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Money Laundering in a Two Sector Model: Using Theory for Measurement

Amedeo Argentiero, Michele Bagella and Francesco Busato

Money laundering in a two-sector model: using theory for measurement[1]

Amedeo Argentiero[2] Michele Bagella[3] Francesco Busato[4]

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This paper implements a methodology that exploits firms and households' optimality conditions to measure money laundering for the Italian economy. This approach, first implemented by Ingram, Kocherlakota, and Savin (1997) to the household production sector, and by Busato, Chiarini and Di Maro (2006) for measuring the underground economy, allows to generate high frequency time-series for money laundering using a theoretical two-sector dynamic general equilibrium model calibrated over the sample 1981:01-2001:04. The analysis of the generated series suggests two main results. First, money laundering accounts for approximately 12 percent of aggregate GDP; second, money laundering is more volatile than aggregate GDP and it is negatively correlated with it.

Keywords and Phrases: Money Laundering; Two-sector dynamic general equilibrium model; Illegal economy.

JEL Classification Numbers: E26, E32, K40.

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[2]University of Rome ``Tor Vergata", Department of Economics and Institute for Study and Economic Analysis (I.S.A.E.), Italy.
[3]University of Rome ``Tor Vergata", Department of Economics
[4]Corresponding Author. University of Naples Parthenope, Dipartimento di Studi Economici; University of Aarhus, School of Economics and Management, Denmark; Via Medina, 40, 80133 Napoli, Italy; email: busato@uniparthenope.it and fbusato@econ.au.dk .

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1. Introduction

Money Laundering (ML, in the sequel) is the process by which criminal organizations try to disguise the criminal origin of a sum. In this sense ML is a by-product of criminal economy, which all over the world has a size of approximately 5% upon the world GDP (Napoleoni, 2005). Therefore, a correct measure of ML may help to infer more accurately what is the dimension of criminal economy and, favorably, what are the criminal actions from which the resources to be laundered are generated. Such information would be also important for contrasting these illegal activities.

The International Monetary Fund has stated in 1996 that the aggregate size of money laundering in the world could be somewhere between two and five percent of the world's gross domestic product. In the previous ten years (1997-2006) the magnitude of total *discovered* money laundering in Italy has represented the 0.1% upon the present GDP.[5] The dataset, from which these results are extracted, is constructed by considering, for the entire sample, the kinds of goods used to launder money, the sort of penal violations contested and for each transgression is indicated the amount of money laundered. [6] The economic goods mainly used in Italy to conceal the illicit origin of a sum have been: jewellery, foreign currencies, bank deposits, shares of quoted companies and real estates.

Nevertheless, this figure hardly corresponds to the actual value of ML; in Italy, as well in the majority of developed countries. judicial authorities find very hard both to detect ML transactions and to sentence definitively convicted guilty subjects.[7] Hence, the repression activity has been accompanied with prevention acts represented by anti-money laundering regulation.[8] The conception of specific anti-money laundering rules can be related to the awareness of a strong expansion of illegal markets also in a framework of liberalization of capital markets within the EU.

The goal of a large number of criminal acts is to generate a profit for the individual or group that carries out the act. Money Laundering is a process in which assets obtained or generated by criminal activity are moved or concealed to obscure their link with the crime (IMF, 2005). This process is of critical importance, as it enables the criminal to enjoy these profits without jeopardizing their source. Masciandaro (1993) underlines how this phenomenon is structured upon two key-characteristics implied in its definition: 1) *illegality* (general feature): ML implies the use of any revenue originated by a criminal or illegal activity; 2) *concealment* (specific feature): the primary goal of ML is to hide the illegal source of such revenues.

Furthermore, Masciandaro (1999) shows theoretically how ML can be seen as a multiplier of criminal financial activities, because of its crucial role in strengthening the ties between the real and the financial side of criminal economy. Moreover, the same author highlights the

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[5]This figure is extracted from a reserved data-set kindly provided to us by the Guardia di Finanza, Nucleo Polizia Valutaria; present GDP is referred to the year 2006.

[6]In Italy there are two articles of Penal Law, that deal with the crime of Money Laundering: *648-bis and 648-ter.* The former hits the subjects, who *substitute* money or goods coming from criminal actions with other money or goods, whereas the latter is against the subjects who *employ* money or goods coming from criminal actions in economic activities.

[7]In Italy only the 5% of the total detected money-laundering transactions reach the definitive sentence. (Source Guardia di Finanza)

[8]Law n. 197/1991 can be considered as the starting point of the Italian anti-money laundering regulation.

inverse relationship between the degree of diffusion of ML activities and the effectiveness of anti-ML regulation on a given economy.

Next, Bagella, Becchetti and Lo Cicero (2001, 2004), starting from the consideration that a country which adopts a more relaxed attitude may attract an inflow of regional illegal wealth to be laundered, thus generating severe negative externalities for their neighbors, test the hypothesis of whether an effective coordination of regulation and enforcement from neighboring countries is fundamental to face this problem. They find for the five Andean Countries (Bolivia, Colombia, Ecuador, Perù and Venezuela) the existence of a relationship between loopholes of domestic legal systems and the types of ML technique adopted in a given country.

More recently, Masciandaro (2004) develops the assumption that lax financial regulation may be a strategic dependent variable for national policymakers seeking to maximize the net benefits produced by any public policy choice. Therefore, given the structural features and endowments of their own countries, policymakers may find it profitable to adopt financial regulations that attract capital of illicit origin (ML services) or destination (terrorism finance services) and thus choosing to be a non-Cooperative Country and Territories (NCCT) in money laundering and terrorist financing.

To conclude this reasoning, to obtain a reasonable understanding on ML, we obviously require its measurement. But ML is, by definition, not directly observable; in addition, the estimates produced by the econometric methods, commonly used in the literature (Frey et al.,1984, Bhattacharyya, 1999, Tanzi, 1999, Thomas, 1999), do not pass the basic statistical tests, cover a limited time-span, and are characterized by a low frequency.

Table 1 sums up how the empirical literature estimates ML, by distinguishing the implemented methodology.

TABLE 1 ABOUT HERE

Three general sets of measurement approaches may be distinguished in the literature (Schneider et al., 2000 and Zizza, 2002) for measuring unobserved variables: the *direct* approach, the *indirect* approach and the so-called *model* approach [9]. The main difficulty with these approaches is that they are generally applicable under very restrictive assumptions and that the estimation techniques tend to be not statistically robust providing a large range of estimates that significantly change with small changes in the model specification. Of course these results are not valueless. Despite their weakness, each estimate of ML constitutes a piece of information and can be useful to improve knowledge about the dimension and selected features of the phenomenon.

For all these reasons, it could be fruitful to utilize a different framework for measuring ML.

This paper implements a methodology which exploits firms and households' optimality

[9]The direct approaches are based on surveys among (supposed) suppliers and demanders of informal services and activities, or they rely on auditing of tax returns undertaken by tax collection and social security administrations. The indirect approaches share the assumption that informal transactions are paid in cash in order to make detection more unlikely. The size of the illegal economy is reflected in the amount of cash used in a country, beyond that used for official transactions. Finally, the model approaches, or MIMIC methods, (Giles, 1999) focus on the causes and the effects of illegal economy and try to estimate models for labor, money and product markets using latent variables techniques.

conditions to generate data for ML in Italy. The aim of this paper is precisely to generate a time series for ML using a theoretical two-sector dynamic general equilibrium model.

We follow the idea that unobserved series may be derived from a well-behaved theoretical model, first implemented by Ingram, Kocherlakota, Savin (1997) to the household production sector, and by Busato, Chiarini, Di Maro (2006) for measuring the underground economy. This methodology has the important advantage to produce data for these unobservable components at a high frequency (i.e. quarterly), and over a longer sample; this creates a sufficient number of observations for undertaking a proper time-series econometric analysis with the simulated data. We intend our generated series as complementary to the existing ones, estimated with classical methods.

The dynamic general equilibrium model, from which we derive the equilibrium time series for ML, contains two sectors (the regular and the criminal sectors), in which there are two agents: firms and households. In addition, the model assumes that there exist two classes of firms, producing two commodities. The former represents the regular good, whereas the latter is the one from which the money to be laundered is generated and whose main feature is the violation of Penal Law. The households operating in the regular sector are subject to a transaction cost, that is proportional to the good: we can think of this cost as the hours spent in transacting.[10] Households working in the criminal sector are instead subject to an idiosyncratic cost represented by the risk of violating the Penal Law with the possible consequences (imprisonment) in case of detection. Firms and households use the criminal sector to carry out criminal offences and ML to hide the revenues of these activities in the formal economy. In this respect, ML represents the link between the criminal economy, as a particular subset of illegal[11] economy, and the formal economy. The essential economic function of the industry of ML is to turn illegal capital into legal. Hence, it represents a transformation function of

potential purchasing power, since it cannot be directly used for consumption, investment or saving, into an effective one (Masciandaro, 1999).

The time-series for ML is then generated from closed-form equilibrium conditions.[12] The analysis focuses on the Italian economy, but the methodology can be applied, without loss of any generality, to any other country.

Here is an **overview of our results**.

The paper generates series for ML for 21 years (84 quarters), over the sample 1981:01 -- 2001:04. According to our analysis, ML accounts for approximately 12 percent of aggregate GDP, is more volatile than aggregate GDP and is negatively correlated with it.

The larger relative volatility of ML is a direct consequence of the explicit introduction of the informal sector. The propagation mechanism operating in this model is a distinctive

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[10] Wen and Love (1998) describe the hours spent in transacting by a function in which this cost is proportional to the tax rate on consumption goods and to the velocity of money in terms of consumption; moreover, they insert this cost in the utility function as an element able to reduce the leisure for the households. We follow their approach in the choice of including the transaction cost in the utility function, but we model the hours spent in transacting proportionally to the consumption of legal economy good.

[11] In what follows, we shall use the expression "criminal economy" referring to the particular subset of unobserved economy, whose activities are in contrast with Penal Law.

[12] Technically, we generate the time series of ML from the solution of the "Decentralized Economy".

characteristic of a class of two-sector models with informal economy and ML. When a shock hits one of the two sectors (for example, the regular one), it is transmitted to the other (the criminal sector), which returns an additional, smoothed impulse to the former sector. The nexus between the propagation mechanism and ML behavior is also discussed along a sensitivity analysis over the parameters.

The paper is organized as follows. The model structure, its properties and the first-order conditions with the closed form solution derived from the Decentralized Economy Problem and the explanation of our procedure for measuring ML are set out in the next section (Section 2). Section 3 describes the calibration process for the model's parameters. In Section 4, we describe the results coming from the time series generated by the model opportunely calibrated and the statistical properties of these time series. Finally, in section 5 we conclude.

2. Model's structure

The dynamic general equilibrium model that we use for measuring ML contains two sectors (the regular and the criminal sectors), in which there are two agents: firms and households. In addition, the model assumes that there exist two classes of firms, producing two different commodities. The former represents the regularly produced good, whereas the latter produces the irregular commodity, which eventually is the one from which the money to be laundered is generated. Suppose, then, that there exists a representative household, supplying labor services in both sectors and consuming both commodities. Transactions in the regular sector are subject to a transaction cost, that is proportional to the good, whereas those related to the criminal good pay a different cost, represented by the disutility of violating the Penal Law, subject to a detection probability. Firms and households use the criminal sector to carry out criminal offences and the formal economy to hide the revenues of these activities by ML.

2.1 Households

The economy is populated by a large number of identical households, each of which lives forever; households have identical preferences defined over consumption and labor inputs at every date. Assume, next, that each household allocates labor services in the regular sector and in the criminal sector (denoted with N_t and $1-N_t$, respectively)

$$U=\left(\eta\frac{C_{1,t}^{1-q_1}}{1-q_1}+(1-\eta)\frac{C_{2,t}^{1-q_2}}{1-q_2}-Bp\frac{(1-N_t)^{1+\psi}}{1+\psi}\right)-\underbrace{Z_tC_{1,t}}_{\text{the "transaction" cost}}, \quad (1)$$

where C_1 is the private consumption of the regular good (for the fraction η), that is subject to a proportional transaction cost $Z_tC_{1,t}$; C_2 represents the private consumption of the criminal good (for the fraction $1-\eta$). Finally, the latter term $Bp\frac{(1-N_t)^{1+\psi}}{1+\psi}$ represents the idiosyncratic cost of working in the criminal economy, therefore it represents a specific disutility from violating the Penal Law. The probability of being detected is defined with $0<p<1$. For the sake of simplicity we assume that labor services supplied in the regular sector do not provide disutility to the representative household. Assume, next, that capital depreciates completely.

The household can hold either cash, M , or capital. The consumer budget constraint is as follows:

$$p_{1,t}\left[K_{t+1}+C_{1,t}\right]+p_{2,t}C_{2,t}+M_{t+1}=w_{1,t}N_t+R_tK_t+\overline{w}_{2,t}\left(1-N_t\right)+M_t \quad (2)$$

$$I_t=K_{t+1}$$

In the previous expression, $p_{1,t}(p_{2,t})$ is the nominal price of $C_1(C_2)$ at t, w_1 is the nominal regular wage rate, R is the capital interest rate and w_2 is the fixed nominal irregular wage rate, whose discussion is carried out in the next section.Moreover, the following conditions hold:

$$K(0),\overline{L} \text{ are given}$$
$$C_{1,t},C_{2,t},p_{1,t},p_{2,t},N_t\geq 0$$
$$A_{t+1}=dF(A_{t+1};A_t),$$

where $A_t\left[\Lambda_t,Z_t\right]$ is a stochastic disturbances vector, that evolves according the following law of motion:

$$A'_{t+1}=\Sigma * A'_t+v_t,$$

where v_t is a vector including shocks' innovations; the autocorrelation coefficient matrix Σ and the covariance matrix Ξ are defined below:

$$\Sigma=\begin{bmatrix}\varphi_\Lambda & 0\\ 0 & \varphi_Z\end{bmatrix} \text{ and } \Xi=\begin{bmatrix}\xi_\Lambda & 0\\ 0 & \xi_Z\end{bmatrix}.$$

Next, assume that cash is needed in order to purchase both the commodities:

$$\overline{M}_t-p_{2,t}C_{2,t}<p_{1,t}C_{1,t} \text{ (Cash Constraint)}$$

where $\overline{M}(t)$ is the money supply provided by the Central Bank. As we can observe from the previous expression, the money supply provided by the central bank minus the value of criminal consumptions is not sufficient in order to buy the regular good C_1 (endogenous money rationing).

Suppose, then, that the prices are sticky in the spirit of Clower (1967), so the cash constraint dynamically binds; the revenues of legal economy cannot be used to buy both the commodities in a period different from the one in which the legal good has been produced. To exceed the Cash Constraint, a "New Money" is needed, i.e. money laundered:

$$\overline{M}_t-p_{2,t}C_{2,t}+\gamma_t\left(p_{2,t-1}C_{2,t-1}\right)=p_{1,t}C_{1,t} \quad (3)$$

where γ_t indicates the fraction of revenues of the criminal good, generated in the previous period, that is *used to buy the legal good*. The quantity $\left(1-\gamma_t\right)$, instead, indicates the fraction of revenues of the criminal good, that is *used to buy the criminal good together with the money supply provided by the central bank.*

$$(1-\gamma_t)\left(p_{2,t-1}C_{2,t-1}\right)+\overline{M}_t = p_{2,t}C_{2,t} \quad (4)$$

We are eventually interested in measuring the fraction γ_t, i.e. the fraction of money laundered, as resulting from the optimization process. The household's problem, eliminating the capital accumulation constraint, is the following one:

$$\max_{\substack{\{C_{1,t},C_{2,t}\}_{t=0}^{\infty} \\ \{M_{t+1},\gamma_t\}_{t=0}^{\infty}}} L = E_0\sum_{t=0}^{\infty}\beta^t \left\{\left(\eta\frac{C_{1,t}^{1-q_1}}{1-q_1}+(1-\eta)\frac{C_{2,t}^{1-q_2}}{1-q_2}-B\frac{(1-N_t)^{1+\psi}}{1+\psi}\right)-Z_tC_{1,t}+\right.$$

$$+\phi_{1,t}[w_{1,t}N_t++R_tK_t+M_t+\overline{w}_{2,t}(1-N_t)-p_{1,t}\left(K_{t+1}+C_{1,t}\right)-p_{2,t}C_{2,t}-M_{t+1}]+$$

$$+\phi_{2,t}[\overline{M}_t-p_{1,t}C_{1,t}-p_{2,t}C_{2,t}+\gamma_t\left(p_{2,t-1}C_{2,t-1}\right)]+$$

$$\left.+\phi_{3,t}[-p_{2,t}C_{2,t}+(1-\gamma_t)\left(p_{2,t-1}C_{2,t-1}\right)+\overline{M}_t]\right\}$$

2.2 Firms

Suppose, next, that the economy is also populated by two classes of firms, producing the two commodities. The good C_1 is produced by a constant-return-to-scale technology using labor, N, and capital, K. It can be either consumed or added to the existing capital stock. Λ represents total factor productivity. The good C_2 is also produced by a constant-return-to-scale technology using labor and fixed-quantity land, $\overline{L}$ with a constant rent $\overline{Q}$; it can only be consumed. We can think at $\overline{L}$ as a physical space where the illicit activities take place. Notice that only the firm producing legal good marginally prices its production factors (regular labor services and rented capital); on the other hand, the firm producing criminal good uses residual labor services $1-N$. As a consequence, regular labor is paid at a nominal wage w_1 and capital is paid at an interest rate R_t both equal to their nominal productivities in equilibrium, whereas criminal labor is remunerated at a fixed nominal wage $\overline{w}_2$. The profits for each kind of firm are indicated in the next two relationships; nevertheless only the legal firm maximizes its profits.

$$\Pi_{1,t} = p_{1,t}N_t^{\alpha}K_t^{1-\alpha}\Lambda_t - w_{1,t}N_t - R_tK_t \quad (5)$$

$$\Pi_{2,t} = p_{2,t}(1-N_t)^{\xi}\overline{L}^{1-\xi}\Lambda_t - \overline{w}_{2,t}(1-N_t) - \overline{Q}\overline{L} \quad (6)$$

2.3 Equilibrium characterization

The first-order conditions for an interior optimal path for the households are given by (7)-(12):

$$C_{1,t} : \eta C_{1,t}^{-q_1} - Z_t = \phi_{1,t} p_{1,t} + \phi_{2,t} p_{1,t} \quad (7)$$

$$C_{2,t} : (1-\eta) C_{2,t}^{-q_2} = \phi_{1,t} p_{2,t} + \phi_{2,t} p_{2,t} + \phi_{3,t} p_{2,t} \quad (8)$$

$$N_t : BP(1-N_t)^{\psi} + \phi_{1,t} w_{1,t} = \phi_{1,t} \overline{w}_{2,t} \quad (9)$$

$$K_{t+1} : p_{1,t} \phi_{1,t} = \beta^t E_t \phi_{1,t+1} R_{t+1} \quad (10)$$

$$M_{t+1} : \phi_{1,t} = \beta^t E_t \left(\phi_{1,t+1}\right) \quad (11)$$

$$\gamma_t : \phi_{3,t} = \phi_{2,t} \quad (12)$$

and the two transversality conditions are the following:

$$\lim_{T \to \infty} \beta^T \phi_{1,t} K_T = 0 \quad (13)$$

$$\lim_{T \to \infty} \beta^T \phi_{2,t} M_T = 0 \quad (14)$$

The first-order conditions for the legal firm are summarized in the next two relationships:

$$w_{1,t} = p_{1,t} \alpha N_t^{\alpha-1} K_t^{1-\alpha} \Lambda_t \quad (15)$$

$$R_t = (1-\alpha) N_t^{\alpha} K_t^{-\alpha} \Lambda_t \quad (16)$$

After some algebra, we obtain the following expression for the quantity γ_t, which represents the "optimal fraction of Money Laundered", normalizing the price of the criminal commodity, i.e. $p_{2,t} = 1$ [13]:

$$\gamma_t = \frac{1}{2}\left(\frac{p_{1,t} C_{1,t}}{\left[\frac{BP(1-N_{t-1})^{\psi}}{\left(w_{1,t-1} - \overline{w}_{2,t-1}\right)(1-\eta)} + \left(2 \frac{\eta C_{1,t-1}^{-q_1} - Z_{t-1}}{p_{1,t-1}}\right) \frac{1}{(1-\eta)} \right]^{-\frac{1}{q2}}} + 1 \right) \quad (17)$$

where

$$w_{1,t-1} = p_{1,t-1} \alpha N_{t-1}^{\alpha-1} K_{t-1}^{1-\alpha} \Lambda_t$$

The equation (17) shows that the optimal share of money laundered depends on the labor services allocated to sector 1, on the labor services allocated to sector 2 and on the prices and on the quantities of both the goods.

[13] The analytical calculations are reported in the Appendix.

2.4 The measurement of money laundering

The model presented in this section, via the optimal inter-temporal and intra-sectoral behavior of the agents, is capable to generate values for ML. Although we do not use statistical inference (observed data to draw conclusions about the population from which the data came), the data (provided and estimated) and the process that generates them may be useful sources of information and comparison among the various estimates of ML.

The first application of the methodology implemented in this paper is due to Ingram, Kocherlakota and Savin (1997) (IKS). They study the cyclical behavior of home production under the motivation that without a good knowledge of the home sector it is not possible to fully understand the business cycle. Their seminal approach follows from the fact that data for home-sector activities are not available at high frequencies (at best they are available yearly). In brief, IKS use macroeconomic theory in conjunction with aggregate macroeconomic data to infer the behavior of unobserved home-sector variables.

In particular, IKS consider a representative agent with stable preferences but stochastic production technologies in the home and market sectors. Then, they assume that observed market variables are well measured and consistent with the optimal behavior of this representative agent. Accordingly, they use the representative agent's first order conditions to generate quarterly series for the home-sector variables.

Busato, Chiarini and Di Maro (2006) construct a measure for the underground production over the sample 1970:01-2001:04, using the same methodology.

This paper specializes this approach to the measurement of an important phenomenon of the criminal sector: ML.

To summarize, our procedure for measuring money laundering consists of two main parts. **First**, we use prediction from theory; in particular, we use the representative consumer's optimality conditions to derive an equation that expresses the variable in which we are interested (ML) as a function of observable and estimated variables. **The second** step is to use the observable and the estimated data to generate the not directly observable variable.

3. Calibration

The model is parametrized for the Italian economy over the sample 1981:01-2001:04. All quantities in the right hand side of equation (17) are observable or previously estimated; **Table 2** describes the observable and estimated data that need to be used for generating the series of ML.

TABLE 2 ABOUT HERE

The nominal prices of the legal commodity $p_{1,t}$ is calibrated with the consumer price index. Next, the regular consumption flow $C_{1,t}$ is calibrated with the corresponding national consumption time series. To provide an estimation of the criminal wage $\overline{w}_{2,t}$, we have applied the Italian average estimation of the "value added" of criminal economy to the entire

sample, which is estimated in one hundred billions of euro[14]. Total factor productivity A is calibrated by converting the series on Italian total factor productivity from an annual frequency to a quarterly frequency.

In order to calibrate the quantity K_t, we use the series of gross fixed investments, according to the theoretical hypothesis of our model of no capital depreciation. The regular labor share N_t is then calibrated with the employment rate of all sectors.

The transaction cost Z_t for the regular good $C_{1,t}$ is set equal to 0.2, which is the present legal tax rate for the VAT[15] in Italy, for the entire sample[16].

The generated series of ML, as a share of aggregate output is computed relying on the following parametrization: capital share α is set to 0.17 and the elasticities of intertemporal substitution for the commodities q_1 and q_2 are respectively set equal to 0.99 and to 0.01 in order to have a stable solution; labor supply parameters follow the analysis of Blundell and MacCurdy (1999), whereas the disutility parameters are calibrated to match volatilities of aggregate labor and investment and in order to have a stable solution. Precisely, we calibrate ψ =1.60, ξ =0.04, the probability of being detected is set to *p=0.03* following Busato and Chiarini (2004), while B =300 represents the very large risk associated to criminal activities. Furthermore, we have supposed a weight of regular consumption η equal to 0.9 in the representative agent's utility function.

Because the model does not provide a description of the trends in the series, we focus on the cyclical component by using the Hodrick and Prescott filter.

4. Numerical results

4.1 Generated series for money laundering

Figure 1 includes a plot for the generated series for ML share of GDP using the equilibrium condition theoretically derived in the model's section

FIGURE 1 ABOUT HERE

A casual inspection of the generated series presented in the figure suggests that the ratio $\frac{ML}{GDP}$ slightly increases by the end of year 1992 and has a sudden jump in the year 1993 with a stable increasing trend for the successive years. How can this structural break in the generated time series be explained?

This structural break can be interpreted as the natural consequence of the European process of the capital liberalization; it started in Italy with DPR 148/1988 and reached its maximum expression with the Maastricht Treaty, which became effective in the fourth quarter of the year 1993. In fact, capital liberalization enhances the phenomenon of ML, creating new channels to hide the illicit origin of a sum.

[14]Source: *Il Sole 24 ore* based on OECD data
[15]Without loss of generality, we can consider the VAT as the most important transaction cost on consumption.
[16]The legal tax rate for the VAT in Italy in the considered sample has remained almost fixed at a level of 20%.

Table 3, next, presents selected statistics for the baseline series over the entire sample (1981:01-2001:04, first row), and over four sub-samples.

TABLE 3 ABOUT HERE

The table shows that ML accounts on average for approximately 12.17 percent of aggregate GDP, that is much more volatile than aggregate GDP (its relative standard deviation is on average almost three times larger than that of aggregate GDP), and that it is negatively correlated with the latter quantity.

Next, it is interesting to focus on two distinctive characteristics of the generated series: the negative relationships with aggregate GDP (see Section 4.1.a), and the larger volatility of ML compared to GDP (see Section 4.1.b.).

4.1.a Money Laundering and aggregate GDP

The relationship between ML and the aggregate economy is an interesting and debated topic we can address in this context[17]. The paper directly compares ML series with the aggregate (regular) GDP both generated by the model.

A priori it is not possible to determine the sign of the relationship between ML and aggregate (regular) GDP. ML is a criminal action to hide the revenues of a crime in a regular sector. The same definition of ML would suggest that when production in the regular sector increases (i.e. regular GDP increases), so does ML. Hence, this interpretation would support a positive correlation between the two quantities, because the increase of GDP would enhance the destination of ML. But we think there might be an alternative interpretation for this result. Precisely, we can think that a relatively larger GDP could mean bigger opportunities, better life conditions and so a deterrent to belong to the criminal organizations. In this respect criminal activities would be seen as a “buffer” that economic agents use in “bad times”. Therefore, this conjecture would suggest a negative correlation between GDP and ML, because the increase of GDP could destroy the origin of ML.

The combined use of a theoretical model and observable data, presented in this paper, contributes to shed light on the economic forces driving the correlation between ML and aggregate (regular) GDP. We think that, from a theoretical perspective, a negative correlation scenario is relatively more reasonable economically, because although an increasing regular sector would mean more chances to launder money, there exist idiosyncratic costs both from working into the criminal sector (the lack of social security contribution, of social insurance) and from laundering money (penal sanctions) which make them relatively more costly than the regular economy.

Therefore when the benefits of belonging to the regular economy increase (i.e. a positive phase of the business cycle), criminal economy is expected to weaken and so does ML. Moreover, we know from the Money Theory (Fisher, 1933), that money growth is increasing with the economic growth; therefore, in positive (negative) phases of the business cycle, money growth increases (decreases) and so decreases (increases) the phenomenon of money rationing emphasized in the Cash Constraint, that generates "the channel of ML" as a new

17 For a study of the relationship between underground economy and aggregate fluctuations see Benhabib et al. (1991) and Conesa et al. (2001).

endogenous money supply. In addition, the parametrization exercise precisely confirms this intuition; the calibrated values for the parameters and for the observable and estimated variables lead to a negative correlation between regular GDP and ML.

Concerning the dynamic behavior over the four sub-samples, the mean slowly increases from 7.11 percent in 1981-85 to 8.54 percent in 1986-1990, and finally quickly increases to 17.35 in 1996-2001, due to the liberalization of capital market legislation. The predicted correlation, then, is negative in all sub-samples, with the exception of 1996-2001, and its absolute value tends to increase from the first two sample periods to the third one (correlations passes from a low value of -0.08 in 1981-85 to a very high value -0.47 in 1991-1995). The sudden positive rise (correlation equals 0.38) in the last sub-sample could be explained with the increase in the last years of the phenomenon of capital market liberalization all over the European Union, which represents a fertile *humus* for hiding resources coming from criminal economy, even though the business cycle is in an expansive phase.

The counterciclycality of ML is an interesting result because it suggests that the phenomenon of ML is more dangerous when the economy is in depressive phase. Hence, during a negative business cycle the anti-ML controls should be more frequent.

The theoretical predictions and the above economic intuition are also confirmed by a casual inspection of the parallel dynamic behavior of ML and regular GDP generated by the model. Following this intuition, **Figure 2** compares the Hodrick-Prescott series of the generated money laundering with the corresponding regular GDP.

FIGURE 2 ABOUT HERE

A causal inspection of the figure suggests that ML (dashed line) is negatively correlated with regular GDP (solid line) for the majority of the analyzed periods; in particular, we can observe a multiplicative effect, for which when GDP goes up (down), ML goes lower (upper).

The negative correlation between ML and GDP generated by our model is consistent with the empirical results of Quirk (1996), whose empirical tests conducted on the relationship between GDP growth and ML in 18 industrial countries found evidence that significant reductions in annual GDP growth rates were associated with increases in the laundering of criminal proceeds in the period 1983-90

4.1.bVolatility of money laundering

As anticipated, the larger relative volatility of ML is a direct consequence of the explicit introduction of the criminal sector combined with the ML mechanism. The propagation mechanism operating in this model is a distinctive characteristic of a two-sector model with an illegal economy.[18] Indeed, its introduction into a stochastic growth model does not affect either the slope of labor demand and supply schedule, or the elasticity of output to shocks,

[18]King and Rebelo (1999) identify four mechanisms that substantially amplify productivity shocks and lead to stronger co-movements of the main variables. The first one makes output respond more elastically to productivity shocks, the second and the third ones rely on a larger elasticity either of the labor demand or the labor supply, while the fourth is based on the non-separability between consumption and leisure (or labor) into the utility function

but introduces a propagation mechanism triggered by the reallocation of labor services between the two sectors. When a shock hits one of the two sectors, it is transmitted to the other, which returns an additional, smoothed, impulse to the former sector.

4.2 Sensitivity Analysis

This section explores the qualitative and quantitative robustness of our results to changes in the six calibrated parameters ψ , BP , ξ , η , q_1, q_2 and α . The quantities ψ and BP are respectively the elasticity of utility function with respect to criminal labor supply schedule and the share of disutility deriving from undertaking a criminal activity. The quantities ξ and α represent, instead, the elasticity of criminal production to criminal labor and the elasticity of regular production to regular labor respectively.

We consider a +/- 5 percent variation in each parameter value; the tables below present the results, and the discussion below outlines the main points[19].

TABLES 4 ABOUT HERE

The volatility of ML with respect to the one of regular GDP is substantially invariant to changes in deep parameters, i.e. the utility function parameters, with the exception to a variation for the elasticities of intertemporal substitution of the two commodities q_1 and q_2 whose respective variation determines a little contraction in the relative volatility.

Also the average value of $\frac{ML}{GDP}$ and the correlation between regular GDP and ML are not sensitive to perturbation in deep parameters, with the exception to a variation for the elasticities of intertemporal substitution q_1 and q_2 , whose respective variation determines a consistent contraction in the ratio $\frac{ML}{GDP}$.

Yet, the model is sensitive to perturbations in the parameters of the production functions: a small positive (negative) variation in the elasticity of criminal production to criminal labor generates a strong positive (negative) variation in the average ratio $\frac{ML}{GDP}$; moreover, a small positive (negative) variation in the elasticity of regular production to regular labor generates a strong positive (negative) variation in the average ratio $\frac{ML}{GDP}$ and a positive (negative) variation in the relative standard deviations. Therefore both an increase (a decrease) in the elasticity of substitution of the regular labor in the regular production and an increase (a decrease) in the elasticity of substitution of the criminal labor in the criminal production generate an increase (a decrease) (on average) in the phenomenon of ML with respect to regular GDP.

In general, results are qualitatively robust to deep parameter's changes. Most importantly, the negative correlation with aggregate GDP is always preserved, as well as the larger volatility compared to aggregate GDP.

[19] We consider only variations that lead to an economic meaningful value of the parameters, i.e. we do not consider a negative value for the elasticities.

5. Conclusions

This paper suggests a further method based on a theoretical model that could be useful for generating otherwise unobservable quantities relying on observable and estimated variables. We apply this technique to the analysis of the phenomenon of "ML". We see this methodology as being complementary to the standard estimation techniques.

From a technical perspective, the paper derives equilibrium expressions for the unobservable quantities (i.e. ML) from a dynamic general equilibrium model; these quantities depend on observable and estimated quantities. The generated series is structurally and dynamically consistent with the behavior of the realizations of the other aggregate macro variables (consumption, investment and capital stock, prices and factor productivity).

We think that a model designed to be consistent with theoretical technologies and preferences would produce the sort of data and relative fluctuation characteristics that we associate with the phenomenon under investigation. Of course we assume that the specification of technologies and preferences are tied to basic observation for the economy of interest, although the parameter calibration process is, itself, linked to the theoretical framework.

Unobservable behavior can be explained and tested using market behavior. If this is true, then we can use the first order conditions of representative individual in the market sectors to determine the implications for the unobservable behavior. In this way we may describe the latter translating the solution (and numbers) on market activity in the economy into solutions (and numbers) for criminal activities. This is an experiment and, following Lucas (1980), we believe that the only place we can perform experiments is in structural models: fully articulated economic systems that can serve as laboratories to test out aspects that would be prohibitively difficult to experiment in actual economies.

Using macroeconomic theory and aggregated data for inferring ML behavior does not mean that analyses approached from a different perspective are useless. On the contrary, the aim is to provide a set of benchmarks related to well behaved preferences and production technologies in the market and informal sector. Thus, the theoretical approach is an alternative one that does not serve to reject econometric techniques and estimates but, rather it may constitute a spur towards their higher standards.

References

1. Bagella M., Becchetti L. and Lo Cicero M., 2004, Regional Externalities and Direct Effects of Legislation against Money Laundering: A Test on Excess Money Balances in the Five Andean Countries, Journal of Money Laundering Control, Vol.7 no.4, 347-366.
2. Bagella, M., Becchetti, L., Lo Cicero, M., 2001, Esternalità Regionali ed Effetti Economici della Regolamentazione contro il Riciclaggio, VI Rapporto Fondazione Rosselli, Dalla banca alla eurob@nk: nuovi mercati e regole, Ed. Edibank, Vol 2, 35-58.
3. Bhattacharyya D. K., 1999, On the Economic Rational of Estimating the Hidden Economy, Economic Journal, 109, 348-359.
4. Benhabib J., R. Rogerson and R. Wright, 1991, Homework in Macroeconomics: Household Production and Aggregate Fluctuations, Journal of Political Economy 99, 1166-1187.
5. Blundell R. and T.E. MaCurdy, 1999, Labor supply: a review of alternative approaches, Handbook of Labor Econmics, 3A, Elsevier Science, Amsterdam.
6. Busato F. and B. Chiarini, 2004, Market and underground activities in a two sector dynamic equilibrium model, Economic Theory, 23, 831-861.
7. Busato F., B. Chiarini and V. Di Maro, Using theory for measurement: an Analysis of the Behaviour of Underground Economy Working Paper, Aarhus University.
8. Clower, R. W. 1967. A Reconsideration of the Microfoundations of Monetary Theory, Western Economic Journal, vol. 6, 1--9
9. Conesa J.C., C.D. Moreno, J. E. Galdón Sánchez, Underground economy and aggregate fluctuations, Spanish Economic Review, Volume 3, Issue 1, Mar 2001, Pages 41 -- 53
10. FATF-GAFI (2006), Trade Based Money Laundering, available on the website http://www.fatf-gafi.org/dataoecd/60/25/37038272.pdf
11. Fisher, Irving (1933) "The Debt-deflation theory of Great Depressions" Econometrica, Vol. 1, no.4, 337-57.
12. Frey, B.S. and Weck-Hanneman, H., 1984, The hidden economy as an unobserved variable, European Economic Review, 26, pp. 33-53
13. Giles D., 1999, Measuring the Hidden Economy: Implications for Econometric Modelling, Economic Journal, 109, F370-80.
14. King R.G. and S.T. Rebelo, 1999, Resuscitating real business cycles, in Taylor J.B. and Woodford M. (eds.), Handbook of Macroeconomics Vol.1 (Elsevier Science, Amsterdam).
15. Ingram B.F., N.R. Kocherlakota and N.E. Savin, 1997, Using theory for measurement: An analysis of the cyclical behavior of home production, Journal of Monetary Economics, 40, 435-456.
16. International Monetary Fund (I.M.F.), 2005, The IMF and the Fight against Money Laundering and the Financing Of Terrorism, available on the website http://www.imf.org/external/np/exr/facts/aml.htm
17. Lucas R.E. Jr., 1980, Methods and problems in business cycle theory, Journal of Money, Credit and Banking, 12, pp. 696-715
18. Masciandaro D. (1993): Analisi economica della criminalità, teoria della regolamentazione e riciclaggio finanziario, in Mercati illegali e mafie, Zamagni S. (a cura di), Il Mulino, pp. 243 -- 297.
19. Masciandaro D. (1999), Money Laundering: the Economics of Regulation, European Journal of Law and Economics, n.3, May, pp 245 - 240.
20. Masciandaro, D. (2004), "Combating Black Money: Money Laundering and Terrorism Finance, International Cooperation and the G8 Role". Università di Lecce Economics Working Paper No. 56/26.

21. Napoleoni, L., 2005, Terrorismo S.p.a., ed. Tropea.

22. Quirk, P. (1996), Macroeconomic implications of money laundering, IMF working paper WP/96/66, Washington, DC.

23. Schneider F. and D. Enste, 2000, Shadow Economies: Size, Causes, and Consequences, Journal of Economic Literature XXXVIII, 77-114.

24. Tanzi V., 1999, Uses and Abuses of Estimates of the Underground Economy, Economic Journal, 109, 338-47

25. Thomas J.J., 1999, Quantifying the black economy: 'measurement without theory' yet again?, Economic Journal 109, 381-89.

26. Wen, J.F., Love, D.R.F., 1998, Evaluating Tax Reforms in a Monetary Economy, Journal of Macroeconomics, 20, 3, 487-508

27. Zizza R., 2002, Metodologie di stima dell'economia sommersa: un'applicazione al caso italiano, mimeo, Banca d'Italia.

6. Appendix: derivation of the "optimal fraction of money laundered"

From the first-order conditions for an interior optimal path, we obtain the following expressions:

$$C_{1,t} : \eta C_{1,t}^{-q_1} - Z_t = \phi_{1,t} p_{1,t} + \phi_{2,t} p_{1,t} \quad (18)$$

$$C_{2,t} : (1-\eta) C_{2,t}^{-q_2} = \phi_{1,t} p_{2,t} + \phi_{2,t} p_{2,t} + \phi_{3,t} p_{2,t} \quad (19)$$

$$N_t : BP(1-N_t)^{\psi} + \phi_{1,t} w_{1,t} = \phi_{1,t} \overline{w}_{2,t} \quad (20)$$

$$K_{t+1} : p_{1,t} \phi_{1,t} = \beta^t E_t \phi_{1,t+1} R_{t+1} \quad (21)$$

$$M_{t+1} : \phi_{1,t} = \beta^t E_t \left(\phi_{1,t+1}\right) \quad (22)$$

$$\gamma_t : \phi_{3,t} = \phi_{2,t} \quad (23)$$

From the relationships (18), (19) and (23) we obtain:

$$\phi_{1,t} + \phi_{2,t} = \frac{\eta C_{1,t}^{-q_1} - Z_t}{p_{1,t}} \quad (24)$$

$$\frac{(1-\eta) C_{2,t}^{-q_2}}{p_{2,t}} = \frac{\eta C_{1,t}^{-q_1} - Z_t}{p_{1,t}} + \phi_{2,t} \quad (25)$$

$$\phi_{2,t} = \frac{(1-\eta) C_{2,t}^{-q_2}}{p_{2,t}} - \frac{\eta C_{1,t}^{-q_1} - Z_t}{p_{1,t}} \quad (26)$$

$$\phi_{1,t} = 2\frac{\eta C_{1,t}^{-q_1} - Z_t}{p_{1,t}} - \frac{(1-\eta) C_{2,t}^{-q_2}}{p_{2,t}} \quad (27)$$

Combining the relationships (3) and (4), we may derive an expression of γ_t :

$$\gamma_t = \frac{p_{1,t} C_{1,t} - \overline{M}_t + p_{2,t} C_{2,t}}{p_{2,t-1} C_{2,t-1}} \quad (28)$$

$$\gamma_t = \frac{1}{2}\left(\frac{p_{1,t} C_{1,t}}{p_{2,t-1} C_{2,t-1}} + 1\right) \quad (29)$$

Now, consider the foc (N_t) and solve for $C_{2,t}$ normalizing $p_{2,t}$ $\left(p_{2,t} = 1\right)$

$$BP\left(1-N_t\right)^{\psi}+\phi_{1,t}\left(w_{1,t}-\overline{w}_{2,t}\right)=0$$

$$BP\left(1-N_t\right)^{\psi}+\left[2\frac{\eta C_{1,t}^{-q_1}-Z_t}{p_{1,t}}-\frac{\left(1-\eta\right)C_{2,t}^{-q_2}}{p_{2,t}}\right]\left(w_{1,t}-\overline{w}_{2,t}\right)=0$$

$$BP\left(1-N_t\right)^{\psi}+\left(2\frac{\eta C_{1,t}^{-q_1}-Z_t}{p_{1,t}}\right)\left(w_{1,t}-\overline{w}_{2,t}\right)-\left(1-\eta\right)C_{2,t}^{-q_2}\left(w_{1,t}-\overline{w}_{2,t}\right)=0$$

$$\left[\frac{BP\left(1-N_t\right)^{\psi}}{\left(w_{1,t}-\overline{w}_{2,t}\right)\left(1-\eta\right)}+\left(2\frac{\eta C_{1,t}^{-q_1}-Z_t}{p_{1,t}}\right)\frac{1}{\left(1-\eta\right)}\right]^{-\frac{1}{q2}}=C_{2,t}$$

Now, it's convenient to substitute this last equation lagged in the equation (29) in order to have an expression for the "optimal fraction of Money Laundered":

$$\gamma\left(t\right)=\frac{1}{2}\left(\frac{p_{1,t}C_{1,t}}{\left[\frac{BP\left(1-N_{t-1}\right)^{\psi}}{\left(w_{1,t-1}-\overline{w}_{2,t-1}\right)\left(1-\eta\right)}+\left(2\frac{\eta C_{1,t-1}^{-q_1}-Z_{t-1}}{p_{1,t-1}}\right)\frac{1}{\left(1-\eta\right)}\right]^{-\frac{1}{q2}}}+1\right)\quad(30)$$

where

$$w_{1,t-1}=p_{1,t-1}\alpha N_{t-1}^{\alpha-1}K_{t-1}^{1-\alpha}\Lambda_t$$

Tables

Empirical Estimates	**Sample**	**Methodology**
Bagella, Becchetti, Lo Cicero (2004)	1989-1999 (annual-quarterly)	MIMIC (panel)
Masciandaro (2004)	2000:06-2004:02	MIMIC (probit)
Quirk (1996)-IMF	1983-1990	INDIRECT
FATF-GAFI (2006)	Cases Study (2006)	INDIRECT

Table 1: Existing estimates for Money Laundering

Table 2: Observable and estimated quantities

VARIABLE	TIME SERIES	PERIOD	SOURCE
$p_{1,t}$	CPI (2000=100)	1981:q1-2001:q4	OECD
N_t	Employment Rate (all sectors)	1981:q1-2001:q4	OECD
K_t	Gross Fixed Investments (2000=100)	1981:q1-2001:q4	ISTAT
C_{1t}	National Consumptions (2000=100)	1981:q1-2001:q4	ISTAT
A_t	Total Factor Productivity	1981:q1-2001:q4	ISTAT
$W_{2,t}$	Estimation Il Sole 24 Ore	1981:q1-2001:q4	OECD

Table 3: Selected statistics of the simulated series

SAMPLE	Mean(%GDP)	σ^*	ρ(ML;GDP)	Sample	Observations
Full Sample	12.17	2.95	-0.17	1981:01-2001:04	84
Sub-sample #I	7.11	3.75	-0.08	1981:01-2001:04	20
Sub-sample #II	8.54	2.68	-0.03	1981:01-2001:04	20
Sub-sample #III	14.41	3.83	-0.47	1981:01-2001:04	20
Sub-sample #IV	17.35	1.67	0.38	1981:01-2001:04	24

Notes: The "mean" column of the table indicates for each sample the average dimension of money laundering with respect to GDP; the σ^* column measures the relative volatility of money laundering with respect to GDP, whereas the ρ(ML;GDP) column indicates the linear correlation between money laundering and GDP.

Table 4/a: Sensitivity analysis with respect to parameter ψ

Parameter	Ψ=1.60	Ψ=1.65	%change	Ψ=1.55	%change
Mean(%GDP)	12.17	12.17	0	12.17	0
σ^*	2.95	2.95	0	2.95	0
ρ(ML;GDP)	-0.17	-0.17	0	-0.17	0

Notes: The "mean" line of the table indicates for each sample the average dimension of money laundering with respect to GDP; the σ^* line measures the relative volatility of money laundering with respect to GDP, whereas the ρ(ML;GDP) line indicates the linear correlation between money laundering and GDP.

Table 4/b: Sensitivity analysis with respect to parameter BP

Parameter	BP=9	BP=9.05	%change	BP=8.95	%change
Mean(%GDP)	12.17	12.17	0	12.17	0
σ^*	2.95	2.95	0	2.95	0
ρ(ML;GDP)	-0.17	-0.17	0	-0.17	0

Notes: The "mean" line of the table indicates for each sample the average dimension of money laundering with respect to GDP; the σ^* line measures the relative volatility of money laundering with respect to GDP, whereas the ρ(ML;GDP) line indicates the linear correlation between money laundering and GDP.

Table 4/c: Sensitivity analysis with respect to parameter ξ

Parameter	ξ=0.04	ξ=0.09	%change	ξ=0.01	%change
Mean(%GDP)	12.17	27.39	+122.85%	3.04	-75%
σ^*	2.95	2.95	0	2.95	0
ρ(ML;GDP)	-0.17	-0.17	0	-0.17	0

Notes: The "mean" line of the table indicates for each sample the average dimension of money laundering with respect to GDP; the σ^* line measures the relative volatility of money laundering with respect to GDP, whereas the ρ(ML;GDP) line indicates the linear correlation between money laundering and GDP.

Table 4/d: Sensitivity analysis with respect to parameter η

Parameter	η =0.9	η =0.95	%change	η =0.85	%change
Mean(%GDP)	12.17	12.17	0	12.17	0
σ^*	2.95	2.95	0	2.95	0
ρ(ML;GDP)	-0.17	-0.17	0	-0.17	0

Notes: The "mean" line of the table indicates for each sample the average dimension of money laundering with respect to GDP; the σ^* line measures the relative volatility of money laundering with respect to GDP, whereas the ρ(ML;GDP) line indicates the linear correlation between money laundering and GDP.

Table 4/e: Sensitivity analysis with respect to parameter α

Parameter	α =0.17	α =0.22	%change	α =0.12	%change
Mean(%GDP)	12.17	28.14	+131.22%	5.76	-52.67%
σ^*	2.95	3.09	+4.75%	2.82	-4.40%
ρ(ML;GDP)	-0.17	-0.17	0	-0.17	0

Notes: The "mean" line of the table indicates for each sample the average dimension of money laundering with respect to GDP; the σ^* line measures the relative volatility of money laundering with respect to GDP, whereas the ρ(ML;GDP) line indicates the linear correlation between money laundering and GDP.

Table 4/f: Sensitivity analysis with respect to parameters q_1 and q_2

Parameter	q_1=0.99; q_2=0.01	q_1=0.94; q_2=0.06	%change
Mean(%GDP)	8.75	5.76	-34.17%
σ^*	2.95	2.82	-4.40%
ρ(ML;GDP)	-0.17	-0.17	0

Notes: The "mean" line of the table indicates for each sample the average dimension of money laundering with respect to GDP; the σ^* line measures the relative volatility of money laundering with respect to GDP, whereas the ρ(ML;GDP) line indicates the linear correlation between money laundering and GDP.

Figures

Figure 1: money laundering as a percentage of GDP

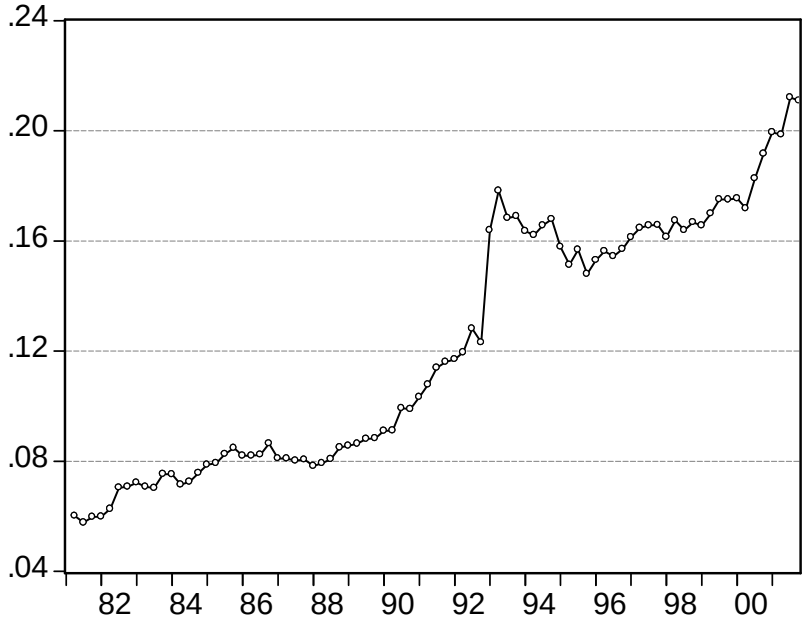
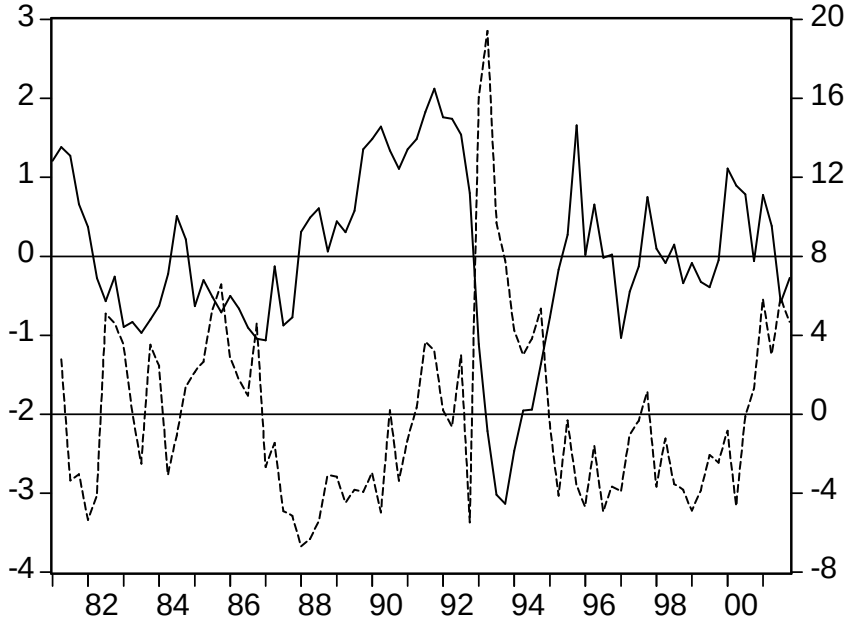
Figure 2: Hodrick-Prescott filtered series for money laundering (dashed line) and of GDP (solid line)