

The Evasional Kuznets Curve: A Possible Shadow Economy Dynamics During The Transition *

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Abstract : Using surveys of the Czech Republic we measure how the percentage of tax evaders evolved from 1995 until 2006. We find that at first evasion rose, leveled off, and then fell along an inverse-U path, suggesting the existence of what we call an evasional Kuznets curve. Part of the curve can be explained by conventional tax evasion theories of personal gain and another part of the curve from variables inspired by the Downsian model of political participation. Using this curve we advocate that evasion rises as taxes increase, summed with a curve along which evasion falls as governments become less corrupt and people stop curtail that part of their evasion which acted as a form of political protest. Separating these two curves and estimating their parameters may shed a light on determinants of tax evasion during transition and help policy makers to choose an optimal approach. Yet most of the curve arises from forces still not understood, what we call the "dark matter" of tax evasion.

[**Key words :** underground economy, tax evasion, transition, evasional Kuznets curve]

1 Introduction and motivation

Tax evasion is a controversial term. The standard matrix for analyzing evasion is that provided by Mirrus and Smith (1997).

Tax evasion research is usually divided into three parts: measuring the value of evaded taxes, theorizing about and measuring the structural equations that predict the partial equilibrium response of an individual to a change in preferences or incentives, and measuring the social costs of evasion. Of all these, measurement of evasion has become a growth industry¹⁾. Schneider and Erste (2006) provides a recent

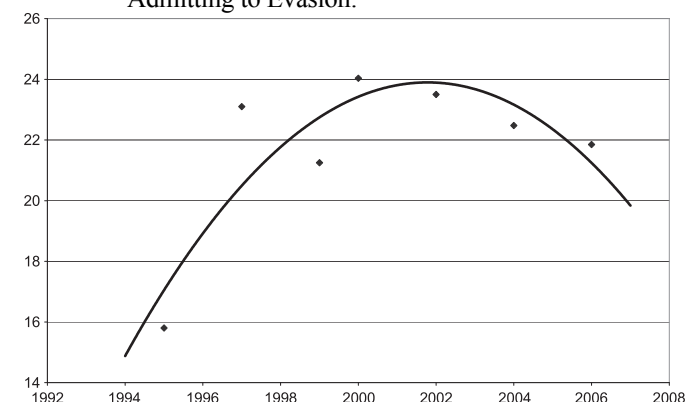
overview of efforts to measure the size of the underground economy. We do not discuss here the consequences of evasion, nor do we look in depth into the causes of evasion (though we give this topic some attention). In this paper we would like to analyze shadow economy dynamics during the period of economic transition. We suggest it follows a non-linear pattern: it may be a curve along which evasion rises as taxes increase, summed with a curve along which evasion falls as governments become less corrupt and people stop curtail that part of their evasion which acted as a form of political protest. Separating these two curves and estimating their

Table 1: A Taxonomy of Underground Economic Activities

	Monetary transactions		Nonmonetary transactions	
Illegal activities	Trade in stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling and fraud.		Barter: drugs, stolen goods, smuggling, etc. Produce or growing drugs for own use. Theft for own use.	
Legal activities	Tax Evasion	Tax Avoidance	Tax Evasion	Tax Avoidance
	Unreported income from self-employment; wages, salaries and assets from unreported work related to legal services and goods	Employee discounts, fringe benefits	Barter of legal services and goods	All do-it-yourself work and neighbor help

Sources: Mirrus and Smith (1997)

Figure 1: Trends in Estimated Level of Tax Evasion (Quadratic Trend Added). Percentage of Those Surveyed Admitting to Evasion.



Sources: Mirrus and Smith (1997)

parameters 1) may aid a country in knowing what it must do to crest the evasion and 2) better understand when the curve culminates and make a possible link to role of institutions in the patterns of evasion we observe.

Our research is motivated in part by the trend depicted in Figure 1, where we plot shadow economy estimates that come from a series of surveys of Czechs we carried out in 2000, 2002, 2004, and 2006. Summary statistics of all variables used in the survey as well as the survey questions are available in Hanousek and Palda (2002)². Our surveys are similar to those of Fortin et al. (2000). The technique they used was to conduct interviews (in our case face-to-face interviews) to gather information about how much tax people evade and why they evade³.

The pattern indicates that evasion rose throughout the 1990's and leveled off since the millennium. Shadow economy estimates based on our microeconomic data (Figure 1) suggest that the Czech Republic may have turned the peak of what might be called an evasional Kuznets curve. We did not expect to find such a result, nor is there any discussion of such a curve in the evasion literature, but the result does not surprise us. As an economy moves into the first parts of transition evasion is low, perhaps as a heritage of the previous authoritarian regime or/and because taxes are also low. Then evasion rises abruptly as the state tries

to reestablish democratic institutions and standard control over the economy. Evasion levels off because the state reduces official corruption and manages to establish an effective mechanism for tax collection. People also tend to evade less as the state improves the quality of services it provides (see Hanousek and Palda 2004). Admittedly we are working with a short time series. Only more observations will be able to confirm whether evasion in a given country follows a Kuznets curve.

The paper is structured as follows.

The first part of this paper provides a focused summary of research on tax evasion and how our desire to map the dynamics of evasion flows from this research. The second part of the paper uses surveys to get an idea of the dynamics of tax evasion by individual Czechs in order to discern the existence of an evasional Kuznets curve. The third part discusses possible forces that generate this curve. The fourth part uses the statistical analysis to simulate an evasional Kuznets curve. Our objective is to see whether the factors we identify as being important for evasion in our statistical analysis are important enough to generate the trends we actually observe in evasion. We use the results from our estimation then to simulate whether the interplay of taxes and changing perceptions of the quality of government might generate a Kuznets curve.

2 Past research and our objective

In 1968 Gary Becker published one of the first articles on the economics of crime. Drawing heavily on this article Allingham and Sandmo sought in a 1972 article to model the tax evasion decision of an individual facing an uncertain aspect of apprehension using the standard economic tools that Becker had found useful. In this mainstream, or canonical approach, the explanatory variables and objective functions of evaders seemed obvious. Risk-averse individuals evaded to put money in their pockets and

responded negatively to heightened probabilities of apprehension. While this research scored theoretical triumphs, it dawned on researchers that it had only a limited ability to explain evasion. If you took the actual probabilities of apprehension and plugged them into a Sandmo-style evasion function the result would be levels of tax evasion far higher than those actually observed. It seemed one should be asking not why people evade taxes but why they agree to pay so much. The proportion of taxes paid which could not be related to the fear of sanction has become like the dark matter of the tax evasion literature; known to exist, but without satisfactory explanation.

One possible explanation was that people did not just evade taxes in order to enrich themselves but also as a means of signaling their discontent with the quality of government services they received. Swiss researchers developed the notion of tax morale to explain these non-monetary motives for paying taxes. In 2004 Hanousek and Palda found some evidence that when people believe the quality of government services to be poor, they will evade taxes in response. This second wave of inquiry can be called the Public Choice approach to tax evasion. It is still fairly undeveloped theoretically, but can be seen as falling in the orbit of the Downsian voting model, with the act of voting replaced by the degree of tax evasion in the scale of costs and benefits of personal political action.

The public finance and public choice approaches to evasion are not in conflict with each other. Yet each may trade with the other the ability to best explain evasion, as political and economic circumstances shift. These shifts have been particularly evident in the so-called transition economies of the former Soviet Bloc. Since the late 1980's these economies have experienced fluctuations in tax rates and the quality of government services that outpaced fluctuations of these quantities in Western countries. We are interested in exploring the degree to which the sum of such changes have contributed to what we call an evasional Kuznets curve, which shows evasion rising at first and then falling. We invoke Kuznets' name because it has become standard to associate it with a

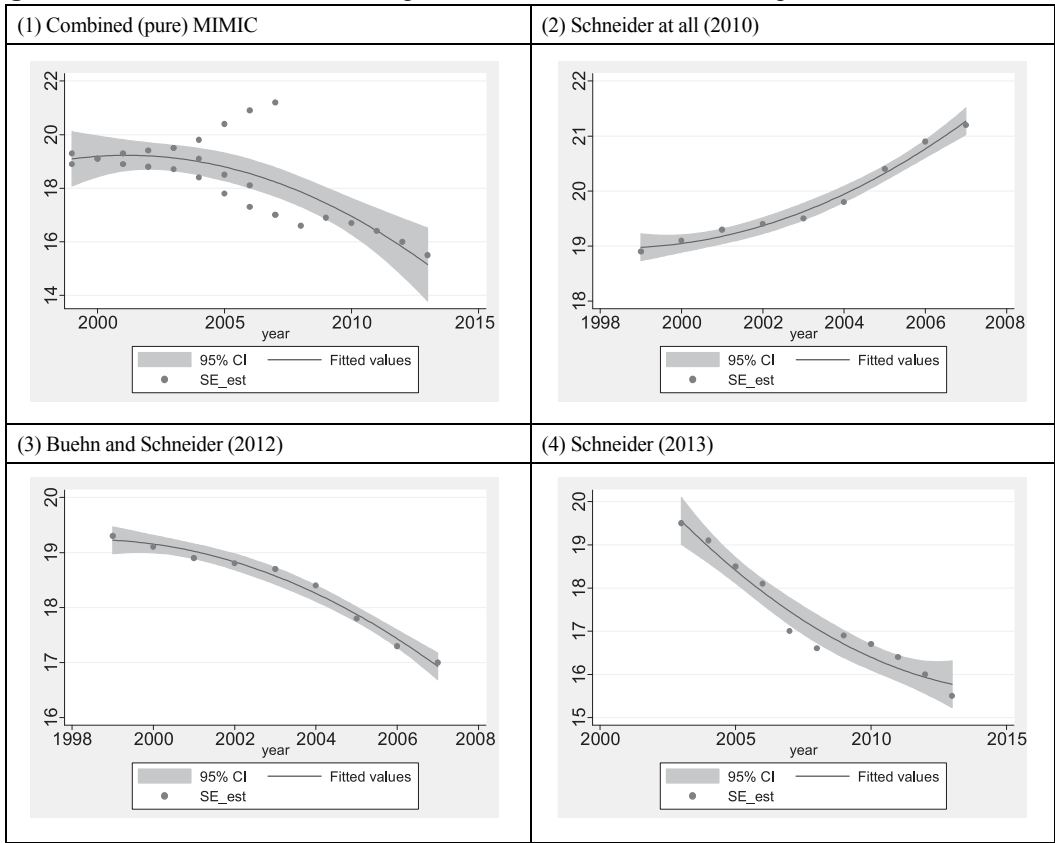
rising and then falling undesirable by-product of economic development, such as income inequality, and pollution. The curve is a conversation piece more than an academic hypothesis. It is a sign that demographic, public choice, and public finance considerations may be important for the policy of a emerging, and transition economies. The interesting question for researchers is to get some idea of the relative strength of the public finance and public choice reasons for evasion. This involves the standard approach of regressing evasion on variables that capture canonical variables such as marginal tax rates, and public choice variables such as the perceived quality of government services, along with the regular roster of demographic variables. We then simulate and illustrate graphically how evasion would evolve if the quality of government services continued to increase and if marginal tax rates continued to increase. This is an exercise that lies in the penumbra between estimation of model parameters and model simulation. The sum of the two curves implied by such trends suggests that Public choice and public finance variables only go part of the way towards generating an evasional Kuznets curve. This is due we believe in part to a lack of pertinent questions asked during evasion surveys, and in part to an as-yet poorly understood role of the interaction of demographic change with taxation in determining tax evasion.

3 Data and trends

Before undertaking a dissection of the evasional Kuznets curve we need to determine whether such an inverse-U relation between time and evasion even exists. The evasional Kuznets curve is a reflection of tax evasion dynamics.

These dynamics have largely been the preserve of researchers working with so-called "macro-estimates" of tax evasion. The Lacko (2000) household electricity demand approach to measuring evasion was popular as was the currency demand approach. Both methods postulate a relation between GDP and electricity or currency demand. If we find either demand for electricity or currency to be above what would be

Figure 2: Recent Macro Estimates Using MIMIC Method, for the Czech Republic.



predicted by actual measured GDP we must conclude that this excess reflects an underlying, undeclared GDP which can be back traced by using electricity or currency income elasticities of demand. As argued by Hanousek and Palda (2006), the problem with macro approaches is that in transition countries the elasticities of demand for currency and electricity are highly volatile due to the rapid change in commercial and industrial technology. For example, as a transition economy shifts from coal to gas-powered turbines or hybrid gas and oil powered turbines, the cost of energy may plummet and energy use may rise in consequence. The enhanced demand for electricity brought about by technological change may not be fully captured in electricity demand curves due to discordance between what the estimating model assumes about the time path of technological change and the actual path. Such an omission may give the false impression of a rapidly rising underground economy in the early stages of

transition countries.

One can argue that newer versions of macro-type estimates such as MIMIC ⁴⁾ method or those that are based on general equilibrium models could bring more time consistent estimates, but a quick inspection of graphs for, say Czech Republic demonstrates inconsistencies.

As is clear from the figures, neither recent estimates, nor restrictions to the same methodology, nor even constancy of the leading author, provide time consistent estimates of the shadow economy dynamics.

Obviously, it would boost our case for the existence of an evasional Kuznets curve to cite the finding of Onnis and Tirelli's 2008 study as well as Feige and Urban's 2008 study. Both find that for transition economies (including the Czech Republic), using macro estimates of evasion, an up and then down pattern of evasion is to be noted. One can find that similar dynamics could be found in selected

macroeconomic estimates of evasion provided by Schneider (2005, 2006, 2007) and Schneider and Klinglmair (2004). These macro estimates indicates that the value of evasion rise steeply for the 1990's and decline after the new millennium. Yet we must desist from such an endorsement. Based on the findings of Hanousek and Palda (2006) and for reasons stated above, we are unable to resort to macro estimates to support our hypothesis of the existence of an evasional Kuznets curve. We find such estimates not be credible either absolutely or in a time-differenced manner, but we note the above results for those who do not share our skepticism.

Instead of examining macro data we prefer to base our search for the evasional Kuznets curve on several surveys of individuals we conducted in the Czech Republic in the last ten years. At the time, we were interested mainly in following the example of Lemieux et al. (1994) who were interested in analyzing the determinants of tax evasion not at the macro-level but at the individual-level. Our initial goal was to devise a means of predicting tax evasion through the use of Markov chain techniques. What we did not expect, and what slowly emerged from our accumulated surveys, was a pattern of evasion over time that could be characterized as an evasional Kuznets curve. We carried out our surveys on residents of the Czech Republic in 2000, 2002, 2004, and 2006. Almost all

respondents were Czechs or naturalized Slovaks, all with an excellent command of Czech. Our surveys were similar to those of Lemieux et al. (1994) and Fortin et al. (2000). Their interviews (in their case as well as in ours, face-to-face interviews) gathered information about how much tax people evade and why they evade.

Table 2 uses contemporary as well as retrospective answers from our surveys on evasion to show the rates of evasion and their 95% confidence intervals for the 2000, 2002, 2004, and 2006 surveys of the Czech Republic. By retrospective we mean the degree to which a person thought he or she had evaded in the past. The column labeled 2000 survey shows rates of evasion based on respondents' retrospective answers concerning 1995 and 1999 and their present answer concerning 2000. Other columns can be similarly read.

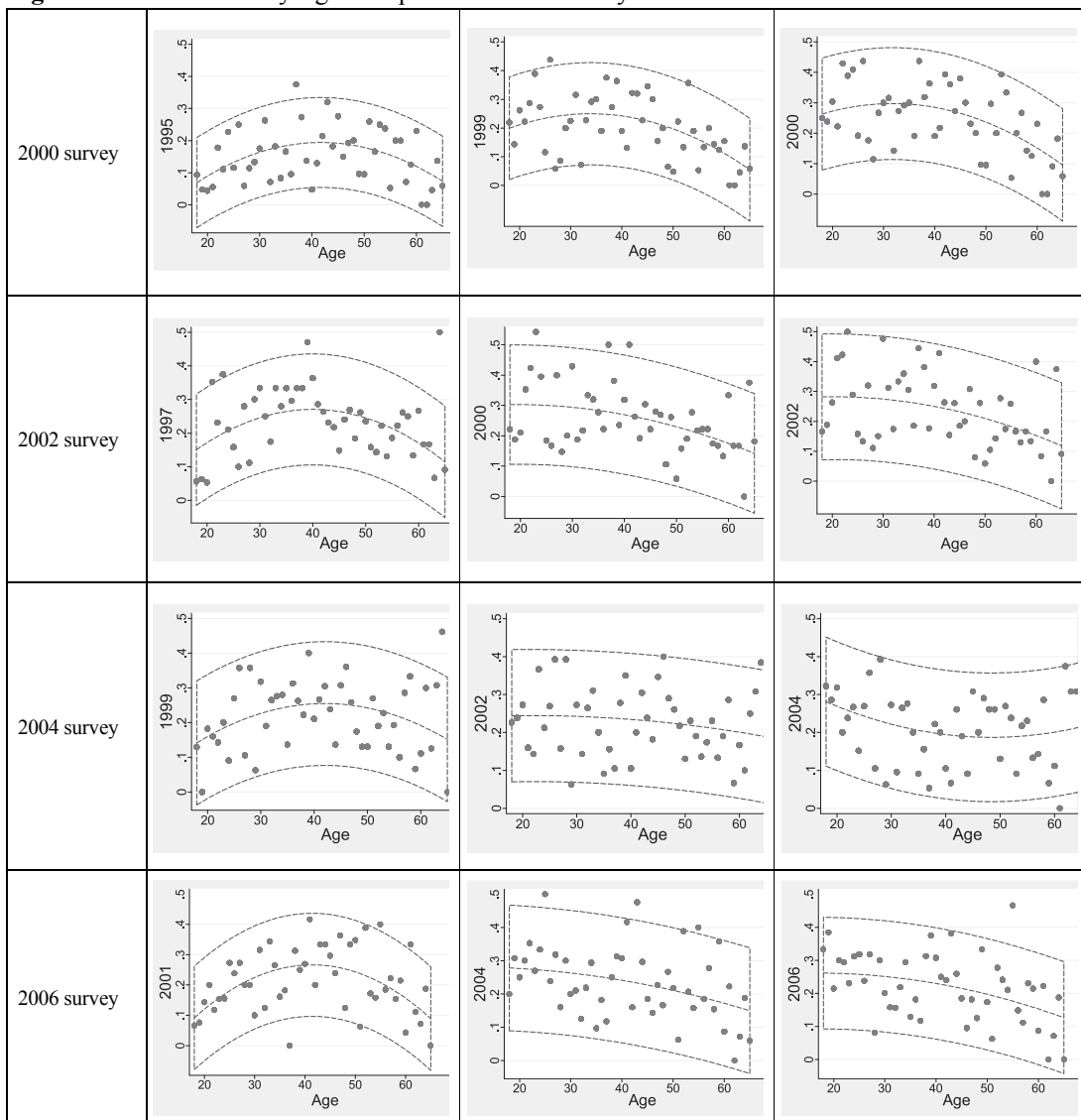
Table 2 is the source of data for the evasional Kuznets curve evident in Figure 1. As mentioned earlier we believe the up and then down nature of this curve is the result of a sum of two separate curves. Before we can decompose the Kuznets curve into these two separate curves we can use this approach to get a feel why evasion evolves as a function of age change during the transition.

With most kinds of survey data it is possible to get an idea of how a variable will vary over time by looking at the value of this variable for different age

Table 2: Tax Evasion Rates and Confidence Intervals for the 2000, 2002, 2004, and 2006 Surveys.

Year	2000 survey	2002 survey	2004 survey	2006 survey
1995	15.4% (13.3%, 17.6%)	NA	NA	NA
1997	NA	23.1% (20.5%, 25.7%)	NA	NA
1999	20.6% (18.2%, 23.1%)	NA	22.2% (19.7%, 24.7%)	NA
2000	25.2% (22.6, 27.9%)	25.9% (23.2%, 28.6%)	NA	NA
2001	NA	NA	NA	21.2% (18.7%, 23.8%)
2002	NA	23.9% (21.3%, 26.5%)	23.2% (20.6%, 25.7%)	NA
2004	NA	NA	21.4% (18.9%, 23.8%)	23.4% (20.8%, 26.1%)
2006	NA	NA	NA	22.0% (19.4%, 24.5%)

Sources: Authors 2000, 2002, 2004, 2006 surveys of tax evasion in the Czech Republic. NA indicates "not applicable". The first lines contain the mean of each category expressed in percents; the second lines give estimated 95% confidence interval.

Figure 3: Evasion Rates by Age Groups for All Four Surveys.

Sources: Authors 2000, 2002, 2004, 2006 surveys of tax evasion in the Czech Republic. Upper and lower lines indicate standard deviation bandwidths.

groups at a particular point in time. Actuaries concerned with pension plans formulate their future payouts based on current demographic profiles. Future demographics are based on current demographic snapshot. A good example comes from Constantatos and West (1991) who use a snapshot of age-earnings profiles to calculate the future benefits of investment in education.

Figure 3 shows evasion rates for each age group between 18 and 65 for each of our four surveys. These

are not individual data as we have been discussing to this point, but averages taken for each age group. For example, the first row of Figure 3 is drawn from the 2000 survey. The leftmost cell of the first row of Figure 3 maps the age of respondents against the average calculated from each age group of their answer to the question of whether they evaded in 1995. Each point on this graph is the evasion rate for an age group, not for an individual. We calculated this average by isolating from the survey all persons of a

certain age and calculating the rate of evasion for that age. We underline that the graphs in Figure 3 are not a time-series of evasion, but rather snapshots of evasion for a particular year, across age groups.

For all our surveys, answers to evasion in the present and two years past show a clear downward tendency (last two columns of figures). A pronounced up and down tendency of evasion by age manifests itself for answers to evasion five years past. Clotfelter (1983), Pommerehne and Week-Hannemann (1996), and Orviska and Hudson (2003), have found that the money value of evasion diminishes with age. The tendency of evasion displayed in the last two columns of Figure 4 accords with these studies. The rise and fall of evasion with age in the first column of Figure 4 may be random. The further back one is asked to remember one's evasion the less well one may remember how one behaved.

If we take as correct the downward relation between age and evasion then we can also speculate on the possibility of an inverse Kuznets curve emerging in the Czech Republic. Earlier we suggested the Czech Republic may have passed the turning point in this curve. As the Czech population ages, *ceteris paribus*, evasion may fall and lead to stronger evidence for the existence of an inverse Kuznets curve in tax evasion.

4 Components of the evasional Kuznets curve

The possible existence of an evasional Kuznets curve invites us to ask why tax evasion should follow such a non-linear path during economic transition. We suggest that the evasional Kuznets curve may be a curve along which evasion rises as taxes increase, summed with a curve along which evasion falls as governments become less corrupt and people stop curtail that part of their evasion which acted as a form of political protest. Separating these two curves and estimating their parameters may aid a country in knowing what it must do to crest the evasional Kuznets curve.

The evasional Kuznets curve, of which we presented some rough evidence in the previous section,

may be the sum of contrary forces acting on tax evasion. A prominent feature of transition economies in general, and the Czech Republic in particular, is that over the transition, tax rates and government indebtedness, which forebodes higher taxes, both rise. As Schneider and Enste (2000) write "In almost all studies, the increase of the tax and social security contribution burdens is one of the main causes for the increase of the shadow economy." While taxes are rising, confidence in government may also be rising, albeit slowly. The first generation of democratic politicians and functionaries may need several years to impose measures of probity and accountability to bureaucracies formerly schooled in obsessive secrecy. During this "wild west" period of transition bribes may be the best way of gaining government favor and corruption may balloon. As politicians learn to tame corruption there is evidence that citizens will respond by cheating less on their taxes. Loayza (1996) found that strong and efficient government institutions are negatively correlated with tax evasion in a general equilibrium model of fourteen Latin American countries. Hanousek and Palda (2004) found survey-based evidence that people who believe government is honest pay more taxes than those who believe otherwise, all other things held constant. Adding the two contradictory forces described above might produce an evasional Kuznets curve.

A simple simulation shows how the evasional Kuznets curve might be generated. From period one to period ten an index of tax rates T rises from one to ten. In this period an index of the perceived quality of government services Q also rises from one to ten. Evasion for this example is an additive function of the tax and quality indices taking the general form $E=f(T)+g(Q)$. The particular form we give this function for illustrative purposes is

$$E = \underbrace{50T^{\frac{1}{2}}}_{f(T)} - \underbrace{(Q^2 + 49)}_{g(Q)} \quad (1)$$

Evasion is a rising function of taxes and a falling function of the quality of government services. Figure 4 maps both the f and g functions and their sum, which

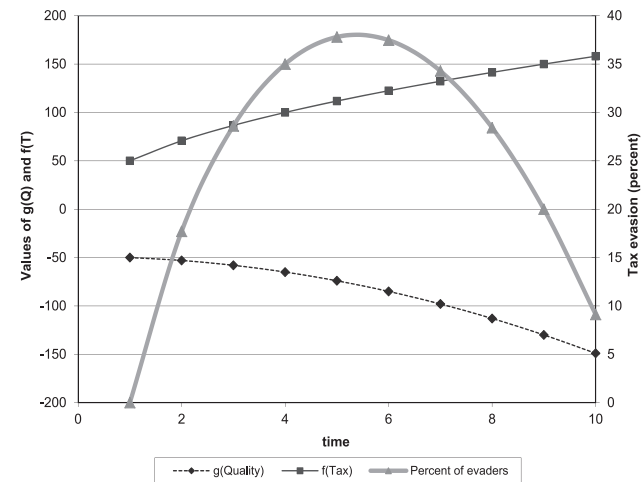
gives the rate of evasion over time and resembles an evasional Kuznets curve. The above exercise proves nothing, but suggests that the evolution of evasion over time depends on the functional dependence of evasion on possibly countervailing forces such as quality of government services, and tax rates, and the evolution of quality and tax rates.

The above example is simplistic because it deems tax rates and the quality of government services are the only influence on evasion, or that changes in these factors are the only influence on evasion over time. We formulated the example in such a manner as to join the two forces that students of evasion believe to be among the most potent determinants of evasion. We also chose this example because it has some empirical backing. Taxes rose in the Czech Republic after 1989. Perceived quality of government services are harder to measure than taxes, but following our 2004 paper methodology we found from our four surveys that since 2000 Czechs are increasingly satisfied with government services, and see corruption as declining. Czechs also increasingly believe it is immoral to evade and that family reactions to evasion are becoming increasingly negative. If both taxes and quality were rising and working against each other in their effect on evasion, the sum of their opposite influences might have given rise to an evasional Kuznets curve over the period we studied.

5 Unraveling the Kuznets curve

The evasional Kuznets curve suggested by Figure 1 may result from the sum of an increasing incentive to evade due to rising tax rates with a decreasing incentive to evade due to a perceived increase in the quality of government services, and possibly other forces such as shifting demographics. Table 3 shows a regression of the determinants of individual tax evasion based on a pooling of four surveys done in the Czech Republic in 2000, 2002, 2004, 2006. We omit

Figure 4: The Evasional Kuznets Curve as the Sum of the Influence of Perceived Quality of Government Services and Index of Taxes.



year dummies from the presentation as they were not significant. What was significant was that the marginal tax rate has a positive influence on evasion, and perceived quality has a negative effect. A variable related to perceived quality is the perceived morality of evasion. The Table 3 also shows that those who believed evasion to be immoral were significantly less likely to evade than those who thought it moral.

Equations of this sort have been estimated before. Here we wish to make use of this equation to see whether under reasonable assumptions about the evolution of marginal tax rates and perceived quality of government services, and morality of evasion, a Kuznets curve can emerge. To this end we used the coefficients in Table 3 to simulate how evasion would evolve if marginal tax rates rise by ten percent for four periods. Then we changed assumptions for later periods to imitate developed and stable economies. In particular, we increased the proportion of the population who are satisfied with government services by ten percent for each period, and also increased the proportion of people believe evasion to be highly or moderately immoral at the same rate. These two exercises generated Kuznets curves similar to those seen in Figure 4.

This is not a common exercise in economics. It lies

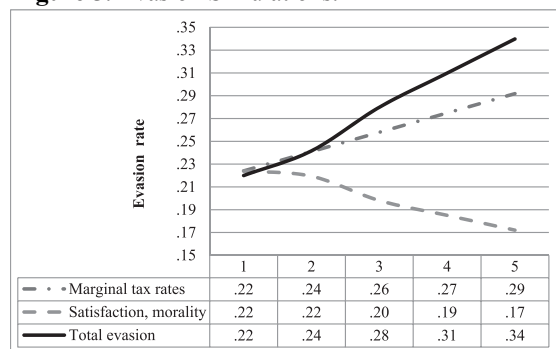
Table 3: Regression of Whether or Not an Individual Evaded on Tax, Public Choice, and Demographic Variables for Pooled 2000, 2002, 2004, 2006 Czech Surveys.

Explanatory variable	Coefficient	P-value
Marginal tax rate	0.010	0.000
Satisfied with government service	-0.046	0.059
Not satisfied with government service	0.002	0.888
Evasion is highly moral	0.375	0.000
Evasion is mildly moral	0.184	0.000
Evasion is mildly immoral	-0.183	0.000
Evasion is highly immoral	-0.236	0.000
Male	0.106	0.000
Age	-0.002	0.000
Primary education	0.135	0.000
Secondary education	0.125	0.000
Above secondary education	0.044	0.055
Constant	0.080	0.137
Number of cases	3,872	R ² =0.167

Note: we left out whether an individual was indifferent to government services in order to avoid the dummy variable trap. We also left out no-opinion on morality for the same reason. These two variables also serve as a base or reference group.

in the penumbra between hypothesis testing and simulation. The effort may be thought of as extracting DNA from a fossil and seeking to recreate an extinct beast in the laboratory. Our attempt at recreation is meant to get a sense of the contribution of public choice and tax, or public finance variables to the evasional Kuznets curve. In this spirit, the top curve in Figure 4 shows how evasion would evolve from its base point of 22% if tax and public choice variables evolved together as mentioned above. The lower curves show how evasion would evolve if tax and public choice variables evolved separately. The Figure does not show a Kuznets curve emerging. We were able to generate a Kuznets curve only under extreme assumptions of huge increases in satisfaction and moral perceptions of paying taxes, and combining these with very small increases in marginal tax rates. The simulations we present suggest to us that the tension between taxation and public choice variables in the evasion decision are not sufficient to generate by itself the evasional Kuznets curve we actually do observe for the Czech Republic. The influence of tax rates on evasional decisions dwarfs the effect of public choice variables. Yet looking at the simulated curve we see that tax explanations of evasion cannot generate a Kuznets curve. Something is missing from our simulations, or something is wrong.

To understand the sources of the evasional Kuznets

Figure 5: Evasion Simulations.

Sources: Coefficients in Table 3 along with data from our 2000, 2002, 2004, 2006 surveys.

curve we actually observe requires a more detailed understanding of how education and demographics have evolved and how they interact with tax and public choice variables. It is perhaps to these forces that we must turn our attention in order to understand the emergence of an evasional Kuznets curve. Uncovering the bases of the evasional Kuznets curve will also require researchers to overcome the biases that are a part of survey answers. There may be a simultaneity between quality and morality measures, and evasion. Those who believe government quality is high may evade less, but they may also say quality is high to justify their low evasion. Perhaps the greatest need in this research is of a survey with questions tailored precisely towards uncovering the sources of an

evasional Kuznets curve. We had no idea of the existence of such a curve when we started our survey research ten years ago and our questions are awkwardly suited for an inquest into the curve.

6 Discussion and conclusion

In this paper we have noted the possible existence of an evasional Kuznets curve for the Czech Republic. In the analysis and estimation we used series of (retroactive) surveys conducted in the Czech Republic in 2000, 2002, 2004 and 2006. The value of survey research lies in its detail. Surveys tell you about the people who answer them. We can build a portrait of evaders and based on this portrait we can predict how evasion will evolve. Surveys do not suffer from the same weaknesses as do macroeconomic estimates of evasion. Macro estimates rest on heroic assumptions of the link between electricity use and growth to produce numbers on evasion.

Our most practical finding is that evasion is on a downward path in the Czech Republic and is likely to remain on this path. By tracking evasion since the mid 1990's, our surveys reveal an evasional Kuznets curve. If we know what side of the Kuznets curve we are on, we can pick the Markov chain method to accurately predict evasion. We would like to be able to predict when a country crosses over the peak of the evasional Kuznets curve, but this may prove to be an impossible task if the point of transition is an emergent phenomenon.

Whether all countries coming out of transition or in the early stages of modern economic development can expect to face such a curve is interesting for the same reason that the pollution Kuznets curve, and the income inequality Kuznets curves are interesting. Is there something inevitable and universal about the rise and fall of these phenomena over the course of an economy's development? If we are to move beyond such ruminations we need to understand the forces that generate the Kuznets curve. While students of tax evasion have long sought to understand its causes, they have rarely framed the question in an evolutionary context. Do the underlying forces driving evasion

change with economic development in a manner that generates an evasional Kuznets curve?

While many countries of the former East Bloc seem to have come out of transition, some have yet to do so, and many countries in the developing world also await their transitions. Knowing that they may face an evasional Kuznets curve may give them some sense of the importance of coordinating tax collection policies with governance measures. We have found evidence of an evasional Kuznets curve for the Czech Republic during its transition years using micro and macro data sources. While we found that public choice variables have a statistically significant effect on evasion, our projections pitting these variables against the influence of the marginal tax rate on evasion suggested that a third category of variables, namely demographic changes, may have ultimately shaped the Czech Kuznets curve. Much work remains to be done in both describing evasion dynamics at the individual level and in seeking the determinants of these dynamics. The key question is whether an evasional Kuznets curve may be considered an inevitable feature of emerging and transition economies. If not, then a firm understanding of the effect of taxation and public choice variables on evasion may be of help in shaping anti-evasion policies.

Note

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1) Quintano and Mazzocchi (2013), Buehn, and Schneider (2012), Elgin and Oztunali (2012), Pickhardt and Sarda (2011), Schneider (2010, 2013), Schneider, et al (2010), Schneider and Buehn (2012), Tafenau, et al (2010), Williams (2009), Onnis and Tirelli (2008), Feige and Urban (2008), Lackó(2000), among others.

2) A detailed description of the surveys including questionnaires, summary tables and results explicitly mentioned in the text are available from the authors upon request or at <http://home.cerge-ei.cz/hanousek/evasion>.

3) The Fortin et al. survey differed from ours in that it did not ask questions that would allow a researcher to infer the dynamics of tax evasion. Fortin et al. were interested in the link between buying goods and services on which taxes were not declared, and evasion.

4) Usually the output (or income) of the underground economy is represented as a latent variable or index, which has causes and effects that are observable but which cannot itself be directly measured. Based on estimated “relationships” with observed data, the index is predicted and interpreted as a time-series estimate of the underground economy.

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Appendix

A Using Non-Panel Data to Analyze Dynamics: Consistency of (Retrospective) Surveys.

A.1 Survey consistency test

Placing results from the four separate surveys on the same graph gives us a longer time series of evasion than if we had explored each survey separately. The problem with juxtaposing surveys in this manner is that our surveys are not panel data but rather independent surveys taken at two-year intervals. The question arises whether such juxtaposition has meaning.

One of the main variables of interest in our surveys is the individual's answer to whether or not he or she evaded taxes. In each survey we asked people about their current and past evasion. If we could find that answers about evasion in 2002 given to questions in the 2004 survey are statistically indistinguishable from answers about evasion in 2002 given by respondents in the 2002 survey, in the sense that we cannot say that both surveys are drawn from a different distribution, we might conclude that memory is good and that surveys in 2002 and 2004 are consistent with each other. Consistency means that we can merge the surveys to form a time series of data on tax evasion. In each survey we might garner retrospective data on evasion and hence in each survey capture data for four periods.

To test the consistency of present answers about evasion with retrospective answers for the same year from a later survey, consider two independent sample surveys of n and m observations respectively $x_1=(x_{11}, x_{12}, \dots, x_{1n})$ and $x_2=(x_{21}, x_{22}, \dots, x_{2m})$, where x_{ij} denotes the j^{th} observation of the i^{th} survey. Survey 1 is taken in the year 2000 and survey 2 is taken in the year 2002. The x 's in the 2000 survey are the answers of each respondent to whether he evaded in 2000 and the x 's in the 2002 survey are the answers to whether a respondent remembered evading in 2000. "Yes" answers are coded as ones, no answers as zeroes. The data are non-panel. Our variables of interest are the

proportions of evaders in each sample $p_1 = \frac{1}{n} \sum_{i=1}^n x_{1i}$,

and $p_2 = \frac{1}{m} \sum_{i=1}^m x_{2i}$ and we wish to test the null

hypothesis $H_0: p_1 = p_2$,

i.e., that the proportion tax evaders in both samples is the same. Consider the following u test statistics

$$u = \frac{p_1 - p_2}{\sqrt{\bar{p}(1-\bar{p})\left(\frac{1}{n} + \frac{1}{m}\right)}}$$

where $\bar{p} = \frac{1}{(n+m)}(np_1 + mp_2)$, Under the null

hypothesis, the test statistic u has a standard normal distribution. The above is a test statistic that allows us to distinguish whether certain variables have been drawn from different distributions. Our results are summarized in Table A.1.

Table A.1 indicates that:

No difference can be found for the 2000 survey estimate of evasion in 2000 and the 2002 survey retrospective estimate of evasion in 2000 because the

U-statistic of $U = -0.359$ is not significant.

The same can be said of the 2002 survey estimate of evasion in 2002 and the 2004 survey estimate of evasion in 2002 ($U = 0.382$, not significant).

The same can be said of the 2002 survey estimate of evasion in 1999 and the 2000 survey and its estimate of evasion in 1999 ($U = -0.863$, not significant).

Similarly, the 2006 survey estimate of evasion in 2004 and the 2004 survey and its estimate of evasion in 2004 show a consistent pattern ($U = -0.955$, not significant).

By showing a strong consistency between surveys we have not only given some justification for merging surveys, but have also uncovered the result that answers to questions about past evasion in a survey taken in one year are statistically indistinguishable from answers to questions about contemporary evasion given in a survey two years earlier. Even though the surveys are independently drawn, we are tempted to say that people remember.

Table A.1: Tests of Consistency of Surveys: Comparison of Retrospective Estimates of Evasion, Czech Republic.

A Tax evasion in 2000 (test of consistency 2000 and 2002)			
Survey	Evaders	Non-evaders	Total
2000	268	794	1062
2002	268	766	1034
Test statistics	-0.359	p-value:	0.360
B Tax evasion in 2002 (test of consistency 2002 and 2004)			
Survey	Evaders	Non-evaders	Total
2002	247	788	1035
2004	245	813	1058
Test statistics	0.382	p-value:	0.649
C Tax evasion in 1999 (test of consistency 2000 and 2004)			
Survey	Evaders	Non-evaders	Total
2000	219	843	1062
2004	234	822	1056
Test statistics	-0.863	p-value:	0.194
D Tax evasion in 2004 (test of consistency 2004 and 2006)			
Survey	Evaders	Non-evaders	Total
2000	227	836	1062
2004	229	762	991
Test statistics	-0.955	p-value:	0.170

Note: we left out whether an individual was indifferent to government services in order to avoid the dummy variable trap. We also left out no-opinion on morality for the same reason. These two variables also serve as a base or reference group.

A.2 Estimating probability of evasion and transition probability matrix

$$\text{Let } T = T_t = \begin{bmatrix} T_{EE} & T_{EN} \\ T_{NE} & T_{NN} \end{bmatrix} \quad (\text{A.1})$$

denotes transition probability matrix between evading and non-evading stages. It means that each cell gives for an individual the probability he will go from one state in period $(t-1)$ to another state in period t . For example, T_{EN} gives the probability an individual who evaded in $(t-1)$ will not evade in the period t , etc.

$$\text{Similarly, } E = E_t = \begin{bmatrix} E_E \\ E_N \end{bmatrix} \quad (\text{A.2})$$

is a vector containing probabilities of an individual evading (E_E) and non-evading (E_N) at the time t , respectively.

Using individual responses to the set of the retrospective questions, we can construct the following set of dummy variables:

$$e_t = e_{t,i} = \begin{cases} 1 & \text{if an individual } i \text{ evaded at period } t \\ 0 & \text{otherwise} \end{cases} \quad (\text{A.3})$$

$$t_{EE,t} = t_{EE,t}^i = \begin{cases} 1 & \text{if } e_{t,i} = 1 \text{ \& } e_{t-1,i} = 1 \\ 0 & \text{otherwise} \end{cases} \quad (\text{A.4})$$

$$t_{EN,t} = t_{EN,t}^i = \begin{cases} 1 & \text{if } e_{t,i} = 1 \text{ \& } e_{t-1,i} = 0 \\ 0 & \text{otherwise} \end{cases} \quad (\text{A.5})$$

$$t_{NE,t} = t_{NE,t}^i = \begin{cases} 1 & \text{if } e_{t,i} = 0 \text{ \& } e_{t-1,i} = 1 \\ 0 & \text{otherwise} \end{cases} \quad (\text{A.6})$$

$$t_{NN,t} = t_{NN,t}^i = \begin{cases} 1 & \text{if } e_{t,i} = 0 \text{ \& } e_{t-1,i} = 0 \\ 0 & \text{otherwise} \end{cases} \quad (\text{A.7})$$

Basically, realization of the random variables defined above in (A.3)-(A.7) forms sample counterparts of the probabilities of evasion and the transition probability matrix, respectively.

$$\text{Therefore, } \hat{E}_E = \hat{E}_{E,t} = \frac{1}{n} \sum_{i=1}^n e_{t,i} \quad \text{and}$$

$$\hat{E}_N = \hat{E}_{N,t} = 1 - \hat{E}_{E,t} \quad (\text{A.8})$$

$$\text{and } \hat{T}_{EE} = \hat{T}_{EE,t} = \frac{1}{n} \sum_{i=1}^n t_{EE,t}^i, \quad \hat{T}_{EN} = \hat{T}_{EN,t} = \frac{1}{n} \sum_{i=1}^n t_{EN,t}^i$$

$$\hat{T}_{NE} = \hat{T}_{NE,t} = \frac{1}{n} \sum_{i=1}^n t_{NE,t}^i, \quad \text{and} \quad \hat{T}_{NN} = \hat{T}_{NN,t} = \frac{1}{n} \sum_{i=1}^n t_{NN,t}^i \quad (\text{A.9})$$

Since all variables defined in (A.3)-(A.7) are sample realizations of Bernoulli (0-1) variables, their estimated sample variance is equal to

$$\text{est. var}(\hat{\Theta}) = \frac{1}{n} \hat{\Theta}(1 - \hat{\Theta}), \quad (\text{A.10})$$

for all estimators defined in (A.8)-(A.9).

A.3 Prediction of future evasion using current evasion and transition probability matrix

We assume that we know (at time t) probability of evasion and we know past transition probability matrix. Using the Markov-type computation, we can construct predicted probability of evasion as:

$$\begin{aligned} \hat{E}_E &= \hat{E}_{E,t+1} = E_{E,t} P(\text{evading}(t+1) | \text{evading}(t)) \\ &+ E_{N,t} P(\text{evading}(t+1) | \text{non-evading}(t)) = \\ &= E_{E,t} \frac{T_{EE}}{T_{EE} + T_{EN}} + E_{N,t} \frac{T_{NE}}{T_{NE} + T_{NN}} \end{aligned} \quad (\text{A.11})$$

It means that probability of evading at the time $t+1$ is equal to probability of evading at the time t times probability that those evading at the time t will be still evading at the time $t+1$ plus probability of non-evading times probability that those not evading at the time t will start evading at $t+1$.

Similarly

$$\begin{aligned} \hat{E}_N &= \hat{E}_{N,t+1} = E_{E,t} \frac{T_{EE}}{T_{EE} + T_{EN}} + E_{N,t} \frac{T_{NE}}{T_{NE} + T_{NN}} \\ &= 1 - \hat{E}_{E,t+1} \end{aligned} \quad (\text{A.12})$$

Point estimates of the predicted probabilities of evasion can be easily constructed from (A.11) and (A.12). Because of non-linear relationship and possible interdependence between estimates of \hat{T} and \hat{E} , estimation of the variance of (A.11) and (A.12) is not straightforward. One could try to employ a delta method to get an estimated asymptotic variance of the predicted probability of evasion at time $(t+1)$, however, it will still need to compute/estimate covariance between T and E , which together with the first derivatives will lead to a complicated formula. In addition, computing the variance via delta method relies on certain set of assumption and more importantly, it gives the asymptotic behavior of the variance. Let us note that its finite sample properties could be rather different

Table A.2: Estimated Short-Term Transition Matrices, with 95% Confidence Intervals.

1999/2000		2000 Evaders	Non-evaders
1999	Evaders	0.21 (0.18 , 0.23)	0 (0.0 , 0.0)
	Non-evaders	0.05 (0.03 , 0.06)	0.75 (0.72 , 0.77)

2000/2002		2002 Evaders	Non-evaders
2000	Evaders	0.21 (0.18 , 0.24)	0.05 (0.04 , 0.06)
	Non-evaders	0.03 (0.02 , 0.04)	0.71 (0.69 , 0.74)

2002/2004		2004 Evaders	Non-evaders
2002	Evaders	0.18 (0.16 , 0.21)	0.05 (0.03 , 0.06)
	Non-evaders	0.03 (0.02 , 0.04)	0.74 (0.71 , 0.76)

2004/2006		2006 Evaders	Non-evaders
2004	Evaders	0.19 (0.17 , 0.22)	0.04 (0.03 , 0.05)
	Non-evaders	0.03 (0.02 , 0.04)	0.74 (0.71 , 0.77)

Note: we left out whether an individual was indifferent to government services in order to avoid the dummy variable trap. We also left out no-opinion on morality for the same reason. These two variables also serve as a base or reference group.

A.4 How to analyze and slow future trends in evasion

The challenge to providing credible estimates of the evolution of tax evasion lies in dealing with changing demographics and policy. As a population grows rich it will change its evasion practices. As government cracks down on evasion or changes the quality of services it provides to its citizens, people will make new decisions about whether to evade or not evade. Such changes are the woof and warp of the Lucas critique and the bane of forecasters. When the parameters that underlie the decision to evade change in aggregate, so must the aggregate Markov probabilities we have calculated. We showed earlier that we cannot believe these probabilities to be stable for the Czech Republic, though unstable parameters of evasion throw into doubt the accuracy of our forecasts of evasion. The best we can do to restore belief in our forecasts is to modify them by guessing how the parameters of evasion will change and using these guesses to modify our Markov transition probabilities. Put technically, we wish to use regression to estimate the impacts of the determinants of the transition between evasion and non-evasion on evasion and non-evasion. With these estimates in hand we can say that if demographics or policy take a certain path, Markov transition probabilities will also take a certain path. With the path of Markov transition probabilities in hand we can modify our forecasts to span over a

changing future ¹⁾.

It is all well and good to say we wish to estimate the importance certain variables have on transition probabilities, but what sorts of variables should we be looking at? The question strikes at the heart of deficiencies in current approaches to tax evasion. Forecasters like to look at reduced-form estimates of the coefficients attached to variables that do not enter into simultaneous relations with the dependent variable. We can estimate reduced-form regressions of the determinants of Markov transition probabilities, but such estimates will be mute on what we believe are important policy variables. We cannot include policy variables in our transition probability regressions because we have no objective measures of policy change that would not require a long time series and call on event-study methods. At best we can ask people what they perceive government policy to be, but perceptions are slippery quantities to include in reduced form regressions because we do not know if people state their perceptions to justify their evasive behavior. Ask me if I evade and I say yes. Then ask me if it is moral to evade and I may say yes to make me look respectable in the eyes of the interviewer (our

¹⁾ Therefore, we recommend a simpler method that uses well-known bootstrap algorithm. Since its introduction bootstrap method become widely used even so that bootstrap algorithms are integrated part of statistical and econometric software (see for example STATA, www.stata.com) therefore we omit here any additional details and implementation.

surveys were face-to-face). My answers will foil the researcher running reduced form regressions and force him to estimate a recursive or simultaneous model of evasion. There is as yet no such generally accepted full-equilibrium model of evasion.

In an earlier study Hanousek and Palda (2004) developed a trick for partially bypassing the need for elaborate modeling of structural parameters while still including variables in their reduced-form regression such as perceptions of government policy. They ran a regression of the evasive behavior of individuals on each individual's perception of the quality of government services. Their notion, drawn from Downsian voting theory, is that people evade not just for instrumental reasons (putting more money in their pockets) but also for moral reasons ("if I do not get good quality government services I will protest by withholding my taxes"). To ensure that people would not justify their evasive behavior by answering that they believed they were getting poor government services, interviewers told subjects that the survey was about the quality of (government) services. Interviewers posed questions of quality at the start of the survey. Much later in the survey came questions about whether the respondent evaded taxes. We believe the order in which the two questions were posed reduced spurious correlation between answers to the two questions; the reverse order of questions gives respondents opportunity to "justify" by claiming that they evaded taxes because they believed government services to be of low quality (For more discussion and results related to this particular phenomenon see Hanousek and Palda, 2004).

Other policy variables that both theory and empirical literature suggest are important are the perceived probability of being caught evading and the perceived penalty for evasion. Clearly such variables belong in a structural regression. Our regressions should thus be thought of as quasi-reduced form regressions, integrating clearly exogenous variables such as demographics, and perceived policy variables over whose exogeneity some cloud of doubt may hang.

Since we consider two basic stages – Evading (E)

and Not evading (N), there are four stage-transition probabilities ($E \rightarrow N$, $E \rightarrow E$, $N \rightarrow E$, $N \rightarrow N$) and this suggests we estimate a reduced-form regression for each of the four possible transition probabilities. Once we estimate the parameters associated with the variables driving tax evasion, we can then simulate how Markov transition probabilities will change should the independent variables in the regressions change²⁾.

Table A.2 shows the reduced form regression of one transition probability; that going from never evading to evading. There are many possible candidates for variables that might influence transition probabilities. We must choose only the most likely candidates for inclusion in our equations because maximum likelihood is a technique whose appetite for data rises exponentially as we add parameters to be estimated. Demographic variables such as age and sex are standard proxies for a vector of individual characteristics. We also include a number of regional variables such as town size, and finally what the individual perceives to be the morality of evading and the probability of being caught, as well as whether his economic status is deteriorating. Table A.2 should be viewed as one that seeks the factors determining evasion. Prominent among the determinants is the change in the economic status of the individual (going from good to bad increased the tendency to evade taxes), an individual's experience of buying goods on which taxes have been evaded, and the perceived probability of being caught evading taxes.

What does Table A.2 tell us about the stability of the transition probabilities we use to forecast the evolution of evasion? As the population ages, we can

²⁾ Readers will wonder how new entrants to the labor force figure in our calculations. Our data give us no way of knowing who is a new entrant. If we assume that entry and exit from the labor force bear a stable relation to each other and that entry and exit from the labor force is uniformly distributed over evasion categories, we need not consider explicitly the rates of entry and exit from the labor force in our calculations of how tax evasion will evolve. Some indirect evidence in support of this conjecture comes from our survey, which shows that those who evade often and those who evade occasionally have statistically indistinguishable average incomes.

expect the transition probability of going from not evading to evading to fall. Space limitation preclude us from doing so, but it is a simple exercise to imagine different rates of increase in the number of elderly, plug them into Table A.3 and add or subtract the change in the transition probability to that transition probability we used in earlier forecasts of the evolution of tax evasion. Table A.3 also tells us that if the government can make people think their chances of being caught increase or that tax evasion is immoral then evasion will also fall. By themselves these findings are unremarkable, if respectable, additions to

empirical work on tax evasion, but in the context of forecasting evasion these findings give us a precise way of modifying Markov transition probabilities to hone our forecasts of the evolution of evasion.

A further step in predicting changes in Markov transition probabilities would be to estimate multinomial logits, which treat all four transition probabilities as simultaneously determined. Table A.3 presents as an example these estimates for three of the four transition probabilities (we need not estimate the fourth regression because the three, less one, by definition give us the fourth equation).

Table A.3: Logit Regression Results for P_{ne} (transition from never to a tax evasion stage) in the Czech Republic, Marginal Effects for Combined Surveys.

Variables	Derivative dP/dX going from never to a tax evading category	
	Long-term	Short-term
Demographics		
Age	-0.006*	-0.002**
Age squared	-4E-05	1E-05
Female	-0.035**	-0.013
Education		
Primary school education	0.060**	0.023
Apprenticeship (2 years)	0.032	0.005
Apprenticeship (3-4 years) w/t diploma	0.028	0.007
Secondary vocational w/t diploma	0.015	-0.002
Income		
< 10.000	0.014	0.032
10.001 to 15.000	0.039	0.034
15.001 to 20.000	0.023	0.035
20.001 to 25.000	0.064*	0.067
25.001 to 30.000	0.025	0.022**
Income relative to the past		
much worst compared to 5 years ago	0.071**	0.039
much better compared to 5 years ago	-0.036	-0.006
much better compared to a year ago	-0.001	0.004
Demographical dummies		
Big town	-0.021	0.003
Village	-0.009	-0.019
Prague	0.051**	-0.003
Middle Bohemia	0.004	0.004
Southern Bohemia	0.021	-0.008
Western Bohemia	0.047*	0.018
Northern Bohemia	0.024	0.007
Eastern Bohemia	0.041	0.032**
Southern Moravia	0.030**	0.012
Factors linked to tax evasion status		
bought goods from the underground economy	0.036**	0.005
Tax evasion is moral	0.006	-0.011
Tax evasion is very immoral	-0.028*	-0.017*
Probability of being caught	0.001**	-9E-05
Scaled R ² (2859 observations)	0.08	0.03

Note: Marks * and ** denote cases when underlying coefficients were significant on 5% and 1% significance level, respectively.