The stabilization role of police spending in a neo-Keynesian economy with credit market imperfections

Pengfei Jia* and King Yoong Lim**

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Abstract

Motivated by a seemingly persistent 'twin-high' phenomenon in Latin America, we present a novel theoretical framework that has linkages between three institutions (education, criminal justice, and credit) to study policy-pertinent research questions with regards to whether police spending has the potential to serve as an unconventional policy tool for macroeconomic management. Based on a stylized parameterization, we find formal and illegal human capital to share common cyclical properties, which can be "decoupled" under a rule-based regime to police spending. This nonetheless comes at a cost of a greater propagation of the credit friction-induced financial accelerator effect.

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*Jia: School of Economics, Nanjing University, China; **Lim: Nottingham Business School, Notttingham Trent University. We would like to acknowledge the helpful comments and feedback from two anonymous reviewers, and our respective colleagues. All views expressed in the article are our own.

1 Introduction

Since the contributions of Becker (1968) and Ehrlich (1973), a branch of the economic literature on crime has developed, where macroeconomists attempt to study the dynamics and macroeconomic implications of crime. In a long-run context, a negative crime-growth relationship has largely been established (see, for instance, Imrohoroglu et al., 2004, 2006; Goulas and Zervoyianni, 2015), with attempts having been made to link crime to the different aspects of agents' decisions and society, which include, non-exhaustively, child-rearing time (Neanidis and Papadopoulou, 2013), job-search and labor market institutions (Engelhardt et al., 2008), inequality (Kelly, 2000; Burdett et al., 2003), and human capital investment choice (Mocan et al., 2005). Nevertheless, macroeconomists have thus far short of examining crime in a shorter term, macroeconomic stabilization context, due to the policy linkages between education, criminal justice system, and financial/credit, being often overlooked by macroeconomists.

This oversight is epitomized by the theoretical treatment of the fiscal variable, *government expenditure on public order & safety* (commonly dubbed—slightly inaccurately—as *police spending* in short, despite the specific fiscal component covering budgets to both criminal justice and judiciary/legal branches of the government institutions), which is merely treated as one of the many components that constitute government expenditure. As such, the common (mis)perception is that, there is no policy value in this variable in terms of it being employed as a policy tool in macroeconomic management. While this is true in most economies where crime is insignificant, an argument can be made that this specific fiscal variable has a potential role to serve as an unconventional policy tool (that complements/supplements conventional policy tools for macroeconomic stabilization, i.e. monetary policy) beyond the common-sense prescription of high level of spending to reduce crime. This is especially intriguing in economies where: (i) organized crime is persistent and criminal activities are a significant part of an individual's income-earning opportunities, à la Mocan et al. (2005); (ii) robust empirical links between business cycle fluctuations and crime are well-established (see, for instance, Arvanites and Defina, 2006; Bushway et al., 2012; Detotto and Otranto, 2012; de Blasio et al., 2016).

This paper contributes to the literature by presenting a novel theoretical framework that has linkages between the institutions: education, criminal justice, and credit. Motivated by a seemingly persistent '*twin-high*' phenomenon observed in Latin America (high crime rate, high financial instability), we develop a model based on a Mocan et al. (2005) style framework with differentiated human capital and criminal activities, interacting with a production sector in which the firms face credit frictions.[1] We highlight three novel linkages in our model that relate crime to credit market: (i) organized criminal extortions impose an additional "tax" onto the unit marginal production costs of firms, which then influences their optimal choice of the level of physical capital and workers employed. Given that firms borrow to pay their wage costs (Ravenna and Walsh, 2006), crime therefore directly influences the demand for credit; (ii) the physical capital stock of firms is used as collateral for loan; crime therefore also influences the component of credit risk premium that depends on the collateral; (iii) in setting its credit risk premium for the gross loan rate, on top of collateral charged, bank also accounts for the aggregate level of crime rate in the economy. Indeed, these model features are consistent with evidence in the Latin American region,[2,3] which as seen in Figure 1, has a

[1] In an economy where criminal activities are a significant part of an individual's income-earning opportunities, this creates a direct trade-off of time between engaging in formal market works and crime. This then has an effect on individuals' choice in pursuing formal human capital accumulation/education. Given that expenditure on public order and safety directly influences crime, this means there is an obvious linkage between formal education and this policy variable that covers both the criminal justice and judiciary/legal functions of a government institution in practice.

[2] For instance, the material costs of crime are estimated to add up to about 3.6 percent of GDP for Latin America (Londoño and Guerrero, 2000; Jaitman and Torre, 2017). Crime is said to consistently undermine business activities and therefore disincentivize human capital accumulation (Ayres, 1998). For the latter, Londoño and Guerrero (2000) estimate that the net accumulation of human capital in Latin America is half of what it ought to be due to the prevalence of crime. For further examples on organized crime in Latin America, see also, Aravena and Solís (2009), UNODC (2012), and Oguzoglu and Ranasinghe (2017).

[3] Notwithstanding the multiple episodes of financial crises seen in Latin America during the 1990s, in terms of the feature on overall high crime rate-induced business uncertainty leading to higher credit risk premium being priced in the region, a conjecture can be made by examining the data on non-performing loans (NPL) net of (loan loss) provisions to bank capital. Despite the region has a generally stable overall NPL rate, the average NPL net of (loan loss) provision in the region is negative. Specifically, between 2006 and 2018, thirteen of the non-British Caribbean Latin American economies have a negative value for the indicator (for comparison, the world average is 16.71). This implies that banks in the region make over-provision for potential loan losses.

relatively low level of government expenditure on public safety and a small number of police personnel to begin with.

In addition to the theoretical contributions, the model also sets the stage for us to study three policy-pertinent research questions, especially in regards to whether government expenditure on public order and safety (police spending, in short) has the potential to serve as an unconventional policy tool for macroeconomic stabilization in a 'twin-high' economy. These questions necessarily requires us to understand the cyclical properties of the key variables in our model, as well as how they respond to stochastic shocks. Our policy experiments are therefore structured according to the following questions: (i) "*Do formal and criminal-specific human capital share a common or counteracting cyclical properties, in response to economic shocks?"; (ii) "Does police spending—be it rule-based or discretionary—have a potential role as an unconventional tool in macroeconomic stabilization?*"; (iii) "*If so, how does it measure, compared to monetary policy?*" To assess police spending's performance in macroeconomic stabilization, we follow Agénor and Alper (2012) and examine the credit cost channel-induced financial accelerator phenomenon (where the existence of credit market resulting in the amplification of the negative effects, which monetary policy is essential in stabilizing). We focus on the characteristics of the transitional dynamics of key variables, as well as the time it takes for them to return to their respective initial steady states.[4]

Based on our analysis, the accumulation processes of formal and illegal human capital are found to share a common cyclical properties, hence contributing to the persistence in crime rate in Latin America. In order for formal education to achieve its desired role in

[4]Note that there are generally **two** main approaches in neo-Keynesian models to go about modelling the financial accelerator arising due to credit market imperfections. First, the more fashionable approach is in the tradition of Bernanke and Gertler (1989) and Bernanke et al. (1999), which model agency costs–which arise endogenously–as the main source of credit market frictions. The financial accelerator operates essentially through the cost of investment in physical capital. On the other hand, a second approach is based on collateral constraints first introduced by Kiyotaki and Moore (1997). In these models, instead of operating through the investment channel, the financial accelerator mechanism operates through the credit cost channel, with firms generally posited as borrowing to pay their wage costs. Studies along these lines include Chowdhury et al. (2006), Hulsewig et al. (2009), Agénor and Alper (2012), Tayler and Zilberman (2016), and our model in this article.

reducing crime [as suggested in Pressman (2008) and Machin et al. (2012)], there appears to be a need for the adoption of a rule-based approach to police spending allocation. Such a policy regime consistently contributes to a "decoupling" of the common cyclical properties of the two types of human capital. This suggests that, in an economy with persistently high crime rate, a more systematic fiscal allocation to expenditure on public security/police may be warranted. Nevertheless, the use of a rule-based approach does come with the cost of it imparting a greater degree of inertia to the post-shock adjustments of key economic variables, hence potentially worsening the financial accelerator effects arising from credit market imperfections.

The rest of the paper is structured as follows. Section 2 presents the model. Section 3 defines and solves for its symmetric and steady-state equilibria. In Section 4, the model solutions are then log-linearized and parameterized to reflect a typical middle-income Latin American economy with the twin-high characteristics. Section 5 discusses the policy effects of the structural shocks introduced, especially on the role of police spending in macroeconomic stabilization. The findings and policy lessons drawn, together with future research directions, are synthesized to conclude the article in Section 6.

2 The Model

We consider a closed economy populated by a continuum of identical infinitely-lived individuals, indexed by $i \in (0,1)$. Individuals consume, hold monetary assets, make human and physical capital investments, and allocate their time, normalized to one, between leisure, market works ($N_{it} \in (0,1)$), and criminal activities ($\theta_{it} \in (0,1)$). In market works, individuals supply effective labor hours ($H_{it}^{Y} N_{it}$) to a continuum of monopolistically competitive intermediate goods (IG) firms, indexed by $q \in (0,1)$, which supply the composite of IG to a final good-producing firm. In line with the definition of Gaviria (2002) and Blackburn et al. (2017), criminal activities are modelled as quasi-organized crimes that impose an extortion cost on the production of IGs and therefore can be treated as a type of marginal cost to the firms. By investing and owning the physical capital stock, individuals rent it to the IG firms, which in turn use it as collateral for borrowing from a commercial bank. Each IG firm employs effective labor and physical capital, while incurring additional marginal cost due to crime, to produce a perishable good. Each individual i owns an IG firm and therefore receives all the profits make by that firm. For simplicity, we assume $N_{it}^{q} = \theta_{it}^{q} = 0$, which means individuals do not work or commit fraud on own firms. There is full flexibility to wages which adjust to clear the labor market. Individuals collectively own the commercial bank, which supplies credit at the prevailing loan rate to IG firms to finance their working capital needs. The bank also pays interest on individuals' deposits and the liquidity from a Central Bank. The Central Bank supplies liquidity to the bank and purchases government bonds (B_t^C), with the corresponding liabilities being the money supply (M_t^S) and required reserves (Ω_t). Monetary policy is operated by fixing the refinance rate (i_t^R) based on a reactionary Taylor-style (1993) policy rule, as in Liu (2006). The government purchases final good (G_t^O) and spend on public order and security (G_t^P), financed by taxing both wage and capital income at a constant rate, $\tau \in (0,1)$, and the issuance of riskless one-period bonds, held by individuals and the Central Bank. Similar to market works, it is the effective hours that count for criminal activities, which are dependent on crime-specific human capital (H_t^C), akin to a form of cultural capital. Each period, crime-specific human capital increases by an exogenous amount Λ, but can be reduced by the government's investment in maintaining public security (G_t^P).[5] The probability of an individual escaping apprehension after committing a crime is given exogenously by $\varkappa \in (0,1)$, in line with most macroeconomic studies on crime.[6] If caught, individuals' income is confiscated.

[5] While the analytical specification is mainly adopted from the differential human capital framework of Mocan et al. (2005), the 'deep-rooted' nature of crime-specific human capital modelled is in consistent with the Italian *Mafia* literature, such as Coniglio et al. (2010) and Caglayan et al. (2017). In addition, for the purposes of this article, police spending and expenditure on public order and security are used interchangeably.

[6] For examples, see Imrohoroğlu et al. (2004, 2006) and Neanidis and Papadopoulou (2013). An alternative specification is to provide the probability with an underlying distribution, and make it evolve according to transitional probabilities that are endogenous to G_t^P. We opt to treat G_t^P as a more general expenditure

2.1 Individuals

Individuals $i \in (0,1)$ derive utility from consumption (C_{it}), leisure, and a composite index of real monetary assets (real cash balances, m_{it}, and bank deposits, d_{it}). They maximize

$$V_t^i = E_t \sum_{s=0}^{\infty} \beta^s \left[\frac{(C_{it})^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} + \eta_N \ln(1 - N_{it} - \theta_{it}) + \eta_F \ln(m_{it}^{H\upsilon} d_{it}^{1-\upsilon}) \right], \qquad (1)$$

where $\beta \in (0,1)$, σ is the constant elasticity of substitution, $\upsilon \in (0,1)$ is the share of money in the financial portfolio, and $\eta_N, \eta_F > 0$ are the utility weights to leisure and financial assets, subject to an end-of-period flow budget constraint of

$$\begin{aligned} \Delta M_{it}^H + \Delta D_{it} + \Delta B_{it}^H &= P_t(r_t K_{it} + w_t H_{it}^Y N_{it}) + P_t[\varkappa H_{it}^C \theta_{it}(r_t K_{it} + w_t H_{it}^Y N_{it})] \qquad (2) \\ &\quad - T_{it} + i_{t-1}^D D_{it-1} + i_{t-1}^B B_{it-1}^H + J_{it}^{IG} + \xi_i J_{it}^B - P_t(C_{it} + I_{it} + IH_{it}), \end{aligned}$$

where $r_t K_{it} + w_t H_{it}^Y N_{it}$ is the total factor payments, r_t the real rental price of capital, w_t the economy-wide real wage, $T_{it} = \tau_K r_t K_{it} + \tau_N w_t H_{it}^Y N_{it}$ is the amount of taxes paid to the government, $M_{it}^H = P_t m_{it}^H$ the nominal cash holdings, $D_{it} = P_t d_{it}$ the nominal deposits, $B_{it}^H = P_t b_{it}^H$ the nominal holding of government bonds by individuals, $i_{t-1}^D D_{it-1}$ ($i_{t-1}^B B_{it-1}^H$) the interests on deposit (government bonds) held in previous period, I_{it} the investment in capital stock, IH_{it} the investment in formal human capital, J_{it}^{IG} the end-of-period profits received from IG firms, and J_{it}^B ($\xi_i \in (0,1)$) the claim (fraction of the profits) hold by individual i on the commercial bank. Individuals therefore hold nominal wealth in the form of nominal cash, deposits, government bonds, and real stock of physical capital (K_{it}) in firm $q = i$.

The stock of physical capital at the beginning of period $t+1$ is given by $K_{it+1} = (1 - \delta^K)K_{it} + I_{it}$, where δ^K is the depreciation rate. The formal and illegal human capital at period $t+1$ evolves according to

that has effects on crime-specific human capital (also interpretable as a sort of cultural/social capital), hence encompassing more than just spending on police.

$$\mathbb{E}_t H_{it+1}^Y = \Theta_t^N I H_{it} + (1-\delta^L) H_{it}^Y, \quad \text{and} \tag{3}$$

$$\mathbb{E}_t H_{it+1}^C = \Lambda - \Theta_t^C G_t^P + (1-\delta^C) H_{it}^C, \tag{4}$$

respectively, where $\delta^L, \delta^C \in (0,1)$ are the formal and illegal human capital depreciation rates, Θ_t^N, $\Theta_t^C > 0$ are the respective human capital investment efficiency for private individuals and government common to all individuals, and Λ is a time-invariant additive parameter for crime-specific human capital. To introduce institutional uncertainty, both investment efficiencies are dynamic parameters with both deterministic and stochastic components. Specifically, for formal human capital,

$$\Theta_t^N = \Theta_{0t}^N (\frac{H_t^C}{\tilde{H}^C})^{-\varrho_N}, \tag{5}$$

where $\varrho_N \geq 0$ measures the strength of a negative spillover effect of crime-specific human capital on formal educational efficiency, $\Theta_{0t}^N = (\Theta_0^N)^{1-\varsigma_N} (\Theta_{0t-1}^N)^{\varsigma_N} \exp(\epsilon_t^N)$ follows an AR(1) process, in which $\Theta_0^N > 0$, $\varsigma_N \in (0,1)$ is the associated autoregressive coefficient, and ϵ_t^N is normally distributed with zero mean and a constant variance (σ_N^2). The issue of uncertainty in formal human capital investment is explored in various macroeconomic studies in the tradition of Galor and Zeira (1993), mainly in deterministic framework, where human capital investment is endogenously linked to factors such as credit constraint and unobserved income [see, for instance, Galor and Moav (2004)]. In an economy where crime is a main part of economic activities, it can be argued that formal human capital investment efficiency is adversely affected by crime-specific human capital, H_t^C. Given that crime-specific human capital is a form of cultural capital, when its level is high, there is likely a negative spillover effect to the functioning of formal educational institutions, such as schools.[7]

[7] Alternatively, a partial-equilibrium job-search mechanism in similar vein of Burdett et al. (2003), Engelhardt et al. (2008), Engelhardt (2010) can be introduced that posits human capital investment efficiency as being derived from a job-search process, the cost of which is adversely affected by the stock of crime-specific human capital in the economy.

In line with the predation and accumulation nature of organized crime (Grossman and Kim, 1996; Mocan et al., 2005), we utilize a "scale effect" specification for the (cultural) crime-specific human capital investment efficiency,

$$\Theta_t^C = \Theta_{0t}^C (\frac{\theta_t}{\tilde{\theta}})^{-\varrho_C}, \tag{6}$$

where $\varrho_C \geq 0$ measures the (negative) elasticity of the effectiveness of police spending on the crime rate, $\Theta_{0t}^C = (\Theta_0^C)^{1-\varsigma_C}(\Theta_{0t-1}^C)^{\varsigma_C} \exp(\epsilon_t^C)$, $\Theta_0^C > 0$, $\varsigma_C \in (0,1)$, and $\epsilon_t^C \tilde{} N(0, \sigma_C^2)$. As such, while crime-specific human capital accumulation in itself is uncertain, the higher overall crime rate implies exposure to larger criminal networks, hence leading to greater "expertise" in criminal activities.

Each household i maximizes lifetime utility by choosing C_{it}, N_{it}, θ_{it}, m_{it}^H, b_{it}^H, d_{it}, K_{it+1}, and H_{it+1}^Y, taking prices (and therefore inflation rates, $\pi_{t+1} = (P_{t+1} - P_t)/P_t \ \forall t$), factor returns, tax rate, i_t^D, i_t^B, and the crime-specific human capital levels, $H_{it}^C \ \forall t$ as given. As shown in Appendix A, solving the intertemporal utility maximization problem yields the following first-order conditions:

$$E_t(\frac{C_{it+1}}{C_{it}})^{1/\sigma} = \beta E_t(\frac{1+i_t^B}{1+\pi_{t+1}}), \tag{7}$$

$$N_{it} - \theta_{it} = \frac{(1-\tau_N)}{\varkappa H_{it}^C} - \frac{r_t K_{it}}{w_t H_{it}^Y}, \tag{8}$$

$$(1 + \varkappa H_{it}^C \theta_{it} - \tau_N) w_t H_{it}^Y = \varkappa H_{it}^C (r_t K_{it} + w_t H_{it}^Y N_{it}), \tag{9}$$

$$i_t^B m_{it}^H = \eta_F \upsilon C_{it}^{1/\sigma}(1 + i_t^B), \tag{10}$$

$$(i_t^B - i_t^D) d_{it} = \eta_F (1-\upsilon) C_{it}^{1/\sigma}(1 + i_t^B), \tag{11}$$

$$E_t(\frac{1+i_t^B}{1+\pi_{t+1}}) = E_t\left[\Theta_t^N (1 + \varkappa H_{it+1}^C \theta_{it+1} - \tau_N) w_{t+1} N_{it+1}\right] + (1 - \delta^L), \tag{12}$$

$$E_t(\frac{1+i_t^B}{1+\pi_{t+1}}) = E_t[(1 + \varkappa H_{it+1}^C \theta_{it+1} - \tau_K) r_{t+1}] + (1 - \delta^K), \tag{13}$$

where the transversality conditions, $\lim_{s\to\infty} E_{t+s}\beta^s \lambda_{t+s}(\xi_{ht+s}/P_{t+s}) = 0$, $\xi = K, m^H$ holds.

Equation (7) is the standard Euler equation explaining the optimal intertemporal allocation of consumption; (8) is the first-order condition for raw labor supply to formal market works, which has a direct trade-off with time allocated to criminal activities; (9) is the first-order condition from the optimal time allocation to crime, which equates the marginal returns from formal market works to the marginal returns from criminal distortion (which in turn depends on crime-specific human capital); (10) and (11) give the optimal holdings of money and deposits (in real terms) respectively; (12) and (13) give the optimal physical capital and formal human capital investments chosen by the individuals. In comparison to a study such as Agénor and Alper (2012), (8)-(9) are novel in that they account for the trade-off faced by individuals who have access to criminal activities. In addition, (12) and (13) show the additional costs brought about by crime, which leads to 'higher-than-normal' optimal rates of return. Indeed, given that firms borrow to pay wages in advance, the former, by virtue of the presence of Θ_t^N, is expected to serve as a transmission channel linking education to the credit market.

2.2 Firms

The final good, Y_t, is produced by a zero profit-making, perfectly competitive representative assembly firm using a standard Dixit-Stiglitz (1977) technology. Specifically, the profit maximization problem is given by $Y_{qt} = \arg\max P_t \{\int_0^1 [Y_{qt}]^{(\varsigma-1)/\varsigma} dj\}^{\varsigma/(\varsigma-1)} - \int_0^1 P_{qt} Y_{qt} dj$, where $\varsigma > 1$. For given IG price, P_{qt}, the demand function for each intermediate good is

$$Y_{qt} = (\frac{P_{qt}}{P_t})^{-\varsigma} Y_t, \ \forall q \in (0,1), \tag{14}$$

and the corresponding final price, $P_t = \{\int_0^1 [P_{qt}]^{1-\varsigma} dj\}^{1/(1-\varsigma)}$.

Using constant returns-to-scale production technology, each IG firm $q \in (0,1)$ employs physical capital, K_{qt}, and labor (in effective terms, $H_{qt}^Y N_{qt}$, supplied by individual i, $q = i$) and faces the production function,

$$Y_{qt} = A_t K_{qt}^{\alpha} (H_{qt}^Y N_{qt})^{1-\alpha}, \tag{15}$$

where $\alpha \in (0,1)$, and A_t denotes a common economy-wide technology shock following an AR(1) process, $A_t = (A_0)^{1-\varsigma_A}(A_{t-1})^{\varsigma_A}\exp(\epsilon_t^A)$, where ϵ_t^A is normally distributed with zero mean and a constant variance (σ_A^2). Following Ravenna and Walsh (2006), IG firm q borrows from the commercial bank to pay wages to effective labor hours in advance. Let L_{qt} be the amount borrowed, the financing constraint is given by

$$l_{qt} = \frac{L_{qt}}{P_t} \geq w_t H_{qt}^Y N_{qt}. \tag{16}$$

At the end of the period, the loan is repaid at a gross nominal loan rate $(1+i_{qt}^L)$. In each period t, each IG firm q therefore incurs a cost of $(1+i_{qt}^L)w_t$ for effective labor hired from a competitive labor market and the rate of returns, r_t for each unit of physical capital hired. In addition, consistent with the urban crime described in studies such as Londoño and Guerrero (2000), each IG firm also faces extortions from criminals (again, in effective terms, $\theta_{qt}H_{qt}^C$, committed by individual j, $q=j$)[8] at a constant probability π_V, hence incurring an additional production cost, $\theta_{qt}H_{qt}^C[w_t H_{qt}^Y N_{qt} + r_t K_{qt}]$. This specification is also consistent with many organized crime described in Latin America-based studies such as Gaviria (2002) and Gomez Soler (2012). For simplicity, we assume $\pi_V = 1$.[9] Each firm q therefore solves the unit cost minimization problem, $\min_{N_{qt},K_{qt}}(1+i_{qt}^L)w_t H_{qt}^Y N_{qt} + r_t K_{qt} + \theta_{qt}H_{qt}^C[w_t H_{qt}^Y N_{qt} + r_t K_{qt}]$, subject to $Y_{qt} = 1$, taking wages, rate of returns of capital, and effective of hours of crime as given. The first-order conditions are derived in Appendix A, with an implied physical capital-effective labor ratio given by:

$$\frac{K_{qt}}{H_{qt}^Y N_{qt}} = \frac{\alpha}{1-\alpha}\frac{(1+i_{qt}^L+\theta_{qt}H_{qt}^C)w_t}{(1+\theta_{qt}H_{qt}^C)r_t}, \tag{17}$$

[8] We assume individuals neither work nor extort from the IG firm they own, $N_{it}^q = \theta_{it}^q = 0$. Similarly, we also assume that, while j belongs to the continuum $i \in (0,1)$, $i \neq j$. In other words, an individual i does not extort from the same firm he is working in.

[9] Such victimization probability can be referred to Imrohoroğlu et al. (2004, 2006), though they model crime as theft. In this article, we model crime as direct extortions from firms, as in Blackburn et al. (2017). In stationary equilibrium, the victimization probability would then equal economy-wide crime rate, $\tilde{\theta}$. We abstract from this by assuming $\pi_V = 1$.

where the marginal cost of both labor and physical capital includes the amount lost to crime. Specifically, the derived unit real marginal cost is:

$$mc_{qt} = \frac{[(1 + i^L_{qt} + \theta_{qt} H^C_{qt}) w_t]^{1-\alpha} [(1 + \theta_{qt} H^C_{qt}) r_t]^\alpha}{\alpha^\alpha (1-\alpha)^{1-\alpha}}. \tag{18}$$

Under monopolistic pricing, the price is given by constant pricing of $P_{qt} = \frac{\varsigma}{\varsigma-1} mc_{qt} P_t$.

2.3 Commercial Bank

The commercial bank receives deposits, $D_t = \int_0^1 D_{it} di$ from individuals. The supply of loans is assumed to be perfectly elastic and collectively, the total loans equal $L_t = \int_0^1 L_{qt} dq = P_t w_t H^Y_t N_t$, where $N_t = \int_0^1 N_{it} di$ and H^Y_t denotes the economy-wide average legal human capital level. By law, the bank holds required reserves with the central bank, $\Upsilon_t = \mu D_t$, which is a fraction of its deposits, $\mu \in (0, 1)$. For a given level of L_t, Υ_t, and D_t, the bank borrows from the central bank, L^B_t, to cover for any financing shortfall. At the end of each period, it repays the central bank at a nominal refinance rate, i^R_t. To determine the borrowing from central bank, we use the commercial bank's balance sheet:

$$L^B_t + D_t = \Upsilon_t + L_t, \text{ or equivalently, } L^B_t = L_t - (1-\mu) D_t. \tag{19}$$

The deposit and loan rates are set by the bank, so as to maximize profit, Π^B_t, as in $\max_{i^D_t, i^L_{qt}} \Pi^B_t = q i^L_{qt} L_t(i^L_{qt}) + (1-q)(\kappa P_t K_{qt} - \Lambda) - i^D_t D_t - i^R_t [L_t(i^L_{qt}) - (1-\mu) D_t]$,where q is the repayment probability. Solving this yields:

$$i^D_t = (1 + \frac{1}{\eta_D})^{-1} (1-\mu) i^R_t, \text{ and } i^L_{qt} = (1 + \frac{1}{\eta_L})^{-1} \frac{i^R_t}{q}, \tag{20}$$

where $\eta_D = [\partial D_t / \partial i^D_t] \cdot (i^D_t / D_t) > 0$ and $\eta_{L_q} = [\partial L_t / \partial i^L_{qt}] \cdot (i^L_{qt} / L_t) < 0$ are the interest elasticity of deposit supply and loan demand respectively. The latter is conceptually speaking different for each IG firm q, but can be assumed to be the same across the firms in a symmetric equilibrium. Assuming that the supply of deposit is perfectly elastic (η_D assumed to be a large value), the optimal deposit rate is then $i_t^D = (1-\mu)i_t^R$.

As argued in Agénor and Montiel (2008), the repayment probability generally increases with the collateral provided, $\kappa P_t K_{qt}$, $\kappa \in (0,1)$, as a percentage of the loan taken out by firms. In addition, in line with the thesis of crime being extortion on firms, we also specify it to depend negatively on a macro-environment factor, in the form of the economy-wide crime rate, θ_t, in line with Baumann and Friehe (2017). The repayment probability therefore takes the form of $q = q_0[1 + \Psi_{qt}(\kappa P_t K_{qt}/L_{qt}; \theta_t)]^{-1}$, which is similar to Agénor and Alper (2012). This, combined with (20), yields $i_{qt}^L = (1+\frac{1}{\eta_{L_q}})^{-1} q_0^{-1}[1 + \Psi_{qt}(\kappa P_t K_{qt}/L_{qt}; \theta_t)] i_t^R$, where $\Psi_{qt} > 0$ $[\Psi'_{qt}(\kappa P_t K_{qt}/L_{qt}) < 0,\ \Psi'_{qt}(\theta_t) > 0]$ is the credit risk premium the bank charges on its lending to firms. Specifically, if $\Psi_{qt} = \Psi_0(\kappa P_t K_{qt}/L_{qt})^{-\phi_1}(\theta_t)^{\phi_2}$, we have

$$i_{qt}^L = (1+\frac{1}{\eta_{L_q}})^{-1} q_0^{-1}[1 + \Psi_0(\frac{\kappa P_t K_{qt}}{L_{qt}})^{-\phi_1}(\theta_t)^{\phi_2}] i_t^R, \tag{21}$$

where $\Psi_0 \geq 0$ is a time-invariant credit risk premium, $\phi_1 \geq 0$ is the collateral component of the premium, and $\phi_2 \geq 0$ is the risk associated with the aggregate crime rate of the economy.

At the end of the period, the commercial bank makes a net profit of $J_t^B = (1+i_{qt}^L)L_t - (1+i_t^D)D_t - (1+i_t^R)L_t^B$, which are paid in equal shares to the individuals.

2.4 Central Bank

The central bank sets the monetary policy. It holds government bonds, B_t^C, and loans to the commercial bank, L_t^B, as assets. Its liabilities consist of the currency, M_t^S, and the required reserves, $\Upsilon_t = \mu D_t$. From the balance sheet of the central bank, the currency in circulation can be determined as:

$$M_t^S = L_t^B + B_t^C - \mu D_t. \tag{22}$$

The net income made on loans to the commercial bank, $i_t^R L_t^B$, is transferred to the government at the end of each period.

The monetary policy is operated by fixing the refinance rate, i_t^R, assumed to be determined by a Taylor-type (1993) policy rule, given by

$$i_t^R = \epsilon_t (i_{t-1}^R)^{\varpi} [(\tilde{r} + \tilde{\pi})(\frac{1+\pi_t}{1+\pi^T})^{\epsilon_1} (\frac{Y_t}{\tilde{Y}})^{\epsilon_2}]^{1-\varpi}, \tag{23}$$

where $\tilde{r}$ denotes the steady-state real interest rate, $\tilde{\pi}$ the steady-state inflation rate, $\tilde{Y}$ the steady-state level of final output, π^T the inflation target, ϵ_1, $\epsilon_2 \geq 0$ are the policy weights placed on inflation and output stabilization, ϵ_t denotes another structural shock with an AR(1) process, $\epsilon_t = (\epsilon_0)^{1-\varsigma_M}(\epsilon_{t-1})^{\varsigma_M} \exp(\epsilon_t^{\varepsilon})$, where ϵ_t^{ε} is normally distributed with zero mean and a constant variance (σ_M^2) [see Rudebusch (2006)]. The specification is in line with the general Taylor Rule specification for monetary policy-setting in developing economies, which combines an element of inertia (measured by a parameter that captures the degree of monetary/interest-rate smoothing, $\varpi \in [0,1]$) and the standard elements of policy reaction. When $\varpi = 0$, monetary policy is purely contemporaneous and reactionary; when $\varpi = 1$, refinance rate-setting merely follows the previous rate. The introduction of a source of random shock to the interest rate-setting is consistent with the "speed limit" policy approach introduced in Liu (2006) and Agénor and Alper (2012).

2.5 Government

The government issues nominal riskless one-period bonds to the central bank and individuals. It taxes both labor and capital income at a constant rate, $T_{it} = \tau_K r_t K_{it} + \tau_N w_t H_{it}^Y N_{it}$. The government also receives the illegal income confiscated from successfully apprehending a criminal, and the net income transferred from the central bank, $i_t^R L_t^B$. These are used to finance the purchases of final good (G_t^O) and investment expenditure on improving public order and security (G_t^P).[10] The budget constraint is given by

$$
\begin{aligned}
& P_t[(1-\varkappa)H_{it}^C\theta_{it}(r_tK_{it}+w_tH_{it}^YN_{it})]+P_tT_{it}+B_t^H+B_t^C+i_t^RL_t^B \qquad (24)\\
= \;& (1+i_{t-1}^B)(B_{t-1}^H+B_{t-1}^C)+P_t(G_t^P+G_t^O)-i_{t-1}^BB_{t-1}^C.
\end{aligned}
$$

Government purchases are assumed to be a constant fraction of output, hence $G_t^O = \upsilon_O Y_t$, $\upsilon_O \in (0,1)$. The expenditure on public order and security, G_t^P, is the novel feature whose properties is examined in this article. For the benchmark case, we assume G_t^P to be set also as a constant fraction of output, $G_t^P = \upsilon_P Y_t$, where the spending share $\upsilon_P \in (0,1)$ is chosen at the discretion of the government. For comparison, we also consider a case that is rule-based, where $G_t^P = G_0^P(\frac{\theta_t}{\bar{\theta}})^{\psi_1}$, $\psi_1 \geq 0$ is the policy responsiveness to aggregate crime rate. This essentially turns the expenditure on public order and security to a *reaction function* that depends on the relative crime rate, θ_t, from its steady-state value.

3 Symmetric and Steady-state Equilibrium

Definition 1: A *symmetric equilibrium* is the one in which all individuals and all IG firms are identical. This means, for all individuals $i \in (0,1)$, $C_{it} = C_t$, $\theta_{it} = \theta_t$, $N_{it} = N_t$, $K_{it} = K_t$, $I_{it} = I_t$, $IH_{it} = IH_t$, $M_{it}^H = M_t^H$, $B_{it}^H = B_t^H$, $D_{it} = D_t$, $K_{it} = K_t$. For all IG firms $q \in (0,1)$, $P_{qt} = P_t$, $mc_{qt} = mc_t$, $K_{qt} = K_t$, $N_{qt} = N_t$, $\theta_{qt} = \theta_t$. All individual and aggregate behaviors are consistent, which means all individual- and firm-specific human capital equal the economy-wide average level of human capital, that is, $H_{\varphi t}^Y = H_t^Y$, $H_{\varphi t}^C = H_t^C$, where $\varphi = i, q$. All firms produce the same output and prices and marginal costs are the same across firms. By implications, the loan rate, i_{qt}^L, and the interest elasticity of loan demand, η_{L_q}, and the risk premium are the same across firms, $i_{qt}^L = i_t^L$, $\eta_{L_q} = \eta_L$, $\Psi_{qt} = \Psi_t$, $\forall q$.

The deposits, credits, currency, government bonds, and goods markets are in equilibrium.

[10] It is debatable whether the expenditure on improving public order and security is treated as a consumption or investment expenditure. Given our specification where it contributes to the "de-accumulation" of crime-specific human capital, it is akin to a type of investment expenditure.

The supply of deposits by households and the supply of loans by the commercial bank are perfectly elastic at the prevailing rates, hence the two markets always clear. For the currency market, the equilibrium condition is $M_t^S = M_t^H + M_t^F$, where $M_t^F = \int_0^1 M_{qt}^F dq$ is firms' total cash-holdings. Assuming that the bank loans to firms are made only in currency form, $L_t = M_t^F$, using (19) and (22), we can eliminate L_t^B to get $M_t^H + D_t = B_t^C$. Further, by using the aggregate expressions (10) and (11), we can write an expression for the real value of central bank's holdings of government bonds:

$$b_t^C = \frac{B_t^C}{P_t} = \eta_F (C_t)^{1/\sigma}(1+i_t^B)\{\frac{\nu}{i_t^B} + \frac{1-\nu}{i_t^B - i_t^D}\}. \tag{25}$$

Given this, and knowing that $P_t/P_{t-1} = 1+\pi_t$, using the government budget constraint, we solve for the real value of the total stock of government bonds, b_t:

$$\begin{aligned} b_t = & (\frac{1+i_{t-1}^B}{1+\pi_t})b_{t-1}^H + \frac{b_t^C}{1+\pi_t} + G_t^P + G_t^O - i_t^R l_t \\ & -[(1-\varkappa)H_t^C\theta_t + \tau_K]r_t K_t - [(1-\varkappa)H_t^C\theta_t + \tau_N]w_t H_t^Y N_t), \end{aligned} \tag{26}$$

with the individuals' holdings of government bonds determined by $b_t^H = b_t - b_t^C$. Lastly, the goods market equilibrium is given by $Y_t = C_t + G_t^P + G_t^O + I_t$, where $C_t = \int_0^1 C_{it} di$, and $I_t = \int_0^1 I_{it} di$. For the benchmark case where $G_t^P = \upsilon_P Y_t$, it can be rewritten as

$$[1-(\upsilon_O + \upsilon_P)]Y_t = C_t + K_{t+1} - (1-\delta^K)K_t. \tag{27}$$

Finally, note that (17), given P_t, can be used to determine both the economy-wide real and nominal wages:

$$w_t = \frac{W_t}{P_t} = \frac{1-\alpha}{\alpha}\frac{(1+\theta_t H_t^C)r_t K_t}{(1+i_t^L+\theta_t H_t^C)H_t^Y N_t}. \tag{28}$$

Definition 2: A *steady-state equilibrium* of this economy is a stationary symmetric equilibrium in which, for a given set of parameters, a probability of escaping apprehension

($\varkappa$), and a set of policy arrangements $\{\mu, \tau, \upsilon_O, \upsilon_P\}$: (i) the endogenous variables ($\tilde{C}$, $\tilde{N}$, $\tilde{\theta}$, $\tilde{M}^H$, $\tilde{B}^H$, $\tilde{D}$, $\tilde{K}$, $\tilde{H}^Y$, $\tilde{H}^C$, $\tilde{B}^C$, $\tilde{Y}$) are constant$\forall t$; (ii) the prices, wages and rates ($\tilde{P}$, $\tilde{r}$, $\tilde{w}$, $\tilde{\imath}^B$, $\tilde{\imath}^D$, $\tilde{\imath}^L$, $\tilde{\imath}^R$) are all constant $\forall t$; and by implications, (iii) the inflation ($\tilde{\pi}$), profits and marginal costs are constant $\forall t$. The steady-state inflation rate also equals its target value ($\tilde{\pi} = \pi^T$). We solve for the steady-state equilibrium in Appendix B. Without losing any generality, we solve for a simplified case where the inflation target is zero. As derived in Appendix B, we obtain the standard Fisher relationship, $\tilde{\imath}^R = \tilde{r} + \tilde{\pi}$. When $\tilde{\pi} = \pi^T = 0$, the steady-state refinance rate ($\tilde{\imath}^R$) equals the real interest rate ($\tilde{r}$), which in this monetary economy with credit financing and criminal extortions, is negatively dependent on the steady-state level of effective crime rate ($\tilde{H}^C\tilde{\theta}$):

$$\tilde{r} = \frac{\beta^{-1} - (1 - \delta^K)}{(1 + \varkappa\tilde{H}^C\tilde{\theta} - \tau)}. \tag{29}$$

In turn, the steady-state crime rate, $\tilde{\theta}$, is determined by:

$$\tilde{\theta} = (\varkappa\tilde{H}^C)^{-1}\left[\frac{(\delta^L - \delta^K)}{(\tilde{\Theta}^N\tilde{w}\tilde{N} - \tilde{r})} + \frac{\tilde{\Theta}^N\tau_N\tilde{w}\tilde{N}}{(\tilde{\Theta}^N\tilde{w}\tilde{N} - \tilde{r})} - \frac{\tau_K\tilde{r}}{(\tilde{\Theta}^N\tilde{w}\tilde{N} - \tilde{r})}\right], \tag{30}$$

which depends on the efficiency of investment in legal human capital ($\tilde{\Theta}^N$), the wage rate ($\tilde{w}$), real interest rate ($\tilde{r}$), tax rates (τ_N, τ_K), and the difference between the depreciation rate of human and physical capital ($\delta^L - \delta^K$). If $\tilde{\Theta}^N\tau_N\tilde{w}\tilde{N} = \tau_K\tilde{r}$, then the **assumption** of $\delta^L > \delta^K$ is needed to ensure positive crime rate in the steady state. In the steady-state, crime-specific human capital ($\tilde{H}^C$) is a function of the steady-state value of government spending on public order and security, and the corresponding spending efficiency in reducing crime-specific (cultural) human capital, as in:

$$\tilde{H}^C = \frac{\Lambda - \tilde{\Theta}^C\tilde{G}^P}{\delta^C}, \tag{31}$$

Also, when $\tilde{\pi} = 0$, the steady-state gross rate of return for government bonds equals the rate of time preference,$1 + \tilde{\imath}^B = \frac{1}{\beta}$, which then determines the steady-state real currency-and deposit-holdings of individuals. The equations for other endogenous variables can be referred to in Appendix B. In summary, the simultaneous equations system characterizing the steady-state equilibrium consists of 18 endogenous variables in real terms ($\tilde{r}$, $\tilde{\imath}^B$, $\tilde{\imath}^D$, $\tilde{\imath}^L$, $\tilde{w}$, $\tilde{H}^Y$, $\tilde{H}^C$, $\tilde{N}$, $\tilde{\theta}$, $\tilde{m}^H$, $\tilde{d}$, $\tilde{l}$, $\tilde{Y}$, $\tilde{K}$, $\tilde{b}^H$, $\tilde{b}^C$, $\tilde{C}$, $\tilde{G}^P$). Given the presence of the four stochastic shocks, to solve the model, we log-linearize the behavioral equations and aggregate resource constraints around a non-stochastic, zero-inflation steady state.

4 Illustrative Parameterization

It is well-documented that the quality of crime data is generally poor, even for the well-used dataset of *United Nations Survey of Crime Trends and Operations of Criminal Justice Systems* (UN-CTS). This is especially true for Latin America, where under-reporting of crime remains prevalent (Fajnzylber et al., 1998; Jaitman and Torre, 2017). This, coupled with the non-availability of quarterly data for variables such as human capital and time allocation, means a Bayesian estimation strategy is impractical. Against this backdrop, we calibrate the model with empirical parameterization using available statistics (as much as possible), so as to calibrate illustratively a typical middle-income Latin American economy where crime remains prevalent. Unless specified otherwise, all calibrations are implemented to obtain initial steady-state values for the endogenous variables that match the first moment of the long-term averages of the 21 non-British caribbean, Latin American economies for the 1991-2016 period.[11] This choice is motivated by three reasons: (i) the selected economies are well known to experience a *twin-high* problem (high crime, high financial instability), and therefore suit the context of the model; (ii) significantly uneven and asymmetric data gaps in intermediate years were abundant across these economies, which then requires averaging over the large number of countries with shared characteristics over a longer period of time to obtain stable steady-state values; (iii) the 1991-2016 period coincides with the seven waves

[11] These include Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Uruguay, and Venezuela.

of the UN-CTS surveys, which are used to calibrate the steady-state values of crime and criminal justice system-related variables.

The parameter values are summarized in Table 1. Given the annual time frequency and developing country context, the discount factor is set at $\beta = 0.952$, which corresponds to an annual interest rate of 5 percent. With $\tilde{\imath}^B = \frac{1}{\beta} - 1$ in steady state, we have the steady-state bond rate, $\tilde{\imath}^B = 0.05$. The intertemporal elasticity of substitution, σ, and the preference parameter for leisure, η_N, are set at 0.6 and 1.75 respectively, consistent with the values commonly used for the Latin American economies (see Agénor and Montiel, 2015). The preference parameter for composite monetary assets, η_F, is set at a very low value of 0.02 to reflect a low utility derived from holding monetary assets (given that criminal activities provide an alternative outlet to generate income). The share parameter in the index of money holdings, υ, is set at 0.2, which is based on the estimated cash-deposit ratio for our sample economies. For convenience, we set both tax rates to be equal, $\tau_K = \tau_N = 0.2$, in the benchmark case, which is within range of the average marginal income tax rates for our sample economies.

In terms of the initial steady-state values for the time allocation variables, a standard 8 hours of formal market work would give $\tilde{N} = 8/24 = 0.33$. The time allocated to criminal activities ($\tilde{\theta}$) has to be estimated. Based on the 'matching-of-first-moment' methodology of Neanidis and Papadopoulou (2013), we estimate $\tilde{\theta}$ based on the long-term average crime incidence of our sample economies using the cross-country UN-CTS dataset. Specifically, first we calculate crime rate as equals to the total recorded crimes for all penal code per 100 million inhabitants at the country level using seven waves of the UN-CTS surveys (1991-2016). After that, for our sample Latin American economies that are covered in the surveys, we calculate the long-term mean, which yields a value of 0.167. We therefore set $\tilde{\theta} = 0.167$. The exogenous probability of escaping apprehension, $\varkappa$, is set at 0.7, which is consistent with the UN-CTS dataset-based estimates of Neanidis and Papadopoulou (2013). Using the *IMF Government Financial Statistics*, we calculate the constant parameters for expenditure on public order and security (υ_P) and other government consumption (υ_O) by dividing the relevant fiscal components with the GDP at the country level. For our sample Latin American economies, the long-term mean values for the period of 1991-2016 are $\upsilon_P = 0.0157$ and $\upsilon_O = 0.167$.

Next, we consider human capital. Following Mocan et al. (2005), we set the depreciation rate for both types of human capital, $\delta^L = \delta^C = 0.05$. The calibration of the remaining parameter, Λ, as well as the determination of the two time-varying endogenous human capital investment efficiency values ($\tilde{\Theta}^N$ and $\tilde{\Theta}^C$) are as follows. First, to satisfy $\delta^L > \delta^K$, we assume physical capital has a lower depreciation rate than human capital, and set $\delta^K = 0.02$. Given this and other parameter values, from (29), we can determine the value of the composite term, $\varkappa\tilde{H}^C\tilde{\theta} = 1.4$. With $\varkappa = 0.7$ and $\tilde{\theta} = 0.167$, the steady-state level of crime-specific human capital, $\tilde{H}^C = 5.133$. From (30), by normalizing the steady-state wage rate to unity, $\tilde{w} = 1$, the efficiency of investment in legal human capital is then calculated, $\Theta_0^N = 0.215$. For crime-specific human capital, we set the investment efficiency to be twice of Θ_0^N, where $\Theta_0^C = 0.43$. From (31), given that all the other values in the expression have been determined, we solve for the time-invariant additive parameter of crime-specific human capital, $\Lambda = 0.258$.

Next, we consider the production side. The parameters in the production function, (15), is parameterized in the standard manner, in that, the share of physical capital, $\alpha = 0.35$, and share of effective labor, $1 - \alpha = 0.65$, are based on the production shares of the respective input. The average productivity parameter, A, is normalized to one, as in Tayler and Zilberman (2016). From *IMF Capital Stock Database*, the average final output-to-physical capital ratio of our sample economies is 0.451. From Appendix B, we know that $\tilde{r} = \frac{\alpha\tilde{Y}}{(1+\tilde{\theta}\tilde{H}^C)\tilde{K}}(\frac{\varsigma-1}{\varsigma})$, which then allows us to calculate the elasticity of demand for intermediate goods, $\varsigma = 2.43$, implying a high mark-up rate of 70 percent. This is relatively high in the literature but consistent with the empirical evidence in Latin American economies.[12]

[12] To our knowledge, there is a lack of study that focuses precisely on the estimation of mark-up in Latin America. However, a back-of-the-envelope calculation can be done using firm-level data from the publicly available *World Bank Enterprise Surveys*. Specifically, based on the 1,836 firms across the Latin American economies examined by Lim and Morris (2020), an average mark-up of 66.4 percent is estimated, which

In terms of the parameters characterizing commercial banks' lending, following Agénor and Alper (2012), we set the effective collateral-loan ratio, $\kappa = 0.2$, and the elasticity of the risk premium with respect to collateral, $\phi_1 = 0.05$. We also set the elasticity of the risk premium with respect to the economy-wide crime rate to be the same, $\phi_2 = 0.05$. For the other parameters, first, from the *World Bank World Development Indicators*, note that the average lending interest rate for our 21 sample economies during the period 1991-2016 is 22 percent, while the average risk premium on lending is 17.2 percent. Using the steady-state relationship of $\tilde{\imath}^L$, and assuming $\eta_{L_q} = 1$ and base repayment probability, $q_0 = 0.2$, the risk premium parameter, Ψ_0, is calculated to be 0.815. For the central bank, we follow Agénor and Alper (2012) by setting the initial reserve requirement ratio, μ, to a relatively low rate of 10 percent. Given this, and that $\tilde{\imath}^D = (1-\mu)\tilde{r}$, we have the steady-state deposit rate, $\tilde{\imath}^D = 0.045$. For the monetary policy, the smoothing parameter is set at $\varpi = 0$, which is in line with the empirical finding of Moura and Carvalho (2010) for Latin American Central Banks, in that monetary policy-setting tends to be reactionary. We also set $\epsilon_1 = 1.5$ and $\epsilon_2 = 0.2$, which is consistent with Liu (2006) and Moura and Carvalho (2010). The latter, ϵ_2, in particular, is consistent with evidence reported for several countries in Latin America. For the rule-based specification for expenditure on public order and safety, in the absence of a relevant estimate in the existing literature, the parameter, ψ_1, which models the responsiveness of the spending with respect to a deviation in crime rate from its steady state, is set at an initial value of 0.1. Intuitively, given that what constitutes 'true' long-run crime rate is unobservable by the authorities, we therefore believe any policy reaction parameter ought to be of a small value. Finally, for the stochastic shocks, we specify all four as first-order autoregressive processes with a common degree of persistence, $\varsigma_A = \varsigma_M = \varsigma_C = \varsigma_N = 0.8$.

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approximates our implied 70 percent mark-up value. Indeed, this empirical evidence further strengthens our model's appropriateness in describing the *twin-high* (high crime rate, high financial instability) phenomenon in the Latin America.

5 Policy Experiments

As alluded in Section 1, we study three policy-pertinent research questions, especially in regards to whether government expenditure on public order & safety (police spending, in short) has the potential to serve as an unconventional policy tool for macroeconomic stabilization in a 'twin-high' economy.[13] To address these questions necessarily requires us to understand the cyclical properties of the key variables in our model, as well as how they respond to stochastic shocks. Our policy experiments are therefore structured according to the following questions: (i) "*Do formal and criminal-specific human capital share a common or counteracting cyclical property, in the response to educational shocks?"; (ii) "Does police spending—be it rule-based or discretionary—have a potential role as an unconventional tool in macroeconomic stabilization?*"; (iii) "*If so, how does it measure,compared to monetary policy?*"

As also emphasized in Section 1, we assess the performance of police spending in macroeconomic stabilization by following Agénor and Alper (2012), and focus on the characteristics of the transitional dynamics of key variables, as well as the time it takes for them to return to their respective initial steady states.

5.1 Formal human capital investment efficiency shock

To address the first question, we first consider a temporary shock to formal human capital investment, or specifically, a 10 percent standard deviation shock to ϵ_t^N. From (5), this reflects a quality uncertainty to households' investment in formal human capital, albeit an upside shock. The impulse responses are presented in Figure 2, which in addition to the benchmark, also illustrates scenarios of (i) an economy with less crime (household spend 5 percent less of their time in criminal activities, $\tilde{\theta} = 0.117$, but 5 percent more time in

[13] The focus is therefore not on an increase in the *level* of police spending. Indeed, a quick deterministic analysis of a steady-state increase in the share of police spending, υ_P, will lead to higher levels of formal human capital, final output, consumption, and lower level of crime-specific human capital in the new steady state. This therefore reaffirms the long-run positive effects of police spending commonly documented in the literature. The results of this analysis is not presented to save space.

formal market works), (ii) higher (quadruple) base efficiency level of formal human capital investment, Θ_0^N, and (iii) a higher (double) initial share of spending on public order and safety, υ_P.

In the benchmark case, the shock to investment efficiency in human capital has an instantaneous effect on formal education, which as expected, leads to increases in both formal market works and formal human capital level. These in turn lead to higher production and consumption. With the temporary uptick in investment efficiency, individuals reduce their asset-holdings, including government bonds, and invest more in human capital. Nevertheless, the expansionary effects on production also result in greater opportunities for extortions, which translates in a general equilibrium effect of a higher level of crime-specific human capital. These observations are interesting in that they highlight a common cyclical property between formal human capital and crime-specific human capital. In other words, as the quality of formal education improves, it is not only that individuals have greater incentives to substitute leisure with formal learning, but also with both formal market work and criminal activities. Indeed, the estimated pairwise correlation of the transition paths of these two human capitals is 0.7177, which corroborates the graphical observation.

Given that our *financial accelerator* mechanism operates through the credit cost channel (with subsequent transmission through the real wage and employment), for this specific shock the effects are largely positive. Specifically, for the two components that determine the credit risk premium, the component associated with the larger value of the collateral (physical capital stock) dominates the component associated with the aggregate crime rate, hence resulting in a net reduction in the loan rate set by banks. For firms, the instantaneous effect on the real marginal cost of production is initially higher due to the expansion in criminal extortions. However, with the expansion in formal human capital translating into more *effective* labor (human capital-adjusted labor, i.e. $H_t^Y N_t$), and with the lower bank loan rate, the real marginal cost of production faced by firms [which depends on the loan rate as well, as in (18)] would quickly decline, as seen in Figure 2. In such instance, the presence of the credit market imperfections can be good for the economy, as this subsequent cost reduction faced by firms would not have taken place had credit friction not existed in the economy. Mathematically, the significance of this crime-credit linkage is confirmed by the estimated pairwise-correlation between the impulse responses of crime rate and the monetary policy rate (i_t^R) in the benchmark case, which is -0.968, despite police spending merely being set as a fraction of output.

For the sensitivity cases, qualitatively the transitional dynamics appear to be largely similar, as the financial accelerator mechanism largely operates the same way as described above. Instead, from Figure 2, what we can observe is that, a lower degree of persistence that characterizes the empirical responses of final output, consumption, formal market work, formal human capital, marginal cost of production, and loan rate, in all three cases considered. Notably, if the initial value of the steady-state crime rate (formal market work) is calibrated to be lower (higher), the adjustment paths of these variables appear to be much shorter (longer), as they return to their respective initial steady states a lot quicker (slower). Indeed, a quick comparison of the estimated coefficients of autocorrelation between this case and the benchmark corroborates this graphical observation. Specifically, for the benchmark simulation, by the time order $t = 5$, the estimated autocorrelation coefficients for most of the variables remain in the 0.80 range; for this sensitivity case the same set of autocorrelation coefficients at $t = 5$ is in the 0.60 range. Indeed, this is the case for most of the variables (including crime rate, θ), except crime-specific human capital, H_t^C, which has autocorrelation coefficient above 0.90 in both cases: a feature that appears to be consistent with the common belief that social norms and culture (recall that this is how crime-specific human capital in the model is defined) tend to be remarkably persistent over time. Nevertheless, if a prolonged adjustment path is deemed as undesirable for macroeconomic stabilization, then this specific sensitivity case reaffirms that an initial environment with lower crime rate is likely to experience less adverse effect from the credit friction-induced financial accelerator effects.

In summary, this first experiment suggests that, both formal and crime-specific human capital appears to share a common cyclical property, with the latter being relatively more persistent than the former. This co-movement appears to partly explain the experience in some Latin American economies over the past decades: In spite of increasing policy efforts in promoting formal education, crime rate appears to persist.

5.2 Police Spending as Unconventional Tool for Macroeconomic Stabilization?

We address the second policy question, *"Does police spending—be it rule-based or discretionary—have a potential role as an unconventional tool in macroeconomic stabilization?"* by first repeating the previous simulation of a 10 percent standard deviation shock to formal human capital investment efficiency. Then, we implement a temporary 10 percent structural shock to ϵ_t^C (interpretable as efficiency of police spending in the crime-specific human capital equation, as in (4)-(6)], followed by a conventional monetary policy shock [a temporary 10 percent increase in ϵ_t, as in (23)]. The simulation results are presented in Figures 3,4, and 5 respectively. For all three structural shocks, we undertake a standard "rule versus discretion" exercise by comparing the impulse responses of the benchmark model (discretionary approach to police spending by setting υ_P as a fraction of output, Y) and the model with reactionary rule (police spending is determined as a direct response to deviations in crime rate).

In Figure 3, we present the impulse responses for both police spending policies (discretion and reactionary rule) in the benchmark case and the case where the initial steady-state crime rate (formal market work) is lower (higher). Given that it is the same shock as in Figure 2, the transmission mechanism essentially operates through the same channels and needs not be repeatedly described. Similarly, the difference in the implementation approach appears to not be significant when the structural shock of concern is originating from the formal education sector. Nevertheless, two key differences are observed. First, the use of a reactionary rule appears to slightly prolong the adjustment path of variables in Figure 3, which is confirmed by the estimated autocorrelation coefficients for $t = 5$. For instance, for inflation, it is 0.844 in the benchmark case with discretion and 0.866 in the case with reactionary rule. These suggest that it is likely a rule-based approach to police spending that may amplify persistence of any post-shock effect arising and transmitting through the three crime-credit linkages showcased in this study. Second, a reactionary rule-based approach to police spending nonetheless has an interesting merit: it results in a "de-coupling" of the common cyclical properties of the two types of human capital (observed in Section 5.1). These are confirmed by the pairwise-correlation values between formal and crime-specific human capital estimated using the transitional dynamics of the two variables. Specifically, in the benchmark discretionary case we have 0.7177 correlation, whereas in the rule-based case we have -0.6943; in the case with a lower initial steady-state crime rate, the discretionary rule has 0.6030 correlation, whereas the rule-based implementation yields a correlation of -0.5778.

For robustness check, we also evaluate the other two structural shocks. First, we evaluate the case where a temporary 10 percent structural shock to ϵ_t^C is simulated, which involves a temporary increase in the efficiency of government spending in reducing crime-specific human capital, perhaps due to knee-jerk reaction from politicians following public pressure. The impulse responses are presented in Figure 4. For this structural shock, the absolute magnitude of the variables response appears to be numerically much smaller than the shock to formal education sector. This is likely due to the unit of measurement of crime rate being small, $\theta_t \in (0, 1)$, which as a ratio to its steady state, means any relative deviation will be small. In the absence of a very large ψ_1 elasticity value, the responses of the other variables are therefore small. In terms of the economics, the financial accelerator mechanism operates as follows. Following the shock, the instantaneous effect of illegal (formal) human capital is predictably negative (positive), which translates to a corresponding decrease (increase) in time allocated to crime (formal market works). This increases production in the real sector, implied by higher consumption. Further, through the three crime-credit linkages showcased in this model, the credit risk premium is lowered due to a combination of more collateral made available by firms and lower credit risk associated with aggregate crime rate. This leads to further expansion in loan demand and hence, further production—the secondary mechanism that further expands the real sector, i.e. the credit loan channel-induced *financial accelerator* effects (positive in this case). In Figure 4, we can see that the temporary gain is greater the higher the initial efficiency level of police spending is. Nevertheless, the opposite holds too. Specifically, if the structural shock of concern is negative where there is a decline in the institutional efficiency in the criminal justice system—perhaps due to a shock to the institution—then the temporary fluctuations and losses are greater too if the initial efficiency level is high. In such an instance, then a rule-based approach to police spending is comparatively more desirable, due to an obviously greater stabilization property, as seen in Figure 4. Indeed, this is supported by the estimated autocorrelation coefficients (for $t = 5$) between the two policy implementation cases: with discretion, for final output it is 0.7413; with reactionary rule, it is 0.5912. The "de-coupling" effect (of reactionary rule) observed from the previous experiment remains true.

Second, we also evaluate Figure 5, which presents the impulse responses from a temporary 10 percent shock to ϵ_t, the stochastic element in the Taylor Rule, (23). Such an assessment based on an adverse monetary policy shock is important not just for the robustness check (on the macroeconomic stabilization properties of police spending), but also to highlight the *financial accelerator* mechanism in our model. Following the shock, an instantaneous increase in the policy rate is expected, which given an initial level of credit risk premium, translates to an increase in the loan rate. As credit becomes relatively expensive, firms scale back on production and the hiring of resources, which then results in the decline of both final output and consumption. These are standard responses from a deflationary monetary policy. As a result of the initial responses, physical capital stock is lower (due to firms reducing their investments), and there is a decline in formal human capital investment (by individuals), *relative* to crime-specific human capital, which means the incentive to engage in criminal activities becomes higher. These, coupled with the initial increase in credit cost, cause the secondary mechanisms to take place. At the same time criminal extortion costs faced by firms gradually rise, credit risk premium charged by the commercial bank further expands (due to the collaterals available having declined, as a result of the decline in physical capital stock). In combination, the firms' real marginal cost of production not just recovers but ends up overshooting above the pre-shock level. This overshooting phenomenon is a result of the credit cost-induced financial accelerator effects, which are also reflected in the overshooting of inflation rate, as can be seen in Figure 5. As a result, the responses of the variables display a higher degree of persistence than in a situation when the crime-credit linkages are absent. Indeed, these responses appear to be robust across the sensitivity scenarios, except for one variable (crime-specific human capital). Specifically, for the crime-specific human capital, the previous observation of a "de-coupling" of the common cyclical properties of the two types of human capital under a reactionary rule regime continues to hold, as confirmed by the estimated pairwise correlations (in the benchmark, with discretionary policy we have 0.641, whereas with the reactionary rule, it is -0.652; in the case where the initial crime rate is lower, with discretionary policy we have 0.641, whereas with the reactionary rule, -0.528).

In summary, after reviewing the results associated with the three different structural shocks, the case for using a reactionary rule for the setting of police spending as a primary macroeconomic stabilization tool is weak. Nevertheless, there appears to be a need for the adoption of a rule-based approach to police spending allocation, due to such a regime consistently contributing to a "decoupling" of the common cyclical property of the two types of human capital. This is despite the rule-based regime appearing to exacerbate the financial accelerator, with the responses of the economic variables to the monetary shock being greater beyond the initial 10 periods, and the propagation process appearing to display a greater degree of inertia.

5.3 Police Spending and Monetary Policy

To examine further the rule-based approach to police spending, as well as to address the question, "*If so, how does it measure, compared to the well known monetary policy shock?*", we simulate a temporary 10 percent shock to firms' productivity, ϵ_t^A, as seen in (15). This structural shock is deliberately chosen as it is the only source of stochastic shock that is not directly originated from the education, criminal justice, or the monetary sector. We examine four sets of results that represent four different stylized "policy regimes": (i) the benchmark case where police spending allocation is purely a fraction of GDP, with no interest-rate smoothing by the Central Bank; (ii) the rule-based approach to police spending allocation, with no interest-rate smoothing by the Central Bank; (iii) police spending allocation is purely discretionary, but there is some degree of interest-rate smoothing by the Central Bank ($\varpi = 0.1$); (iv) police spending allocation is purely discretionary, but there is a high degree of interest-rate smoothing by the Central Bank ($\varpi = 0.5$). The final case illustrates a monetary authority who concentrates more on smoothing its own policy rate, and places less emphasis on the other sectors of the economy. The impulse responses of the four cases are presented in Figure 6.

While the regime with a rule-based approach to police spending shows the "decoupling" benefit again, it also imparts a greater degree of inertia to the adjustment process. This suggests that, while a rule-based police spending might be effective in supporting formal human capital investment (by smoothing out the fluctuations associated with educational quality uncertainty), as well as decoupling the cyclical properties of formal and illegal human capital accumulation, it comes at a cost of imparting greater inertia to the adjustment process. In other words, it cannot serve as a sole macroeconomic stabilization policy, but it does exhibit much stable properties (in terms of having much less fluctuations to the post-shock transitional dynamics of variables such as final output and consumption) than the benchmark case to serve as a potential secondary, supplementary policy tool to monetary policy.

6 Concluding Remarks

Motivated by a seemingly persistent '*twin-high*' phenomenon observed in Latin America (high crime rate, high financial instability), we present a novel theoretical framework that investigates the linkages between education, criminal justice, and credit to study policy-pertinent research questions, especially in regards to whether government expenditure on public order and safety (police spending, in short) has the potential to serve as an unconventional policy tool for macroeconomic stabilization, beyond its generally assumed function of crime reduction. The linkage between education and criminal justice system is obvious and in the tradition of Mocan et al. (2005), whereas three empirically consistent, original novel linkages are proposed to relate crime to credit market imperfections: (i) organized criminal extortions impose an additional "tax" on the real marginal production costs of firms, which then influences their optimal choice of the level of physical capital and workers employed. Given that firms borrow to pay their wage costs in typical Ravenna-Walsh (2005) fashion, crime therefore directly influences the demand for credit; (ii) the physical capital stock of firms is used as a collateral for loans; crime therefore also influences the component of credit risk premium that depends on the collateral; (iii) in setting their credit risk premium for the gross loan rate, on top of collateral charged, the commercial bank also accounts for the aggregate level of crime rate in the economy. The model is parameterized illustratively for a stylized middle-income Latin American economy.

Based on our analysis, the accumulation processes of formal and illegal human capital are found to share common cyclical properties, hence contributing to the persistence in crime rate in Latin America. In order for formal education to achieve its desired role in reducing crime [as suggested in Pressman (2008) and Machin et al. (2012)], there appears to be a need for the adoption of a rule-based approach to police spending allocation. Such a policy regime consistently contributes to a "decoupling" of the common cyclical properties of the two types of human capital. This suggests that, in an economy with persistently high crime rate, a more systematic fiscal allocation to expenditure on public security/police may be warranted. Nevertheless, the use of a rule-based approach does come with the cost of it imparting a greater degree of inertia to the post-shock adjustments of key economic variables, hence potentially worsening the financial accelerator effects arising from credit market imperfections. As such, a rule-based regime to police spending cannot serve as a primary macroeconomic stabilization tool, but it does have the potential to serve as a secondary, supplementary policy to monetary policy.

For future research, we acknowledge the limitations of our analysis due to the uneven quality of crime data. With longer time series, the heterogeneous nature of the different Latin American economies can be accounted for by either Bayesian-estimating the model, or applying a DSGE-vector autoregression exercise. In terms of theoretical modeling, it is also worth pointing out that neither income inequality nor other demographic factors are explored (see, for example, Fajnzylber et al., 2002), which are issues worth exploring. Indeed, our model also does not allow us to answer the question, "*Is financial friction the main explanation to Latin America's decades of financial instability, compared to other exogenous external shocks?*" However, we believe the theoretical framework developed here can serve as a basis for future empirical exercise to be implemented, in accounting for the relative importance of different economic shocks in the region.

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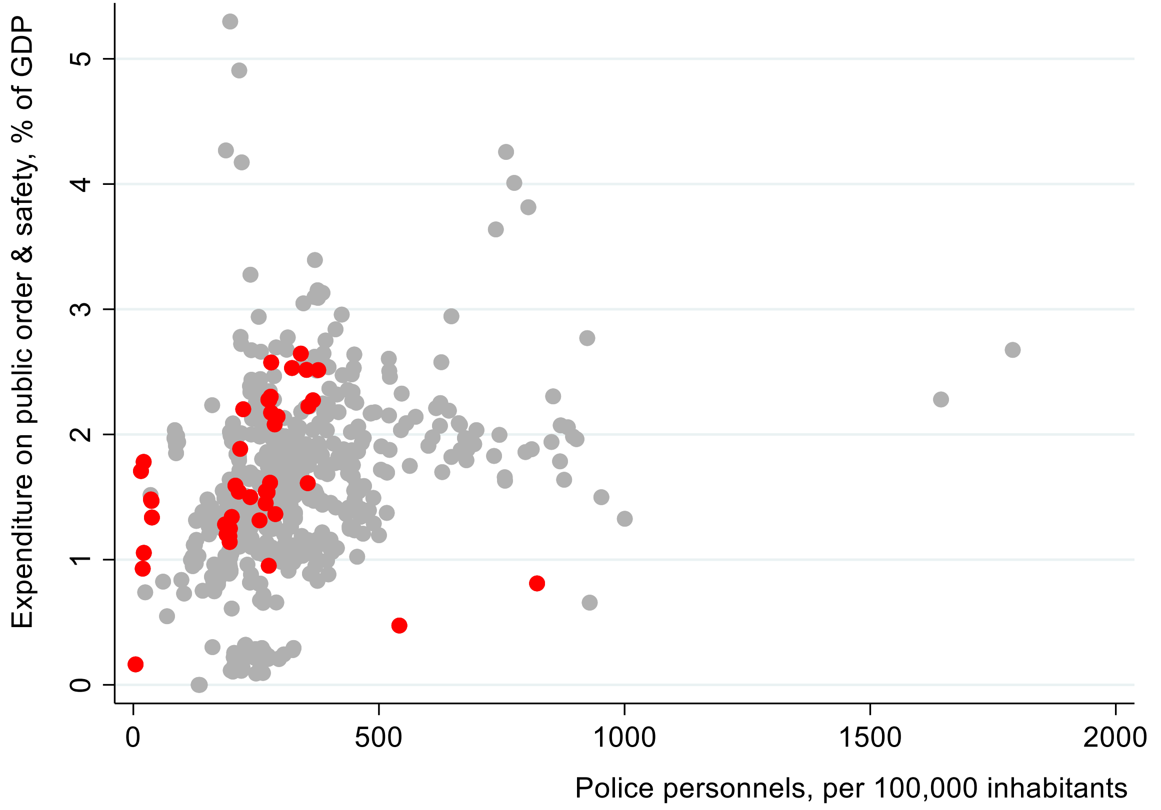
Table 1
Benchmark: Key Parameter Values

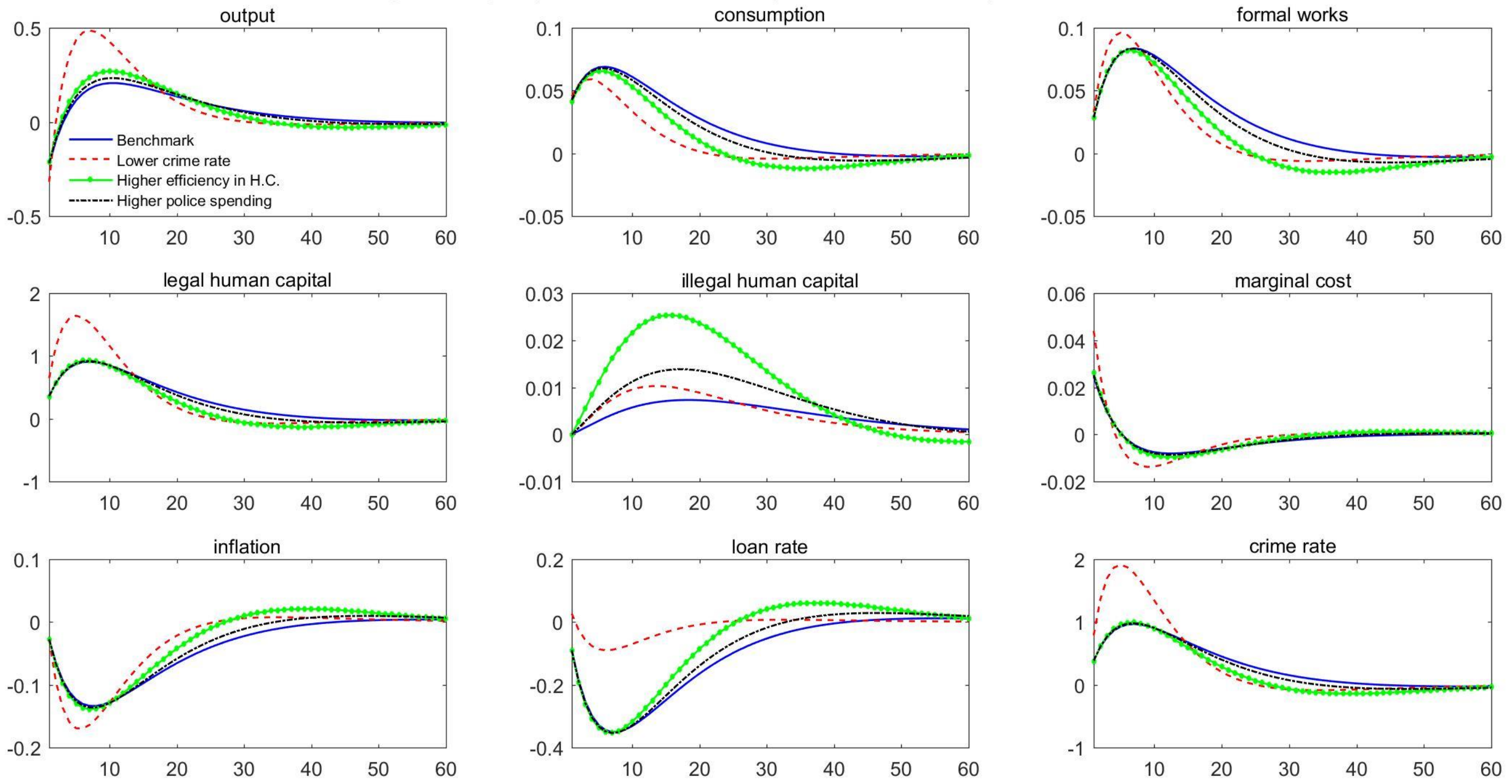
Parameter	Value	Description
		Preferences
β	0.952	Discount factor
σ	0.6	Elasticity of intertemporal substitution
η_N	1.75	Preference parameter for leisure
η_F	0.02	Preference parameter for monetary assets
υ	0.2	Share parameter in index of money holdings
		Human Capital and Crime
δ^L, δ^C	0.05	Depreciation rate, both types of human capital
$\varkappa$	0.7	Probability, escaping apprehension
Λ	0.258	Time-invariant, crime-specific human capital
Θ_0^N	0.215	Base inv. efficiency, formal human capital
Θ_0^C	0.430	Base inv. efficiency, crime-specific h.capital
		Production
ς	2.43	Elasticity of demand for intermediate goods
α	0.35	Share of physical capital, intermediate goods
δ^K	0.02	Depreciation rate, physical capital
		Commercial Banks and Loans
κ	0.2	Effective collateral-loan ratio
ϕ_1	0.05	Elasticity of repayment prob, collateral
ϕ_1	0.05	Elasticity of repayment prob, crime rate
η_{L_q}	1.0	Interest elasticity of loan demand
q_0	0.2	Base repayment probability
Ψ_0	0.815	Parameter, risk premium for loan
		Central bank
μ	0.1	Reserve requirement ratio
ϖ	0.0	Degree of interest rate smoothing
ϵ_1	1.5	Response of policy rate to inflation deviations
ϵ_2	0.2	Response of policy rate to cyclical output
		Government
τ_K	0.2	Tax rate, physical capital income
τ_N	0.2	Tax rate, labor income
υ_O	0.167	Gov. consumption parameter, % of GDP
υ_P	0.0157	Spending on public order & safety, % of GDP
ψ_1	0.1	Parameter, responsiveness to crime rate

Figure 1
Government Expenditure on Public Order & Safety, and Number of Police Personnel, 1990-2014



Notes: Red dots denote observations Note: for Latin American economies. The expenditure data are obtained from IMF Government Finance Statistics, whereas the police personnels data are obtained from the United Nations Survey of Crime Trends and Operations of Criminal Justice Systems (UN-CTS).

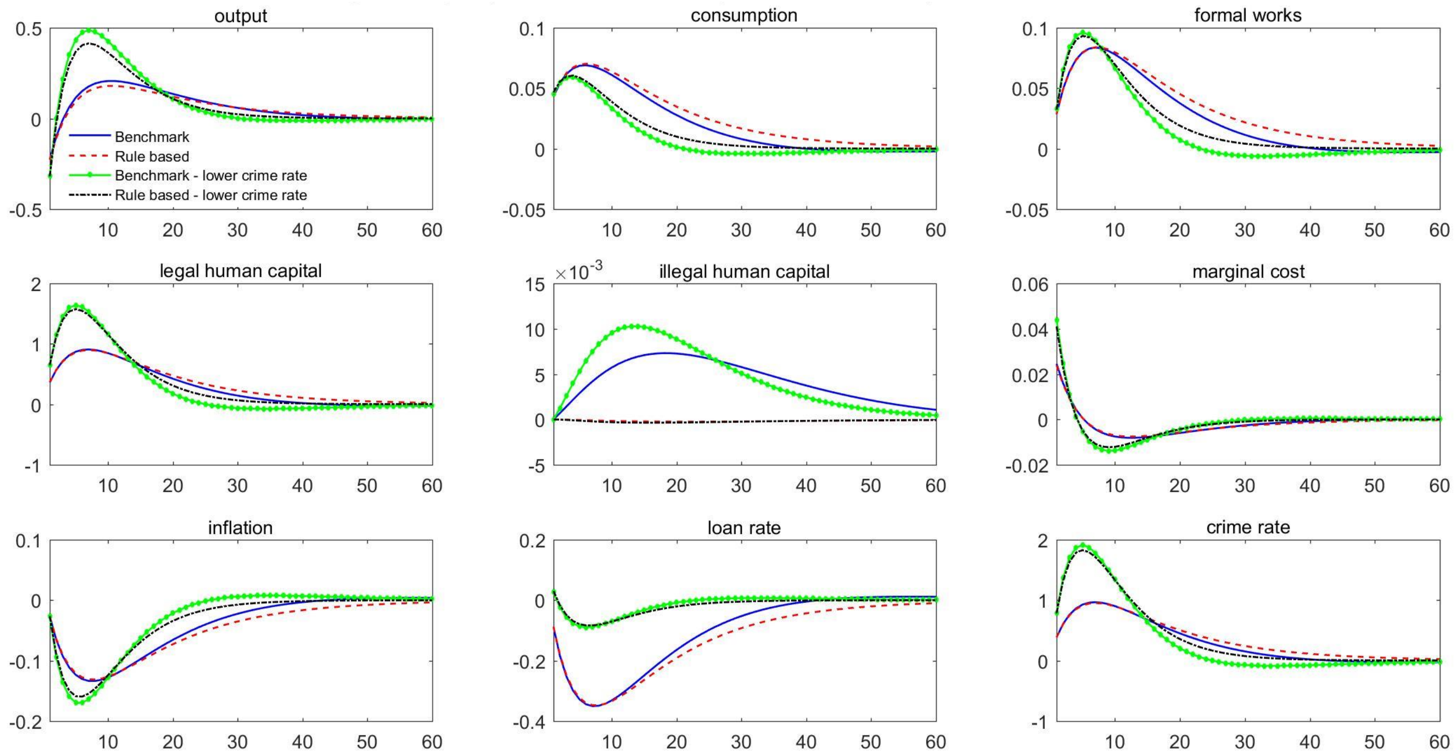
Figure 2: Temporary shock in formal human capital investment efficiency, Benchmark



Note: All lines denote the absolute deviations of the variables from their respective steady-state values, following a temporary 10 percent standard deviation shock to formal human capital investment efficiency.

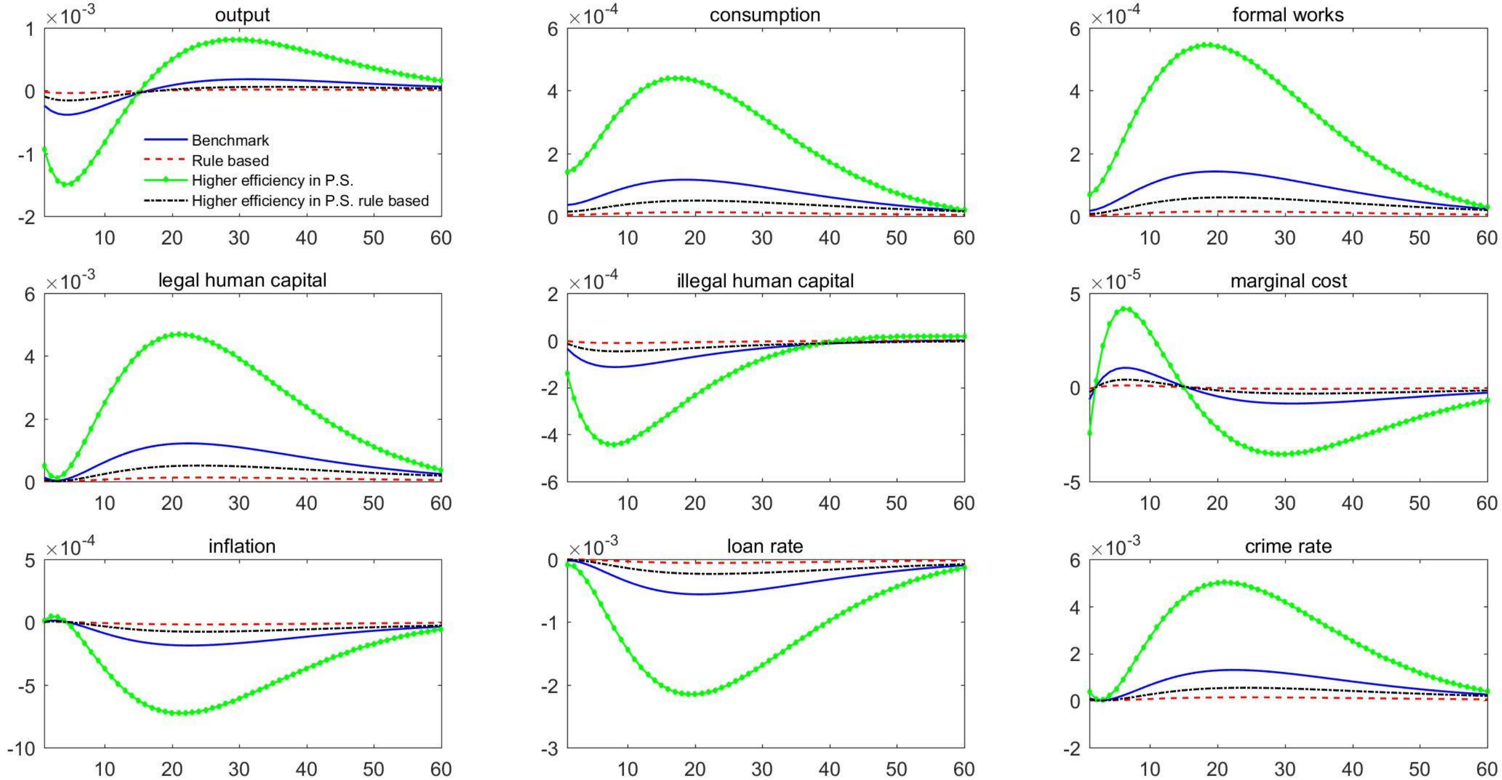
Figure 3: Temporary shock in formal human capital investment efficiency,

Rule versus Discretion



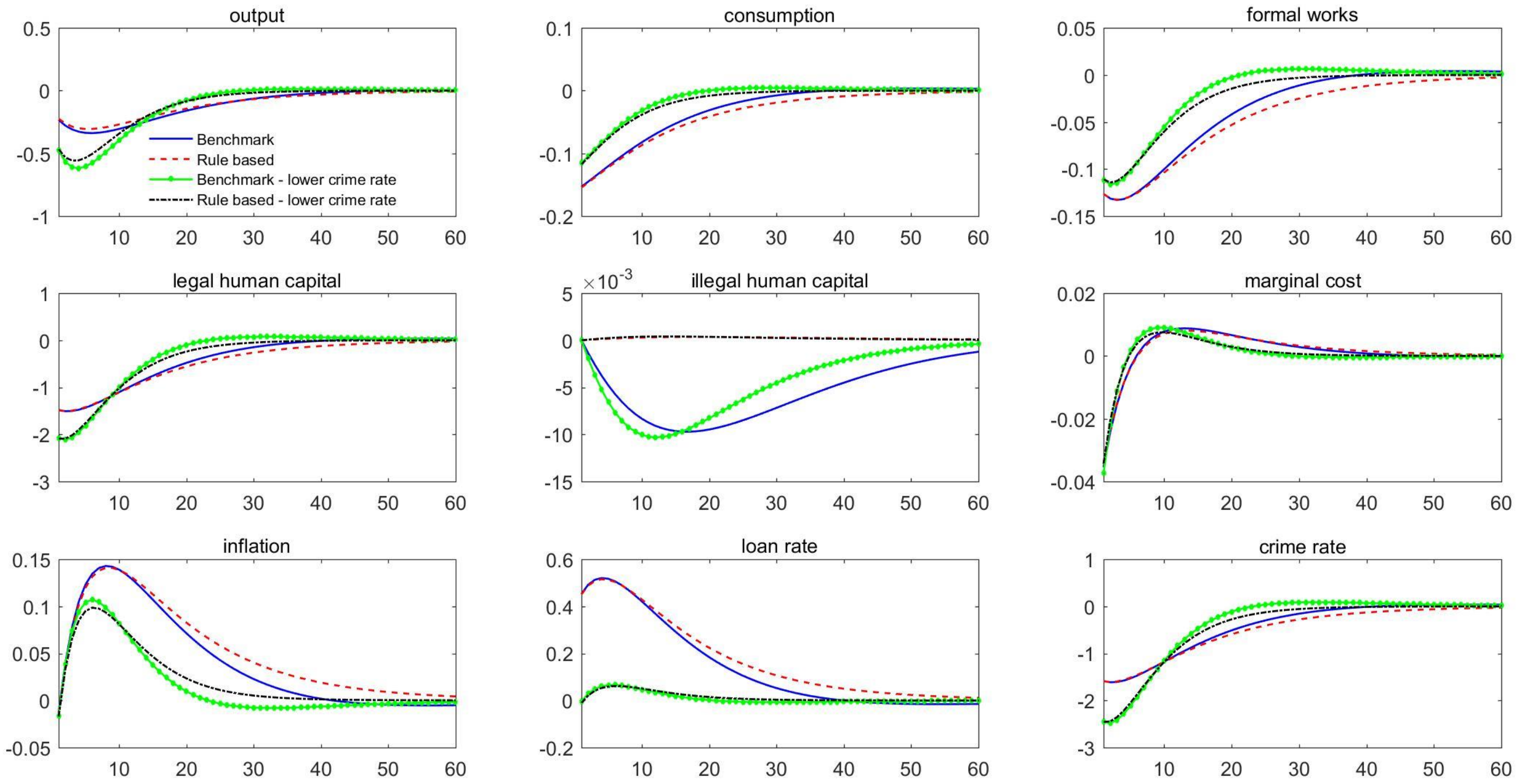
Note: All lines denote the absolute deviations of the variables from their respective steady-state values, following a temporary 10 percent standard deviation shock to formal human capital investment efficiency.

Figure 4: Temporary shock in crime-specific human capital investment efficiency



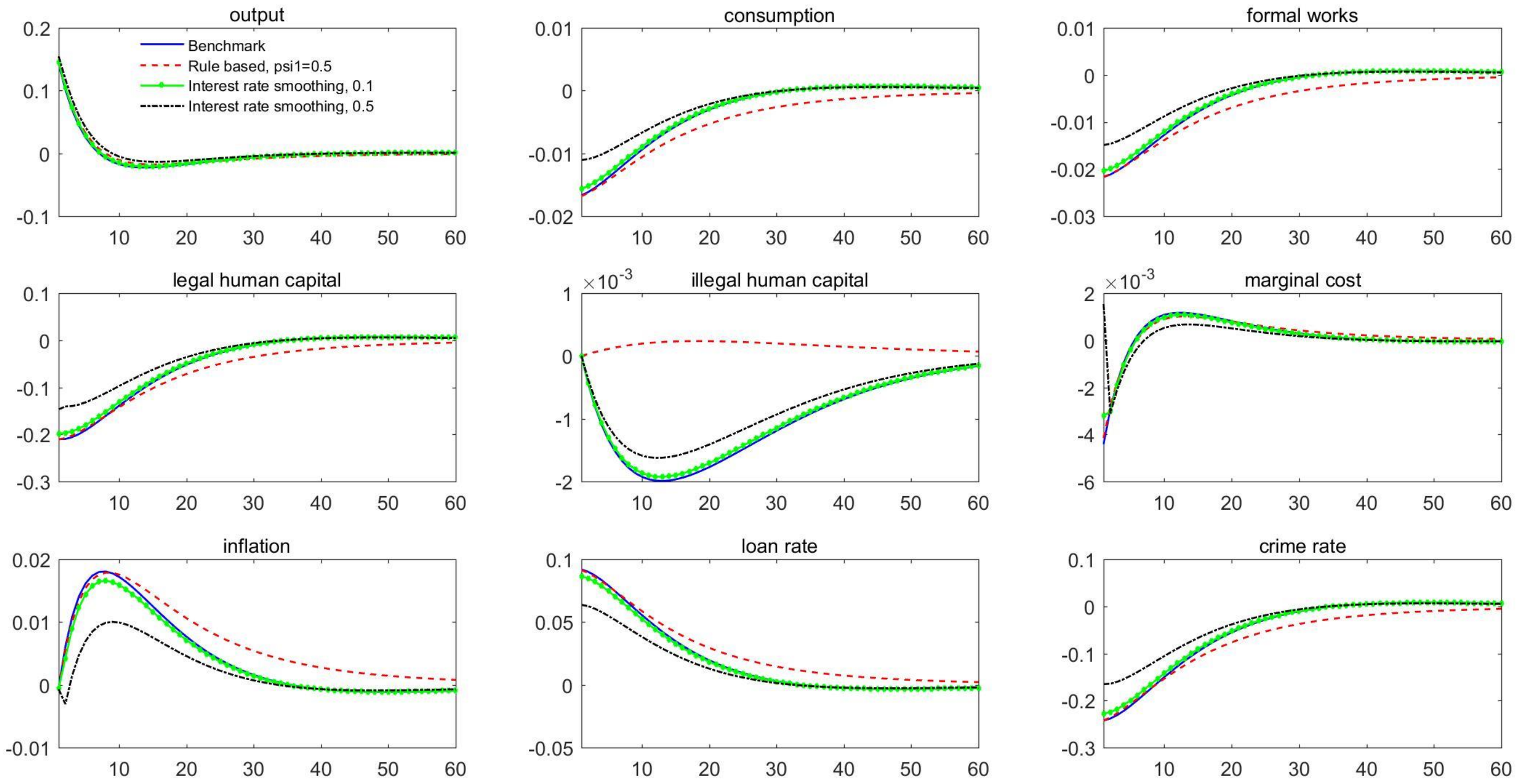
Note: All lines denote the absolute deviations of the variables from their respective steady-state values, following a temporary 10 percent standard deviation shock to crime-specific human capital investment efficiency.

Figure 5: Temporary shock in monetary policy rate-setting



Note: All lines denote the absolute deviations of the variables from their respective steady-state values, following a temporary 10 percent standard deviation shock to the Taylor Rule equation for monetary policy-setting.

Figure 6: Temporary shock in productivity



Note: All lines denote the absolute deviations of the variables from their respective steady-state values, following a temporary 10 percent standard deviation shock to the firms' productivity.