Global Economics Science
http://ojs.wiserpub.com/index.php/GES/

UNIVERSAL WISER PUBLISHER

Special Issue
Research Article

The Impact of the COVID-19 Crisis on the Dutch Criminal Justice System

Debora Moolenaar*, Sunil Choenni

Dutch Ministry of Justice and Security WODC, Research and Documentation Centre, Hague, Netherlands
Email: d.moolenaar@wodc.nl

Received: 17 May 2021; **Revised:** 01 November 2021; **Accepted:** 12 November 2021

Abstract: This paper tries to ascertain the overall impact of the COVID-19 pandemic on the Dutch criminal justice system. In the Netherlands, the first case of COVID-19 was reported in February 2020. On March 16, 2020, the Netherlands went into its first lockdown which lasted until approximately June 15, 2020. The effect of the COVID-19 crisis on crime is ambiguous. Whereas less crime was expected in the physical world, more crime was expected in the online world due to the crisis. During the first lockdown all government offices were closed, including the court buildings. Only urgent criminal cases were handled by the courts. Urgent criminal cases refer to those cases where the rights of suspects were violated or the safety of victims was endangered. During the first lockdown, the backlog of court cases increased, which adversely affected all criminal justice institutions that were responsible for executing court verdicts, like the prison and probation services. This paper assesses the effect of the COVID-19 crisis on crime and the criminal justice system. First, the effect of COVID-19 on crime is assessed by performing a regression analysis on monthly crime data. Second, using a long-standing forecasting model for the criminal justice system, an estimation is made of the long term impact of the changes in the level of crime, of the shifts towards different types of crime, as well as of the reduction of the prosecutor and court backlogs, and of a possible economic downturn and increasing unemployment for the complete criminal justice system.

***Keywords*:** criminal justice system, crime, forecasting model, COVID-19, time series analysis

JEL Code: C53, C54, K14, H68

1. Introduction

The COVID-19 pandemic keeps the world in its grasp for nearly two years now and has affected the day to day life in many countries. In the Netherlands, the first COVID-19 case was reported on the 27th of February 2020. On March 16, 2020, the Netherlands went into its first lockdown which lasted until approximately June 15, 2020. During the lockdown most offices, restaurants, bars, clubs and shops were closed with the exception of supermarkets and drugstores. Furthermore, employees were expected to work from home as much as possible, but people were allowed to go out for a walk. People who could not work from home, like household waste collectors and police officers were allowed

DOI: https://doi.org/10.37256/ges.232021945

to go to work. Initially there was no curfew. On December 19, 2020, the Netherlands went into its second lockdown. A curfew was imposed on the 23rd of January 2021, meaning that everybody had to be indoors by 21:00 hours. When daylight saving time went into effect on March 28, 2021, the curfew time was reset to 22:00 hours. The curfew was lifted on April 28, 2021, more or less ending the second lockdown. Figure 1 shows how COVID-19 infections (i.e., the percentage of positively tested individuals to total tests) developed in the Netherlands during this period.

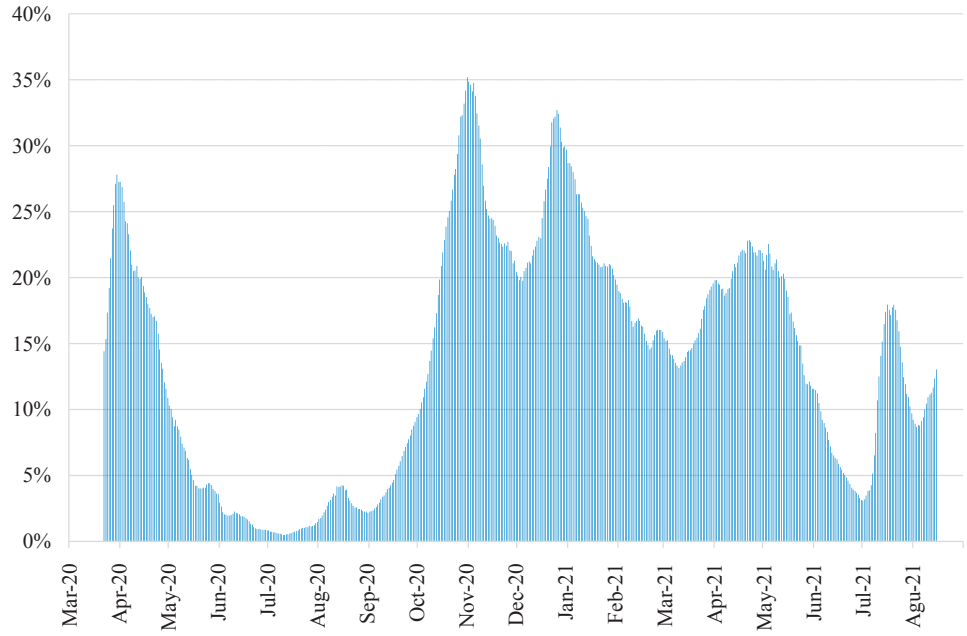

Figure 1. Daily percentage of positive COVID-19 tests in the Netherlands, 2020-2021
Source: Johns Hopkins University (ourworldindata.org/coronavirus-data)

To a greater or lesser extent, all sectors in the Dutch society have been suffering from the consequences of the pandemic. This paper is devoted to the impact of the pandemic on crime and the Dutch criminal justice system. At first glance, less conventional crime (i.e. off line crime) and more cybercrime (i.e. on line crime) are expected. The impact of the pandemic on the Dutch criminal justice system depends on the developments of crime as well as on the organization of the criminal justice system. The system operates as a network of interdependent organizations, where each organization covers a specific stage of the enforcement of criminal law, such as investigation, prosecution, trial, and sentence execution. For example, the police, who are at the beginning of the chain, are responsible for upholding law and order, investigating criminal cases, and arresting people who break the law. The Public Prosecution Service is responsible for prosecuting the suspects brought in by the police, while the courts may convict or acquit a suspect and impose sanctions. The sanctions are carried out by the prison service, the fine collection agency and/or probation services. All organizations together ensure that criminal offences are tracked down, prosecuted and punished (Van Dijk et al., 2018).

During the first lockdown all offices of these organizations were closed, including the court buildings. Only urgent cases were handled by the courts. Cases were classified as urgent if the rights of suspects were violated or the safety of victims were in danger. In this period, the backlog of court cases increased, which adversely affected all organizations in the criminal justice system that are responsible for executing court verdicts, like the prison and probation services and the fine collection agency. When the first lockdown slowly ended, court buildings started to reopen. Buildings were adapted with signage and see-through screens, tables moved apart and fewer chairs were placed per room. In addition, there were many other restrictions, like 1.5 meters distance between people, not too many people in one room, extra cleaning in between court hearings, etc. Prisons cells that were meant for multiple occupants, could only be used for one prisoner at a time. Probation services had a difficult time finding suitable work places for people sentenced to a

community service because many of the work places were either closed or could not be adapted in accordance with COVID-19-regulations. As a result, the courts, probations services, and prisons could not operate at full capacity. The second lockdown was different from the first one in the sense that court buildings were not closed and court hearings proceeded as planned with the above-mentioned restrictions. After the first lockdown, various measures were taken to clear the backlog of court cases. In less serious cases, suspects were fined instead of being summoned. When a fine was not an option and a summons was necessary, cases were heard by a single judge instead of three judges if the severity of the case allowed it.

It should be clear that the above-mentioned developments have affected the criminal justice system and crime. Gaining insights in the possible effects of the COVID-19 crisis on the criminal justice system is important to meet the objectives of a well-functioning legal system such as efficiency, effectiveness, and transparency (Netten et al., 2014). These insights, for example, may contribute to identifying the possible bottlenecks that are caused by the COVID-19 crisis within the criminal justice system or, on the contrary, reveal that the justice system can withstand the effects of the COVID-19 crisis. In the former case, measures may be taken to tackle the bottlenecks, i.e., improving efficiency and effectiveness, while in the latter case the insights indicate that the existing policies may be continued. In either case, the insights in possible effects of the COVID-19 crisis contribute to shaping a healthy strategy for a well-functioning criminal justice system. Therefore, this study aims at assessing the effect of the COVID-19 crisis. Based on the outcomes of the study, the impact of the pandemic on recorded crime is limited, while the impacts on the number of suspects and the criminal justice system are noticeable. Furthermore, as expected, a shift between different categories of crime is observed.

The remainder of the paper is organized as follows. Section 2 presents an overview of previous research on the effects of COVID-19 on crime. In section 3, the developments in recorded crime and the number of suspects are discussed. Then, in section 4, an assessment of the effects of the developments on the number of suspects on the criminal justice system are presented. Finally, section 5 concludes the paper.

2. Related work

Several studies have already been published assessing the effect of COVID-19 on crime or the criminal justice chain. Some of these studies describe the situation before and during COVID-19 (Criminal Justice Chief Inspectors, 2021; Maskály et al., 2021; Levi & Smith, 2021). But others try to estimate the net effect of COVID-19 (Gerell et al., 2020; Ashby, 2020a; 2020b; Payne & Morgan, 2020; Payne et al., 2020; Nivette et al., 2021; Hodgkinson & Andresen, 2020; Campedelli et al., 2020; Mohler et al., 2020). These studies generally follow a similar approach. Based on the figures from the pre-COVID-19 period, a statistical model is fitted and used to forecast recorded crime for the COVID-19 period. Assuming that these forecasts are reasonably accurate, this would have been the level of crime had the COVID-19 crisis not occurred. By comparing these forecasts with the actual crime figures in the COVID-19 period, the effect of COVID-19 can be estimated. The studies mainly differ in the type of forecasting model that is used.

Ashby (2020a; 2020b), Payne and Morgan (2020a; 2020b), Payne et al. (2020) and Piquero et al. (2020) use a Autoregressive Integrated Moving Average (ARIMA) model. Ashby (2020a) found no significant changes in assault frequency in the United States. In some cities, there was a decrease in residential burglaries, but little change in non-residential burglaries. Motor vehicle theft declined in some cities. Ashby (2020b) analyzed the number of Police calls for services. Contrary to expectations, the number of Police calls for services decreased in the first weeks of the pandemic. There was a substantial decrease in the number of traffic accident reports and a significant increase in reports of dead bodies. Other types of calls related to crime and public order remained at the same level. Piquero et al. (2020) have found some evidence for a short-term spike in the number of domestic violence cases in Dallas in the first two weeks after the lockdown, but then observed a decline. It could not be determined whether this is the result of COVID-19 because the trend in domestic violence was already increasing in the pre-COVID-19 era. Payne and Morgan (2020) and Payne et al. (2020) examined the crimes recorded in Queensland, Australia with figures up to April 2020. They conclude that COVID-19 had no effect on vandalism, domestic violence, burglary and motor vehicle theft, but there were significant decreases in aggravated assault, sex crimes, shoplifting, other theft and credit card fraud.

Nivette et al. (2021) and Hodgkinson and Andresen (2020) use an Interrupted Time Series (ITS) analysis. Nivette et al. (2021) make an international comparison of the impact of a lockdown in various cities in different countries

on different types of crime. They concluded that the lockdowns led to a significant drop in urban crime. They also concluded that travel restrictions were a good predictor of declines in crime. Hodgkinson and Andresen (2020) found a statistically significant decrease in overall crime, vehicle theft and theft, and a significant increase and a subsequent decrease in commercial burglaries in Vancouver. They did not observe significant changes in violent crime.

Gerell et al. (2020) used a Poisson process. They concluded for Sweden that total recorded crime, assault, pickpocketing and burglary decreased significantly as a result of COVID-19, while violent theft and drug crime were unchanged. The actual impact was quite small for most types of crime. It should be noted that, unlike most other countries, Sweden did not have a lockdown. Campedelli et al. (2020) analyzed crime using Bayesian Structural Time Series (BSTS). They found no change in serious violence, domestic violence, car theft or burglary in Los Angeles but they observed a small decrease in minor abuse, and a slightly larger decrease of shoplifting, theft and robbery and overall crime. Mohler et al. (2020) used a difference in means analysis and found that distancing in Los Angeles has statistically significant consequences for a number of specific types of crime.

The first part of this study follows the approach of Ashby (2020a), Payne and Morgan (2020a; 2020b), Payne et al. (2020) and Piquero et al. (2020) by estimating ARIMA-model for recorded crime in the Netherlands. Like Nivette et al. (2021), this study will include travel restrictions in the model, which are approximated by the number of travelers at the main Dutch airports (see Figure 2). But unlike the aforementioned studies, this study tries to look beyond the stage of observing/reporting/recording crime and also look at other parts of the criminal justice system. This is done by also estimating a similar ARIMA-model for the number of suspects registered by the Police and by using a long-standing forecasting model for the Dutch criminal justice system (Moolenaar et al., 2007) to determine the long term impact of COVID-19 (see paragraph 4 for further discussion).

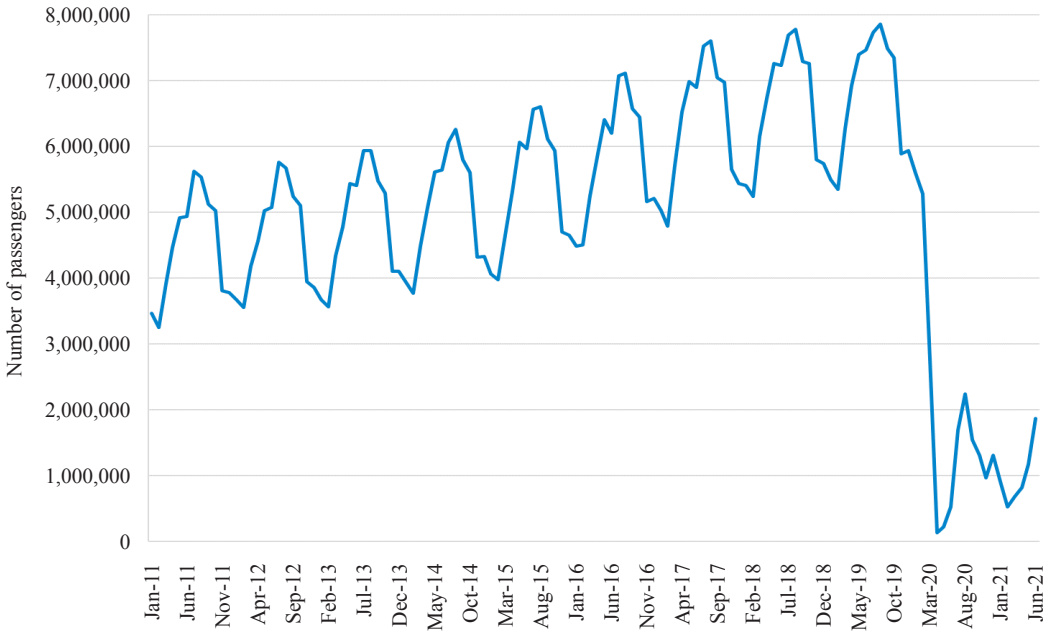

Figure 2. Monthly number of travelers at the main Dutch airports, 2011-2021
Source: Statistics Netherlands (opendata.cbs.nl)

3. Developments in recorded crime and the number of suspects

In this section, monthly and quarterly data are used to analyze the developments in recorded crime, i.e. the numbers of criminal incidents per crime type registered by the Police, and the number of suspects, also registered by the Police. Section 3.1 focuses on recorded crime, while section 3.2 focuses on suspects. Then in section 3.3, an estimate is made

of the overall impact of the COVID-19 crisis on recorded crime and the number of suspects.

3.1 *Recorded crime*

The effect of the COVID-19 crisis on the crime itself is ambiguous. Less crime was expected in the physical world, but more crime was expected in the online world. Monthly police figures show this expectation to be true (see Figure 3). There was a drop in property crime (excluding fraud) during the lockdowns because most people were at home most of the time, and most shops, bars and clubs were closed. Therefore, there was less opportunity for burglary and robbery, and pickpocketing was difficult at 1.5 meters distance. However, between lockdowns the number of recorded crime seems to follow the downward trend that already started in 2014. Violent crime also seems to be on a long-term downward trend, with small dips during the lockdowns. Fraud and cybercrime increased in 2020 as expected, but again the numbers seem to follow the upward trend that started much earlier. Note that fraud and cybercrime are the only types of crime that actually exhibit such a long term upward trend. As an additional complication, the way that the number of recorded crime is counted has been changed twice since 2012. Up to June 2015, frauds reported to the fraud helpdesk were not included in the recorded crime figures. This changed in July 2015. Furthermore, in July 2018 there was a general revision of the way that the recorded crime was counted. As a result, the numbers after July 2018 are, strictly speaking, not fully comparable with those before July 2018, although the differences seem to be small. This leads us to ask how large is the impact of the COVID-19 crisis actually and what part of the changes in recorded crime can be attributed to the long term trend (i.e., not related to the COVID-19 crisis)?

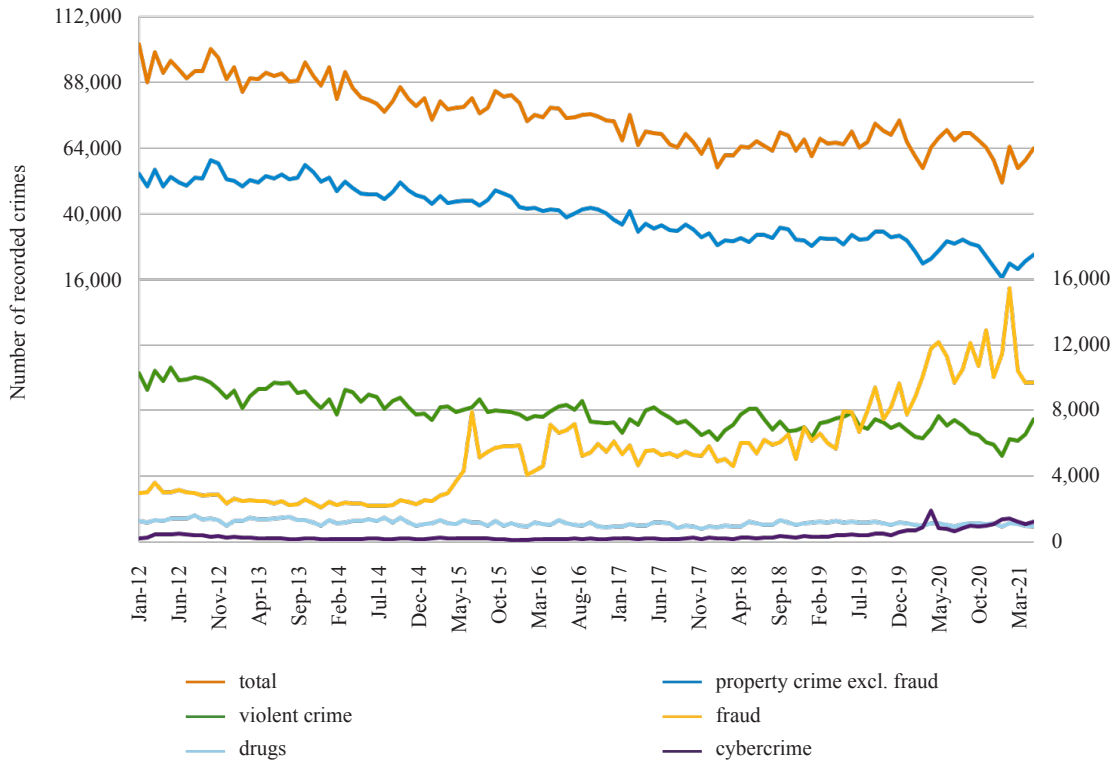

Figure 3. Recorded crime in the Netherlands per month, 2012-2021
Source: Dutch Police Force (data.politie.nl)

Table 1. Estimated ARIMAX-models for various types of recorded crime (in natural logarithms), January 2012-June 2021

	total		violent crime		Drugs		property crime excl. fraud		fraud		cybercrime		total excl fraud and cybercrime	
Best model: (p, d, q)	(2, 1, 0)		(0, 1, 1)		(0, 1, 1)		(2, 1, 0)		(0, 1, 1)		(0, 1, 1)		(0, 1, 1)	
(P, D, Q)	(1, 0, 0)		(0, 0, 0)		(0, 0, 0)		(1, 0, 0)		(0, 0, 0)		(0, 0, 0)		(0, 0, 0)	
COVID-19 effects														
Positive COVID-19 tests	-0.261		-0.330	*	-0.330	*	-0.242	**	0.042		-1.460	***	-0.436	***
Travel restrictions	0.003		-0.001		-0.001		0.040	*	-0.081		0.004		0.023	
first lockdown	-0.105		-0.073		-0.073		-0.129		-0.086		0.731	*	-0.091	
second lockdown without curfew	-0.070	**	-0.047		-0.047		-0.225	***	-0.003		0.279		-0.057	*
second lockdown with curfew	-0.071	***	-0.082	**	-0.082	**	-0.227	***	0.192		0.202		-0.130	***
Administrative effects														
fraud included in crime figures	0.015		0.033		0.033		-0.030		0.547	***	-0.016		-0.002	
revision of crime figures	0.043		0.029		0.029		0.050		-0.016		-0.004		0.053	
seasonal dummies														
January	0.034	***	0.026		0.026		-0.013		0.074		0.086		0.033	***
February	-0.119	***	-0.087	***	-0.087	***	-0.079	***	-0.122	***	0.033		-0.120	***
March	0.092	***	0.106	***	0.106	***	0.075	***	0.115	*	0.144	**	0.092	***
April	-0.051	***	0.000		0.000		-0.059	***	-0.087	*	-0.128		-0.045	***
May	0.028	***	0.025	*	0.025	*	0.010		0.145	***	0.143	**	0.010	
June	-0.011		0.027	**	0.027	**	-0.024	*	0.040		0.000		-0.015	
July	0.003		-0.019		-0.019		0.023		0.003		-0.064		0.000	
august	-0.039	**	-0.023		-0.023		-0.023		-0.069		-0.018		-0.033	**
September	0.014		-0.027	*	-0.027	*	0.026		-0.017		0.051		0.017	
October	0.069	***	0.001		0.001		0.071	***	0.074		0.117	***	0.069	***
November	-0.034	*	-0.039	*	-0.039	*	-0.021		-0.056		-0.019		-0.025	
December	-0.037	***	-0.038	**	-0.038	**	-0.064	***	-0.049		-0.164	**	-0.044	***
Time series effects														
AR(1)	-0.602	***					-0.760	***						
AR(2)	-0.413	***					-0.524	***						
AR(3)														
AR(4)														
Seasonal AR(1)	-0.264	*					-0.278	*						
MA(1)			-0.751	***	-0.751	***			-0.465	***	-0.197	*	-0.572	***
σ^2	0.001	***	0.001	***	0.001	***	0.001	***	0.012	***	0.026	***	0.001	***
Model performance														
R-squared	0.826		0.691		0.691		0.807		0.484		0.407		0.825	
Adjusted R-squared	0.783		0.623		0.623		0.759		0.371		0.278		0.787	
Durbin-Watson stat	1.924		1.737		1.737		2.002		1.879		1.981		2.060	
Number of observations	113		113		113		113		113		113		113	

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

To answer these questions a time series analysis is performed on monthly recorded crime figures for the period January 2012 until March 2021. The first question is whether or not to transform the data. From figure 1, it is clear that the growth rate is not constant over time. Therefore, it is likely that the data may suffer from heteroscedasticity. Taking natural logarithms will linearize the relationship and solves the problem of heteroscedasticity. Second, the transformed data are tested on unit roots, which are a cause for non-stationarity. The hypotheses that the various types of recorded crime do not contain a unit root are rejected, so all the series need to be differenced (Hyndman & Khandakar, 2008). Then an ARIMA analysis is applied to performed to estimate the effect of the COVID-19 crisis, allowing for any seasonal effects (Box et al., 2015). An ARIMA-model contains p autoregressive terms, P seasonal autoregressive terms, q moving average terms and Q seasonal moving average terms. The order of integration is d and the order of seasonal integration is D. Then, the general form of the ARIMA(p, d, q)(P, D, Q) model is:

$$\left(1-\sum_{i=1}^{p}\varphi_i B^i\right)\left(1-\sum_{j=1}^{p}\Phi_j B^{jS}\right)(1-B)^d(1-B^S)^D(y_t-X_t\beta)=\left(1+\sum_{h=1}^{q}\theta_h B^h\right)\left(1+\sum_{k=1}^{Q}\Theta_k B^{kS}\right)\varepsilon_t \quad (1)$$

where $X_t\beta=\sum_{s=1}^{S}\beta_{0s}DS_{ts}+\beta_1 DF_t+\beta_2 DR_t+\beta_3\ln(POS_t)+\beta_4\ln(PASS_t)+\beta_5 LD1_t+\beta_6 LD2_t+\beta_7 LDC_t$. Here B is the backshift operator, meaning , y_t = recorded crime and S = 12 (months). The DS_s are seasonal dummies, *DF* is a dummy indicating the period that crime figures include fraud, *DR* is a dummy indicating a revision of crime figures, *POS* is the percentage of positive COVID-19 tests, *PASS* is the number of travelers at main Dutch airports, *LD1* is a dummy indicating the first lockdown, *LD*2 is a dummy indicating the second lockdown without a curfew, and *LDC* is a dummy indicating the second lockdown with a curfew. All the β, φ, Φ, θ and Θ are coefficients to be estimated and ε is the error term. It was already established that all the series contain unit roots, but no seasonal unit roots, so d = 1 and D = 0. The number of autoregressive (p and P) and moving average terms (q and Q) are chosen on the basis of the Schwarz-Bayes criterion and the significance level of the autoregressive and moving average terms. Table 1 gives an overview of the best model per type of crime. The ARIMAX analysis is applied to several variables: total record crime, 4 specific types of crime and total record crime excluding the types of crime that have been exhibiting an upward trend for a longer period of time.

An increase in the percentage of positive COVID-19 tests leads to a significant decrease in violent crime, property crime (excl. fraud) and cybercrime. The measures taken to prevent COVID-19 from spreading too quickly have a mixed effect. The first lockdown has little effect on the number of recorded crimes with the exception of cybercrime. The number of recorded cybercrimes increases significantly during the first lockdown. The second lockdown has a greater effect on overall crime levels and on violent crime, drug crime, and property crime in particular. The effect on drug crime is positive, i.e. the number of recorded drug crimes increases significantly during the second lockdown (without curfew). Finally, the travel restrictions lead to fewer property crimes.

3.2 *Suspects*

As shown in the previous section, the effect of the COVID-19 crisis on record crime is limited. This does not necessarily mean that the effect on the criminal justice system is limited too. It is important to note that not crimes but people are prosecuted. Thus, in order to determine the effect on the criminal justice system, it is important to know what the effect was on the number of suspects. For the number of suspects there is quarterly data available for the period 2011-2020 (see Figure 4). Therefore, a similar analysis as before is made but this time *yt* = suspects, S = 4 (quarters). Table 2 shows the results.

Table 2. Estimated ARIMAX-models for suspects of various types of crime (in natural logarithms), January 2012-December 2020

	total		Violent crime		drugs		property crime excl. fraud		fraud		cybercrime		total excl. fraud and cybercrime	
Best model: (p, d, q)	(1, 1, 0)		(0, 1, 1)		(1, 1, 1)		(0, 1, 0)		(0, 1, 0)		(0, 0, 0)		(1, 1, 0)	
(P, D, Q)	(0, 0, 0)		(0, 0, 0)		(0, 0, 0)		(0, 0, 0)		(0, 0, 0)		(0, 0, 0)		(0, 0, 0)	
COVID-19 effects														
Positive COVID-19 tests	-0.288		-0.281		0.079		-0.636	***	-0.231		-0.154		-0.297	
Travel restrictions	-0.047		-0.044		0.011		0.013		-0.161	*	-0.644	***	-0.041	
first lockdown	-0.203		-0.144		-0.025		-0.102		-0.502	**	-1.660	***	-0.186	
second lockdown without curfew	-0.047		0.010		-0.189		-0.764	***	0.036		1.464		-0.064	
second lockdown with curfew	-0.273		-0.320		0.390		0.703	***	-0.570		-1.785		-0.257	
Administrative effects														
fraud included in crime figures	0.026		0.011		-0.017		0.027		-0.063		-0.318	***	0.029	
revision of crime figures	0.025		-0.037		0.105	*	0.007		-0.046		0.753	***	0.025	
seasonal dummies														
quarter 1	0.008		-0.008		0.030		0.017		0.069	**	14.194	***	0.006	
quarter 2	-0.025		-0.013		0.011		-0.059	***	-0.068	**	14.325	***	-0.025	
quarter 3	-0.061	***	-0.023		-0.131	**	-0.060	***	-0.114	***	14.235	***	-0.059	***
quarter 4	0.005		-0.034		0.049		0.049	***	0.093	***	14.253	***	0.003	
Time series effects														
AR(1)	-0.330	*			0.000	***							-0.318	**
MA(1)			-0.437	**	-0.585	***								
σ^2	0.000	***	0.000	***	0.002	***							0.000	***
Model performance														
R-squared	0.824		0.628		0.676		0.840		0.755		0.859		0.816	
Adjusted R-squared	0.749		0.469		0.538		0.786		0.673		0.814		0.737	
Durbin-Watson stat	2.021		2.017		2.056		2.262		2.696		1.981		2.011	
Number of observations	41		41		41		41		41		42		41	

*** significant at 1%
** significant at 5%
* significant at 10%

The results for suspects are somewhat different from those for recorded crimes. A higher percentage of positive COVID-19 tests leads to fewer suspects of property crime. Travel restrictions lead to more suspects of fraud and cybercrime. The first lockdown leads to a significant drop in the number of suspects of fraud and cybercrime (while the number of recorded cybercrimes actually increased significantly). The second lockdown leads to a decrease and the curfew results in an increase in the number of suspects of property crimes, but has no effect on other crimes.

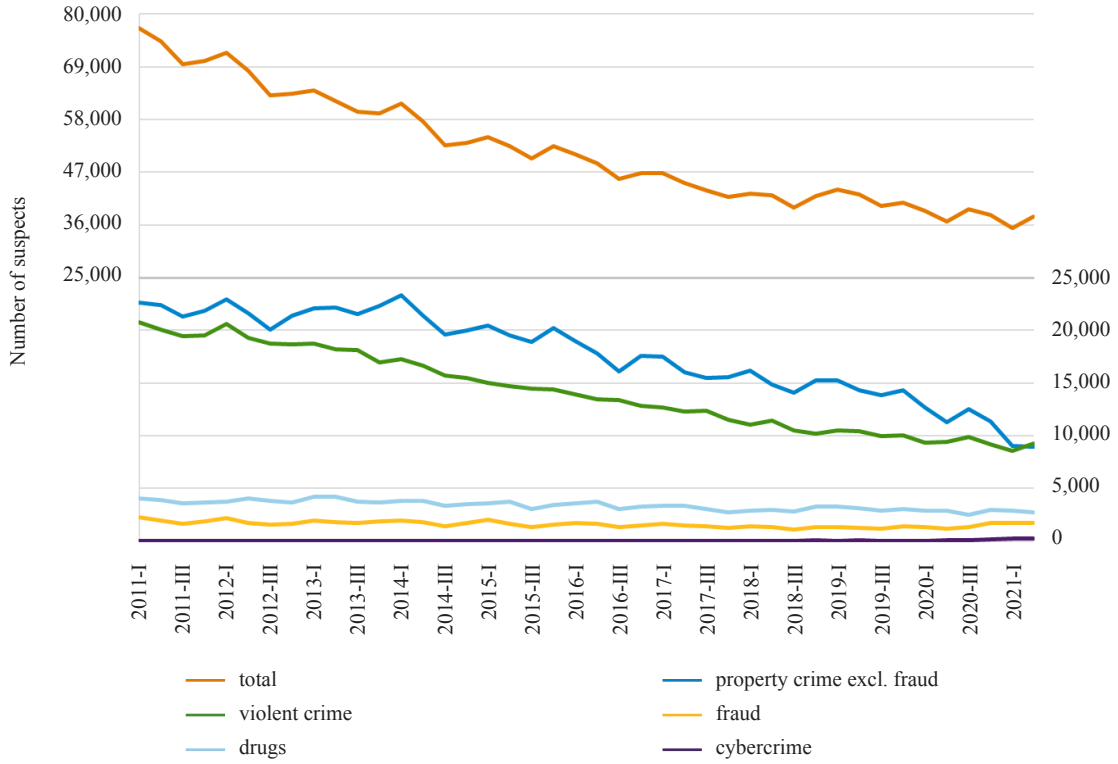

Figure 4. Suspects in the Netherlands per quarter, 2011-2020

Source: Dutch Police Force

3.3 *The impact of the COVID-19 crisis*

The effect of the COVID-19 crisis on the number of suspects seems more significant than the effect on the number of recorded crimes. But significant effects do not necessarily mean large effects. From the data it can be inferred that in 2020 there was only a 1% decrease in recorded crime and an 8% decrease in the number of suspects compared to 2019. The question is which part of this decrease is due to the COVID-19 crisis. To answer this question the models in Tables 1 and 2 are used to forecast recorded crime and the number of suspects in 2020 and the first half of 2021 with all the COVID-19-specific variables set to pre-COVID-19 values, thereby forecasting the number of recorded crimes and suspect as if the COVID-19 crisis had not occurred. By comparing these forecasts with the actual crime figures in the COVID-19 period, the impact of COVID-19 can be estimated. Table 3 shows the results.

With all the COVID-19-specific variables set to pre-COVID-19 values, thereby ignoring COVID-19, the model for overall recorded crime in Table 1 forecasts a growth of 2.4%. So if COVID-19 had not occurred the number of recorded crimes would have increased. However, the 95%confidence interval is quite large, ranging from 4.9% to 10.2%. Subtracting the forecasted growth rate from the actual growth rate, the total impact of the COVID-19 crisis on recorded crime is estimated to be 3.3%. Because, the actual decrease of 1% is well within the 95%confidence interval of the forecasts for a world without COVID-19, the overall impact of COVID-19 is limited. Only for property crime the actual growth rate falls outside the 95%confidence interval. Therefore, here the impact is significant and quite large. Applying the same analysis to the number of suspects, it turns out that the overall impact of COVID-19 is only 1.7%. Again, the actual decrease is within the 95%confidence interval. Without COVID-19, the number of suspects was expected to decrease anyway. For property crime and cybercrime the actual growth rates fall outside their respective confidence intervals. Thus, the impact of COVID-19 is significant for both types of crime and it is very large in the case of cybercrime. This can also be seen in Figure 5. The solid lines show the actual values, while the dashed lines show the forecasted values. The 95%confidence intervals are indicated with dotted lines. Note that the vertical axes have a

logarithmic scale.

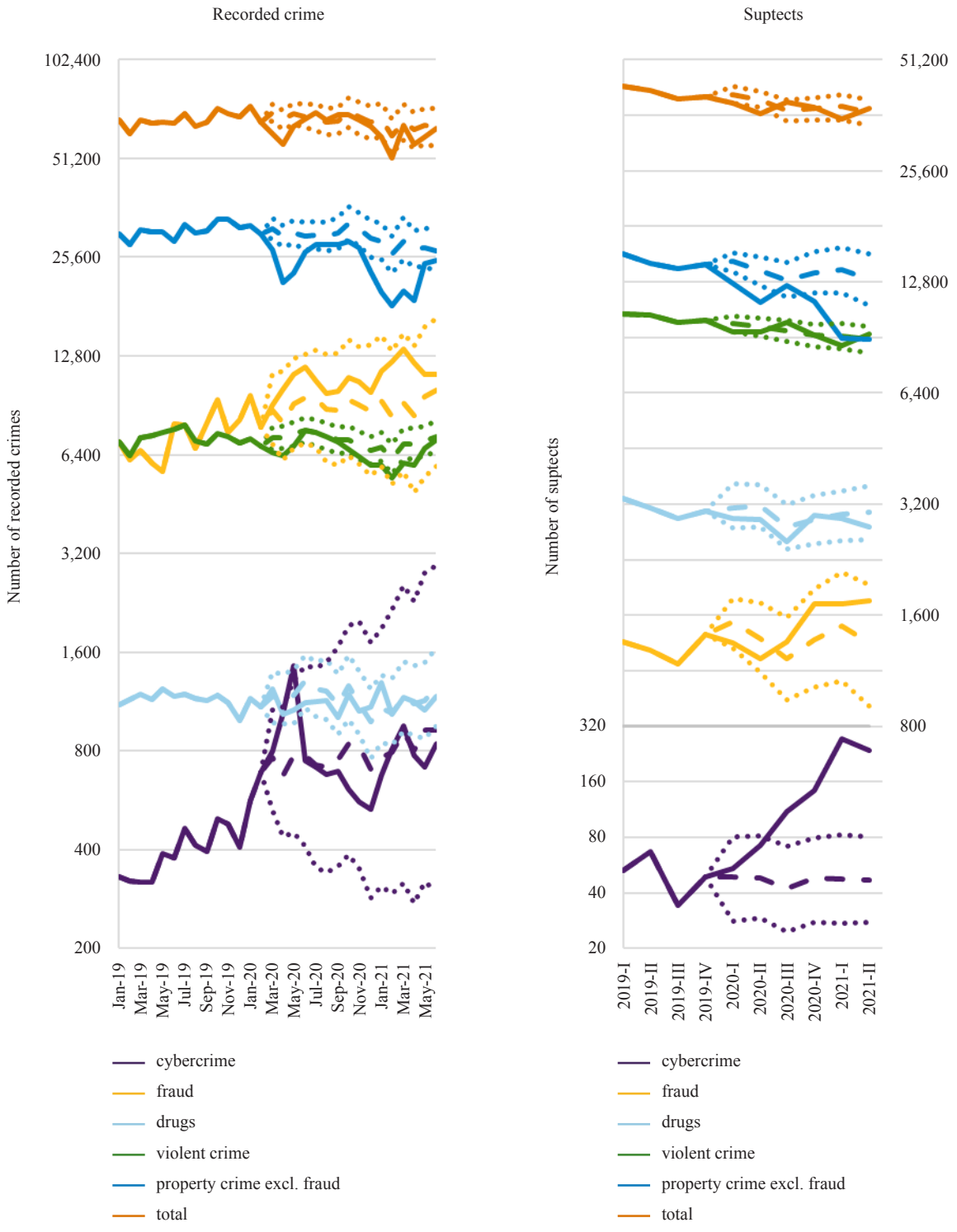

Figure 5. Actual (solid lines) versus estimated (dashed lines) growth rates, incl. 95%-confidence intervals (dotted lines), logarithmic scale
Source for actual figures: Dutch Police Force

Table 3. Growth rate of the number suspects in 2020, actual and fitted

	Estimated impact of COVID-19*	Actual growth rate		Estimated growth rate without COVID-19	Lower bound 95%-confidence interval	Upper bound 95%-confidence interval
Recorded crime						
total	-3.3	-1.0		2.4	-4.9	10.2
violent crime	-4.6	-5.3		-0.7	-7.8	7.0
drugs	-9.7	-8.4		1.4	-14.3	20.4
property crime excl. fraud	-9.6	-11.0	**	-1.4	-9.1	7.2
Fraud	23.4	46.4		23.1	-7.3	68.8
Cybercrime	41.8	128.4		86.6	9.2	247.7
total excl. fraud and cybercrime	-8.3	-7.6	**	0.7	-6.2	8.2
Suspects						
Total	-1.7	-8.1		-6.4	-11.6	-0.8
violent crime	-0.6	-7.4		-6.9	-12.4	-1.1
drugs	-4.9	-8.6		-3.8	-16.0	11.1
property crime excl. fraud	-12.0	-17.2	**	-5.2	-13.9	4.4
fraud	2.5	7.6		5.1	-16.4	32.9
cybercrime	94.7	86.7	**	-8.0	-46.0	53.8
total excl. fraud and cybercrime	-2.0	-8.7		-6.6	-11.4	-1.2

* The estimated impact of COVID-19 is calculated by subtracting the estimated growth without COVID-19 from the actual growth. Small differences may occur due to rounding errors
** Outside 95%-confidence interval

3.4 *Discussion*

The results show that the overall effect of the pandemic on the number of recorded crimes is limited. Gerell et al. (2020) found similar results, but Nivette et al. (2021), Hodgekinson and Andresen (2020) and Campedelli et al. (2020) find a more significant effect. However, there are differences between types of crime. The first and second lockdown had a negative effect on recorded property crime (excluding fraud). The travel restrictions also led to fewer recorded property crimes. A higher percentage of positive COVID-19 tests led to fewer suspects of property crime. Comparing the forecasts from the ARIMA-model to actual numbers shows that the impact of COVID-19 on property crime is significant. The results on recorded property crime concur more or less with the results of Gerell et al. (2020), Ashby (2020a), Payne et al. (2020), Hodgekinson and Andresen (2020) and Campedelli et al. (2020) who also observed significant decreases in various types of property crime. The second lockdown had a negative effect on overall recorded crime levels and on violent crime in particular but had no effect on the number of suspects. Gerell et al. (2020), Payne and Morgen (2020) and Campedelli et al. (2020) found similar results on recorded violent crime, although this was in an earlier stage of the pandemic. The effect of the second lockdown on drug crime was positive (i.e. a decrease of drug crime), which is contrary to Gerell et al. (2020) who found no effect on drug crime. The first lockdown had a positive effect on recorded cybercrime, but at the same time less suspects of cybercrime were apprehended. Comparing the forecasts from the ARIMA-model to actual numbers shows that the impact of COVID-19 on the number of suspects of

cybercrime is significant and very large. Finally, the travel restrictions led to more suspects of cybercrime and fraud, although the first lockdown led to a significant drop in the number of suspects of fraud. This seems to concur with Payne et al. (2020), who found a negative effect on one specific type of recorded fraud, namely credit card fraud. Note that the results in this study are preliminary in nature. Because it is unknown how recorded crime will develop after the COVID-19 crisis, it is difficult for the models to distinguish between temporary and structural changes.

4. Expected effects in the criminal justice system

For over 20 years, the Dutch government has been using an econometric model to make forecasts for the required capacity for the complete (criminal) justice system (Moolenaar et al., 2007). The outcomes of this model are the basis for the government's justice budget. This model can also be used for simulations. To determine the effect of a decreasing number of suspects on the criminal justice system, the observed decreases in the number of recorded crimes and suspects in 2020 are entered into this model. Section 4.1 gives a short description of this model, while section 4.2 presents the results of some simulations with this model in order to determine the effect of COVID-19 in the long run.

4.1 *A forecasting Model for the Dutch Justice System*

The first building bricks for the forecasting model for the Dutch (criminal) justice system were laid in 1998 (Van Tulder, 2000). The original model used demographic and economic forecasts to make the forecasts of recorded crime, which in turn were used to make forecasts of the required sanction capacity (prison, community services etc.). In 2003, this model was gradually expanded to include the complete (criminal) justice system (Moolenaar et al., 2007). The most recent forecasts can be found in Moolenaar et al. (2021). This model will be referred to as the Forecasting Model for the Justice System (FMJS).

The FMJS-model is a combination of causal models and time series models, consisting of approximately 6,600 equations. The equation coefficients are estimated using regression analysis on annual data. Roughly speaking, the model consists of five types of equations. The inflow (I) of the organization (S) at the beginning of the network is determined by demographic, social and economic factors (X_i), such as the population in different age categories, unemployment, gross national product, drug use, etc. The growth rate of the inflow of organization S can be expressed as:

$$\Delta \ln(I_S) = \sum_i \gamma_i \Delta \ln(X_i) + v, \tag{2}$$

where v is an error term and the coefficients γ_i represent elasticities. For example, the I_s could represent the number of recorded crimes by the Police. The outflow O of any organization R, regardless of its place within the network, depends on its backlog at the beginning of the current period (BV), its inflow (I) and the time needed to process the input (δ_1, measured as a proportion of a year). The change in the outflow of organization R can be expressed as:

$$\Delta(O_R) = (1-\delta_1)\Delta(I_R) + \delta_2 \Delta(BV_R) + \eta, \tag{3}$$

where η is an error term and δ_2 represents the portion of the backlog that is to be processed. The backlog of organization R at the end of the current period (EV) is equal to the backlog at the beginning of the current period (BV) plus the inflow (I) minus the outflow (O), expressed as:

$$EV_R = BV_R + I_R - O_R. \tag{4}$$

Of course, the backlog at the beginning of the next period $t + 1$ is equal to the backlog at the end of the current period t, expressed as:

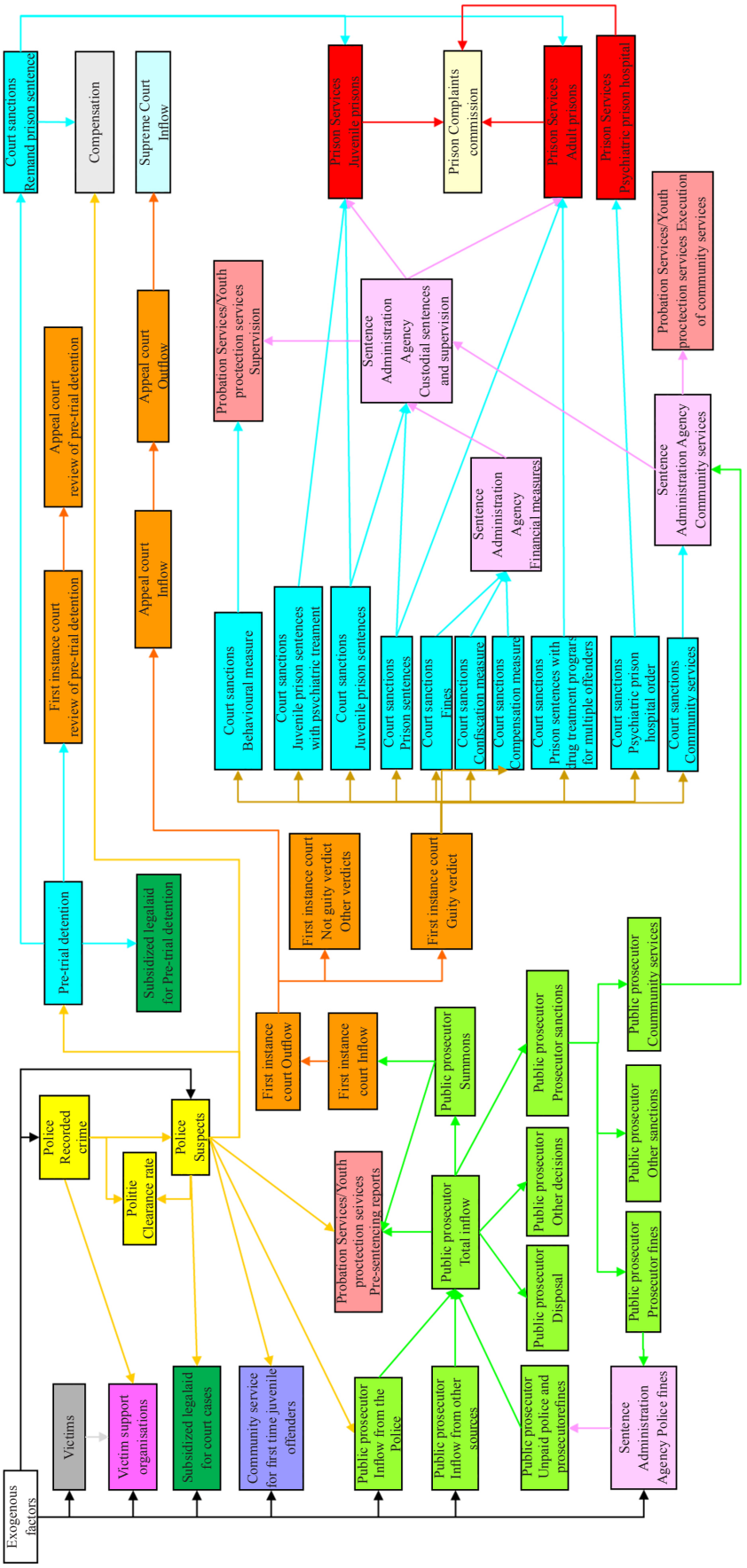

Figure 6. A forecasting model for the Dutch criminal justice system

Source: adapted from Moolenaar et al. (2021)

$$BV_R(t+1) = EV_R(t). \tag{5}$$

The relationship between the inflow (I) of organization Z somewhere in the middle of the network and the outflow (O) of the previous organization R in the network is formulated in terms of elasticities (α). The growth rate of the inflow of organization Z can be expressed as:

$$\Delta \ln(I_Z) = \alpha \Delta \ln(O_R) + u \tag{6}$$

where u is an error term. For example, the I_Z could be the number of incoming court cases and O_R could be the number of summonses issued by the public prosecutor. The five equations above are a simplified rendering of the model. In practice, the model distinguishes between nineteen crime types and between adults and juveniles. Moreover, most organizations have several types of input and output and often these inputs and outputs can be divided into subcategories. For statistical purposes, sometimes autoregressive terms are added. Figure 6 gives a simplified schematic rendering of the model.

Using forecasts for demographic and economic developments, the model makes a forecast for recorded crime. Using the forecasts for recorded crime, the model makes a forecast for the number of suspects, which in turn is used to make a forecast for the number of cases handled by the Public Prosecutor, and so on. Following this method, forecasts can be made for the complete criminal justice system. For more details about the model see Moolenaar et al. (2004).

4.2 *Simulations*

In November 2020, the FMJS-model was used to make forecasts for the government budget for 2022-2026 (Moolenaar et al., 2021). These forecasts were based on annual data up to and including 2019. This meant that 2020-2021 also had to be forecasted. We refer to this forecast as the pre-COVID-19 baseline scenario. In November 2020, when these forecasts were made, the full extent of the COVID-19 crisis was still unknown. Thus, it was assumed that COVID-19 would be a temporary problem and that in 2022 life would return to normal. Almost a year later, figures over 2020 are slowly pouring in and the problems that the COVID-19 crisis has caused, are becoming clearer. Although the number of suspects registered by the Police decreased, the suspects that had to be prosecuted started piling up. This was due to the fact that during the first lockdown government offices were closed and later some physical limitations were introduced such as the limited number of people that were allowed in the court room and extra cleaning in between court hearings. Probation services had and still have problems finding COVID-19-proof workplaces for people doing a community service. Prisons were and still are allowed to put only one prisoner in multi-occupancy cells. In some less serious cases, the public prosecutor decided to impose a fine instead of bringing the suspect before a judge. However, this led to other problems, like more people objecting to an imposed fine. Consequently, the public prosecutor still had to bring these cases to court. Also note that many people objected to the fines they received for violating the temporary COVID-19-rules, because they perceived these rules as unfair, contrary to the constitution and illogical. Furthermore, in their opinion the amount of the fines was not in accordance with the severity of the offences.

To assess the effects of the COVID-19 crisis, the forecasted police figures in the pre-COVID-19 baseline scenario for 2020 are replaced by observed figures. In addition, the increases in backlogs are manually entered into the model as well as recent economic forecasts (March, 2021). By resolving the model with the new figures and comparing the new forecasts with pre-COVID-19 baseline scenario, the effect of the COVID-19 crisis can be determined. There are two alternative scenarios. In the first alternative scenario, the decrease in recorded crime is considered to be temporary and it is assumed that the recorded crime in 2022 will return to the level predicted with the pre-COVID-19 baseline scenario. In the second alternative scenario, the number of recorded crimes is assumed to remain at the 2020 level. Rationales for this assumption might be that people will continue to work from home with the consent of their employers and criminals prefer cybercrime to conventional crime. In both scenarios, the various backlog problems will be gradually resolved in the period 2021-2023.

Table 4. Expected effect of COVID-19 for two alternative scenarios, as a percentage of the pre-COVID 19 baseline scenario

	Recorded crime	Suspects	Public prosecutor cases	Court cases	Prison beds
Scenario 1: COVID-effect is temporary					
2020	-0.9	-9.1	-5.0	-3.0	-1.2
2021	-1.0	-9.2	-5.1	-4.1	-2.5
2022	0.0	0.0	0.0	-1.0	0.3
2023	0.0	0.0	0.0	0.0	1.0
2024	0.0	0.0	0.0	0.0	-0.5
2025	0.0	0.0	0.0	0.0	-0.3
2026	0.0	0.0	0.0	0.0	-0.2
Scenario 2: COVID-effect is structural					
2020	-0.9	-9.1	-5.0	-3.0	-1.2
2021	-1.0	-9.2	-5.1	-4.1	-2.5
2022	-1.0	-9.2	-5.0	-4.1	-1.0
2023	-1.0	-9.2	-5.1	-4.1	-1.3
2024	-1.0	-9.2	-5.1	-4.1	-3.2
2025	-1.0	-9.2	-5.1	-4.1	-3.3
2026	-1.0	-9.2	-5.1	-4.1	-3.3

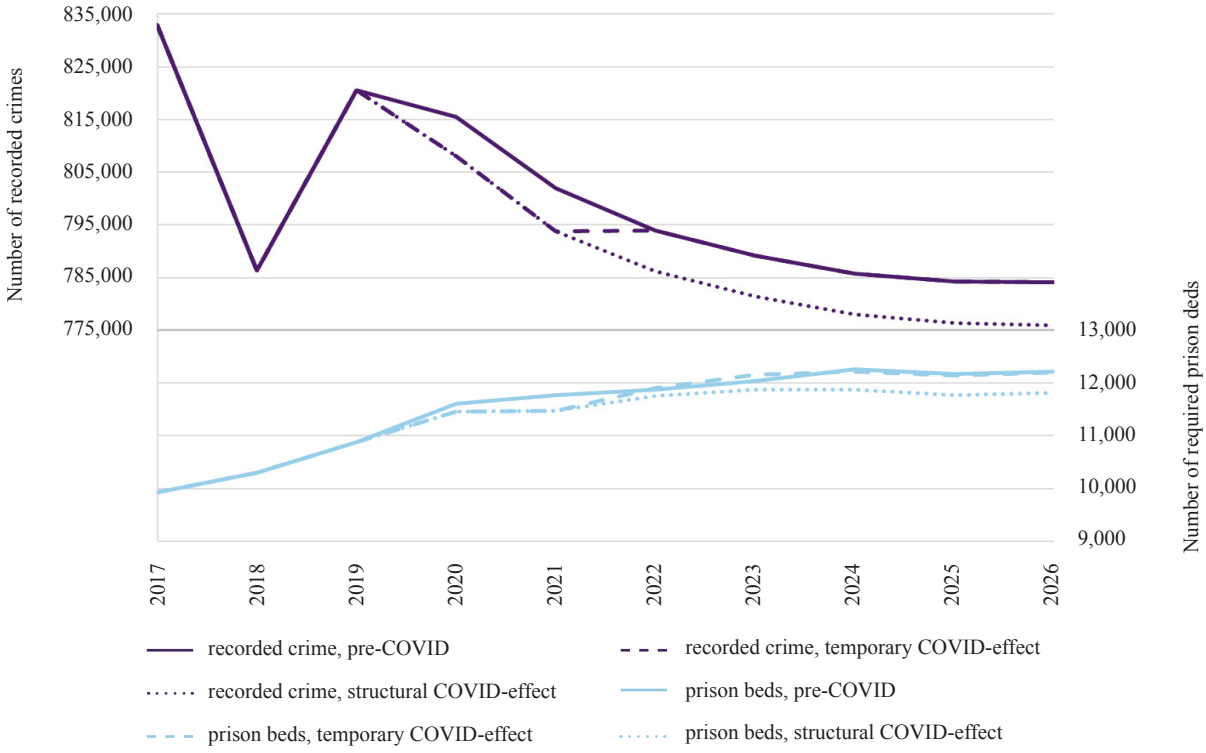

Figure 7. Expected effect of COVID-19 on the number of suspects and prisons for two alternative scenarios compared to the pre-COVID-19 baseline scenario

Source for actual figures: Dutch Police Force and Dutch Prison Services

Table 4 shows the results for five key variables. The percentages indicate the differences with the pre-COVID-19 baseline scenario. Although crime rates have fallen during the COVID-19 crisis, this does not mean that the decrease will be permanent. In the temporary scenario, recorded crime and the number of suspects will be the same as in the pre-COVID-19 baseline scenario from 2022 onwards. Further on in the criminal justice system, the effects of the COVID-19 linger on. The number of court cases always lags behind and will therefore take a year longer to return to the level of the pre-COVID-19 baseline scenario. Because of the decrease in the number of suspects and consequently the court cases, initially less prison beds are required. But when the backlog of court cases and sentences will be cleared in 2022 and 2023, more beds will be needed than forecasted in the pre-COVID-19 baseline scenario. From 2024 onwards, the number of prison beds will gradually return to the level of the pre-COVID-19 baseline scenario.

If the COVID-effect is structural (i.e. lower levels of crime than in pre-COVID times), then all sectors will experience a decrease compared to the pre-COVID-19 baseline scenario. Figure 7 shows the number of suspects and prison beds in the two alternative scenarios and the pre-COVID-19 baseline scenario. At this moment, it is too early to predict which of these two scenarios is more likely to become reality.

5. Summary and conclusion

For the assessment of the impact of the COVID-19 crisis, crime data was collected both on a monthly and a quarterly basis for the period of January 2011 until March 2021. ARIMA models were used to analyze the data, taking into account the seasonal influences. The results show that the overall effect of the pandemic on the number of recorded crimes is limited. However, there are differences between types of crime. The first and second lockdown had a negative effect on recorded property crime (excluding fraud). The travel restrictions also led to fewer recorded property crimes. A higher percentage of positive COVID-19 tests led to fewer suspects of property crime. Comparing the forecasts from the ARIMA-model to actual numbers shows that the impact of COVID-19 on property crime is significant. The second lockdown had a negative effect on overall recorded crime levels and on violent crime in particular but had no effect on the number of suspects. The effect of the second lockdown on drug crime was positive (i.e. a decrease of drug crime). The first lockdown had a positive effect on recorded cybercrime, but at the same time less suspects of cybercrime were apprehended. Comparing the forecasts from the ARIMA-model to actual numbers shows that the impact of COVID-19 on the number of suspects of cybercrime is significant and very large. Finally, the travel restrictions led to more suspects of cybercrime and fraud, while the first lockdown led to a significant drop in the number of suspects of fraud. The results on recorded property crime, violent concur and total crime more or less with the results from previous studies in other countries.

Secondly, the so-called Forecasting Model for the Justice System was used to predict the effect of the decline in the number of suspects on the criminal justice system. Because at this stage it is unknown whether the COVID-19 crisis has a structural or a temporary effect, both scenarios may occur and therefore both scenarios have been calculated. These scenarios were compared with the original pre-COVID-19 baseline scenario. When it is assumed that the COVID-19 effect is temporary, there is a return to the original baseline scenario. Depending on the stage in the criminal justice system, this may vary between two and three years. If the COVID-19 effect will be permanent, all organizations involved in the criminal justice system will have a lower workload in 2024 and onwards compared to the pre-COVID-19 baseline scenario. However, the COVID-19 crisis does not alter the upward trend in the number of prison cells that has started in 2017.

From a research point of view the COVID-19 pandemic proofs to be an interesting natural experiment. Unfortunately, social distancing does not seem to have led to a significant decrease in the level of recorded crime. Criminals seem very resilient and resourceful in finding new ways of committing crimes. Although the number of suspects decreased, it is likely that this may be due to the fact that the Police were busy enforcing de COVID-19 regulations.

Conflict of interest

There is no conflict of interest for this research work.

References

Ashby, M. P. J. (2020b, May 13). *Changes in police calls for service during the early months of the 2020 coronavirus pandemic*. Center for Open Science: SocArXiv, nr. h4mcu. https://doi.org/10.1093/police/paaa037

Ashby, M. P. J. (2020a). Initial evidence on the relationship between the coronavirus pandemic and crime in the United States. *Crime Science, 9*(1), 6. https://doi.org/10.1186/s40163-020-00117-6

Box, G. E. P., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M. (2015). *Time series analysis: Forecasting and control (5th ed)*. John Wiley & Sons.

Campedelli, G. M., Aziani, A., & Favarin, S. (2020). Exploring the immediate effect of COVID-19 containment policies on crime: An empircal analysis of the short-term aftermath in Los Angeles. *American Journal of Criminal Justice, 46*, 704-727. https://doi.org/10.1007/s12103-020-09578-6

Criminal Justice Chief Inspectors. (2021). *Impact of the pandemic on the Criminal Justice System. A joint view of the Criminal Justice Chief Inspectors on the Criminal Justice System's response to COVID-19*. Londen: HM Crown Prosecution Service Inspectorate.

Gerell, M., Kardell, J., & Kindgren, J. (2020). Minor COVID-19 association with crime in Sweden. *Crime Science, 9*(1), 19. https://doi.org/10.1186/s40163-020-00128-3

Hodgkinson, T., & Andresen, M. A. (2020). Show me a man or a woman alone and I'll show you a saint: Changes in the frequency of criminal incidents during the COVID-19 pandemic. *Journal of Criminal Justice, 69*(69), 101706-101706. https://doi.org/10.1016/J.JCRIMJUS.2020.101706

Hyndman, R. J., & Khandakar, Y. (2008). Automatic time series forecasting: The forecast package for R. *Journal of Statistical Software, 27*(3), 1-22. https://doi.org/10.18637/JSS.V027.I03

Levi, M., & Smith, R. G. (2021). *Fraud and its relationship to pandemics and economic crises: From Spanish flu to COVID-19*. Canberra: Australian Institute of Criminology. Research Report 19. https://www.aic.gov.au/publications/rr/rr19

Maskály, J., Ivkovic, S. K., & Neyroud, P. (2021). Policing the COVID-19 pandemic: Exploratory study of the types of organizational changes and police activities across the globe. *International Criminal Justice Review, 31*(3), 1-20. https://doi.org/10.1177/10575677211012807

Mohler, G., Bertozzi, A. L., Carter, J., Short, M. B., Sledge, D., Tita, G. E., Uchida, G. D., & Brantingham, P. J. (2020). Impact of social distancing during COVID-19 pandemic on crime in Los Angeles and Indianapolis. *Journal of Criminal Justice, 68*, 101692. https://doi.org/10.1016/j.jcrimjus.2020.101692

Moolenaar, D., Choenni, S., & Leeuw, F. (2007). Design and implementation of a forecasting tool of justice chains. In F. Galves (ed.), *Proceedings of the Law and Technology Conference 2007* (pp. 60-66). UC Berkeley. https://dl.acm.org/doi/10.5555/1650341.1650353

Moolenaar, D. E. G., Huijbregts, G. L. A. M., & van der Heide, W. (2004). *Prognosemodel Justitiële Ketens [Forecasting Model for the Justice System]*. WODC. Cahier 2004-8.

Moolenaar, D. E. G., Kriege, A. G., & Diephuis, B. J. (2021). *Capaciteitsbehoefte Justitiële Ketens t/m 2026* (Demand for capacity in the Justice System until 2026). Den Haag: WODC/Rvdr. Cahier 2021-12.

Netten, N., Van den Braak, S., Choenni, S., & Leertouwer, E. (2014, October). Elapsed times in criminal justice systems. *Proceedings of the 8th International Conference on Theory and Practice of Electronic Governance.* https://doi.org/10.1145/2691195.2691264

Nivette, A. E., Zahnow, R., Aguilar, R., Ahven, A., Amram, S., Ariel, B., Arosemena, B. M. J., Astolfi, R., Baier, D., Bark, H.-M., Beijers, J. E. H., Bergman, M., Breetzke, G., Concha-Eastman, I. A., Curtis-Ham, S., Davenport, R., Díaz, C., Fleitas, D., Gerell, M., ... Eisner, M. P. (2021). A global analysis of the impact of COVID-19 stay-at-home restrictions on crime. *Nature Human Behaviour, 5*(7), 868-877. https://doi.org/10.1038/s41562-021-01139-z

Payne, J. L., Morgan, A., Piquero, A. R. (2020, July 29). COVID-19 and social distancing measures in Queensland, Australia, are associated with short-term decreases in recorded violent crime. *Journal of Experimental Criminology,* 1-25. https://doi.org/10.1007/s11292-020-09441-y

Payne, J. L., & Morgan, A. (2020). *Property crime during the COVID-19 pandemic: a comparison of recorded offence rates and dynamic forecasts (ARIMA) for March 2020 in Queensland, Australia*. Center for Open Science: SocArXiv, nr. de9nc. https://doi.org/10.31235/osf.io/de9nc

Piquero, A. R., Riddel, J. R., Bishop, S. A., Narvey, C., Reid, J. A., & Piquero, N. L. (2020, June 14). Staying home, staying safe? A short-term analysis of COVID-19 on dallas domestic violence. *American Journal of Criminal Justice,* 1-35. https://doi.org/10.1007/s12103-020-09531-7

Van Dijk, J., Kalidien, S., & Choenni, R. (2018). Smart monitoring of the criminal justice system. *Government Information Quarterly, 35*(4), 524-532. https://doi.org/10.1016/j.giq.2015.11.005

Van Tulder, F. (2000). Crimes and the need for sanction capacity in the Netherlands: Trends and backgrounds. *European Journal on Criminal Policy & Research, 8*(1), 91-106. https://link.springer.com/article/10.1023/A:1008717715657