure 8) shows a significant overlap between treatment and control groups and the estimate of the relationship between market food consumption and household total net income (see figure 9) shows basically identical Engel curves for treatment and control groups in the pre-treatment period. Thus, the two groups are not too dissimilar.

Results The results confirm the previous analysis. The coefficient of interest is always negative, both when using the "dummy treatment" (see table 3b) and the "continuous treatment" (table 3c.) In each case, regressions controlling for changes in home production of food, changes in household income, the level and change of household income as well as employee characteristics and geographical dummies are included. Significance is almost always achieved when using the "dummy treatment" and the magnitude of the coefficient in the range 1,000-1,500 HUF is reasonable, considering that in this case, earnings by "treated" employees on average increased by around 9,000 HUF²⁵. In "continuous treatment", significance is mainly achieved when additional controls beside month dummies are included. Also in this case is the magnitude of the coefficient reasonable²⁶.

Including in the analysis only households with a net income between 50,000 HUF and 150,000 HUF in both years (results not reported) generally makes coefficients greater in absolute value. Significance improves in the "continuous treatment" case, in particular when only month dummies are used as additional controls, while the outcome is more mixed in the "dummy treatment" case.

The negative impact on the change in food consumption of being treated has been confirmed by the use of different definitions of treatment and different specifications. The use of employees with stable working positions in

²⁵The reasoning is the same as in the previous case. An increase in reported income translates, according to the model, into a drop in true income, due to increased fiscal payments, corresponding to more than half that quantity. Moreover, also in this case around one quarter of income is spent in food.

²⁶See the previous note. Having earnings pushed up by the minimum wage increase by 1 HUF implies, according to the model, a decrease in true income of around 0.5 HUF.

the definition of treatment makes it unlikely that the effect is due to adverse labour market effects of the minimum wage hike which, anyhow, other studies have found to be rather limited. Thus, there is support for the implication of the model that the minimum wage may actually squeeze more fiscal revenues from affected households.

7 Evidence on underground economy and minimum wage spike

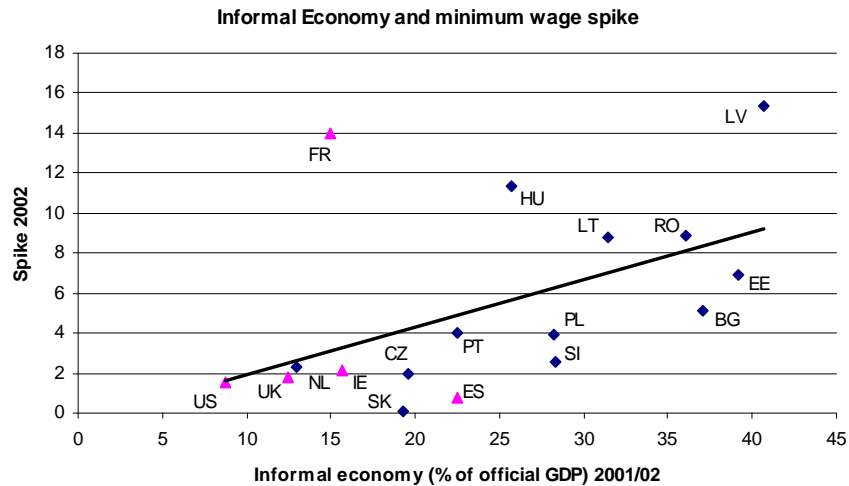
As stated in Proposition 6, a prediction of the model is that enforcement parameters (as summarized by α) should induce a positive correlation between the spike at the minimum wage and the size of the informal economy relative to the formal economy. In this section, some supporting evidence is presented.

The two figures below present the relationship of the spike at the minimum wage²⁷ with the size of the informal economy relative to the formal economy²⁸ and the ratio of the minimum wage to the average wage²⁹ (in what follows, this measure is indicated as the Kaitz index.) The countries included are all countries for which Eurostat reports data on the minimum wage spike and Schneider (2005) reports estimates of the informal economy. The sample includes 16 European countries and the US. Ten of the European countries are Central and Eastern European, where statutory minimum wage arrangements are common.

²⁷Proportion of full-time employees with earnings exactly equal to the monthly minimum wage (source: Eurostat). Notice that the data collected by Eurostat are obtained from administrative sources. For data points indicated with a triangle, the definition is different: part-time workers are included (France, Spain), minimum wage is fixed on an hourly basis (France, Ireland, UK, USA), earnings below the minimum wage are also included (UK, USA). See Eurostat (2004) for details.

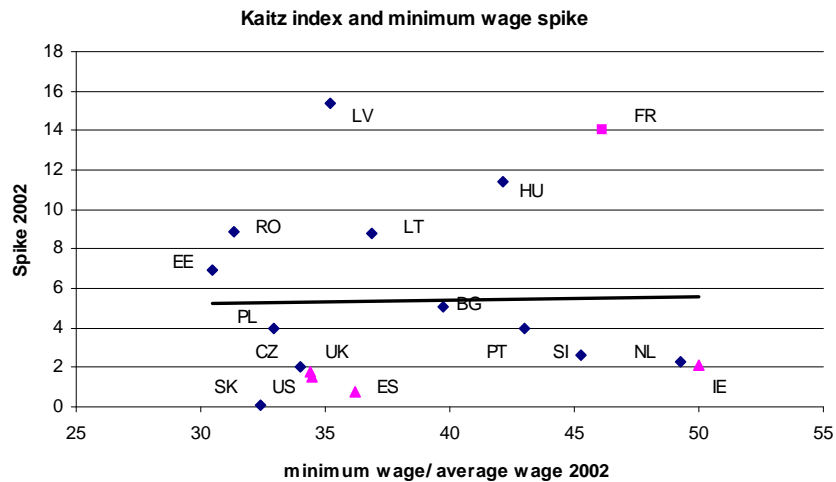
²⁸Informal economy as % of official GDP (source: Schneider 2005).

²⁹Minimum monthly wage as a proportion of average monthly earnings in industry and services (source: Eurostat). For France, the figure has been calculated by the author dividing the hourly gross wage by the average gross hourly wage for a full-time employee in industry, trade and services (data source: INSEE.)



Sources: informal economy: Schneider (2005); spike: Eurostat

A positive correlation clearly appears between the size of the spike at the minimum wage level and the estimated size of the informal economy. As mentioned in the introduction, other mechanisms have been proposed to explain the existence of a spike at the minimum wage level and one natural "culprit" for a high spike would be a minimum wage "biting" deeply into the wage distribution. However, no clear relationship appears between a measure of this "bite", the Kaitz index, and the size of the spike.



Source: Eurostat, except France - Kaitz Index: own calculations

Regression analysis (see table 4) confirms that the positive relationship between the spike and the informal economy is not driven by a high minimum wage resulting in both a high spike and a sizeable informal economy. Regressing the size of the spike on the size of the informal economy and the Kaitz index, the former is significant, while the latter is not. The model suggests that the positive correlation between the size of the spike and the size of the informal economy is instead driven by the common dependence on enforcement parameters. The regression implies that a 1% increase in the size of the informal economy is associated with a 0.28% increase in the share of employees earning the minimum wage.

8 Conclusions

The paper develops a tractable model of underreporting of earnings by employed labour and works out the implications of introducing minimum wage regulation in such an environment.

A contribution of the paper to the literature on tax evasion is to show that imperfect detection alone is able to generate an internal solution to the tax evasion decision, even with the fixed probability of an audit and risk neutrality by the agent subject to this.

The interaction between tax evasion and minimum wage gives rise to a spike at the minimum wage level. This is a mechanism that has never been proposed in the literature, that works in a perfectly competitive labour market and that can account for the double digit spike present in some countries³⁰.

In addition, the model contributes to the policy discussion on minimum wage in countries where underreporting of earnings is a relevant phenomenon. In particular, it is shown that introducing or increasing the minimum wage can boost fiscal revenues. The discussion of the fiscal impact of the minimum wage has usually focused on the expenditure side. The role of the state as an employer or the fact that in some countries social benefits are indexed to the minimum wage are two reasons why a higher minimum wage could worsen the fiscal balance. This paper claims that this may not be the case, if the effect on revenues is sufficiently large to counterbalance the higher spending. The boost in revenues is due to extracting more resources from the lower end of the productivity distribution. This may be desirable as there is some

³⁰A simple numerical exercise showing this can be found in Tonin (2006a.)

evidence that tax evasion among employees is concentrated at the low end of the income distribution (see section 2.) On the other hand, if the aim of the minimum wage hike is to boost income for those affected, it could have opposite consequences. An increase in reported income could actually correspond to a decrease in true income, unless the minimum wage hike is accompanied by a decrease in fiscal pressure for minimum wage earners. The elimination of personal income tax for minimum wage workers undertaken by the newly elected centre-left government in Hungary in 2002 may be due to this kind of considerations.

The model also makes a new prediction about the correlation between the size of the spike at the minimum wage level and the size of the informal economy that finds support in the data.

The optimal auditing strategy by a tax authority in case it possesses an imperfect detection technology is the subject of ongoing research.

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Appendix

The survey A household consists of persons forming a common income and/or consumption unit, completely or partly sharing the current costs of living

The selection of the sample is done by multistrata method using census data. In a given month during the year, households keep a diary registering income and expenditures during the month and “general household characteristics” containing demographic, employment and housing data.

In subsequent interviews, data on personal incomes, family income, stock of consumer durables, expenditures of significant value, are retrospectively collected for the year as a whole.

Main variables and categories

- "Households with constant family structure" are households where the same individuals are present for the relevant period. Restricting the analysis to this type of household reduces the sample in the panel 1999-2000 from 3581 to 3181, with a loss of 400 households, for the panel 2000-2001 the loss is of 329 households, from 3529 to 3200. The advantage of only using such households is that exactly the same individuals are observed in two subsequent years.
- M is a set of dummies capturing the month of diary keeping. So, for instance in the panel 2000-2001, there is a dummy for households that kept the diary in January 2000 and in January 2001 and a different dummy for households that kept the diary in January 2000 and in February 2001. Potentially, there are 144 month dummies. However, in both panels, around 70% of the households kept the diary in the same month in both years.
- "Employees" are defined as employees in public or private enterprises, institutions, co-operatives, private entrepreneurs or societies (firms owned by several private entrepreneurs) with positive earnings from their main activity during the year and positive months in which earnings from the main activity have been realized. "Public employees" are defined as employees in public or private enterprises, institutions active in public administration and defence, compulsory social security, education, or health and social work. "Private employees" are all employees who are

not public employees. The dataset contains the number of months in which earnings from the main activity have been realized during the year. If in a given year the number of months corresponds to twelve, the employee is considered to have been employed the whole year.

- Employee characteristics include three sets of "dummies", describing the labour market characteristics of employees in the households.
 1. Sectoral: the number of employees in the household working in each of the 60 branches according to two-digit ISIC (e.g. manufacture of textiles);
 2. Position: the number of employees in the household belonging to each of the 10 categories characterising the hierarchical position³¹ (e.g. skilled worker);
 3. Type of employer: the number of employees in the household working for different types of employers³² (e.g. private entrepreneurs);
- Geographical dummies include a set of dummies for the 20 counties into which Hungary is divided and a set of dummies capturing whether the household place of residence is the capital, a large city, a town or a village. Note that by construction, in subsequent years the survey only includes households whose place of residence did not change.
- Income variables include household level income³³, the sum of net personal incomes of household members³⁴, plus other components³⁵. A

³¹top leader; leader, manager; employee with diploma; employee with secondary qualification; administrative employee; skilled worker; semi-skilled worker; unskilled worker; self-employed; family helper;

³²In 1999, the following three categories are listed: 1. public or private enterprises, institutions; 2. cooperatives, firm owned by several private entrepreneurs; 3. private entrepreneurs.

In 2000 and 2001, the following four categories are listed: 1. public or private enterprises, institutions; 2. cooperatives; 3. private entrepreneurs; 4. firm owned by several private entrepreneurs.

³³e.g. family allowance, income from dividends, income from agricultural sales.

³⁴e.g. income from main activity, self-employment, authorship. Paid social security contributions and personal income tax are subtracted from gross personal income to obtain net personal income.

³⁵e.g. income from sales of belonging. Outgoing household transfers, like maintenance for a child outside the household, are subtracted.

distinction is made between two types of income, including home production or not. In a household budget survey, it is questionable whether we should consider income data as true income or income reported to fiscal authorities. The interview collecting data for yearly income is conducted around the time of filling the tax declaration form and the surveyors should get their data from it or from some other type of documentation whenever possible. For these reasons, we consider our income data as income reported to fiscal authorities. If income data actually corresponded to true income, then, after controlling for that, we should not find any effect of a shock to underreporting, as it would be fully accounted for by the income change.

- Food consumption is aggregated from very detailed consumption items. A distinction is made between food bought in the market and food produced at home.

Tables

TABLE 1 - Labour Market Status - Whole Sample

		2001					
		Employed	Retired	Child care	Unemployed	Other	Total
2000	Employed	32.5%	1.3%	0.4%	1.7%	0.3%	36%
	Retired	0.4%	40.1%	0.0%	0.1%	0.8%	41%
	Child care	0.8%	0.0%	2.8%	0.2%	0.2%	4%
	Unemployed	2.0%	0.2%	0.1%	2.5%	0.5%	5%
	Other	1.0%	0.5%	0.1%	0.5%	10.8%	13%
	Total	37%	42%	3%	5%	13%	100%

NB: Only people present for both years (Total: 7064)

		1999					
		Employed	Retired	Child care	Unemployed	Other	Total
2000	Employed	31.9%	0.6%	0.6%	2.2%	1.4%	37%
	Retired	0.9%	40.1%	0.0%	0.2%	0.7%	42%
	Child care	0.5%	0.0%	3.1%	0.0%	0.1%	4%
	Unemployed	1.8%	0.0%	0.3%	2.4%	1.3%	6%
	Other	0.2%	0.3%	0.2%	0.4%	10.8%	12%
	Total	35%	41%	4%	5%	14%	100%

NB: Only people present for both years (Total: 7207)

TABLE 2a - Descriptive Statistics: "Potential Treatment"

	T		150			200		
PANEL 1999-2000								
Number of households	197		412			651		
Number of "treated" among HH members	1.1		0			0		
Number of "control" among HH members	0.2		1.2			1.2		
(for T the two figures refer to 150 and 200)	mean	sd	mean	sd	t-stat	mean	sd	t-stat
1999								
N of HH members	3.2	1.1	3.2	1.1	-0.04	3.2	1.1	-0.02
Area of the dwelling (m2)	80	28	80	28	-0.02	79	28	0.31
Expenditures on food (no home prod.; M)	18564	8970	20455	8764	-2.45	20960	9208	-3.26
Total net income HH (no home prod.); (A/12)	74341	28615	80302	29919	-2.37	83767	30582	-3.99
Own production: total (M)	7429	7478	7070	7799	0.55	6702	7591	1.19
Own production: food (M)	7082	7086	6785	7472	0.48	6410	7231	1.16
HH level income from main activity	69409	40815	77827	43039	-2.34	83858	46057	-4.22
HH level income from self-employment	2608	12733	1226	8986	1.37	1448	9120	1.19
Total expenditures	75013	29849	75995	27823	-0.39	79148	29139	-1.71
Total expenditures with durables	78994	34114	79092	31653	-0.03	82209	32719	-1.17
Expenditures on food as % of: expenditures	25%		27%			26%		
net income	25%		25%			25%		
2000								
N of HH members	3.2	1.1	3.2	1.1	-0.04	3.2	1.1	-0.02
Area of the dwelling (m2)	79	26	80	29	-0.33	79	28	0.16
Expenditures on food (no home prod.; M)	20181	9335	22796	10309	-3.13	23413	10441	-4.14
Total net income HH (no home prod.); (A/12)	82338	32431	90999	33160	-3.06	95225	33690	-4.84
Own production: total (M)	7867	7938	7168	8619	0.99	6889	8275	1.50
Own production: food (M)	7612	7693	6853	8126	1.12	6573	7787	1.66
HH level income from main activity	73226	44117	85009	45836	-3.04	93552	49283	-5.51
HH level income from self-employment	2493	12936	1471	9900	0.98	1736	10550	0.75
Total expenditures	82402	30491	83198	33869	-0.29	86292	33267	-1.54
Total expenditures with durables	86651	34605	86382	40609	0.08	89667	38940	-1.04
Expenditures on food as % of: expenditures	24%		27%			27%		
net income	25%		25%			25%		
Increase in HH net income YY (HUF; %):	7997	11%	10697	13%		11457	14%	
Increase in HH food consumption YY (HUF; %):	1617	9%	2341	11%		2453	12%	
PANEL 2000-2001								
Number of households	195		369			587		
Number of "treated" among HH members	1.1		0			0		
Number of "control" among HH members	0.3		1.2			1.2		
(for T the two figures refer to 150 and 200)	mean	sd	mean	sd	t-stat	mean	sd	t-stat
2000								
N of HH members	3.3	1.3	3.2	1.1	1.18	3.2	1.1	1.20
Area of the dwelling (m2)	80	25	80	26	0.04	79	26	0.46
Expenditures on food (no home prod.; M)	21032	9599	22218	9967	-1.38	23167	10545	-2.63
Total net income HH (no home prod.); (A/12)	80901	33731	87978	30028	-2.46	92221	30673	-4.15
Own production: total (M)	7457	7622	7806	8478	-0.50	7226	8184	0.36
Own production: food (M)	7255	7497	7448	8022	-0.28	6912	7775	0.55
HH level income from main activity	71154	43404	81189	42358	-2.63	90179	45696	-5.23
HH level income from self-employment	3599	17535	1724	11312	1.35	1877	11876	1.28
Total expenditures	79313	30274	81606	30824	-0.85	86029	33068	-2.62
Total expenditures with durables	82829	34330	85719	39758	-0.90	90646	40600	-2.63
Expenditures on food as % of: expenditures	27%		27%			27%		
net income	26%		25%			25%		
2001								
N of HH members	3.3	1.3	3.2	1.1	1.18	3.2	1.1	1.20
Area of the dwelling (m2)	80	25	81	27	-0.27	80	27	0.16
Expenditures on food (no home prod.; M)	25229	11294	27102	11626	-1.85	28354	12795	-3.23
Total net income HH (no home prod.); (A/12)	101066	38845	103751	34469	-0.81	107925	34941	-2.19
Own production: total (M)	8663	9547	7814	9725	1.00	7152	9132	1.93
Own production: food (M)	8439	9389	7433	9183	1.22	6804	8660	2.15
HH level income from main activity	93176	53270	97730	51349	-0.98	105582	54156	-2.81
HH level income from self-employment	3765	17061	1933	12845	1.32	2478	15503	0.93
Total expenditures	97268	36233	98179	37042	-0.28	101653	38120	-1.45
Total expenditures with durables	100630	41548	103488	42620	-0.77	106724	43558	-1.75
Expenditures on food as % of: expenditures	26%		28%			28%		
net income	25%		26%			26%		
Increase in HH net income YY (HUF; %):	20165	25%	15773	18%		15703	17%	
Increase in HH food consumption YY (HUF; %):	4198	20%	4884	22%		5186	22%	
Only HH with constant family structure, with positive income below 200,000 HUF in both years								
T: treatment group; 200: control group using 200% of MW as upper bound; 150: control group using 150% of MW as upper bound;								

TABLE 2b - Results: "Potential Treatment" - Panel 2000-2001

Dependent variable:		Δ Food Consumption (excluding own production); monthly											
Sample:	MW2000<Wage 2000<2* MW2001						MW2000<Wage 2000<1.5* MW2001						
Treatment	-1287**	-1538**	-1298*	-1084*	-1328**	-1158*	-1029	-1218	-1063	-785	-963	-838	
	(644)	(655)	(661)	(635)	(646)	(648)	(733)	(745)	(749)	(719)	(731)	(733)	
Δ HH Income - no Home Production	-	0.05***	0.06***	-	-	-	-	0.04*	0.05**	-	-	-	
		(0.021)	(0.021)					(0.023)	(0.023)				
HH Income - no Home Production; 2000	-	-	0.03***	-	-	-	-	-	0.03**	-	-	-	
			(0.011)						(0.013)				
Δ Food own production; monthly	-	-	-	-0.17***	-0.21***	-0.21***	-	-	-	-0.19***	-0.22***	-0.23***	
				(0.063)	(0.066)	(0.065)				(0.070)	(0.073)	(0.071)	
Δ HH Income - with Home Production	-	-	-	-	0.05**	0.05***	-	-	-	-	0.04*	0.04*	
					(0.020)	(0.020)					(0.023)	(0.022)	
HH Income - with Home Production; 2000	-	-	-	-	-	0.02**	-	-	-	-	-	0.02*	
						(0.010)						(0.012)	
R-Squared	0.30	0.31	0.32	0.31	0.31	0.32	0.30	0.31	0.32	0.32	0.32	0.33	
Additional Controls:	Month dummies.												
Treatment	-1942**	-2178***	-1710*	-1804**	-2023**	-1751**	-1843**	-1936**	-1591	-1646*	-1729*	-1544	
	(824)	(838)	(876)	(823)	(835)	(874)	(923)	(931)	(970)	(907)	(914)	(956)	
Δ HH Income - no Home Production	-	0.05**	0.06***	-	-	-	-	0.03	0.04	-	-	-	
		(0.022)	(0.023)					(0.025)	(0.026)				
HH Income - no Home Production; 2000	-	-	0.04**	-	-	-	-	-	0.03*	-	-	-	
			(0.014)						(0.017)				
Δ Food own production; monthly	-	-	-	-0.18***	-0.22***	-0.21***	-	-	-	-0.19**	-0.21***	-0.21***	
				(0.069)	(0.072)	(0.070)				(0.080)	(0.082)	(0.080)	
Δ HH Income - with Home Production	-	-	-	-	0.05**	0.05**	-	-	-	-	0.03	0.03	
					(0.022)	(0.022)					(0.025)	(0.025)	
HH Income - with Home Production; 2000	-	-	-	-	-	0.02	-	-	-	-	-	0.02	
						(0.013)						(0.015)	
R-Squared	0.38	0.39	0.40	0.39	0.40	0.40	0.41	0.42	0.42	0.42	0.43	0.43	
Additional Controls:	Month dummies, Employee characteristics for 2000.												
Treatment	-1717**	-1951**	-1575*	-1626*	-1840**	-1597*	-1608*	-1690*	-1449	-1485	-1554	-1435	
	(838)	(853)	(882)	(835)	(848)	(875)	(952)	(959)	(984)	(941)	(946)	(975)	
Δ HH Income - no Home Production	-	0.05**	0.06**	-	-	-	-	0.02	0.03	-	-	-	
		(0.023)	(0.024)					(0.027)	(0.027)				
HH Income - no Home Production; 2000	-	-	0.03**	-	-	-	-	-	0.02	-	-	-	
			(0.015)						(0.017)				
Δ Food own production; monthly	-	-	-	-0.19***	-0.22***	-0.22***	-	-	-	-0.18**	-0.20**	-0.20**	
				(0.070)	(0.073)	(0.072)				(0.080)	(0.082)	(0.081)	
Δ HH Income - with Home Production	-	-	-	-	0.05**	0.05**	-	-	-	-	0.02	0.02	
					(0.023)	(0.023)					(0.026)	(0.027)	
HH Income - with Home Production; 2000	-	-	-	-	-	0.02	-	-	-	-	-	0.01	
						(0.014)						(0.016)	
R-Squared	0.41	0.42	0.42	0.42	0.43	0.43	0.45	0.45	0.46	0.46	0.46	0.46	
Additional Controls:	Month dummies, Employee characteristics for 2000, Geographical dummies.												
Number of HH	782						564						
HH treated	195						195						

OLS estimation - Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.

Treatment: Number of household members employed for the whole period earnings in the private sector a wage in 2000 between 100% of the minimum wage in 2000 and 100% of the minimum wage in 2001;

Sample: Households with constant family structure and positive income below 200,000 HUF in both years, with at least one member employed for the whole period, earning in 2000 between 100% of the minimum wage in 2000 and 200% (150%) of the minimum wage in 2001;

TABLE 2c - Results: "Potential Treatment" - Panel 1999-2000 - Placebo

Dependent variable:		Δ Food Consumption (excluding own production); monthly											
Sample:		MW2000<Wage 2000<2* MW2001						MW2000<Wage 2000<1.5* MW2001					
Treatment		-743	-510	-446	-704	-457	-400	-624	-494	-419	-572	-429	-355
		(652)	(622)	(628)	(646)	(616)	(620)	(700)	(676)	(684)	(694)	(669)	(676)
Δ HH Income - no Home Production		-	0.08***	0.08***	-	-	-	-	0.06***	0.06***	-	-	-
			(0.018)	(0.018)					(0.022)	(0.022)			
HH Income - no Home Production; 1999		-	-	0.01	-	-	-	-	-	0.01	-	-	-
				(0.010)						(0.011)			
Δ Food own production; monthly		-	-	-	-0.09	-0.16**	-0.16**	-	-	-	-0.12	-0.18**	-0.17**
					(0.070)	(0.074)	(0.074)				(0.080)	(0.085)	(0.086)
Δ HH Income - with Home Production		-	-	-	-	0.08***	0.08***	-	-	-	-	0.06***	0.06***
						(0.017)	(0.018)					(0.021)	(0.021)
HH Income - with Home Production; 1999		-	-	-	-	-	0.01	-	-	-	-	-	0.02
							(0.009)						(0.010)
R-Squared		0.22	0.24	0.24	0.22	0.25	0.25	0.21	0.23	0.23	0.22	0.24	0.24
Additional Controls:		Month dummies.											
Treatment		212	529	520	244	581	603	554	747	771	613	831	880
		(731)	(709)	(714)	(727)	(705)	(710)	(821)	(802)	(816)	(819)	(802)	(813)
Δ HH Income - no Home Production		-	0.08***	0.08***	-	-	-	-	0.06**	0.06**	-	-	-
			(0.018)	(0.019)					(0.024)	(0.024)			
HH Income - no Home Production; 1999		-	-	0.00	-	-	-	-	-	0.00	-	-	-
				(0.013)						(0.014)			
Δ Food own production; monthly		-	-	-	-0.09	-0.16**	-0.16**	-	-	-	-0.13	-0.19**	-0.19**
					(0.074)	(0.078)	(0.077)				(0.087)	(0.092)	(0.092)
Δ HH Income - with Home Production		-	-	-	-	0.08***	0.08***	-	-	-	-	0.06***	0.06***
						(0.018)	(0.018)					(0.023)	(0.024)
HH Income - with Home Production; 1999		-	-	-	-	-	0.00	-	-	-	-	-	0.00
							(0.012)						(0.013)
R-Squared		0.30	0.32	0.32	0.30	0.33	0.33	0.30	0.32	0.32	0.31	0.32	0.32
Additional Controls:		Month dummies, Employee characteristics for 2000.											
Treatment		156	468	477	175	508	541	602	794	862	646	859	956
		(758)	(729)	(736)	(754)	(726)	(731)	(874)	(851)	(866)	(872)	(850)	(861)
Δ HH Income - no Home Production		-	0.08***	0.08***	-	-	-	-	0.06***	0.06***	-	-	-
			(0.019)	(0.019)					(0.024)	(0.024)			
HH Income - no Home Production; 1999		-	-	0.00	-	-	-	-	-	0.01	-	-	-
				(0.013)						(0.015)			
Δ Food own production; monthly		-	-	-	-0.12	-0.18**	-0.18**	-	-	-	-0.16*	-0.22**	-0.21**
					(0.076)	(0.080)	(0.080)				(0.091)	(0.096)	(0.096)
Δ HH Income - with Home Production		-	-	-	-	0.08***	0.08***	-	-	-	-	0.06***	0.06***
						(0.019)	(0.019)					(0.023)	(0.023)
HH Income - with Home Production; 1999		-	-	-	-	-	0.00	-	-	-	-	-	0.01
							(0.012)						(0.014)
R-Squared		0.32	0.35	0.35	0.33	0.35	0.35	0.34	0.35	0.35	0.35	0.36	0.36
Additional Controls:		Month dummies, Employee characteristics for 2000, Geographical dummies.											
Number of HH		848						609					
HH treated		197						197					

OLS estimation - Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.

Treatment: Number of household members employed for the whole period earnings in the private sector a wage in 2000 between 100% of the minimum wage in 2000 and 100% of the minimum wage in 2001;

Sample: Households with constant family structure and positive income below 200,000 HUF in both years, with at least one member employed for the whole period, earning in 2000 between 100% of the minimum wage in 2000 and 200% (150%) of the minimum wage in 2001;

TABLE 3a - Descriptive Statistics: "Actual Treatment"

	T		150			200		
	mean	sd	mean	sd	t-stat	mean	sd	t-stat
Number of households	149		422			659		
Number of "treated" among HH members	1.1		0			0		
Number of "control" among HH members	0.3	0.4	1.2			1.3		
<i>(for T the two figures refers to 150 and 200)</i>								
2000								
N of HH members	3.2	1.2	3.3	1.2	-0.77	3.2	1.2	-0.04
Area of the dwelling (m2)	80	26	78	25	0.83	79	26	0.74
Expenditures on food (no home prod.; M)	20016	9493	22214	10291	-2.38	22374	10490	-2.68
Total net income HH (no home prod.); (A/12)	75383	32039	87727	31292	-4.07	89588	31588	-4.90
Own production: total (M)	7473	7712	7488	8389	-0.02	7562	8616	-0.13
Own production: food (M)	7260	7622	7163	7935	0.13	7253	8231	0.01
HH level income from main activity	67010	41104	77370	48826	-2.51	82687	49099	-4.05
HH level income from self-employment	1733	9311	2715	15924	-0.90	2833	15306	-1.14
Total expenditures	78188	29696	81190	32810	-1.03	83918	34515	-2.06
Total expenditures with durables	81031	31789	85169	41237	-1.26	87965	40623	-2.28
Expenditures on food as % of: <i>expenditures</i>	26%		27%			27%		
<i>net income</i>	27%		25%			25%		
2001								
N of HH members	3.2	1.2	3.3	1.2	-0.77	3.2	1.2	-0.04
Area of the dwelling (m2)	80	26	79	26	0.44	79	27	0.31
Expenditures on food (no home prod.; M)	23976	10657	27190	11811	-3.07	27462	12185	-3.51
Total net income HH (no home prod.); (A/12)	93069	36758	103022	33909	-2.90	105246	34309	-3.70
Own production: total (M)	7836	8770	7419	9556	0.49	7407	9293	0.53
Own production: food (M)	7561	8552	7083	9162	0.58	7103	8935	0.59
HH level income from main activity	82209	44610	93702	50579	-2.61	98557	51347	-3.92
HH level income from self-employment	3111	13998	2206	13997	0.68	2869	16552	0.18
Total expenditures	92843	35777	97002	36648	-1.21	98962	36732	-1.88
Total expenditures with durables	96970	42233	101538	41643	-1.14	103359	40706	-1.68
Expenditures on food as % of: <i>expenditures</i>	26%		28%			28%		
<i>net income</i>	26%		26%			26%		
Increase in HH total net income:								
<i>absolute (HUF)</i>	17685		15295			15657		
<i>percentage</i>	23%		17%			17%		
Increase in expenditures on food:								
<i>absolute (HUF)</i>	3960		4976			5088		
<i>percentage</i>	20%		22%			23%		
Only HH with constant family structure, with positive income below 200,000 HUF in both years								
T: treatment group; 200: control group using 200% of MW as upper bound, 150: control group using 150% of MW as upper bound;								

TABLE 3b - Results: "Actual Treatment" - Dummy - Panel 2000-2001

Dependent variable: Δ Food Consumption (excluding own production); monthly												
Sample:	MW2000<Wage 2000<2* MW2001						MW2000<Wage 2000<1.5* MW2001					
Treatment	-1385**	-1471**	-1195*	-1206*	-1301**	-1129*	-1292*	-1372*	-1172	-1140	-1228*	-1076
	(651)	(643)	(653)	(643)	(635)	(637)	(739)	(731)	(733)	(731)	(723)	(717)
Δ HH Income - no Home Production	-	0.05***	0.05***	-	-	-	-	0.05**	0.05**	-	-	-
		(0.017)	(0.017)					(0.022)	(0.022)			
HH Income - no Home Production; 2000	-	-	0.03**	-	-	-	-	-	0.03*	-	-	-
			(0.011)						(0.013)			
Δ Food own production; monthly	-	-	-	-0.15***	-0.19***	-0.19***	-	-	-	-0.15*	-0.18**	-0.19**
				(0.053)	(0.055)	(0.054)				(0.075)	(0.076)	(0.074)
Δ HH Income - with Home Production	-	-	-	-	0.04**	0.05***	-	-	-	-	0.04**	0.05**
					(0.017)	(0.017)					(0.021)	(0.021)
HH Income - with Home Production; 2000	-	-	-	-	-	0.02*	-	-	-	-	-	0.02
						(0.010)						(0.012)
R-Squared	0.31	0.32	0.32	0.32	0.33	0.33	0.34	0.35	0.36	0.35	0.36	0.36
Additional Controls:	Month dummies.											
Treatment	-1766**	-1745**	-1401*	-1646**	-1637**	-1478**	-1794**	-1761**	-1518*	-1684**	-1665*	-1500*
	(744)	(744)	(753)	(732)	(731)	(735)	(865)	(859)	(855)	(856)	(851)	(842)
Δ HH Income - no Home Production	-	0.04**	0.06***	-	-	-	-	0.04*	0.05**	-	-	-
		(0.019)	(0.020)					(0.024)	(0.026)			
HH Income - no Home Production; 2000	-	-	0.03**	-	-	-	-	-	0.03*	-	-	-
			(0.014)						(0.017)			
Δ Food own production; monthly	-	-	-	-0.17***	-0.20***	-0.20***	-	-	-	-0.17**	-0.21**	-0.21***
				(0.056)	(0.058)	(0.057)				(0.078)	(0.080)	(0.078)
Δ HH Income - with Home Production	-	-	-	-	0.04**	0.05**	-	-	-	-	0.04*	0.05*
					(0.018)	(0.019)					(0.023)	(0.025)
HH Income - with Home Production; 2000	-	-	-	-	-	0.01	-	-	-	-	-	0.02
						(0.012)						(0.015)
R-Squared	0.39	0.39	0.40	0.39	0.40	0.40	0.42	0.43	0.43	0.43	0.44	0.44
Additional Controls:	Month dummies, Employee characteristics for 2001.											
Treatment	-1595**	-1573**	-1309*	-1489**	-1478*	-1355*	-1671*	-1624*	-1441	-1585*	-1552*	-1433
	(773)	(772)	(787)	(755)	(754)	(766)	(893)	(887)	(890)	(879)	(873)	(872)
Δ HH Income - no Home Production	-	0.05**	0.06***	-	-	-	-	0.05**	0.06**	-	-	-
		(0.019)	(0.020)					(0.024)	(0.026)			
HH Income - no Home Production; 2000	-	-	0.03*	-	-	-	-	-	0.03	-	-	-
			(0.015)						(0.018)			
Δ Food own production; monthly	-	-	-	-0.17***	-0.21***	-0.20***	-	-	-	-0.19**	-0.23***	-0.24***
				(0.059)	(0.061)	(0.060)				(0.080)	(0.081)	(0.080)
Δ HH Income - with Home Production	-	-	-	-	0.04**	0.05**	-	-	-	-	0.05**	0.06**
					(0.019)	(0.020)					(0.023)	(0.025)
HH Income - with Home Production; 2000	-	-	-	-	-	0.01	-	-	-	-	-	0.02
						(0.013)						(0.017)
R-Squared	0.41	0.42	0.42	0.42	0.43	0.43	0.45	0.45	0.46	0.46	0.46	0.47
Additional Controls:	Month dummies, Employee characteristics for 2001, Geographical dummies.											
Number of HH	808						571					
HH treated	149						149					

OLS estimation - Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.

Treatment: Number of household members employed in the private sector for the whole 2001 earning in 2000 between 90% of the minimum wage in 2000 and 110% of the minimum wage in 2001, and in 2001 around the minimum wage in 2001 (90%-110%);

Sample: Households with constant family structure and positive income below 200,000 HUF in both years, with at least one employee for the whole 2001 earning in 2001 between 90% and 200% (150%) of the minimum wage in 2001;

TABLE 3c - Results: "Actual Treatment" - Continuous - Panel 2000-2001

Dependent variable: Δ Food Consumption (excluding own production); monthly												
Sample:	MW2000<Wage 2000<2* MW2001						MW2000<Wage 2000<1.5* MW2001					
Treatment	-0.09	-0.11*	-0.09	-0.08	-0.09	-0.08	-0.08	-0.10	-0.08	-0.07	-0.09	-0.08
	(0.065)	(0.063)	(0.064)	(0.064)	(0.062)	(0.062)	(0.072)	(0.070)	(0.071)	(0.070)	(0.069)	(0.068)
Δ HH Income - no Home Production	-	0.05***	0.05***	-	-	-	-	0.05**	0.05**	-	-	-
		(0.017)	(0.018)					(0.022)	(0.022)			
HH Income - no Home Production; 2000	-	-	0.03**	-	-	-	-	-	0.03**	-	-	-
			(0.011)						(0.013)			
Δ Food own production; monthly	-	-	-	-0.15***	-0.19***	-0.19***	-	-	-	-0.15**	-0.19**	-0.19**
				(0.053)	(0.055)	(0.054)				(0.075)	(0.076)	(0.074)
Δ HH Income - with Home Production	-	-	-	-	0.04**	0.05***	-	-	-	-	0.04**	0.05**
					(0.017)	(0.017)					(0.022)	(0.022)
HH Income - with Home Production; 2000	-	-	-	-	-	0.02*	-	-	-	-	-	0.02*
						(0.010)						(0.012)
R-Squared	0.31	0.32	0.32	0.32	0.32	0.33	0.34	0.35	0.35	0.35	0.36	0.36
Additional Controls:	Month dummies.											
Treatment	-0.14*	-0.14*	-0.11	-0.13*	-0.13*	-0.12*	-0.15*	-0.16*	-0.14*	-0.14*	-0.15*	-0.14*
	(0.075)	(0.074)	(0.075)	(0.073)	(0.072)	(0.073)	(0.083)	(0.082)	(0.082)	(0.081)	(0.080)	(0.080)
Δ HH Income - no Home Production	-	0.04**	0.06***	-	-	-	-	0.04*	0.06**	-	-	-
		(0.019)	(0.020)					(0.024)	(0.026)			
HH Income - no Home Production; 2000	-	-	0.03**	-	-	-	-	-	0.03*	-	-	-
			(0.014)						(0.017)			
Δ Food own production; monthly	-	-	-	-0.17***	-0.20***	-0.20***	-	-	-	-0.18**	-0.21***	-0.21***
				(0.056)	(0.058)	(0.057)				(0.078)	(0.080)	(0.079)
Δ HH Income - with Home Production	-	-	-	-	0.04**	0.05**	-	-	-	-	0.04*	0.05*
					(0.018)	(0.019)					(0.023)	(0.025)
HH Income - with Home Production; 2000	-	-	-	-	-	0.01	-	-	-	-	-	0.02
						(0.012)						(0.015)
R-Squared	0.38	0.39	0.40	0.39	0.40	0.40	0.42	0.43	0.43	0.43	0.44	0.44
Additional Controls:	Month dummies, Employee characteristics for 2001.											
Treatment	-0.14*	-0.15*	-0.13	-0.14*	-0.14*	-0.13*	-0.14*	-0.15*	-0.14	-0.14	-0.14*	-0.14
	(0.078)	(0.077)	(0.078)	(0.075)	(0.074)	(0.075)	(0.087)	(0.086)	(0.086)	(0.085)	(0.084)	(0.084)
Δ HH Income - no Home Production	-	0.05**	0.06***	-	-	-	-	0.05**	0.07**	-	-	-
		(0.019)	(0.020)					(0.025)	(0.026)			
HH Income - no Home Production; 2000	-	-	0.03*	-	-	-	-	-	0.03	-	-	-
			(0.015)						(0.019)			
Δ Food own production; monthly	-	-	-	-0.17***	-0.21***	-0.21***	-	-	-	-0.20**	-0.24***	-0.24***
				(0.059)	(0.061)	(0.061)				(0.080)	(0.082)	(0.081)
Δ HH Income - with Home Production	-	-	-	-	0.04**	0.05**	-	-	-	-	0.05**	0.06**
					(0.019)	(0.020)					(0.023)	(0.025)
HH Income - with Home Production; 2000	-	-	-	-	-	0.01	-	-	-	-	-	0.02
						(0.013)						(0.017)
R-Squared	0.41	0.42	0.42	0.42	0.43	0.43	0.45	0.45	0.46	0.46	0.46	0.47
Additional Controls:	Month dummies, Employee characteristics for 2001, Geographical dummies.											
Number of HH	808						571					
HH treated	114						114					

OLS estimation - Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.

Treatment: Sum within household of the difference between the minimum wage in 2001 and the wage in 2000 for all household members employed in the private sector for the whole 2001 earning in 2000 between 90% of the minimum wage in 2000 and 100% of the minimum wage in 2001, and in 2001 around the minimum wage in 2001 (90%-110%);

Sample: Households with constant family structure and positive income below 200,000 HUF in both years, with at least one employee for the whole 2001 earning in 2001 between 90% and 200% (150%) of the minimum wage in 2001;

TABLE 4 - Underground Economy and Minimum Wage Spike

Dependent variable: Spike at minimum wage level (2002)

Informal Economy as % official GDP (2001-2)	0.279** (0.113)
Minimum Wage / Average Wage (2002)	0.179 (0.179)
Constant	-8.337 (8.381)
R-Squared:	0.30
Number of observations:	17

OLS estimation - Standard errors in brackets;

* significant at 10%; ** significant at 5%; *** significant at 1%.

Figures

Figure 1: Declared Income

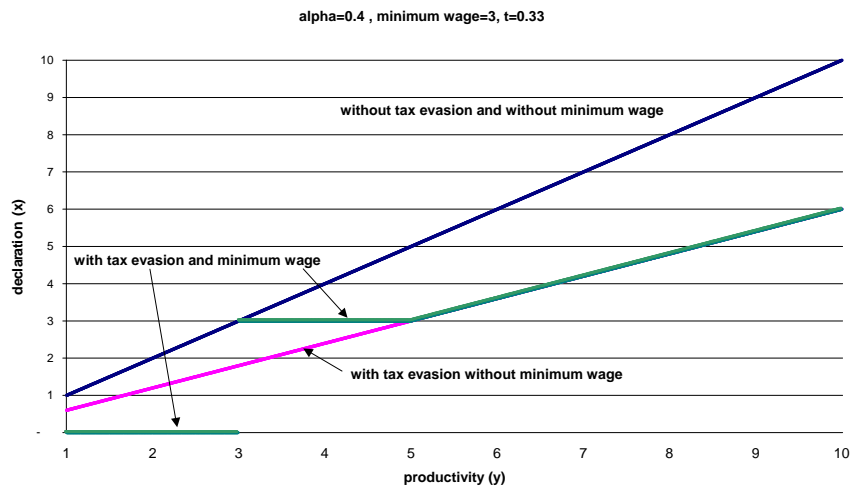
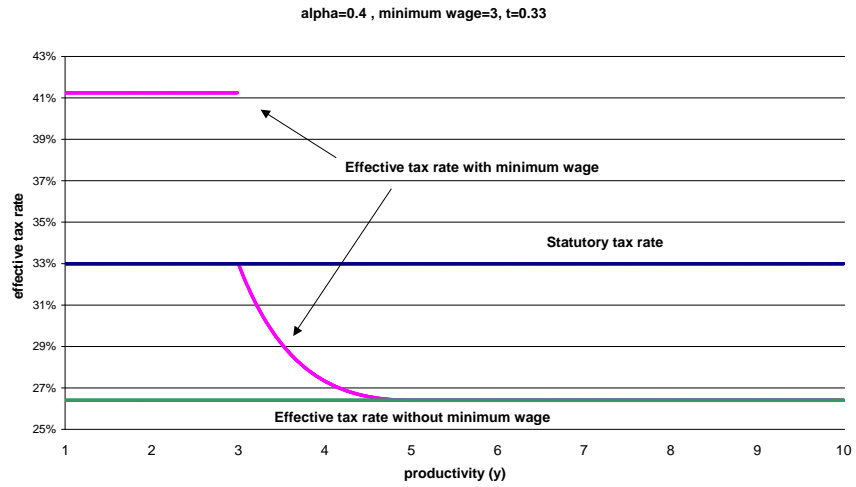


Figure 2: Effective Tax Rate



Effective Tax Rate = Total Payments to Fiscal Authorities / Productivity

Figure 3: Wage Dynamics in Hungary 1992-2005

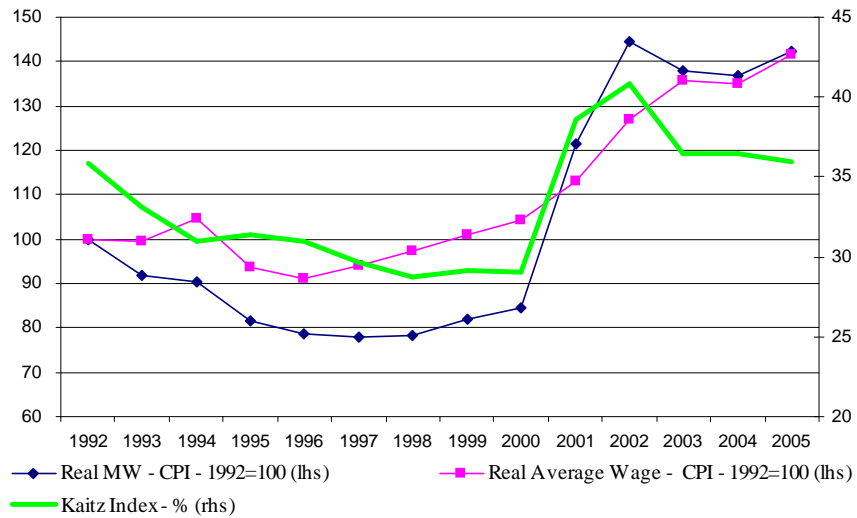
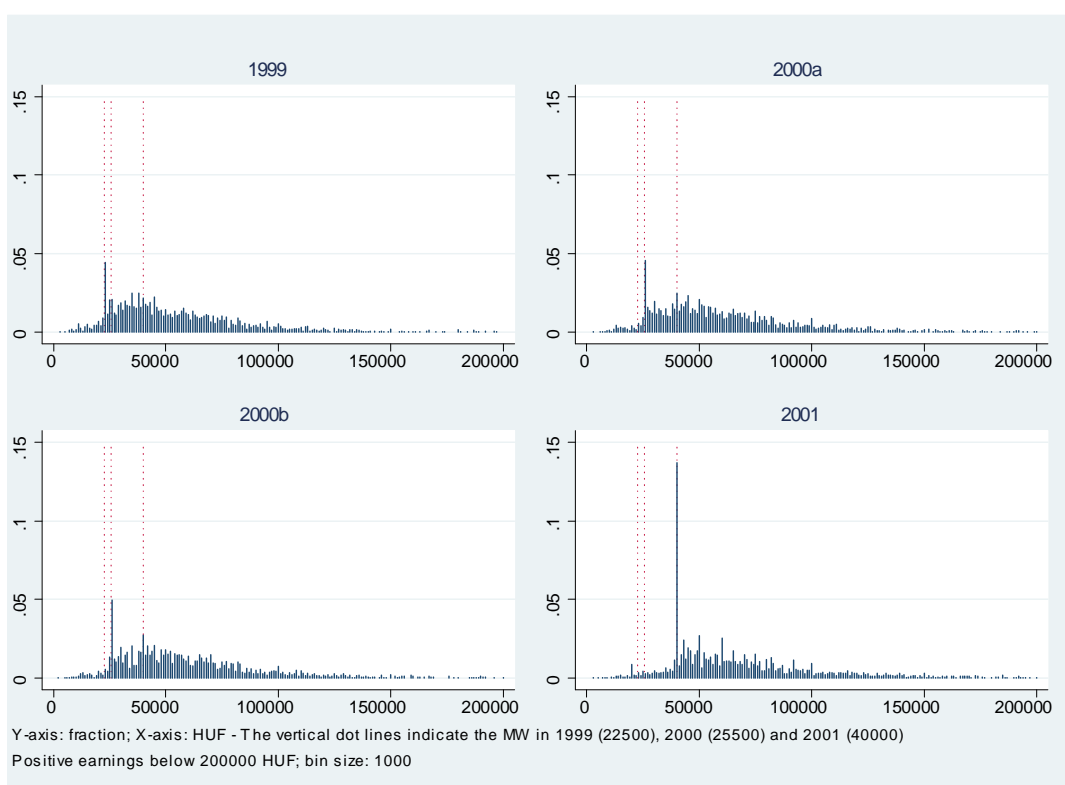
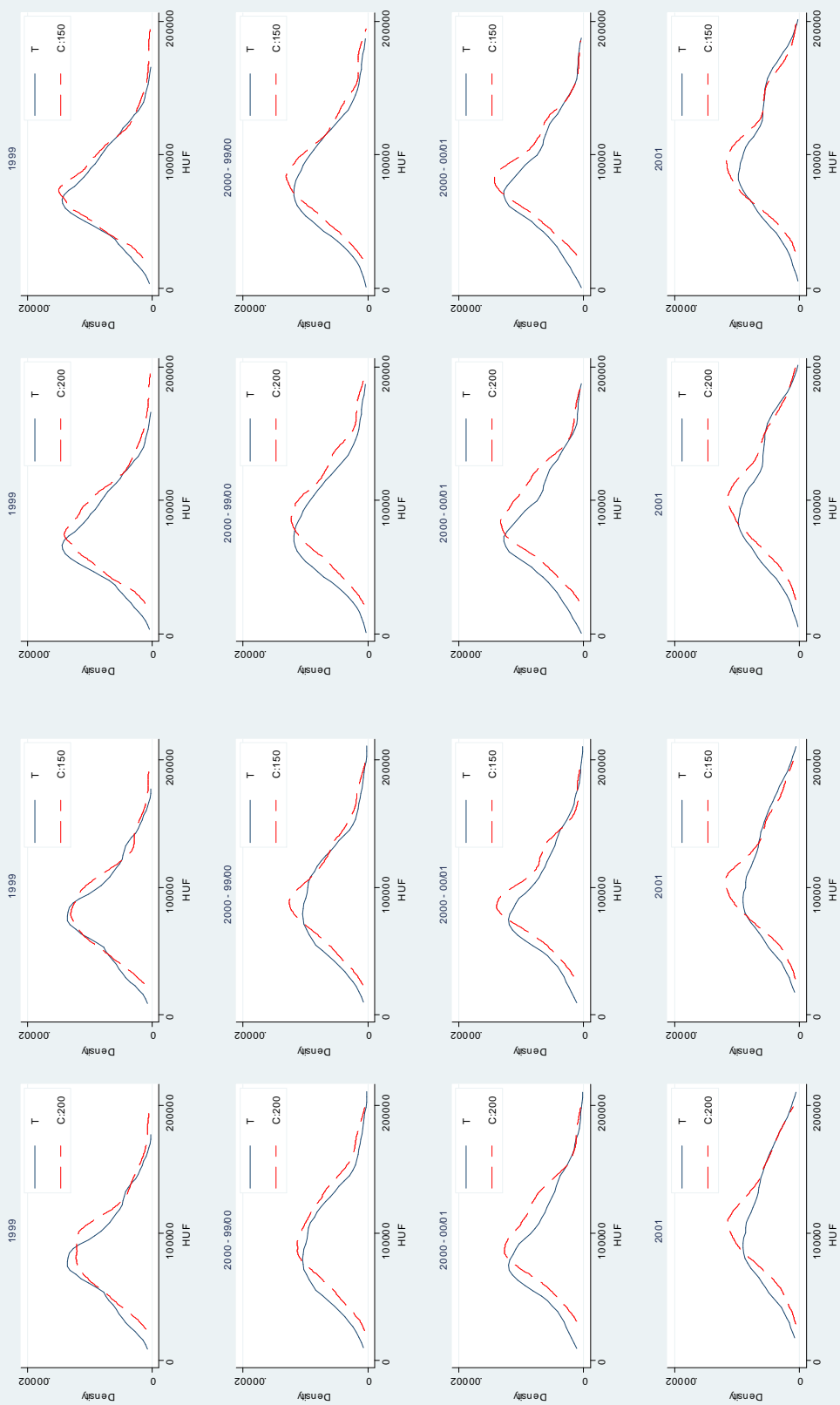


Figure 4: Earnings from main activity



With (lhs) and without (rhs) home production



T - treatment group; C:200 - control group using 200% MW as upper bound; C:150 - control group using 150% MW as upper bound; Kernel density estimation (epanechnikov); HH with positive net income below 200000 HUF in both years;

Figure 5: Household Total Net Income: "Potential Treatment"

Figure 6: Relationship between market food consumption and income - "Potential Treatment" - Control Group 150

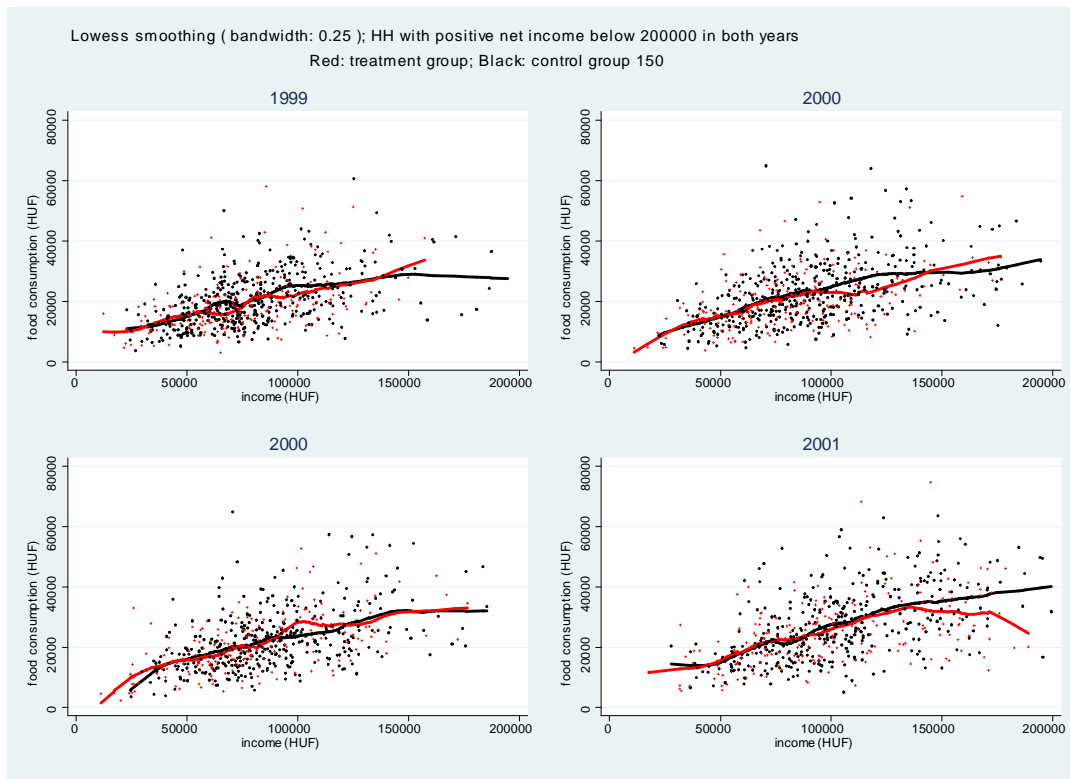


Figure 7: Relationship between market food consumption and income - "Potential Treatment" - Control Group 200

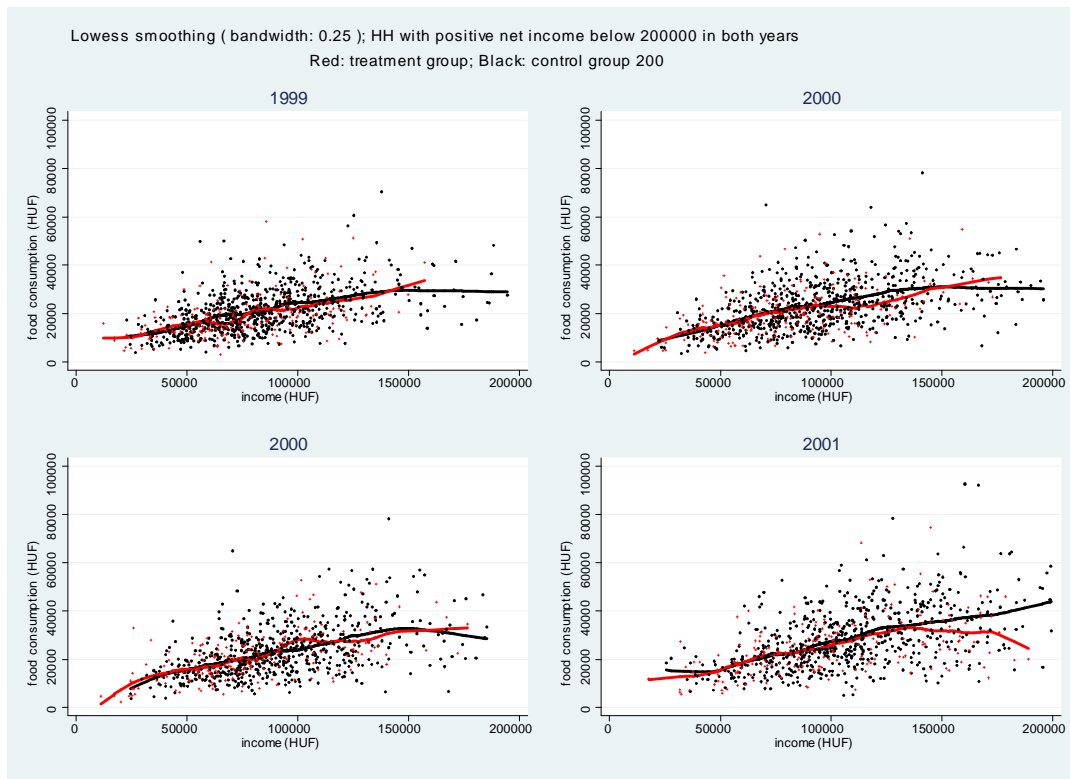


Figure 8: Household Total Net Income: "Actual Treatment"

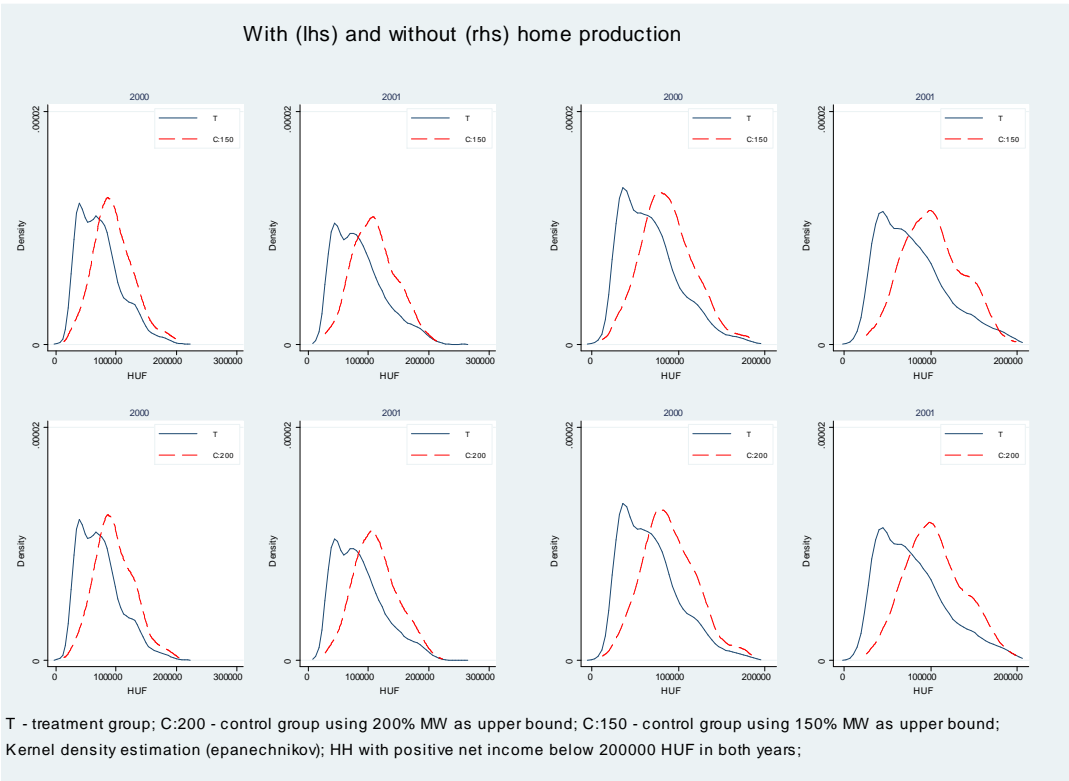
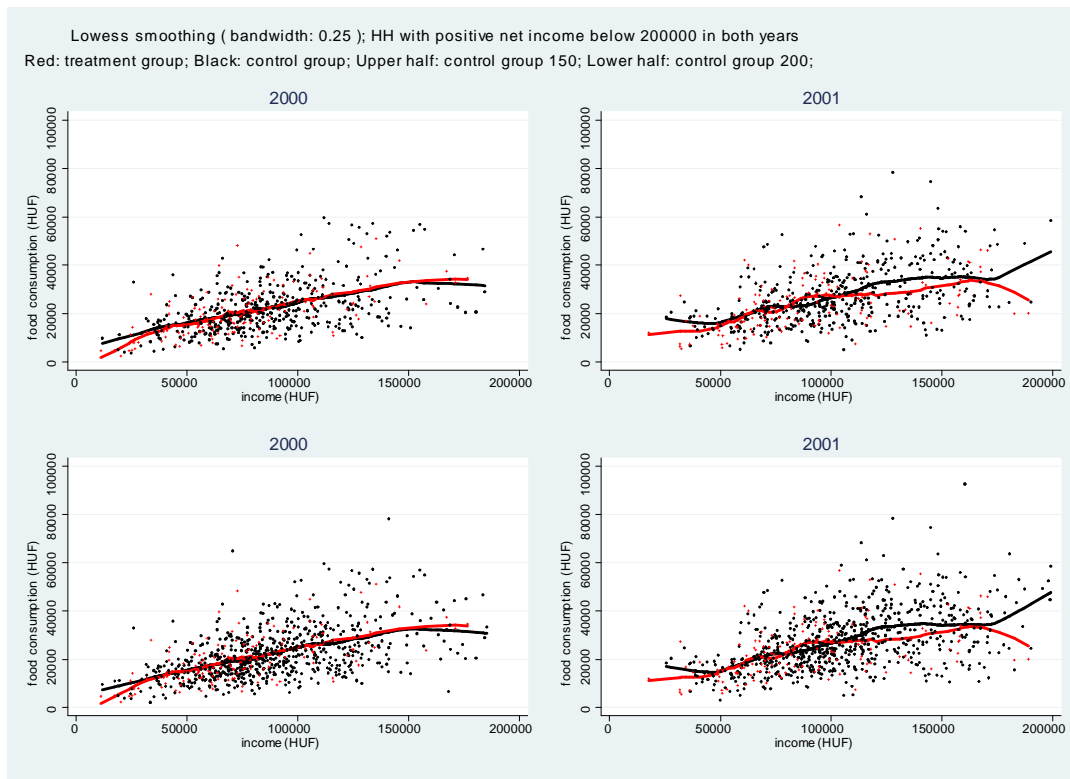


Figure 9: Relationship between market food consumption and income - "Actual Treatment"



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