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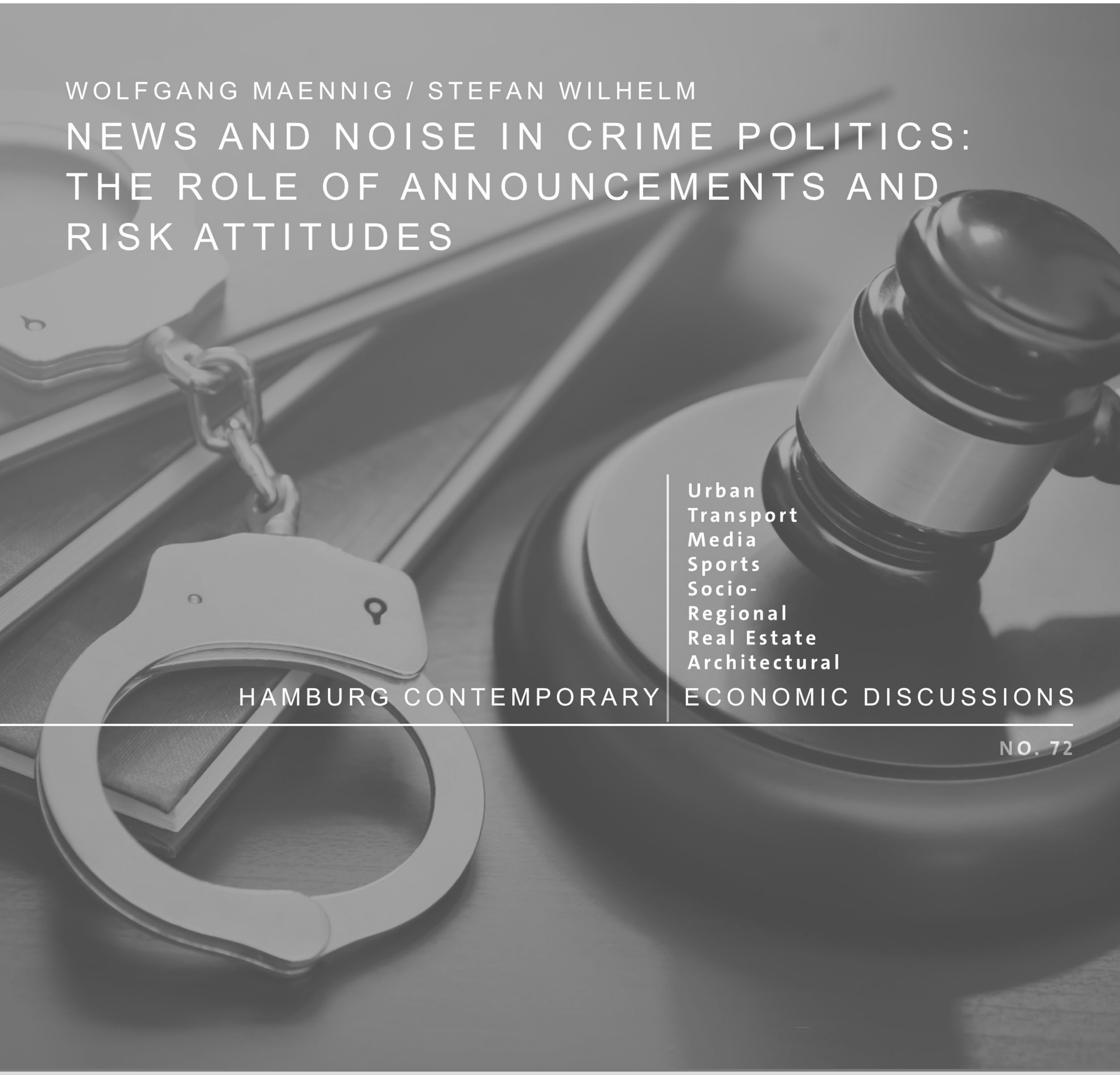

WOLFGANG MAENNIG / STEFAN WILHELM

# NEWS AND NOISE IN CRIME POLITICS: THE ROLE OF ANNOUNCEMENTS AND RISK ATTITUDES

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# News and Noise in Crime Politics:

# The Role of Announcements and Risk Attitudes

**Abstract:** We examine the short- and medium-term effects of announcements of changes in anti-crime policies in the distant future (news shocks) and provide a first extension of the analysis to cases where the announced policy changes may not be realized in the end (noise shocks). We further innovate by analyzing the effects of policy changes that increase the variance while holding the expected values of policy instruments constant. We confirm that news shocks can bring about immediate changes in delinquency. However, announcements of tighter anti-crime policies may even increase delinquent activities, at least temporarily. In the case of noise shocks, we observe persistent reactions of potential offenders, indicating that a credible communication strategy may generate an impact on crime politics. Finally, increasing the variance of policy instruments without changing the mean expected detection rate may have similar effects.

## 1. Introduction

In the US, the aggregate cost of crime amounts to $4.71-$5.78 trillion, of which crime-induced production (for example, expenditures on police protection or federal agencies) account for approximately 20% (Anderson 2021). These costs occur as resources used in crime-induced production could be employed more efficiently in a crime-free society. Therefore, exploring the forces that drive the decision toward criminal behavior and developing more cost-efficient measures in crime prevention may bring substantial economic benefits.

Becker (1968) models delinquent activities of potential offenders as a rational choice, identifying differing values of expected benefits and costs as sources of variance of delinquencies on an individual and societal basis. (Machin, Marie, and Vujić 2011; Deming 2011) point out the role of education, other socioeconomic determinants of delinquency include income inequality (Saridakis 2004), or social capital as defined by Sickles and Williams (2008). Various authors stress the role of institutions and their decisions on the size of penalties for convicted offenders and actions that alter the probability of detecting delinquent behavior (see Chalfin and McCrary [2017], for an overview).

While there is considerable evidence on the responsiveness of crime to higher sanctions or an increased detection probability, evidence on the communication of such measures is scarce. To the best of our knowledge, no such evidence is available, with the exception of Maennig and Schumann (2022), who find that an early announcement of measures to enhance detection or increase sanctions may lead to adjustment processes that may suppress illicit activities in advance. Thus, proficient communication strategies may enhance the efficiency of anti-crime policies.

We add to this discussion by allowing for different intertemporal elasticities of substitution for consumption, labor supply, and illicit activities, which differs from Maennig and Schumann (2022). In addition, we allow potential offenders to endogenously decide the extent of their engagement in criminal activities. We further complement the analysis by examining the reactions of potential offenders in a scenario where the announced policy is ultimately not implemented. The effect of such unfulfilled expectations – also referred to as noise shocks – has been examined in macroeconomics (Beaudry and Portier 2014; Blanchard, L'Huillier, and Lorenzoni 2013; Lorenzoni 2009) and finance (Bordalo et al. 2019; De Long et al. 1990; Black 1986); however, our paper is the first to analyze the phenomenon in a dynamic equilibrium model of crime prevention. An unsuccessful implementation of expected or announced policy measures may occur due to a lack of funding as well as missing political or legal approval.[1]

Our analysis accounts for the uncertainty that potential offenders face when forming expectations about detection rates. Officially published statistics, such as the clear-up

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[1] Most prominent are cases of a rejection of a law by a (supreme) court. In the United Kingdom, the Law Commission shall make recommendations for modifications of law; however, its suggestions are not always implemented.

rate (that is, the ratio of cases where the police must have identified at least one suspect divided by the number of crimes recorded by the police) may not always be relevant as survey studies exhibit substantial differences between such “actual” and perceived probabilities of arrest for a variety of delinquencies (see Apel [2013], for an overview). Furthermore, perceptions do not seem to be biased in a specific direction. Potential offenders may overestimate detection rates in some cases but also underestimate the chances of being arrested in others (Kleck et al. 2005). We incorporate this uncertainty by introducing the possibility that the detection rate may change unexpectedly, in addition to the anticipated preannounced changes. By using higher-order solution techniques to our model, we ensure that potential offenders integrate the continuous uncertainty resulting from the potential surprise changes in their decision-making process.

The reactions to the underlying uncertainty depend substantially on the potential delinquents’ risk preferences. However, while some studies argue that the observed behavior of delinquents may only be explained by the assumption of risk-seeking preferences (Block and Lind 1975; Polinsky and Shavell 1999), others develop alternative explanations that also allow for risk aversion among potential offenders (Mungan and Klick 2015; Pyne 2012). Therefore, we conduct our analysis using Epstein-Zin (1989) preferences that allow us to differentiate between risk-averse, risk-neutral, and risk-seeking behavior. The results imply that risk attitudes substantially determine the impact of anti-crime politics in an environment of uncertainty. Our paper is the first to explicitly derive the importance of risk attitudes in the communication of anti-crime politics when individuals have imperfect information about future detection rates.

After identifying uncertainty as a decisive factor in crime prevention, we develop the idea of Harel and Segal (1999) that policy makers may exploit the effects of uncertainty as a policy tool. To date, research has concentrated on how altering the perception of detection probabilities may influence criminal behavior (Abramovaite et al. 2022; Mourtgos and Adams 2020). We innovate by accounting for the possible effects of changes in the detection variance with a constant mean detection rate. The impacts of such mean preserving spreads, also referred to as stochastic volatility shocks, on agents' behavior have been analyzed in risk-sensitive macroeconomic contexts by Bachmann, Elstner, and Sims (2013), Basu and Bundick (2017) and Fernández-Villaverde et al. (2015) but to our knowledge, no analysis exists in the case of crime and crime prevention.

Our results suggest that the efficiency of communicating policy measures in crime prevention crucially depends on delinquents' risk preferences. Whereas more distinct risk aversion may enhance the effects in the implementation period (namely, the period after the announcement until the implementation of a policy), risk-seeking may mitigate the impact and even lead to increased criminal activities until the policy is implemented. Furthermore, we show that different adjustment processes of risk-averse and risk-seeking delinquents become particularly important if the announcements may not be implemented in the end: Risk-seeking delinquents may persistently increase criminal activities after they realize that a preannounced policy is ultimately not implemented. In addition, we show that increasing uncertainty about future detection rates among potential offenders may only be sensible in the case of risk-averse individuals. A high uncertainty about detection rates among risk-seeking delinquents may even enlarge engagement in criminal activities, as it may be perceived as a sign of potentially low detection probabilities.

The remainder of this paper is structured as follows. Sections 2 and 3 describe the main features of our model and discuss the underlying calibration. Section 4 presents the results of the various shocks that we impose. The implications of our results and concluding remarks are discussed in Section 5.

## 2. Model

We analyze the effects of announcing future changes in anti-crime politics by adapting the news shock model of Maennig and Schumann (2022), who apply a dynamic stochastic general equilibrium (DSGE) model in the sense of Kydland and Prescott (1982) and King, Plosser, and Rebelo (1988). In addition to our focal innovation that we account for noise in the implementation of the news shocks (that is, the announcements may not be realized), we innovate by allowing potential offenders to endogenously determine their involvement in criminal activities. In the sense of optimal time allocation (Gronau 1977), they must decide how to allocate their resources between ordinary working time and illicit activities. We focus on one of the policy measures discussed by Maennig and Schumann (2022): Policy makers may affect the decision of potential criminals by altering the detection rate and its variance.

### *2.1. The Production Process*

Potential offenders may generate income from two different sectors: 1) wages and capital earnings from the legal production sector or 2) income from illicit activities. Their time endowment is fixed and normalized to unity, similar to the model of Busato and Chiarini (2004):

$$\overline{N} = n_{p,t} + n_{c,t}. \tag{1}$$

Here, $n_{p,t}$ is the time spent in the legal production process, and $n_{c,t}$ is the time used for illicit activities. Thus, we can also express time spent in illicit activities as $(1 - n_{p,t})$. Concerning the legal production process, firms act under perfect competition and produce the consumption good using the labor $n_{p,t}$ and capital $k_t$ supplied by the households. The inputs are transformed according to a Cobb-Douglas production function:

$$y_{p,t} = k_t^{\alpha} n_{p,t}^{1-\alpha}. \tag{2}$$

The parameter $\alpha$ captures the output elasticities of labor and capital. As we assume perfect competition, firms do not retain any profits, so Equation (2) describes the aggregate income of delinquents from production.

In addition, spending time on illicit activities offers a second source of income:

$$y_{c,t} = a_t\left(1 - n_{p,t}\right). \tag{3}$$

In this context, $a_t$ describes the efficiency of illicit activities and crucially depends on the detection rate that can be influenced by the institutions responsible for crime politics. Note that we can use this rather simple production function for illicit activities without loss of generality. Alternatively, we can rewrite Equation (3) as $y_{c,t} = a_t(1-n_{p,t})^{1-\beta} k_{c,t}^{\beta}$. However, we can set $\beta$ to zero if legal production is more capital intensive (Lucas 1988; Uzawa 1965). Since we assume that illicit activities require only little capital, criminal production can be simplified to the expression in Equation (3).
In total, the delinquents' income sums up to:

$$y_{tot} = y_{p,t} + y_{c,t} = k_t^{\alpha} n_{p,t}^{1-\alpha} + a_t(1-n_{p,t}). \tag{4}$$

## *2.2. Delinquents' Behavior*

Potential offenders maximize their utility from lifetime consumption $c$ with respect to their budget constraint. Having derived the income of delinquents, we formulate the budget constraint:

$$n_{p,t}^{1-\alpha} s_t^{\alpha} + a_t(1-n_{p,t}) = c_t + k_{t+1} - (1-\delta)k_t \tag{5}$$

Potential offenders can decide to either consume their income or to invest in tomorrow's capital stock. Investment is the difference between the capital stock in the next period and the depreciated capital stock in the current period, with a depreciation given by the parameter $\delta$.

We assume that the intertemporal elasticities of substitution may differ between consumption, labor supply, and illicit activities, which differs from Maennig and Schumann (2022). This approach allows us to better account for empirical findings such as the high responsiveness of illicit activities to policy changes (Lemieux, Fortin, and Frechette 1994). Moreover, we employ recursive preferences as introduced by Epstein and Zin (1989), allowing us to analyze risk aversion separately from the intertemporal elasticity of substitution. The resulting lifetime utility function $V_t$ is given by:

$$V_t = V_{norm} U_t(c_t, n_{p,t}) + \beta E\left[V_{t+1}^{1-\xi}\right]^{\frac{1}{1-\xi}}. \tag{6}$$

More specifically, current utility is determined by:

$$U_t\left(c_t, n_{p,t}\right) = \frac{c_t^{1-\eta}}{1-\eta} - \theta \frac{{n_{p,t}}^{1+\chi}}{1+\chi}\left(1 - n_{p,t}\right) - \kappa \frac{\left(1 - n_{p,t}\right)^{1+\phi}}{1+\phi}. \tag{7}$$

The second term captures the delinquents' disutility from working, whereas the last term accounts for the additional losses in utility that potential offenders may experience due to social exclusion, guilt, or shame. We use the preference parameters $\eta$, $\chi$, and $\phi$ to calibrate the sensitivity of the individuals regarding consumption, working time, and illicit activities in response to the introduced shocks. In addition, $\theta$ and $\kappa$ control for the ratio between working time and illicit activities, $\beta$ is the discount factor, and $\xi$ measures delinquents' risk aversion. In the case of $\xi = 0$, Equation (6) collapses to the standard separable utility function. We normalize the value function to one by the parameter $V_{norm}$. By maximizing the potential delinquents´ lifetime utility with respect to the constraint expressed by Equation (5), we obtain the optimality conditions that describe the delinquents' behavior concerning the optimal allocation of time between working time and illicit activities:

$$\frac{\partial V_t}{\partial c_t} = c_t^{-\eta} = \lambda_t. \tag{8}$$

$$\frac{\partial V_t}{\partial n_{p,t}} = \theta n_{p,t}^{\chi}\left(1 - n_{p,t}\right) - \frac{\theta n_{p,t}^{1+\chi}}{1+\chi} - \kappa\left(1 - n_{p,t}\right)^{-\phi} = \lambda_t\left((1-\alpha) n_{p,t}^{-\alpha} k_t^{\alpha} - a_t\right) \tag{9}$$

In this context, $\lambda_t$ is the Lagrangian multiplier. The left side of Equation (9) describes the marginal disutility of potential offenders that results from a marginal increase in working time and a corresponding decrease in illicit activities. Similarly, the right side of Equation (9) shows the marginal utility gains in terms of consumption from such a shift in the time allocation. Individuals will adjust their criminal activities until real marginal earnings equal the marginal rate of substitution between consumption and leisure in both sectors.

Finally, the Euler equation describes the optimal choice of an individual between consumption today and tomorrow. A formal derivation of the Euler equation is provided in the appendix. Because of the Epstein-Zin (1989) preferences, potential offenders not only take into account the ratio of consumption in the current and future periods but also consider changes in the value function:

$$1 = \frac{\frac{\partial V_{t+1}}{\partial c_{t+1}}}{\frac{\partial V_t}{\partial c_t}} \left( \frac{V_{t+1}}{E\left[V_{t+1}^{1-\xi}\right]^{\frac{1}{1-\xi}}} \right)^{-\xi} \left(1 - \delta + \alpha n_{p,t}^{1-\alpha} s_t^{\alpha-1}\right). \tag{10}$$

## *2.3. The Institutions Responsible for Crime Policy*

The institutions responsible for crime policy can affect the efficiency of illegal activities by changing the detection rates $d_t$ now or by announcing changes in the future:

$$a_t = \Omega(1 - d_t). \tag{11}$$

We introduce the parameter Ω to normalize the efficiency to one in steady state. Furthermore, we model changes in the detection rate as an autoregressive process:

$$d_t = (1 - \rho_\pi)\pi + \rho_\pi d_{t-1} + \sigma_t^\pi \varepsilon_{t-k}^\pi + \sigma_t^\pi \epsilon_t^\pi. \tag{12}$$

The detection rate fluctuates around the π state and may increase due to improvements in technologies or check frequency. These temporary fluctuations are captured in the exogenous shock terms $\varepsilon_{t-k}^\pi$ and $\epsilon_t^\pi$. They adjust according to the persistency parameter $\rho_\pi$ before converging back to the initial value. In line with Maennig and Schumann (2022), potential offenders learn about policy measures introduced by the shock $\varepsilon_{t-k}^\pi$ $k$ periods in advance, which leaves them time to adjust their behavior. We extend the model by introducing a surprise shock $\epsilon_t^\pi$ to the analysis. Potential offenders cannot observe the timing and magnitude of the shock until its realization, causing permanent uncertainty about the detection rate in the next period. However, they perceive that the shock is normally distributed with a mean of zero and variance $\sigma_t^\pi$ and integrate this information into their decision process.

Introducing uncertainty into policy through the surprise shock has two advantages. First, it allows potentially differentiated responses to the announcement due to individuals' different risk preferences. Second, we exploit the structure of the shock process to extend the analysis by balancing the news shock with a negative surprise shock of equal magnitude at the time of implementation to produce a noise shock (namely, actions announced but ultimately not implemented [Beaudry and Portier 2014]). Such noise shocks can occur, for example, when crime-prevention practices are not legally permitted or when such measures are not funded.

In addition, we introduce a stochastic volatility shock as implemented by Fernández-Villaverde et al. (2011) or Basu and Bundick (2017) in the context of business cycles. As a result, the variance $\sigma_t^\pi$ of the temporary detection shock becomes time-variant in a way that policy makers can create a higher degree of uncertainty about temporary policies:

$$\sigma_t^\pi = (1-\rho_\pi)\overline{\sigma^\pi} + \rho_\pi \sigma_{t-1}^\pi + \varepsilon_{t-k}^\pi. \tag{13}$$

The total variance $\sigma_t^\pi$ depends on a permanent component $\overline{\sigma^\pi}$ and a temporary component $\varepsilon_{t-k}^\pi$. The temporary component $\varepsilon_{t-k}^\pi$ follows a standard normal distribution, as perceived by the potential delinquents. However, they do not have information on the timing or magnitude of the shock and can hence only rely on expectations in their decision process. A temporary variance shock increases the probability of larger shocks to the detection rate. As a result, potential offenders may want to insure themselves against such large shocks.

## 3. Calibration

To calibrate our model, we use empirical estimates derived from the literature. The calibration parameters are summarized in Table 1. For young men, estimates of the Frisch elasticity of labor are between 0.1 and 0.5 (Blundell, Pistaferri, and Saporta-Eksten 2016; French 2005; MaCurdy 1981). We assume that the working time of potential offenders is similarly inelastic and calibrate the parameter $\chi$ to 5, resulting in an elasticity of 0.2. Furthermore, we choose an intertemporal elasticity of substitution of 0.5 ($\eta$ = 2) as in (Fernández-Villaverde et al. 2015; Rudebusch and Swanson 2012). An increasing marginal disutility of crime precludes corner solutions where criminal activity is the only form of production in the economy; we use the scaling parameters $\theta$ and $\kappa$ to ensure that in steady state, potential offenders still spend most of their time on legal production.

Finally, we vary the coefficient of relative risk aversion $\xi$ throughout the analysis to compare behavior under different forms of risk-taking. Setting $\xi$ to zero leads to the standard case of separable utility. In this case, the Arrow-Pratt measure of risk aversion $-\frac{U_c''(c,n_a,n_p)}{U_c'(c,n_a,n_p)}$ of 1.25 suggests moderate risk aversion. Rudebusch and Swanson (2012) state that if $U(c, n_a, n_p) \geq 0$, as ensured by normalization, smaller values of $\xi$ correspond to lower degrees of risk aversion. Hence, we sequentially decrease $\xi$ throughout the analysis to approach risk-neutrality first and later risk-seeking behavior. We define an individual as risk neutral if it does not respond to changes in uncertainty. According to this definition, a risk aversion parameter $\xi$ of -5.9 corresponds to risk neutrality. Similarly, we increase $\xi$ to observe the reactions of more risk-averse delinquents.

Taking account of long-run US business cycle statistics, we set the capital share of income $\alpha = 0.31$ and the depreciation rate $\delta = 0.025$, which mirrors a yearly depreciation rate of ten percent. To generate a sensible capital to output ratio, we use a discount factor $\beta$ = 0.95. The comparatively low value is in line with the evidence on small discount rates of potential offenders (Davis 1988). Regarding the productivity of illicit activities, we use the parameter $\Omega$ to achieve a steady state value of one.

According to the Federal Bureau of Investigation (2019), clear-up rates range from 13.8-32.9 percent depending on the type of crime; thus, we choose a steady state detection rate $\pi$ = 0.2. The detection rate variance $\overline{\sigma^{\pi}}$ is set to 0.05, implying an uncertainty of potential offenders about future detection rates. In addition, we assume transitory shocks with a decreasing effect over time. Hence, we decide on a persistency parameter for the detection rate shock $\rho_{\pi}$ of 0.99, indicating that enforced detection strategies lose their effect from period to period as potential offenders may adopt new methods. In contrast, we choose a persistency parameter for the variance shock $\rho_{\sigma}$ = 1, suggesting that potential offenders cannot evade the policy even in the future. Thus, the institutions responsible for crime policies may permanently increase the variance of their policy measures.

**Table 1. Calibration**

| Parameters | | Value |
|---|---|---|
| $\beta$ | Discount factor | 0.95 |
| $\delta$ | Depreciation rate | 0.025 |
| $\alpha$ | Capital share of income | 0.31 |
| $\pi$ | Steady state detection rate | 0.2 |
| $\Omega$ | Productivity parameter | 1.25 |
| $\eta$ | Intertemporal elasticity of substitution (inverse) | 2 |
| $\chi$ | Preference parameter | 1 |
| $\Phi$ | Frisch elasticity (inverse) | 5 |
| $\xi$ | Risk-aversion | [-15; 10] |
| $\theta$ | Scaling parameter for labor/crime ratio | 20.22 |
| $\phi$ | Scaling parameter for labor/crime ratio | 2 |
| $\bar{N}$ | Total time endowment | 1 |
| $\rho_{\pi}$ | Persistence of detection rate shock | 0.99 |
| $\rho_{\sigma}$ | Persistence of variance shock | 1 |
| $\overline{\sigma^{\pi}}$ | Steady state variance | 0.05 |

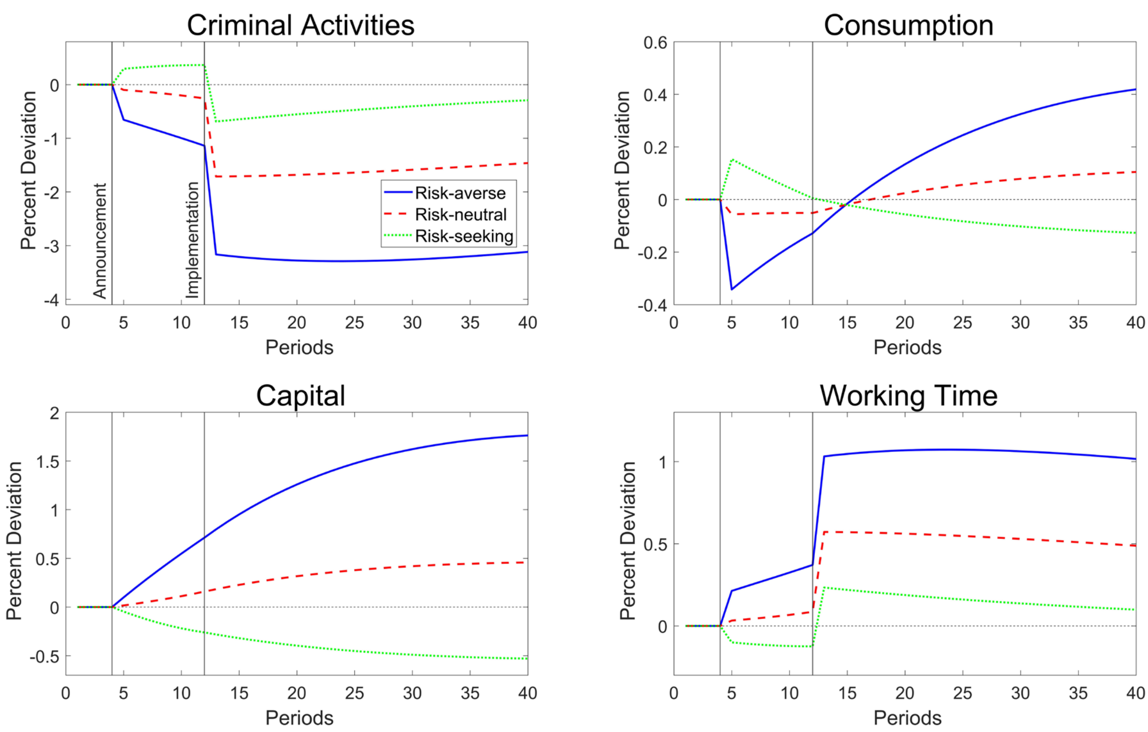
## 4. Results

We simulate delinquents' behavior in response to different policy measures. We impose a detection rate shock that policy makers announce eight periods in advance and that leads to an increase in the detection rate. We analyze the response of potential offenders if the policy is unexpectedly not realized. Finally, we explore the effect of announced stochastic volatility shocks that cause a mean preserving spread in delinquents' expectations about potential changes in the detection rate. We control for the risk aversion of potential offenders and find substantial differences in the responses to the stochastic volatility shock between risk-averse and risk-seeking delinquents.

### *4.1. The Impact of News Shocks*

Increasing the detection rate affects the efficiency of illicit activities, as indicated by Equation (11). This could result from potential sanctions in the case of apprehension or because of opportunity costs that occur in the case of unsuccessful illicit activities.

**Figure 1. Impulse response functions to a 1.5% increase in the detection rate that is announced in period 4 and implemented in period 12**




Hence, criminal activities decrease when the detection rate rises, independent of risk attitudes. The idea of news shocks in crime prevention suggests that policy makers may exploit the positive effect of an increased detection rate by announcing measures in advance. If potential offenders react to this information during the implementation period, providing them information about future measures may then be a cost-efficient tool to reduce criminal activity without concrete actions. Therefore, we integrate this idea by introducing a 1.5 percent increase in the detection rate eight periods in advance. As Figure 1 shows, potential offenders react to the announcement already in the implementation period. However, the effects differ substantially depending on the risk attitudes of potential offenders.

The response of risk-neutral individuals will serve as a baseline scenario to better understand why the behavior of risk-seeking and risk-averse offenders may deviate. The risk-neutral delinquents respond immediately after the measure has been announced. However, their reactions appear comparatively small in relation to the responses of their risk-seeking or risk-averse counterparts. As they anticipate that the efficiency of illicit activities and the illicit income will decline when the policy is implemented, they use the implementation period to mitigate the effect of the policy on their level of consumption and will spend more time working in the legal production sector. The additional wage income cannot completely compensate for the income loss from criminal activities; therefore, consumption will fall as a result of an increased detection rate. Potential offenders can mitigate the decline in consumption by accumulating capital in the implementation period. To increase the capital stock, they must forgo consumption in the implementation period to finance the investment. In return, they will be able to expand consumption in the future even though the detection rate rises. Due to the positive interdependencies of the higher capital stock, the time reallocation to the production sector can overcompensate for the income loss resulting from the decline in the efficiency of illicit activities in the long run. Even though the detection has not yet changed, criminal activities already decline in the implementation period, indicating a positive effect of announcing policies in advance.

The effects are noticeably enlarged if we assume that potential offenders are risk-averse. During the implementation period, they sharply reduce their involvement in criminal activities and spend their time working in the production sector. Risk aversion amplifies the effects by altering the Euler equation that determines the decision between consumption in the current and in future periods. The Euler equation is given by Equation (10) in Section 2.2 and is the only equation where the coefficient of risk-aversion $\xi$ enters. Exploiting that $\left(1-\delta+\alpha n_{p,t}^{1-\alpha} s_t^{\alpha-1}\right)$ is the return of one unit of forgone consumption that is used to increase the capital stock, we can derive the stochastic discount factor $\Lambda_{t,t+1}$ of individuals:

$$\Lambda_{t,t+1} = \left(\frac{c_{t+1}}{c_t}\right)^{-\eta} \left(\frac{V_{t+1}}{E\left[V_{t+1}^{1-\xi}\right]^{\frac{1}{1-\xi}}}\right)^{-\xi}. \tag{14}$$

When $\xi = 0$, the second multiplicand cancels, and the stochastic discount factor collapses to the case of standard separable utility. Then, an expected decline in future consumption increases the stochastic discount factor, and individuals gain a higher valuation of future consumption. They start to increase the capital stock and shift current consumption to the future.

Note that there is a linear relationship between the coefficient of risk aversion and the impact of a detection rate shock on the stochastic discount factor. A negative coefficient indicates more risk-averse behavior, whereas positive values of $\xi$ imply more risk taking. Increasing the coefficient of risk aversion by one unit leads to a 0.03% decline in the stochastic discount factor.[2]

The stochastic discount factor of risk-averse delinquents thus rises more substantially in response to the shock than in the baseline scenario of risk-neutral individuals: they have an even stronger desire to compensate for the future consumption loss resulting from the detection rate shock by cutting consumption today and investing in the capital stock. The upper right panel and the lower left panel of Figure 1 display this development. Consumption in the implementation period falls more strongly, but the capital stock also increases more substantially. Again, the higher capital stock encourages potential offenders to reduce their time in criminal activities and to work in the production sector as the marginal income from work increases (Equation 9). In addition, the higher capital stock further amplifies the impact of the detection rate shock as delinquents become less reluctant to reallocate their time to the production sector if the efficiency of criminal

[2] Although the effect may seem negligible, the observed change in the stochastic discount factor may lead to significant adjustment processes to generate a new equilibrium. Here, we only observe the direct impact of the shock without accounting for interdependencies between variables. Note also that we set $\xi$ to -22.5 for risk-seeking individuals, implying a change of 0.77%.

activities falls. In the case of risk-averse individuals, news shocks are an even more cost-effective tool than in the case of risk-neutral individuals. Risk-averse individuals benefit since in the long run, consumption rises as production capacities increase due to a higher capital stock.

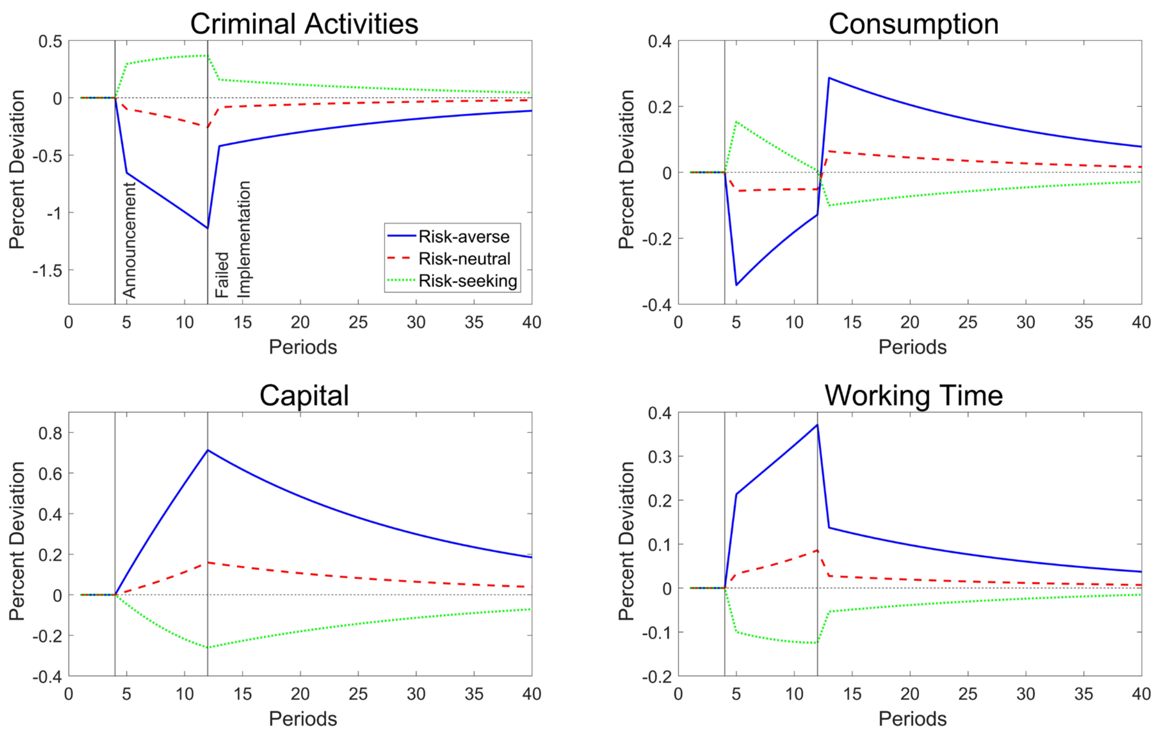
In contrast, if potential offenders tend to risk-seeking behavior, then the detection rate shock may decrease the stochastic discount factor, and individuals will cut investments to substitute future against current consumption. Thus, the capital stock declines. Criminal activities increase during this period as working in legal production becomes less attractive due to reduced capital. Risk-seeking potential delinquents seek to exploit the conditions in the implementation period. At the time of implementation, time is reallocated to the production sector as the efficiency of criminal activities declines. However, the adjustment is less significant than in the previous scenarios due to the lower capital stock.

As a policy implication, the effectiveness of news shocks in crime prevention hinges crucially on the risk attitudes of potential offenders. If risk-seeking may be prevalent among offenders, then immediate changes in the detection rate may be more promising in crime prevention than news shocks. Conversely, if potential offenders behave risk-averse then an early announcement of future policy changes may lead to immediate reductions in criminal activities. Overall, policy makers face a tradeoff when announcing policies in advance if they cannot rule out the possibility that at least some potential offenders behave risk-seeking.

### *4.2. The Impact of Noise Shocks*

Considering the substantial effects that risk-averse individuals exhibit in response to the announcement of an increased detection rate, the question arises whether a subsequent implementation is necessary to generate an impact in crime prevention. In the following, we will analyze the effect of a noise shock – a preannounced policy that is ultimately not implemented. Technically, we simulate such a scenario by imposing a surprise shock at the date of implementation that completely offsets the impact of the announced measure (Beaudry and Portier 2014), ensuring that potential offenders do not anticipate the failed implementation. Because potential offenders do not expect the implementation to fail, they behave as if the policy is realized during the implementation period, as shown in Figure 2.

**Figure 2. Impulse response functions to a noise shock**




The effects in the implementation period exactly resemble the behavior that has been discussed in Section 4.1. While risk-averse and risk-neutral individuals accumulate capital to sustain a similar level of consumption in the future, risk-seeking delinquents prefer to increase consumption as long as the detection rate still remains at its initial level.

As a result of the adjustment process during the implementation period, risk-averse and risk-neutral delinquents face a higher capital stock when they realize that the policy is not implemented. When they realize that the detection rate remains unchanged, potential offenders become aware of their overaccumulation of capital and immediately start to reduce the capital stock by cutting investments and expanding consumption.

The process is accompanied by a sharp increase in criminal activities and a corresponding decline in working time. In general, the failed implementation works like a negative shock of the perceived detection rate that increases the efficiency of criminal activities.

Nevertheless, criminal activities do not instantly return to their initial level. After the sharp reaction at the date of failed implementation, delinquents only gradually adjust their behavior as they wish to smoothen the additional consumption over time. Capital converges only gradually back to the initial steady state (lower left panel of Figure 2). This behavior is desirable from the point of crime prevention. While the level of capital remains above the initial level, potential offenders can spend their time more efficiently working in the production sector than

engaging in criminal activities. For risk-averse and risk-neutral delinquents, the noise shock may persistently reduce criminal activities due to reallocation effects in the implementation period.

The intermediate results that suggest that announced policy measures must not be implemented to have an impact on crime prevention suffer from two caveats. First, noise shocks do not have such welcome effects in the case of risk-seeking delinquents. As described in Section 4.1, risk-seeking delinquents increase consumption in the implementation period and only reduce their criminal activities after the policy is implemented. When they realize that the detection rate does not change, they wish to return to the former optimal allocation in steady state. However, they do not instantaneously adjust their capital stock, which would require a substantial waiver of consumption. Thus, they increase investment only gradually, leading to sluggish adjustment of the capital stock. In contrast to the case of risk neutral or risk-averse individuals, risk-seeking individuals engage more intensively in criminal activities since the marginal product of working in the production sector is decreasing.

In summary, the results imply that policymakers should only use empty threats with caution in crime prevention. In the case of risk-averse and risk-neutral offenders, an announcement of policy changes may not necessarily require an action in the implementation period to have a positive impact on crime prevention. The reallocation effects during the implementation period exhibit a large persistency that reduces criminal activities even after delinquents realized that the implementation failed. Intentionally misleading announcements may then prove to be a cost-efficient tool in crime prevention. However, if the responsible institutions lose credibility, then potentially delinquent individuals may anticipate empty threats, leading to less substantial effects. In the extreme case, potential offenders would not respond to the announcement at all. Moreover, if at least some potential offenders are risk-seeking, then the noise shock may even increase criminal activities.

### *4.3. The Impact of a Stochastic Volatility Shock*

The previous results indicate that policy makers must not necessarily implement concrete actions to generate an impact on crime prevention. Similar to noise shocks, increasing uncertainty may turn out to be another cost-efficient strategy in crime prevention that solely requires proficient communication. Thus, it may be worthwhile to explore whether policy makers may exploit the impact of increased uncertainty to reduce criminal activities.

We examine the impact of uncertainty by introducing shocks that alter the variance of the detection rate shock but leave the expected detection rate unchanged. As is common in DSGE models, potential offenders form expectations about future detection rate shocks based on the distribution of these shocks. We assume that the shocks are normally distributed around a constant mean and with variance $\sigma_t$. As indicated by the subindex $t$, we allow the variance to be time varying. Consequently, the stochastic volatility shock performs a mean preserving spread to the distribution of the detection rate shock that the delinquents consider in their decision-making. The probability of larger shocks increases, leading to higher uncertainty for potential offenders about the detection rate. Notably, we raise the probability of larger deviations in the detection rate without actually altering the detection rate level. The observed effects are caused merely by perceived changes in variance.

**Figure 3. Impulse response functions to a 1% shock to the detection rate variance announced in period 4 that is implemented in period 12**

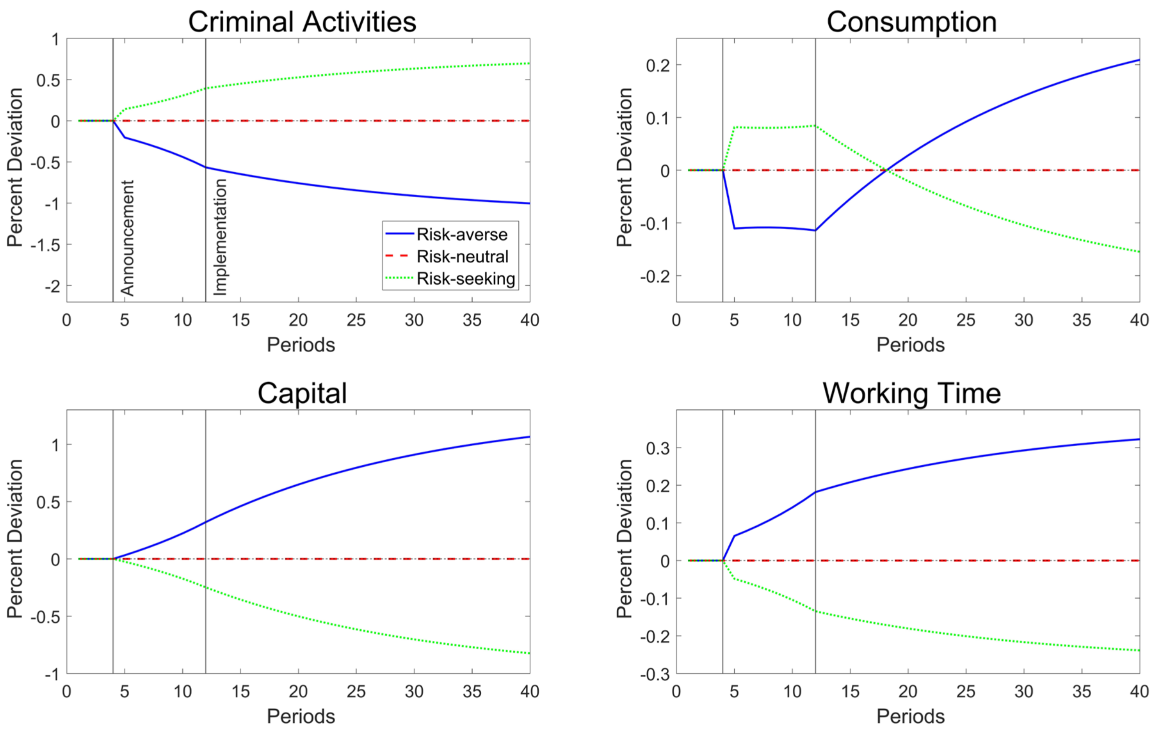



Figure 3 displays the impulse response functions to the policy measure. For consistency, we announce the stochastic volatility shock in period 4 (first gray line), allowing us to observe anticipation effects like that of the news shock. Then, in period 12 (second gray line), the variance of policy changes increases permanently by 1%.

Not surprisingly, risk-neutral delinquents do not respond to an increase in uncertainty. Since they only consider the mean of future shocks when forming expectations, they will not adjust their behavior when the variance increases. Even though we use higher solution methods, the risk-neutral delinquents behave as if under certainty equivalence.[3] As long as the mean detection rate remains unaltered, increasing uncertainty does not affect risk-neutral delinquents.

Increasing uncertainty in anticrime policies may not serve as a policy tool in crime prevention in such a case.

However, increasing the risk of larger future changes in the detection rate may suppress criminal activities among risk-averse individuals. Starting at the time of the announcement, the stochastic volatility shock forces risk-averse delinquents to cut criminal activities to ensure a smoothed level of consumption. Potential offenders diminish the risk of a rising detection rate by reallocating time to the production sector, as income in this sector is not affected by the detection rate. Thus, they may reduce potential deviations in their level of consumption by increasing their income share from the production sector. In addition, this time reallocation incentives investments as the marginal product of capital rises. Temporarily, consumption is cut to afford these investments, but risk-averse potential offenders benefit in the long run from the expanded production.

Importantly, preventing potential offenders from perceiving correct future detection rates may turn out to be even harmful in terms of crime prevention when dealing with risk-seeking delinquents. Due to symmetry, increasing uncertainty also increases the expected probability of decreasing detection rates. Whereas risk-averse delinquents are more concerned about the possibility of higher detection rates, risk-seeking individuals consider the enhanced uncertainty as an increased chance of lower future detection rates. Consequently, they start to increase consumption in the current period while accepting that this behavior will cause a decline in the capital stock due to less investment. This will lead to less consumption in the long run. However, risk-seeking delinquents accept the anticipated decline in consumption as they hope for a future

[3] Under certainty equivalence, first order solutions of a stochastic model are identical to the solution of the same model under perfect foresight. We use a third order perturbation method when solving our model to account for the effects of uncertainty and precautionary behavior. For further details, see Fernández-Villaverde et al. (2016).

shock to the detection rate that will increase the efficiency of criminal activities and, thus, raise their income and consumption.

Our results suggest that differing risk attitudes of potential delinquents hinder a news shock policy that announces a larger variance of detection rates to unambiguously support crime prevention. Risk-averse delinquents may be more concerned about the possibility of upward changes in the detection rate, even though they assume changes to be normally distributed. In contrast, uncertainty about future detection rates may lead to a bias of decreasing detection rates in the case of risk-seeking potential offenders. The impact of uncertainty as a policy tool in crime prevention may crucially depend on the share of risk-seeking individuals among potential offenders if we assume that risk preferences differ between individuals.

## 5. Summary

Our results identify risk preferences as an important determinant of the efficiency of crime-prevention politics if we account for uncertainty in delinquents' perceptions about future detection rates. In general, our findings support the conclusions of Maennig and Schumann (2022) that the announcement of future changes in the detection rate may cause immediate changes in the behavior of potential delinquents. By including endogenous decisions about the intensity of criminal activities, we additionally show that the adjustment dynamics in the implementation period, which depend on delinquents' risk attitudes, substantially influence the amount of time that potential offenders spend in criminal activities.

Preannouncing future changes in the detection rate may not be beneficial in the case of risk-seeking delinquents, as they will increase criminal activities during the implementation period to exploit the initial conditions before the detection rate rises. Furthermore, the announcement not only leads to adverse effects among risk-seeking delinquents in the implementation period but also undermines the effect of the policy at the time of implementation due to the preceding reallocation effects.

Our work demonstrates that the described effects among risk-seeking delinquents may become particularly harmful when policy makers are not able to implement the announced policy. Individuals will only gradually adjust their behavior toward the initial steady state, causing the rise in criminal activities to persist after potential offenders realize that the detection rate remains unchanged. Reducing criminal activities by imposing empty threats may only work in the case of risk-averse and risk-neutral individuals and only if they do not anticipate in advance that policy makers will ultimately not be able to implement the policy.

Finally, we contribute to the literature on crime prevention by testing the hypothesis that increased uncertainty in future detection rates may support crime prevention in our model. As before, the results suggest an ambiguity of the effects that depends on the risk preferences of the potential delinquents. The results shed new light on the findings of Baker, Harel, and Kugler (2003) and DeAngelo and Charness (2012), implying that policy makers should increase the predictability of future detection rates when potential offenders are risk-seeking. Note that a policy of announcing a larger variance of detection rates may well reduce criminal activities of risk-averse delinquents.

Overall, our results suggest that policy makers may face increasing criminality when implementing policies to increase detection rates in an environment where they are not able to observe the risk attitudes of potential offenders. To date, there is no consensus on whether potential offenders tend to behave in a risk-averse or risk-seeking manner (Block and Lind 1975; Polinsky and Shavell 1999; Mungan and Klick 2015; Pyne 2012).

A similar argument applies in the case of noise shocks as well as stochastic volatility shocks, leading us to the conclusion that the determinacy of risk attitudes of potential offenders remains an important future field of research. Without further evidence on delinquents' risk attitudes, crime prevention politics may be restrained by the ambiguity of its outcome to prevent undesirable effects.

We acknowledge potential limitations in our analysis. We assume the detection rate to be exogenous, but increasing detection rates may require more resources and financial funds. Additional funding may involve additional taxation of the production sector, which may mitigate the incentives to turn away from criminal activities (Busato and Chiarini 2004).

Furthermore, we assume that an increased detection rate reduces the efficiency of criminal activities without specifying the consequences that follow from conviction. Whether the loss in efficiency results from expectations of impending financial sanctions, the incapacity to generate income while imprisoned, or simply from the damage in social status may affect the response of potential offenders further.

Our model may serve as a basis for further extensions. The substantial differences in reactions between potential offenders with different risk attitudes may lead to interaction effects. When risk-averse delinquents cut criminal activities, the incentives for risk-seeking individuals to engage more intensively in illicit activities may rise. A heterogeneous agent version of our model may address such hypotheses. Finally, our model may also be used to estimate the parameter of risk attitudes that matches the observed data.

## Appendix A: Derivation of the Euler Equation and the Delinquents' Optimality Conditions

We derive the Euler equation and the optimality conditions of delinquents using a Lagrangian with respect to Equations (1), (5) and (6):

$$\begin{aligned}\mathcal{L} = V_0 + \sum_{t=0}^{\infty} \omega_t &\left\{ \begin{array}{c} \frac{c_t^{1-\eta}}{1-\eta} - \theta \frac{n_{p,t}{}^{1+\chi}}{1+\chi}\left(1-n_{p,t}\right) - \kappa \frac{(1-n_{p,t})^{1+\phi}}{1+\phi} \\ +\beta^t E_t \left[V_{t+1}^{1-\xi}\right]^{\frac{1}{1-\xi}} - V_t \end{array} \right\} \\ &+ \sum_{t=0}^{\infty} \beta^t \lambda_t \left[n_{p,t}^{1-\alpha} s_t^{\alpha} + a_t\left(1-n_{p,t}\right) - c_t - k_{t+1} + (1-\delta)k_t\right] \\ &+ \sum_{t=0}^{\infty} \beta^t \mu_t \left[\overline{N} - n_{d,t} - n_{p,t}\right]. \end{aligned} \tag{A1}$$

Taking the derivatives with respect to $n_{p,t}$, $c_t$, $V_t$ and $k_{t+1}$ yields:

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial n_{p,t}} = \omega_t &\left( -\theta n_{p,t}^{\chi}\left(1-n_{p,t}\right) + \frac{\theta n_{p,t}^{1+\chi}}{1+\chi} + \kappa\left(1-n_{p,t}\right)^{-\phi} \right) \\ &+\lambda_t \left((1-\alpha) n_{p,t}^{-\alpha} k_t^{\alpha} - a_t\right). \end{aligned} \tag{A3}$$

$$\frac{\partial \mathcal{L}}{\partial c_t} = \omega_t c_t^{-\eta} - \lambda_t. \tag{A4}$$

$$\frac{\partial \mathcal{L}}{\partial V_t} = \omega_{t-1} \beta^{-1} E_{t-1} \left[V_t^{1-\xi}\right]^{\frac{1}{1-\xi}-1} V_t^{-\xi} - \omega_t. \tag{A5}$$

$$\frac{\partial \mathcal{L}}{\partial k_{t+1}} = -\lambda_t + \beta \lambda_{t+1} \left(\alpha n_{p,t+1}^{1-\alpha} k_{t+1}^{\alpha-1} + (1-\delta_S)\right). \tag{A6}$$

All equations must be set to equal zero. Combining Equations (A2) and (A3) to cancel out $\lambda_t$ yields:

$$\omega_t \left( -\theta n_{p,t}^{\chi}\left(1-n_{p,t}\right) + \frac{\theta n_{p,t}^{1+\chi}}{1+\chi} + \kappa\left(1-n_{p,t}\right)^{-\phi} \right) = \omega_t c_t^{-\eta} \left((1-\alpha) n_{p,t}^{-\alpha} k_t^{\alpha} - a_t\right). \tag{A7}$$

The multiplier $\omega_t$ can be canceled and therefore does not appear in Equations (8) and (9). From Equation (A5), we obtain:

$$\frac{\omega_t}{\omega_{t-1}} = \beta^{-1}\left(\frac{V_t}{E_{t-1}\left[V_t^{1-\xi}\right]^{\frac{1}{1-\xi}}}\right)^{-\xi}. \tag{A8}$$

After iterating one period forward, we can insert Equation (A8) and Equation (A4) into Equation (A6) to obtain Equation (10) in the main text.

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