

Someone will be left out in the cold: Exploring the impact of prosecutors' turnover on statute-barred crimes

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ABSTRACT

This article delves into the implications of turnover among prosecutors in cases where crimes reach the maximum time limit allowed by statutes of limitation before prosecution can commence. Statutes of limitations in criminal law are intended to prevent judicial errors and minimize transaction costs by setting a finite timeframe for prosecuting individuals. However, when criminal cases are dismissed due to the expiration of the statute of limitations, it signifies a failure on the part of the justice system to address criminal activities and a decision by the state to forgo prosecuting offenses that, even if relatively minor, still raise social concerns such as corruption, sexual violence, or fraud. Using a two stage least squared approach and drawing from data spanning the years 2013 to 2021 in Italian courts, our research reveals that prosecutor turnover is closely tied to their individual caseloads, specifically the number of criminal cases involving known offenders they are responsible for handling. This turnover, in turn, impacts the accountability of criminals and contributes to a higher number of cases becoming time-barred and exiting the judicial system before they can even reach the trial stage. In light of these findings, the article proposes the implementation of measures to prevent investigations from falling under the statute of limitations, enhance the overall efficiency of the judicial system, and systematically address the issue of prosecutor turnover.

1. Introduction

The notion of time has a significant and enduring role in various legal systems, particularly through statutes of limitations. These rules, originating from legislative and judicial authorities, have been in existence for centuries and are now widespread. Statutes of limitations are procedural rules establishing time limits to pursue legal actions (Heise, 2001), with the aim to balance the need for an organized legal system that swiftly, efficiently, and fairly handles claims with the need to address legal disputes and achieve individual justice.

Statutes of limitations are an essential aspect of criminal law, intended to lessen judicial error and transaction costs (Solimine, 1989). The original purpose of a limitation system is to protect individuals from defending themselves against charges when the facts have become obscured by time (Powell, 2008), recognizing that it could be more unjust to revive an old claim than to extinguish it (Ochoa & Wistrich, 1997).

Nevertheless, it has been demonstrated that statutes of limitations can make it challenging, if not impossible, to prosecute certain crimes, even heinous ones, such as those related to custom offenses (Mila-Ibàñez, 2023), industrial and employment-related wrongdoings (Gaffar et al., 2022), medical malpractice (Cooney, 2010; Scott, 2009; Sanbar, 2007) sexual abuse (Sandomir & Butler, 2011) and even child exploitation (Wekerle et al., 2013), just to name a few.

The challenge is particularly pronounced, especially in the context of tax fraud and evasion, in countries such

as Greece (Nicolau & Greece, 2020), Italy (Fasone, 2020; Scampuddu & Nieddu, 2019), and Spain (Winter, 2022). These nations have had to initiate extensive legal system reforms aimed at enhancing compliance, efficiency, and the effective collection of taxes. Notably, in Italy, the statute of limitations has allowed significant cases related to political bribery (Rullo, 2019), corruption (Borlini, 2021), art theft (Gerstenblith, 2019), and environmental issues (Venturato & Greco, 2017; Rotolo, 2017) to go unpunished.

Prosecutors in the Italian criminal justice system hold a pivotal role, being directly responsible for the investigation and prosecution of criminal offenses, as well as addressing issues related to incivilities, deviance, immigration, and disorder (Montana & Nelken, 2011). If a prosecutor fails to file charges before the statute of limitations expires, the case becomes statute-barred, rendering it unprosecutable. In this paper, we will also refer to these situations, interchangeably, as "time-barred crimes" or "crimes reaching the statute of limitation."

An intriguing aspect of the Italian legal system is the significant number of criminal cases that become time-barred during their legal proceedings. According to statistics from the Ministry of Justice, Italy processes nearly one million trials annually, and approximately 12.5% of these cases are subject to the statute of limitations (Anastasia & Anselmi, 2020). It's worth noting that a substantial 62% of time-barred cases expire during the early phases of criminal proceedings, specifically during the "indagine preliminari" or investigation phase (Intrieri, 2017).

This paper aims to investigate the impact of prosecutorial turnover on time-barred crimes. Turnover has been observed to affect the productivity of various entities, including schools (Ronfeldt et al., 2013), businesses (Hausknecht & Trevor, 2011), and judges (Boylan, 2004). Much like judges influenced by personal convictions and policy preferences

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(Posner, 1993), turnover among prosecutors can lead to inconsistent decision-making (Staszkiwicz et al., 2020). This inconsistency can erode public confidence in legal institutions (Sarat & Felstiner, 1988) and create a perception of bias or unfairness (Frank, 1963).

Previous research has shown that judge turnover in Italy results in case processing delays, leading to backlogs and reduced court efficiency (Guerra & Tagliapietra, 2017). Surprisingly, no studies have explored the effect of prosecutors' turnover on time-barred crimes, despite the urgency and relevance of the statute of limitation topic (Macchia, 2017). Building on the existing literature, it is reasonable to anticipate that turnover within the prosecutorial office can influence the application and enforcement of statutes of limitations, which dictate the time frame for prosecuting specific crimes.

Prosecutors often grapple with challenges such as heavy caseloads and prolonged legal proceedings, leading to frustration and a perceived inefficiency in their roles. This frustration may drive some prosecutors to seek career advancement or more efficient work environments elsewhere. When prosecutors vacate their positions without immediate replacements, it can result in delays in both investigations and prosecutions. This, in turn, heightens the likelihood that a case may surpass the statute of limitations. Moreover, turnover among prosecutors disrupts the continuity in case management, resulting in inconsistent decisions and a lack of accountability. Different prosecutors may prioritize and approach cases differently, leading to varying levels of prosecution for similar offenses.

To investigate the effect of prosecutors' turnover on the handling of statute-barred cases, we use a dataset spanning Italian courts ("Tribunali") from 2013 to 2021, provided by the Ministry of Justice ("Ministero della Giustizia") and made available by the High Council for the Judiciary ("Consiglio Superiore della Magistratura"). Our analysis centers on the impact of turnover among both head and assistant prosecutors in the context of statute-barred cases, yielding several noteworthy findings.

We employ a robust two-stage least squares (2SLS) estimating method to shed light on the relationship between prosecutorial turnover and the persistence of statute-barred crimes in Italy. This method allows us to uncover the causal links between these variables.

In the first stage of the 2SLS approach, we use the sum of incoming and pending cases as our instrumental variable to estimate the impact of increased prosecutorial workload, often referred to as "fascicoli noti per pm" in Italian. This workload serves as a proxy for the challenges prosecutors face in handling cases.

Subsequently, in the second stage of the 2SLS methodology, we employ the predicted values of the number of missing prosecutors, as determined in the first stage, as our primary independent variable. This variable forms the basis of our analysis, as we seek to understand its effect on the rate of statute-barred cases.

Our empirical findings from the second stage of the 2SLS analysis suggest a significant and positive relationship between prosecutors leaving the prosecutorial office and the occurrence of time-barred criminal cases. This relationship signifies that as the number of prosecutors leaving their positions increases, so does the number of crimes exiting the legal system due to the expiration of the statute of limitations during the prosecution phase.

The estimated coefficients in the 2SLS regressions reveal that a unitary rise in assistant prosecutors' turnover corresponds to a substantial 2.31% increase in the number of crimes that reach the statute of limitations during the prosecution phase, ultimately resulting in time-barred cases. Furthermore, this positive association indicates that a unitary increase in head prosecutors leaving their office leads to an 11.44% rise in the incidence of time-barred crimes.

This key finding is further reinforced by our analysis using smoothed instrumental variable quantile regressions (SIVQR), which, although displaying limited statistical significance between the median and the upper quantile for head prosecutors, corroborates the link between the turnover of prosecutors and the persistence of time-barred crimes.

To give you an overview of the paper's structure, Section 2 provides an in-depth exploration of the issues surrounding statute-barred crimes in Italy. In Section 3, we delve into the methodology, offering a detailed description of our empirical model, the variables we consider, and presenting descriptive statistics. Section 4 presents the empirical results, which we discuss in Section 5. Finally, Section 6 draws the conclusions of our study, summarizing the key findings and their implications.

2. Statute-barred crimes as a serious concern for Italian justice efficiency

Statutes of limitations are a fundamental component of legal systems in many jurisdictions. They establish a time limit within which criminal prosecutions must commence; beyond this time, the defendant has the right to demand acquittal or the dismissal of charges (Leibowitz, 2003).

From an economic standpoint, statutes of limitations play a crucial role in restricting their authority and minimizing the legal costs associated with using outdated evidence to resolve disputes (Posner, 1986). They also act as a constraint on prosecutorial discretion, influencing whether a defendant is charged, and are aimed at preventing futile litigation (Bellin, 2019; Baker & Miceli, 2000).

In the realm of criminal law, the primary purpose of statutes of limitations is to serve the cause of general prevention (Mongillo, 2020). From the perspective of procedural efficiency, which pertains to the optimal allocation of human and instrumental resources within the criminal justice system, the inclination to prosecute long-past offenses gives way to the pursuit of recent and socially harmful crimes (Cavaliere, 2021).

Notably, the effects of time on the public punishment mechanism are multifaceted. Over time, it can partially

mitigate the harm caused by a crime, cause the incident to fade from memory, diminish the stigma associated with the perpetrator, complicate the process of proving facts and assigning responsibility, hinder the ability to mount a defense, and raise questions about the effectiveness of imposing penalties long after the fact, especially when the offender may have already undergone rehabilitation and reintegration (Gatta, 2020).

In the Italian legal system, statutes of limitations are structured based on the nature of the offense rather than a traditional classification by time range, and they do not impose any statutory limitations on serious felonies (Lonati, 2019). This approach has faced criticism for being imprecise, inconsistent, and dysfunctional (Caruso, 2008), contributing to anomalies and impasses in definitively establishing a defendant's responsibility (Marafioti & Centorame, 2022).

Within the Italian jurisdiction, it is common for alleged crimes to be dismissed due to the statute of limitations expiring. This situation is perceived as emblematic of a judiciary that is not functioning optimally, leading to protracted court proceedings, a widespread lack of trust in the legal system, and the belief that it predominantly benefits those who can afford lengthy and expensive legal battles (Loher, 2020).

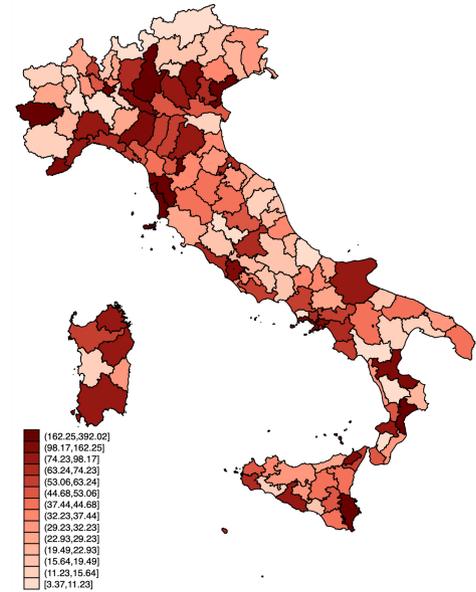
The distribution of statute-barred cases across Italian provinces varies due to factors like population size, the prevalence of legal disputes, and the effectiveness of local legal systems in pursuing cases before the statute of limitations expires. For instance, highly populated provinces like Lombardy or Lazio may have more statute-barred cases simply because of their larger population and greater potential for legal disputes. In contrast, less populated provinces like Molise or Basilicata may have fewer statute-barred cases due to a lower volume of legal disputes.

In reality, there's a high degree of heterogeneity among provinces regarding the rate of statute-barred cases (see Figure 1). This figure displays the average proportion of statute-barred cases among total prosecution cases for each Italian province between 2013 and 2021.

Interestingly, the graph doesn't reveal a clear relationship between the rate of statute-barred cases and geographical distributions. For example, some northern regions like Piedmont, Lombardy, and Veneto have relatively high heterogeneity, while certain southern provinces, including those in Calabria, Marche, and Abruzzo have similar rates. This suggests that factors other than geography contribute to the variation in statute-barred cases among Italian provinces.

Italian law establishes time limits for prosecuting specific criminal offenses. Once the time limit expires, prosecution is impossible, irrespective of the evidence against the defendant. Significant time-barred crimes have posed a distinct challenge in Italy, impeding the pursuit of justice for serious offenses such as torture and inhuman treatments (Carcano, 2023; Amoroso, 2021), enforced disappearance (Citroni, 2021), and corruption (Gatta, 2022). Time-barred crimes have also, at times, run afoul of the EU's legal obligations to combat criminal activities affecting the financial interests of the Union (Manacorda, 2018; Giuffrida, 2016).

Figure 1: Geographical distribution of statute-barred cases



Note: Average proportion of statute-barred cases among total reported crimes among Italian tribunals, per 100.000 inhabitants, based on data from 2013-2021.

Based on our data, spanning from 2013 to 2021, one-sixth of prosecutorial offices encountered a situation where more than one-tenth of the cases handled by the prosecution office reached the statute of limitations. In addition, seven tribunals experienced an even more concerning scenario, with over 20% of cases becoming time-barred before trial. This indicates that a significant number of criminal offenses remained unprosecuted, leaving those responsible unaccountable.

This predicament has adverse consequences for Italian society. It corrodes public confidence in the criminal justice system, leaving victims and their families disheartened, as they perceive a lack of justice being served. Moreover, it undermines trust in the system's ability to penalize wrongdoers and can foster a sense of impunity among criminals who believe they can act without facing consequences.

Statute-barred crimes also result in disparities in how defendants are treated. For example, when two individuals commit a similar crime, but one is charged before the statute of limitations expires and the other is not, it can create a perception of unfairness and further erode trust in the criminal justice system. Time-barred crimes can hinder law enforcement agencies in reducing criminal activity and may indicate systemic issues within the criminal justice system, such as resource constraints or a failure to prioritize certain types of cases.

3. Methodology

To investigate the relationship between prosecutor turnover and statute-barred crimes in Italy, we employ three distinct

econometric methods: ordinary least squares (OLS), two-stage least squares (2SLS), and smoothed quantile instrumental variable regressions (SIVQR).

In our OLS model, we consider the number of missing prosecutors per prosecutor's office as the primary independent variable and the count of statute-barred crimes as the dependent variable. We also incorporate several control variables to address potential influences on the number of statute-barred cases. These controls encompass population size, disposition time (measuring the average predictable case processing time), the significance of the prosecutor's office (proxied by its relationship with the Court of Appeal and the Tribunal), the rate of burglaries aggravated by the use of agility (a petty crime necessitating ex officio prosecution), regional and temporal fixed effects to account for unobserved variations, time trends, and spatial distinctions.

Nonetheless, we recognize the potential for endogeneity concerns. Prosecutor turnover may be interconnected with unobservable factors, including workplace culture, job satisfaction, management practices, and personal preferences. These factors are challenging to measure directly but can significantly affect turnover rates, leading to endogeneity.

To address this issue, we employ a 2SLS model. In this model, we use a proxy for prosecutor workload, constructed as the sum of incoming and pending cases per prosecutor. This proxy considers factors that can trigger turnover and helps resolve endogeneity. The rationale for using prosecutors' workload as a key factor lies in the fact that when incoming and pending cases increase, prosecutors face substantial stress, often managing numerous cases with tight deadlines. This stress can lead to burnout, characterized by physical and emotional exhaustion, making prosecutors feel overwhelmed due to the sheer volume of cases they must handle.

An excessive workload not only impacts job satisfaction but also impedes the effective delivery of justice, potentially causing prosecutors to become disillusioned with their profession. Reduced job satisfaction, in turn, can result in a higher turnover rate as prosecutors seek more fulfilling career opportunities. Furthermore, recruiting qualified candidates can become challenging, and retaining experienced prosecutors may prove difficult when the profession is associated with excessive stress and work demands.

In our 2SLS model, in the first stage, we use the ratio between the sum of incoming and pending cases per total prosecutors as an instrumental variable to assess the impact of increased workload ("fascicoli noti per pm" in Italian). Subsequently, in the second stage, we employ the predicted values of the number of missing prosecutors from the first stage as the primary independent variable to estimate the effect of the number of missing prosecutors on the log of statute-barred cases.

It's important to note that standard linear regression methods assume uniform effects across the entire distribution of the dependent variable. In the real-world context of prosecuting crimes, the relationship between variables can vary across different quantiles of the distribution. This

is where the SIVQR estimating method proves its value. It is considered the most reliable approach for large-scale inference in quantile regression (He et al., 2021) and excels in handling non-linear relationships, varying conditional quantile variances, and reducing sensitivity to model assumptions (Kaplan, 2022; Kaplan & Sun, 2017). Ultimately, the SIVQR allows us to estimate causal effects at different quantiles, providing a more nuanced understanding of how the relationship evolves across the distribution.

The empirical model used to assess the impact of prosecutor turnover on time-barred prosecutions is characterized by the following parameters:

$$\ln(TBcrimes)_{ct} = \beta_1 \text{ihS}(Turnover)_{ct} + \beta_2 X_{ct} + \alpha_{ct} + \epsilon_{ct} \quad (1)$$

The dependent variable, denoted as $\ln(TBcrimes)_{ct}$, represents the natural logarithm of time-barred crimes. These are criminal cases that have reached the statute of limitations during the prosecution phase in a specific court (c) at a given point in time (t).

Our variable of interest and primary independent variable, represented as $(Turnover)_{ct}$, is a composite variable that reflects two distinct aspects of prosecutor turnover within the Italian prosecutorial hierarchy. This variable, sourced from the Ministry of Justice, is based on the comparison between the actual number of prosecutors in a specific prosecutorial office and the ideal number of prosecutors that should be assigned to that office. It provides insights into turnover patterns among prosecutors across different hierarchical levels, considering both assistant prosecutors and head prosecutors, across various times and locations.

For clarity, it's essential to distinguish between head prosecutors and assistant prosecutors. Head prosecutors hold the highest rank within the prosecutorial office and have supervisory responsibilities over other prosecutors. On the other hand, assistant prosecutors, typically first-level prosecutors, are assigned to specific prosecutorial offices and are responsible for conducting criminal prosecutions, supporting accusations in court, and responding to emergencies under the guidance of the head prosecutor.

To make the variable of interest more suitable for analysis, both in the case of head and assistant prosecutors, we apply an inverse hyperbolic sine (ihS) transformation. The ihS transformation, also known as the hyperbolic sine area transformation (Harris & Stocker, 1998), is a valuable method when dealing with data that include zeros and negative values without needing to exclude observations (Pence, 2006). The advantage of the ihS transformation lies in its ability to normalize the data and convert non-linear relationships into linear ones for mean values greater than ten, as is the case in our analysis (Bellemare & Wichman, 2020).

The empirical strategy incorporates a vector X_{ct} of control variables to consider other factors affecting the number of statute-barred cases.

Firstly, we introduce the natural logarithm of the population. Population size and density can influence legal cases,

judicial decisions, and legal outcomes. A larger population often correlates with higher crime rates and convictions (Landes, 1971). Increased population and density lead to more interactions among residents, resulting in a higher incidence of legal disputes (Rosales & Jiménez-Rubio, 2017). The population variable helps normalize the data and accounts for the fact that larger populations naturally have more legal cases and judicial decisions. Without population controls, certain types of time-barred cases or legal decisions might be overrepresented in smaller populations due to their limited number, potentially leading to misleading conclusions. We use the natural logarithm (\log) of the population to linearize relationships between variables, make the distribution more symmetric (given the highly skewed distribution of the population data), and interpret coefficients in terms of percentage changes, which are more meaningful in our context.

Secondly, the vector of control variables includes the registered disposition time between the preliminary investigations judge ("giudice indagini preliminari") and the preliminary hearing judge ("giudice udienza preliminare"). Prolonged disposition times remain a consistent and enduring policy concern within the court system (Walsh & Steelman, 2013) and pose a risk to the quality of evidence, as memories may deteriorate, evidence may degrade, and witnesses and litigants may pass away (Heise, 2000). A shorter disposition time indicates a more streamlined process, while a longer disposition time suggests delays or inefficiencies. By including this variable, we account for differences in the pace of case progression and assess whether cases that spend an extended period in the preliminary investigation phase are more prone to reaching the statute of limitations. This control variable helps ensure that our results are not confounded by variations in case progression within the Italian legal system.

We also include a dummy variable that equals one if the tribunal is in the same location as the Court of Appeal. The ubiquity of both a tribunal and a Court of Appeal within the same courthouse can be seen as a proxy for a more prestigious legal forum (Klein & Morrisroe, 1999; McCormick, 1993). This arrangement signifies access to higher legal authorities, opportunities for career advancement, exposure to legal expertise, involvement in complex and high-profile cases, and potential networking and collaboration within the legal community. Furthermore, courthouses with a Court of Appeal may handle complex legal cases and high-profile appeals. Prosecutors in these locations may find themselves involved in cases with significant public and legal interest.

Additionally, we include two dichotomous variables, equal to 1 if the tribunal is considered small (*SmallTrib*) or big (*BigTrib*) by the High Council of the Judiciary. The size and structure of the court system impact efficiency and productivity, as indicated by various studies (Agregli et al., 2020; Falavigna et al., 2018; Dalton & Singer, 2014; Santos & Amado, 2014; Kittelsen & Førsund, 1992; Lewin et al., 1982). Larger tribunals tend to handle a higher volume of cases, while smaller tribunals deal with a smaller

number. Additionally, larger tribunals may have more resources, both in terms of personnel and infrastructure, compared to smaller tribunals. These resources can influence the efficiency of case processing and the ability to prevent cases from reaching the statute of limitation. Including both variables ensures that the results are not driven by the characteristics of a specific tribunal type but are applicable across different settings within the legal system.

The vector also includes the rate of burglaries aggravated by agility that are reported to the prosecutorial office by the police. This variable aims to capture the congestion of the prosecutors in dealing with a higher volume of small but very common crimes (Di Amato & Fucito, 2020) that impose compulsory arrest and have to be necessarily prosecuted by the office. X_{ct} also includes the natural log of the population in the relative catchment area of each tribunal having a prosecution office, to normalize data and account for demographic changes. Larger populations often represent diverse communities with varying legal needs (Sandefur, 2015), more complex social dynamics (Knoke, 1982), socioeconomic disparities (Kondo, 2012, and Barbieri, 2022), cultural diversity (Nijkamp & Poot, 2015), and higher social inequalities (Navarro & Shi, 2001). Without controlling for population, for example, an increase in the absolute number of crimes might erroneously suggest a rise in crime rates when, in fact, it might simply be due to population growth.

The model also includes time and geographical indicators (α_{ct}) representing the different years of observation and the different regions that the Italian National Institute for Statistics (Istat) and the European Unions consider level two in the Nomenclature of Territorial Units for Statistics (NUTS2). By including these variables, we control for any temporal or regional differences that may affect the number of statute-barred cases. The year indicators help us capture any time trends that may impact the dependent variable, while the geographical dummy variables allow us to differentiate the impact of turnover and other factors such as the North-South socio-institutional divide (Felice, 2018), different labour-market institutions (Fanti et al., 2023) persistent territorial disparities (Federici et al., 2023), different productivity dynamics (Bripi et al., 2023).

Finally, we assume that there is an unobserved random error term represented by ϵ_{ct} , which captures other unobservable factors that may impact the number of cases reaching the statute of limitation.

Descriptive statistics of the variables included in the dataset are provided in Table 1.

Before conducting any empirical analysis, we have performed a Variance Inflation Factor (VIF) test (see Figure 6, in the Appendix), to assess potential multicollinearity in multiple regression analysis and avoid that two or more independent variables in the regression model could be highly correlated with each other. The VIF values for all the variables in the model are relatively low, with the highest VIF being 2.76. In general, a VIF of 1 indicates no multicollinearity, so having VIFs mostly below 2 suggests that there is not a severe multicollinearity problem in your model.

Table 1
Descriptive statistics

Variable	n	Mean	Std. Dev.	Min	.25	Mdn	.75	Max
Time-barred crimes	1220	384.55	904.74	2.00	49.00	120.00	311.50	11771.00
Turnover assistant prosecutors	1220	1.51	2.33	-2.00	0.00	1.00	2.00	22.00
Turnover head prosecutors	1220	0.12	0.34	-1.00	0.00	0.00	0.00	1.00
Workload (IV)	1220	1611.45	761.54	334.74	1097.66	1446.20	1980.99	6058.00
Registered cases	1220	9520.33	9279.14	1091.00	4362.00	7070.50	10865.50	78673.00
Pending cases	1220	9675.57	13597.05	151.00	3180.50	5823.50	10740.00	1.1e+05
Disposition time GIP/GUP	1220	325.83	379.51	37.56	132.30	202.86	352.45	3666.18
Tribunal = Court Appeal	1220	0.19	0.39	0.00	0.00	0.00	0.00	1.00
Tribunal is small	1220	0.39	0.49	0.00	0.00	0.00	1.00	1.00
Tribunal is big	1220	0.02	0.15	0.00	0.00	0.00	0.00	1.00
Rate aggravated theft	1220	3.59	2.89	0.18	1.49	2.85	4.52	16.62
Total population	1220	4.4e+05	3.8e+05	4591.00	2.0e+05	3.3e+05	5.2e+05	2.9e+06
ln(Time-barred crimes)	1220	4.89	1.40	0.69	3.89	4.79	5.74	9.37
ihs(Turn. ass. pros.)	1220	0.85	0.90	-1.44	0.00	0.88	1.44	3.78
ihs(Turn. pros.)	1220	0.11	0.30	-0.88	0.00	0.00	0.00	0.88
ln(Tot. population)	1220	12.73	0.73	8.43	12.21	12.70	13.16	14.87

Note: The table provides descriptive statistics of the dataset, composed of a total sample of 136 courts, based on the data (2013-2021) provided by the Italian Ministry of Justice and the High Council for the Judiciary.

This is a positive aspect as it implies that the independent variables are not overly correlated with each other. The mean VIF across all variables is 1.54, which is relatively low. This further supports the idea that multicollinearity is not a significant issue in our model.

4. Empirical results

In this section, we present the results of the OLS, the 2SLS and the SIVQR regressions, based on the dataset of 136 first instance court prosecutions offices in Italy between 2013 and 2021. The aim of the analysis is to investigate the relationship between turnover of prosecutors and the rate of statute barred cases, while controlling for various other factors that may influence the dependent variable.

In Table 2 and Table 3 we estimate several OLS models, each with a different specification of the independent variables. In particular, we start with a basic model that includes only the turnover of head and assistant prosecutors as the main independent variable, including the geographical and temporal indicators. We then progressively add more control variables to the model to test the robustness of the results and investigate the effect of different factors on the dependent variable, time barred crimes (TBC). Table 2 presents the results of the OLS regressions regarding assistant prosecutors, while Table 3 refer to head prosecutors.

In addition to the mere OLS specifications, Table 4 and Table 5 report the results of regressions across quantiles. Quantile regressions are less sensitive to the distributional assumptions of linear regression and assess how the relationship varies at different quantiles of the distribution, providing insights into potential heterogeneity that linear regression might miss.

According to the results presented in Table 2, Table 5, Table 4, Table 5, there is no statistically significant relationship between an increase in the turnover among prosecutors and the occurrence of time-barred crimes. This observation holds, particularly when we adjust the results for population size within the catchment area. It's worth noting that larger populations often encompass diverse communities with varied legal needs and more complex social dynamics.

Table 2
OLS regressions: Assistant prosecutors

VARIABLES	(1) TBC	(2) TBC	(3) TBC	(4) TBC	(5) TBC	(6) TBC	(7) TBC
ihs(Turnover sub. pros.)	0.377*** (0.0457)	0.0600 (0.0495)	0.0521 (0.0483)	0.0186 (0.0428)	0.00994 (0.0409)	0.00267 (0.0403)	0.000953 (0.0392)
log(Population)		1.142*** (0.109)	1.169*** (0.104)	0.940*** (0.110)	0.830*** (0.129)	0.804*** (0.134)	0.703*** (0.131)
Disposition time GIP/GUP			0.000237** (9.82e-05)	0.000260*** (9.22e-05)	0.000258*** (8.75e-05)	0.000253*** (8.69e-05)	0.000236*** (8.25e-05)
Tribunal = Court of appeal				0.700*** (0.0962)	0.680*** (0.0923)	0.661*** (0.0887)	0.555*** (0.0863)
Tribunal is small					-0.257*** (0.0945)	-0.273*** (0.0972)	-0.306*** (0.0943)
Tribunal is big						0.303 (0.272)	0.315 (0.251)
Rate aggravated theft							0.0778*** (0.0151)
Yearly-indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,220	1,220	1,220	1,220	1,220	1,220	1,220
Adjusted R-squared	0.326	0.516	0.519	0.546	0.549	0.560	0.560
Centered R-squared	0.341	0.527	0.531	0.557	0.561	0.562	0.573

Double clustered standard errors – at id and year level – in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The table reports the empirical coefficients of the OLS regressions regarding time-barred crimes (TBC) and the turnover of assistant prosecutors (ass. pros.), among 136 courts in the timeframe 2013-2021.

Table 3
OLS regressions: Head prosecutors

VARIABLES	(1) TBC	(2) TBC	(3) TBC	(4) TBC	(5) TBC	(6) TBC	(7) TBC
ihs(Turnover head pros.)	0.0638 (0.124)	-0.00265 (0.0926)	-0.00156 (0.0929)	-0.0187 (0.0904)	-0.0233 (0.0903)	-0.0248 (0.0901)	-0.0128 (0.0888)
log(Population)		1.176*** (0.0941)	1.200*** (0.0887)	0.949*** (0.100)	0.834*** (0.122)	0.805*** (0.129)	0.703*** (0.126)
Disposition time GIP/GUP			0.000244** (0.000101)	0.000263*** (9.33e-05)	0.000259*** (8.80e-05)	0.000253*** (8.70e-05)	0.000236*** (8.26e-05)
Tribunal = Court of appeal				0.705*** (0.0993)	0.683*** (0.0942)	0.662*** (0.0897)	0.555*** (0.0866)
Tribunal is small					-0.259*** (0.0967)	-0.274*** (0.0994)	-0.306*** (0.0961)
Tribunal is big						0.306 (0.274)	0.316 (0.252)
Rate aggravated theft							0.0777*** (0.0151)
Yearly-indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,220	1,220	1,220	1,220	1,220	1,220	1,220
Adjusted R-squared	0.276	0.515	0.518	0.546	0.549	0.550	0.560
Centered R-squared	0.292	0.526	0.530	0.557	0.561	0.562	0.573

Double clustered standard errors – at id and year level – in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The table reports the empirical coefficients of the OLS regressions regarding time-barred crimes at the prosecutor office level and their turnover, during the years 2013-2021.

What is particularly intriguing is the outcome of the quantile OLS regressions displayed in Table 4 which demonstrates a negative and statistically significant correlation between turnover and time-barred crimes in the first two quantiles. However, the effect does not remain constant across all quantiles, and the upper quantile even shows a positive effect, although it's not statistically significant. The relationship is not consistent throughout the entire dataset and varies in magnitude and sign as we look at different sections of the data, suggesting potential bias.

In this regard, given the well-documented issue of failing to consider the endogenous nature of turnover, as noted by Stern et al. (2021), this leads to a systematic underestimation of the actual causal impact in the estimates (Antwi & Bowblis, 2018). To address this endogeneity concern, we instrument our endogenous variable, namely prosecutors' turnover, with the workload faced by each prosecution office concerning registered criminal cases and pending cases.

The workload of prosecutors is calculated as the ratio between the sum of registered criminal cases and pending cases and the total number of prosecutors in the office. This

Table 4

Quantile OLS regressions: Assistant prosecutors

VARIABLES	(1) TBC	(2) TBC	(3) TBC	(4) TBC	(5) TBC
ihS(Turnover ass. prosec.)	-0.174** (0.0763)	-0.111** (0.0504)	-0.0450 (0.0438)	-0.0199 (0.0465)	0.0453 (0.0444)
log(Population)	0.662*** (0.244)	0.899*** (0.141)	0.988*** (0.121)	1.019*** (0.126)	0.914*** (0.135)
Disposition time GIP/GUP	4.64e-05 (0.000124)	7.35e-05 (9.72e-05)	0.000152 (9.49e-05)	7.97e-05 (0.000111)	0.000192 (0.000126)
Tribunal = Court of Appeal	0.664*** (0.179)	0.509*** (0.111)	0.459*** (0.108)	0.480*** (0.106)	0.429*** (0.106)
Tribunal is small	-0.525*** (0.197)	-0.194* (0.112)	-0.0920 (0.0997)	-0.0979 (0.116)	-0.185 (0.132)
Tribunal is big	0.987*** (0.360)	0.377 (0.270)	-0.0443 (0.260)	-0.395 (0.267)	-0.359 (0.424)
Rate aggravated theft	0.00732 (0.0326)	0.0427** (0.0214)	0.0613*** (0.0209)	0.0675*** (0.0194)	0.0663*** (0.0213)
Yearly-indicators	Yes	Yes	Yes	Yes	Yes
Regional-indicators	Yes	Yes	Yes	Yes	Yes
Observations	1,220	1,220	1,220	1,220	1,220
Quantile level	0.0500	0.150	0.250	0.350	0.500
Pseudo-R2	0.338	0.350	0.360	0.359	0.362

Double clustered standard errors – at id and year level – in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: The table reports the empirical coefficients of the quantile OLS regressions, regarding time-barred crimes at the prosecutor office level and prosecutorial turnover, during the years 2013–2021.

Table 5

Quantile OLS regressions: Head prosecutors

VARIABLES	(1) TBC	(2) TBC	(3) TBC	(4) TBC	(5) TBC
ihS(Turnover head pros.)	0.108 (0.129)	0.0999 (0.109)	-0.0404 (0.102)	-0.0524 (0.138)	-0.0392 (0.140)
log(Population)	0.870*** (0.127)	0.978*** (0.120)	0.977*** (0.140)	0.893*** (0.176)	0.786*** (0.218)
DT gip/gup	0.000103 (0.000106)	0.000162* (8.84e-05)	0.000222* (0.000124)	0.000173 (0.000166)	0.000263 (0.000205)
Tribunal = Court of Appeal	0.537*** (0.106)	0.438*** (0.105)	0.403*** (0.111)	0.314** (0.151)	0.416** (0.204)
Tribunal is small	-0.129 (0.117)	-0.0858 (0.103)	-0.171 (0.137)	-0.306** (0.137)	-0.312* (0.163)
Tribunal is big	0.331 (0.254)	-0.107 (0.250)	-0.414 (0.377)	0.895 (0.666)	0.524 (0.450)
Rate of agility theft	0.0478** (0.0226)	0.0627*** (0.0207)	0.0716*** (0.0209)	0.0730*** (0.0236)	0.0721*** (0.0251)
Yearly-indicators	Yes	Yes	Yes	Yes	Yes
Regional-indicators	Yes	Yes	Yes	Yes	Yes
Observations	1,220	1,220	1,220	1,220	1,220
Quantile level	0.150	0.250	0.500	0.750	0.850
Pseudo-R2	0.347	0.359	0.362	0.381	0.395

Double clustered standard errors – at id and year level – in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: The table reports the empirical coefficients of the OLS regressions regarding time-barred crimes at the prosecutor office level and their turnover, during the years 2013–2021.

instrumental variable is plausible because in legal settings, heavy workloads are often cited as “one of the more consistently echoed reasons for leaving,” (Barrow & Zuk, 1990). A heavier workload places significant stress on prosecutors as they must manage numerous cases, often with tight deadlines. This stress can lead to burnout, characterized by physical and emotional exhaustion, as prosecutors grapple with the overwhelming volume of cases, resulting in mental and emotional fatigue.

Moreover, increased workload can also negatively affect prosecutorial turnover by influencing how the judiciary is perceived as a career option. This can lead to challenges in recruiting qualified candidates, as well as difficulties in retaining experienced prosecutors, especially when the

profession is associated with excessive stress and demanding workloads. It's noteworthy that Italian prosecutors have the maximum flexibility to switch functions, potentially becoming judges (Nelken, 2013). Hence, if prosecutors face mounting pressure from various stakeholders, including government officials, to clear backlogs and manage an excessive caseload, they might opt to leave the prosecutorial profession in favor of a judicial career. Finally, higher workloads may prompt prosecutors to seek positions in other courts with lighter workloads, better work-life balance, or enhanced career advancement opportunities. This is one of the reasons why we include a control variable for the ubiquity of Tribunals and the Court of Appeal.

When considering exclusion restrictions, it's essential to recognize that prosecutors' workload cannot directly influence the occurrence of time-barred crimes for several reasons. First, the impact of a higher caseload today, driven by prosecutors' work, would affect time-barred cases in subsequent years, given the minimum time requirement mandated by the law for cases to reach the time-barred status, which is generally a period of at least 6 years. In essence, there is a temporal disconnect between prosecutors' workload changes and their potential influence on the time-barred status of cases, making it implausible for workload to be a direct driver of time-barred crimes.

Secondly, the process of cases reaching the statute of limitations is governed by the legal framework, which operates independently of prosecutors' workload. The determination of whether a case becomes time-barred or not is a primarily legal matter, decided by the legislator. It escapes the control or influence of prosecutors. In this context, prosecutorial activities and caseload management are secondary to the legal definitions and statutory time limits. As such, there is a clear separation between prosecutorial actions and the legal process leading to cases becoming time-barred.

In our empirical analysis, we take these considerations into account and incorporate this temporal separation as part of the identification strategy. To further verify the plausibility of our exclusion restrictions, we conduct a formal test following the approach outlined by D'Haultfœuille et al. (2021). The results of this test align with our theoretical rationale, as we do not find evidence to reject the null hypothesis that the exclusion restrictions are satisfied. This holds true at a significance level of 1%, confirming that our chosen instrument, prosecutors' workload, is unlikely to have a direct influence on the occurrence of time-barred crimes and meets the criteria for a valid instrument (see Appendix, Table 13).

With regard to addressing the potential endogeneity of the turnover variable, we employ the two-stage least squares (2SLS) estimation method. To ensure the validity of the instrument used in our model, we conduct various tests to assess the strength and robustness of our instrumental variable.

We begin by performing the weak instrument test proposed by Montiel Olea and Pflueger (2013), which is a reliable method for gauging the strength of instruments by

examining the first-stage F-statistic. The results of these tests are presented in Table 14 of the Appendix. For assistant prosecutors, the effective F-statistic is 55.08***, and for head prosecutors, it is 14.84***. This indicates that the instrument used for assistant prosecutors demonstrates robust strength, with the worst-case bias limited to 5%. While the IV used for head prosecutors is slightly less promising but still highly significant, surpassing the threshold of $\tau=30\%=12.04$. This implies that the maximum potential bias due to weak instruments is capped at 20%. Additionally, if we trim our dataset by excluding outliers at a 10% level according to the approach by Koenker & Bassett (1978), the robustness of the instrument is enhanced, resulting in an effective F-statistic of 17.80*** and a maximum worst-case bias of 10%.

To further safeguard against potential bias affecting the quality of our 2SLS estimates, we conduct Anderson-Rubin (AR) and Wald tests. These tests are designed to examine the null hypothesis that the beta coefficient of our instrument is approximately near zero. The results of these tests, detailed in Table 15 of the Appendix, confirm that we can confidently reject this null hypothesis with very high statistical significance. This demonstrates the strength of the instrument in both model specifications, assuring its validity for both assistant prosecutors and head prosecutors.

To bolster the validity of our instrument and substantiate the primary results regarding time-barred cases, we perform placebo tests of the IV. These tests involve substituting the instrumented and instrumental variable, with and without the logarithmic and inverse hyperbolic area transformations, and also replacing the IV with the number of defined cases. Importantly, these placebo tests show that the results remain consistent and align with the expected non-causal relationship between prosecutorial turnover and defined cases. This further reinforces our confidence in the primary results regarding time-barred cases, and these results are available in the Appendix (Table 16).

Turning to the estimation results, Table 6 and Table 7 present the empirical coefficients of the first stage of the 2SLS regressions, while the second stage coefficients are reported in Table 8 and Table 9. In line with our approach in the OLS estimation, we gradually introduce the confounding factors into the regression model one by one to assess the sensitivity of our coefficient of interest to the introduction of the controls included in the vector of control variables.

To address concerns related to the endogeneity of prosecutors' turnover, we conducted a comprehensive endogeneity test. The outcome of this test confirmed the presence of endogeneity in our regressor of interest, which is the turnover of assistant and head prosecutors. Specifically, the test statistics returned values of 79.112 and 81.499, both indicating a significant presence of endogeneity. Furthermore, the Chi-squared p-values were 0.0000 in both cases, leading us to confidently reject the null hypothesis that the endogenous regressor is exogenous, signifying that it is indeed correlated with the error term. In essence, our analysis provides robust evidence supporting the validity of the endogeneity concern regarding the regressor. It underscores

Table 6
First stage 2SLS regressions - Assistant Prosecutors

VARIABLES	(1) TAP	(2) TAP	(3) TAP	(4) TAP	(5) TAP	(6) TAP	(7) TAP	(8) TAP
Cases per prosecutor	0.000168*** (3.44e-05)	0.000270*** (3.78e-05)	0.000236*** (3.71e-05)	0.000229*** (3.73e-05)	0.000265*** (3.91e-05)	0.000269*** (3.92e-05)	0.000287*** (3.88e-05)	0.000291*** (3.92e-05)
log(Population)			0.552*** (0.0580)	0.563*** (0.0560)	0.435*** (0.0612)	0.353*** (0.0742)	0.258*** (0.0728)	0.268*** (0.0766)
Disposition time GIP/GUP				0.000112* (6.62e-05)	0.000115* (6.19e-05)	0.000112* (5.88e-05)	9.00e-05 (5.58e-05)	8.13e-05 (5.59e-05)
Tribunal = Court of Appeal					0.350*** (0.0787)	0.335*** (0.0762)	0.277*** (0.0755)	0.290*** (0.0776)
Tribunal is small						-0.182*** (0.0677)	-0.230*** (0.0678)	-0.227*** (0.0683)
Tribunal is big							0.964*** (0.167)	0.964*** (0.167)
Rate of agility theft								-0.00857 (0.0115)
Yearly-indicators	No	Yes						
Regional-indicators	No	Yes						
Observations	1,220	1,220	1,220	1,220	1,220	1,220	1,220	1,220
Adjusted R-squared	0.019	0.187	0.312	0.313	0.328	0.332	0.350	0.350
Centered R-squared	0.0201	0.206	0.328	0.330	0.345	0.350	0.368	0.368
Effective F stat.	23.97***	51.23***	40.41***	37.73***	45.97***	47.08***	54.85***	55.08***

Note: The table reports the empirical coefficients of the first stage of the 2SLS regressions between case workload (measured as registered criminal cases + pending cases / total prosecutors) and assistant prosecutors' turnover, among 136 first instance courts between 2013-2021. For the sake of clarity, "TAP" is the acronym of turnover of assistant prosecutors; "Trib." refers to Tribunal; "aggrav. theft." stands for agility aggravated burglaries; "Effective F stat." is the Montiel Olea and Pflueger effective F statistic.

Table 7
First stage 2SLS regressions - Head Prosecutors

VARIABLES	(1) THP	(2) THP	(3) THP	(4) THP	(5) THP	(6) THP	(7) THP	(8) THP
Cases per prosecutor	4.39e-05*** (1.27e-05)	5.85e-05*** (1.64e-05)	5.78e-05*** (1.65e-05)	5.86e-05*** (1.66e-05)	6.30e-05*** (1.70e-05)	6.34e-05*** (1.70e-05)	6.44e-05*** (1.71e-05)	6.70e-05*** (1.74e-05)
log(Population)			0.0106 (0.0153)	0.00921 (0.0157)	-0.00627 (0.0180)	-0.0141 (0.0220)	-0.0193 (0.0232)	-0.0114 (0.0231)
DT gip/gup				-1.34e-05 (2.48e-05)	-1.31e-05 (2.49e-05)	-1.34e-05 (2.52e-05)	-1.46e-05 (2.54e-05)	-1.36e-05 (2.52e-05)
Tribunal = Court of Appeal					0.0424 (0.0266)	0.0410 (0.0272)	0.0378 (0.0287)	0.0478* (0.0287)
Tribunal is small						-0.0175 (0.0247)	-0.0201 (0.0250)	-0.0176 (0.0249)
Tribunal is big							0.0528 (0.0706)	0.0530 (0.0706)
Rate of agility theft								-0.00660 (0.00432)
Year-indicators	No	Yes						
Regional-indicators	No	Yes						
Observations	1,220	1,220	1,220	1,220	1,220	1,220	1,220	1,220
Adjusted R-squared	0.012	0.014	0.014	0.013	0.014	0.014	0.014	0.015
Centered R-squared	0.0127	0.0367	0.0371	0.0373	0.0394	0.0398	0.0403	0.0420
Cragg-Donald Wald F stat.	21.34	23.06	22.03	22.11	23.87	23.73	23.73	23.73
Effective F stat.	15.22***	16.28***	15.25***	15.33***	16.16***	16.14***	16.14***	16.14***

Note: The table reports the empirical coefficients of the first stage of the 2SLS regressions between case workload (measured as registered criminal cases + pending cases / prosecutor) and head prosecutors' turnover, among 136 first instance courts between 2013-2021. For the sake of clarity, "THP" is the acronym of turnover of head prosecutors; "Trib." refers to Tribunal; "aggrav. theft." stands for agility aggravated burglaries; "Effective F stat." is the Montiel Olea and Pflueger effective F statistic.

the significance of evaluating potential bias in the estimated coefficients obtained through OLS, thus reinforcing the importance of our 2SLS approach in addressing endogeneity issues.

In summary, the 2SLS empirical results demonstrate robustness as we systematically introduce control variables into the regressions. These results consistently point to a statistically significant relationship between a higher caseload and prosecutorial turnover. Specifically, a one hundred unit increase in legal cases that add to the workload of prosecutors leads to a 2.9% increase in the turnover of assistant prosecutors and a 0.67% increase in the rate of head prosecutors leaving their positions. Additionally, a unitary increase in assistant prosecutors' turnover corresponds to a 1.70% increase in the rate of crimes reaching the statute of limitation in the prosecution phase, ultimately rendering them time-barred. Notably, this positive relationship extends to time-barred crimes, resulting in a 7.2% increase for every unitary increase in head prosecutors leaving their office.

Table 8

Second stage 2SLS regressions - Assistant Prosecutors

VARIABLES	(1) TBC	(2) TBC	(3) TBC	(4) TBC	(5) TBC	(6) TBC	(7) TBC	(8) TBC
ihs(Turnover sub. pros.)	4.430*** (0.965)	1.786*** (0.315)	1.743*** (0.351)	1.749*** (0.366)	1.855*** (0.337)	1.852*** (0.332)	1.769*** (0.299)	1.669*** (0.289)
log(Population)		0.185 (0.212)	0.179 (0.226)	0.037 (0.191)	0.057 (0.177)	0.203 (0.148)	0.142 (0.142)	
DT gip/gup				-2.28e-05 (0.000124)	-3.29e-05 (0.000128)	-3.17e-05 (0.000127)	4.30e-06 (0.000118)	2.23e-06 (0.000113)
Tribunal = Court of Appeal					0.235 (0.172)	0.241 (0.169)	0.340** (0.158)	0.259* (0.156)
Tribunal is small						0.0484 (0.152)	0.0922 (0.153)	0.0414 (0.146)
Tribunal is big							-1.183*** (0.457)	-1.089** (0.437)
Rate of agility theft								0.0720*** (0.0215)
Yearly-indicators	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-indicators	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,220	1,220	1,220	1,220	1,220	1,220	1,220	1,220
Adjusted R-squared	-6.597	-0.380	-0.333	-0.339	-0.449	-0.446	-0.348	-0.240
Centered R-squared	-6.591	-0.348	-0.301	-0.306	-0.412	-0.408	-0.311	-0.206
Cragg-Donald Wald F stat.	25	51.15	45.75	42.87	56.58	58.42	67.85	68.30
Effective F stat.	23.97***	51.23***	40.41***	37.70***	45.97***	47.08***	54.85***	55.08***

Double clustered standard errors - at id and year level - in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The table reports the empirical coefficients of the second stage of the 2SLS regressions between time-barred crimes and assistant prosecutors' turnover, among 136 first instance courts between 2013-2021. For the sake of clarity, "TBC" is the acronym of Time barred crimes; "ass. pros." are assistant prosecutors; "Trib." refers to Tribunal; "aggrav. theft." stands for agility aggravated burglaries; "Effective F stat." is the Montiel Olea and Pflueger effective F statistic.

Table 9

Second stage 2SLS regressions - Head Prosecutors

VARIABLES	(1) TBC	(2) TBC	(3) TBC	(4) TBC	(5) TBC	(6) TBC	(7) TBC	(8) TBC
ihs(Turnover head pros.)	16.99*** (5.147)	8.252*** (2.591)	7.106*** (2.217)	6.837*** (2.118)	7.814*** (2.258)	7.861*** (2.247)	7.892*** (2.234)	7.237*** (2.020)
log(Population)			1.071*** (0.155)	1.101*** (0.148)	0.890*** (0.180)	0.822*** (0.221)	0.812*** (0.235)	0.673*** (0.222)
DT gip/gup				0.000265 (0.000202)	0.000283 (0.000218)	0.000281 (0.000219)	0.000279 (0.000219)	0.000253 (0.000200)
Tribunal = Court of Appeal					0.553** (0.229)	0.538** (0.227)	0.531** (0.230)	0.396* (0.220)
Tribunal is small						-0.152 (0.225)	-0.157 (0.230)	-0.210 (0.212)
Tribunal is big							0.105 (0.596)	0.137 (0.544)
Rate of agility theft								0.105*** (0.0344)
Yearly-indicators	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-indicators	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,220	1,220	1,220	1,220	1,220	1,220	1,220	1,220
Adjusted R-squared	-12.784	-2.753	-1.768	-1.596	-2.228	-2.263	-2.288	-1.820
Centered R-squared	-12.77	-2.666	-1.702	-1.532	-2.146	-2.178	-2.199	-1.741
Cragg-Donald Wald F stat.	15.66	18.34	17.84	18.13	20.19	20.37	20.84	22.23
Effective F stat.	11.94***	12.70***	12.29***	12.51***	13.71***	13.86***	14.23***	14.84***

Double clustered standard errors - at id and year level - in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The table reports the empirical coefficients of the 2SLS regressions between time-barred crimes and head prosecutors' turnover, among 136 first instance courts between 2013-2021. For the sake of clarity, "TBC" is the acronym of Time barred crimes; "Trib." refers to Tribunal; "aggrav. theft." stands for agility aggravated burglaries; "Effective F stat." is the Montiel Olea and Pflueger effective F statistic.

To further evaluate the robustness of our 2SLS empirical findings, we turn to smoothed instrumental quantile regressions (SIVQR). These SIVQR analyses are instrumental in identifying potential influential observations or outliers that may disproportionately affect the estimates and verifying whether extreme observations exert a significant influence on the results. Building upon our previous application of double clustered standard errors at the tribunal and year levels, we conduct bootstrap replications to resample clusters at both the year and ID levels. The outcomes of these SIVQR regressions are presented in Table 10 and Table 11. These results align with our earlier findings, confirming the consistency of the relationship between prosecutorial turnover and caseload, though it's worth noting that the impact of head prosecutors' turnover varies significantly across different quantiles.

Table 10

SIVQR regressions - Assistant Prosecutors

VARIABLES	(1) TBC	(2) TBC	(3) TBC	(4) TBC	(5) TBC
ihs(Turnover ass. pros.)	1.775*** (0.399)	1.613*** (0.298)	1.691*** (0.302)	1.764*** (0.364)	1.702*** (0.352)
Disposition time GIP/GUP	2.03e-06 (0.000219)	1.98e-06 (0.000221)	2.23e-06 (0.000204)	2.45e-06 (0.000234)	2.64e-06 (0.000211)
Trib. = Court Appeal	-0.190 (0.229)	-0.136 (0.214)	-0.276 (0.216)	-0.102 (0.257)	-0.0903 (0.204)
Tribunal is small	0.0978 (0.219)	0.260 (0.203)	0.243 (0.226)	0.173 (0.223)	0.186 (0.229)
Tribunal is big	-1.663*** (0.602)	-1.612*** (0.564)	-1.074 (0.699)	-1.869** (0.895)	-1.871** (0.843)
Rate aggrav. theft	0.132*** (0.0271)	0.114*** (0.0272)	0.109*** (0.0249)	0.109*** (0.0353)	0.106*** (0.0314)
log(Population)	-0.0965 (0.219)	0.110 (0.216)	0.236 (0.208)	0.221 (0.211)	0.293 (0.185)
Yearly-indicators	Yes	Yes	Yes	Yes	Yes
Regional-indicators	Yes	Yes	Yes	Yes	Yes
Observations	1,220	1,220	1,220	1,220	1,220
Quantile level	0.150	0.250	0.500	0.750	0.850

Bootstrapped errors - resampled double clustering - in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The table reports the empirical coefficients of the SIVQR regressions between time-barred crimes and assistant prosecutors' turnover, among 136 first instance courts between 2013-2021. For the sake of clarity, "TBC" is the acronym of Time barred crimes; "ass. pros." stands for assistant prosecutors; "Trib." refers to Tribunal; "aggrav. theft." stands for agility aggravated burglaries

Table 11

SIVQR regressions - Head Prosecutors

VARIABLES	(1) TBC	(2) TBC	(3) TBC	(4) TBC	(5) TBC
ihs(Turnover prosecutors)	2.519 (3.143)	3.286* (1.828)	7.231*** (3.160)	8.18*** (4.129)	11.193* (5.805)
Disposition time GIP/GUP	0.000136 (0.000235)	0.000142 (0.000199)	0.000139 (0.000254)	0.000138 (0.000265)	0.000141 (0.000245)
Trib. = Court Appeal	0.289 (0.287)	0.213 (0.251)	0.211 (0.264)	0.239 (0.281)	0.212 (0.268)
Tribunal is small	0.0234 (0.229)	-0.0195 (0.230)	-0.128 (0.234)	-0.0770 (0.250)	-0.110 (0.269)
Tribunal is big	0.0835 (0.630)	-0.169 (0.670)	-0.00393 (0.668)	-0.139 (0.676)	-0.0124 (0.668)
Rate aggrav. theft	0.106*** (0.0370)	0.111*** (0.0399)	0.120*** (0.0400)	0.116*** (0.0433)	0.123*** (0.0383)
log(Population)	0.919*** (0.227)	0.941*** (0.212)	0.784*** (0.200)	0.857*** (0.208)	0.823*** (0.217)
Yearly-indicators	Yes	Yes	Yes	Yes	Yes
Regional-indicators	Yes	Yes	Yes	Yes	Yes
Observations	1,220	1,220	1,220	1,220	1,220
Quantile level	0.150	0.250	0.500	0.750	0.850

Bootstrapped standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The table reports the empirical coefficients of the SIVQR regressions between time-barred crimes and head prosecutors' turnover, among 136 first instance courts between 2013-2021. For the sake of clarity, "TBC" is the acronym of Time barred crimes; "Trib." refers to Tribunal; "aggrav. theft." stands for agility aggravated burglaries

5. Discussion

The empirical results suggest that statute-barred crimes in Italy are due, at least in part, to the turnover of prosecutors who leave the prosecution office. Specifically, the analysis shows that there is a significant positive relationship between prosecutors leaving the prosecutorial office and time-barred criminal cases. This means that as the number of missing assistant prosecutors increases, the number of crimes exiting the system because of the reaching of the statute of limitation period also tends to increase.

The OLS coefficients related to our variable of interest do not exhibit statistical significance. According to these estimations, the most notable factor that has a positive impact on time-barred crimes and affects the statistical significance of the turnover of associated prosecutors is the population. This outcome aligns with the existing literature, as previously discussed, which suggests that demographic changes can influence legal needs, as well as social, cultural, and economic disparities.

Another factor that positively affects time-barred crimes across all quantiles is the rate of thefts aggravated by dexterity, also known as "agility" in the Italian criminal code. Italy has been notably affected by a surge in minor criminal cases that congest the legal system (Coscas-Williams & Alberstein, 2019). Theft aggravated by dexterity entail compulsory arrest and are prosecutable *ex officio*. This means that legal action is initiated automatically or as a matter of official duty, without requiring a formal complaint or an individual's request.

An increase in the rate of petty crimes, such as thefts aggravated by dexterity, can impact the number of time-barred crimes for several reasons. Firstly, a rise in recent petty crimes can strain the court system, with judges and prosecutors having to allocate more resources to handle minor cases. Consequently, more significant cases, like white-collar crimes, which are less socially alarming but equally important, may be deprioritized due to the limited availability of judicial resources, potentially leading to them becoming time-barred. Furthermore, an increase in petty crimes can generate public and political pressure to address the immediate crime wave, diverting attention and resources away from other types of cases, such as those related to bribery, corruption, cybercrime, and environmental crimes.

The empirical results also indicate that a higher population is associated with an increased number of crimes reaching the statute of limitations. This outcome can be explained by the fact that in regions with larger populations, there are more interactions and activities among residents. These interactions can result in various legal situations, disputes, or criminal incidents. This increased social interaction leads to a higher incidence of legal cases and disputes, subsequently elevating the overall caseload of prosecution offices. Indeed, a higher population creates an environment conducive to an expanded caseload, complex social interactions, and challenges in resource allocation within the legal system. These factors collectively contribute to a greater number of cases reaching the statute of limitations, as they face delays and potential neglect in the legal process.

Lastly, when both a court of appeal and a tribunal are located in the same place, there is a higher number of crimes reaching the statute of limitations. This situation often indicates that the location serves as a prominent legal center or a regional legal hub. As a result, complex and high-stakes cases, which tend to have protracted legal processes, are frequently handled there. The complexity and prolonged nature of these cases increase the likelihood of them reaching the statute of limitations. An additional explanation could be

that legal professionals working in such locations with both a tribunal and a court of appeal may specialize in certain types of cases. While specialization can lead to expertise in these specific cases, it may result in other cases receiving less attention. Cases that do not align with the specialized expertise of legal professionals might experience longer processing times, elevating their risk of becoming time-barred.

However, it's important to note that OLS coefficients may be biased due to endogeneity issues related to the dependency of turnover on various circumstances. As such, the results should be interpreted with caution, especially regarding the lack of statistical significance in the turnover coefficient. This particular concern is addressed by the results of the 2SLS regressions, which present a different perspective.

The first-stage 2SLS coefficients reveal a positive and statistically significant correlation between a higher workload and prosecutors' turnover. Specifically, an increase in the workload of prosecutors by approximately a hundred additional criminal cases leads to a 2.9% increase in assistant prosecutors' turnover and a 0.67% increase in the rate of head prosecutors leaving their positions. These results demonstrate that when the workload becomes more burdensome, both assistant prosecutors and head prosecutors are more likely to depart from their roles.

This outcome can be explained by the fact that a heavier workload typically entails longer working hours, heightened pressure, and increased stress levels for prosecutors. Handling a larger number of cases can lead to burnout and job dissatisfaction, motivating prosecutors to explore employment opportunities elsewhere. Moreover, in the competitive job market for prosecutors, they may have alternative job opportunities available to them. If they believe they can secure positions as judges with similar salaries or find prosecutor roles with improved working conditions, they may be more inclined to leave their current positions.

Looking at it from a broader perspective, it's also plausible that prosecutors, especially those in leadership roles, might view a heavy workload as an obstacle to their career advancement. Rational individuals, if they believe their current offices cannot offer opportunities for career progression or a reduction in workload, may choose to transfer to another office or pursue different career paths (Khan & Siriwardhane, 2021; Nightingale et al., 2021; Ingusci et al., 2019; Eden et al., 2009).

The presence of both the tribunal and the court of appeal in the same location is noteworthy for its positive and statistically significant impact on assistant prosecutors leaving their positions, while it does not have a statistically significant effect on head prosecutors. One potential explanation for this outcome is that cases appealed to the court of appeal often tend to be more complex or contentious. Managing such cases can be more challenging and time-consuming for assistant prosecutors.

Moreover, head prosecutors typically have more experience and may serve as mentors or supervisors for assistant

prosecutors. If cases are frequently appealed, and assistant prosecutors are handling them independently, they might miss out on valuable guidance and mentoring. This lack of support could be a factor influencing their decision to leave. The added pressure and complexity of handling appeals might make the job less appealing, especially if there is a lack of resources or support to manage these cases effectively.

This situation provides insights into why the size and reputation of an office do not significantly affect head prosecutors' turnover, while they have substantial implications for assistant prosecutors. The results highlight a positive and statistically significant relationship between a higher population and assistant prosecutors' turnover. Similarly, a positive and statistically significant relationship is observed between the size of the tribunal and turnover, with smaller tribunals experiencing lower turnover rates.

These findings can be explained by the fact that regions with larger populations tend to exhibit more competition for legal talent. Assistant prosecutors in such areas may find more opportunities for career advancement or positions with improved working conditions, ultimately leading to higher turnover. Furthermore, while larger tribunals may offer greater prospects for career progression, this may come at the cost of increased pressure due to a potentially reduced level of personalized mentoring and support. Consequently, some assistant prosecutors may opt to work in smaller tribunals or offices where they can achieve a better work-life balance, particularly when compared to larger tribunals where they may grapple with a substantial caseload, job-related stress, and eventual turnover.

From an econometric perspective, it's essential to assess the robustness of our instruments. A widely acknowledged rule of thumb in the field suggests that a pre-testing first-stage statistic should ideally surpass a value of ten (Lee et al., 2022) to ensure the reliability of instrumental variables. However, it's important to recognize that this threshold is slightly conservative (Sanderson et al., 2021).

In our analysis, the first-stage statistics for our instruments exceed this rule of thumb, instilling confidence in their robustness. Furthermore, when evaluating instrument strength through the Cragg-Donald Wald F statistics, our results are notably above the critical value of 16.38, as established by Stock and Yogo (2005). This underlines the reliability of our instruments in addressing the endogeneity of prosecutorial turnover.

To corroborate the strength and validity of our instruments, we conducted a series of tests as detailed in the Appendix (see Table 15 and Table 14). These tests ultimately confirm that our instruments are strong, and the beta coefficients associated with them are statistically different from zero. This further supports our confidence in the robustness and efficacy of the instrumental variables employed in our analysis.

Moving on to the second stage of the regressions, the coefficients reveal that a one-unit increase in assistant prosecutors' turnover is associated with a 1.67% rise in the number

of crimes that reach the statute of limitations during the prosecution phase, ultimately becoming time-barred. Similarly, this positive relationship translates into a 7.24% increase in time-barred crimes when there is a one-unit increase in head prosecutors leaving their office.

This outcome is further confirmed by the SIVQR regressions, although it's worth noting that the high statistical significance of the relationship between the turnover of head prosecutors and time-barred crimes is not statistically significant in the first quartile. One plausible explanation for this variation in significance is that the impact of head prosecutors' turnover is not uniform across the entire range of time-barred crimes. Instead, the relationship appears to be less pronounced at lower quantiles and becomes most noticeable as time-barred crimes reach medium to higher thresholds.

Indeed, the statistical significance at specific quantiles indicates that the effect of head prosecutors' turnover on time-barred crimes may be more evident or relevant at particular levels of the dependent variable (time-barred crimes). This may clarify why the relationship is statistically significant at the 0.5 and 0.75 quantiles, signifying that head prosecutors' turnover has a more substantial impact when time-barred crimes are around the median or higher levels.

It's important to consider that the statistical significance of these relationships may also be influenced by the sample size. It's possible that there are more data points or greater variability in the data at the specific quantiles where significance is observed, making it easier to detect a relationship. Given the relatively small and aggregated sample size (1,220 observations, encompassing 136 courts), variations in the relationship at different points of the distribution may become more evident. This highlights the importance of considering the potential impact of sample size and data distribution on the statistical findings.

Some possible explanations for these findings are that high turnover can result in a lack of continuity in the handling of cases. When prosecutors frequently change positions, it can disrupt ongoing cases. This can lead to delays, incomplete investigations, or a lack of follow-through, making it more likely for cases to reach the statute of limitations before they are resolved. High turnover may also reflect inefficiencies within the prosecutorial office. Prosecutors who are new to their roles or have a high workload due to staff shortages may struggle to manage cases effectively. This can result in delays and ultimately contribute to cases becoming time-barred.

Furthermore, head prosecutors, who often have more experience, might provide mentoring and guidance to assistant prosecutors. When head prosecutors leave their positions, assistant prosecutors may lack this mentorship, making them less equipped to handle complex cases efficiently. This can contribute to delays and, ultimately, time-barred cases. More in general, high turnover can result from the stress and workload faced by prosecutors. If they feel overwhelmed by the number of cases they need to handle, they might decide to leave their positions. This turnover, in turn, can lead to

more cases reaching the statute of limitations. All these factors, collectively, suggest that a higher turnover among prosecutors can lead to inefficiencies, disruptions, and delays in the legal system, ultimately contributing to an increase in time-barred crimes.

Regarding control variables, our analysis shows that time-barred crimes are positively influenced by a higher rate of petty crimes and a larger population (see Table 11).

The positive impact of a higher rate of petty crimes on time-barred crimes suggests that an increased prevalence of minor offenses, such as petty thefts, contributes to more cases reaching the statute of limitations. The higher caseload of minor cases can divert resources and attention away from more complex and time-consuming cases, like white-collar crimes or those demanding extensive investigations.

A larger population also has a positive effect on the number of time-barred crimes. In regions with larger populations, increased social interactions among residents lead to a higher incidence of legal cases, disputes, and criminal incidents. This surge in social interactions creates a greater overall caseload for prosecution offices, which can challenge efficient case management and result in delays, neglect, and more cases reaching the statute of limitations.

Conversely, the size of the tribunal, particularly big tribunals, has a negative impact on time-barred crimes, primarily for assistant prosecutors (see Table 10). Larger tribunals typically have more resources, including personnel and infrastructure. This resource advantage enhances the efficiency of case processing and the ability to prevent cases from becoming time-barred. The larger workforce can handle cases more effectively, reducing processing delays. Additionally, big tribunals may have streamlined processes, reducing delays in case handling.

Furthermore, the presence of both a tribunal and a court of appeal in the same area, known as the ubiquity of the tribunal with the court of appeal, has a positive impact on time-barred crimes (see ?? and ??). This suggests that when both a tribunal and a court of appeal coexist, it often signifies a more significant legal center or regional legal hub. Complex and high-stakes cases are frequently handled in these locations, resulting in lengthier case resolution times and an increased likelihood of cases reaching the statute of limitations. Legal professionals in such locations may also be more specialized in certain types of cases, which can lead to delays in processing other types of cases that don't align with their expertise.

In our investigation, we have explored various factors that contribute to the occurrence of time-barred crimes. However, it is imperative to acknowledge the limitations inherent in our research, which arise from the nature of the available data and the complexity of the issue being studied. These limitations prompt the need for more extensive and nuanced future studies, potentially involving micro-level data or the inclusion of a broader panel dataset.

The dataset we use in our study serves as a valuable resource for examining the relationship between different

variables and time-barred crimes. Nevertheless, it is important to recognize that data availability on this particular subject matter can be constrained. Criminal justice data, especially when examined at a granular level, may not encompass all the relevant variables or offer a comprehensive understanding of the intricate dynamics that underlie time-barred crimes.

Time-barred crimes constitute a multifaceted and sensitive issue influenced by a wide spectrum of legal, administrative, and sociopolitical factors. While our study contributes valuable insights, it may not comprehensively capture the complexities of this problem due to its sensitivity and potential external factors that may not have been fully considered.

To gain a more precise understanding of the determinants of time-barred crimes, future research could greatly benefit from access to micro-level data. This detailed data would provide a finer level of granularity, enabling researchers to delve into individual cases, legal procedures, and specific circumstances that contribute to time-barred outcomes. Micro-data analysis can yield deeper insights into the decision-making processes within the criminal justice system.

Furthermore, expanding the dataset to encompass a broader array of regions or jurisdictions could offer a more comprehensive perspective. Different regions may operate under distinct legal frameworks, resource allocations, and sociodemographic characteristics that influence the prevalence of time-barred crimes. A more extensive dataset would empower researchers to conduct cross-sectional analyses, shedding light on regional disparities and trends.

6. Conclusions

This paper investigates the impact of prosecutorial turnover on the occurrence of time-barred crimes. Among the determinants under scrutiny, we place particular emphasis on examining the impact of understaffed prosecutorial offices, specifically investigating whether assistant and head prosecutors leaving their positions contribute to an increase in cases reaching the statute of limitation. Using a novel dataset spanning the years 2013 to 2021, we discover robust evidence linking a shortage of prosecutors, as indicated by the turnover of assistant and head prosecutors, to a positive association with crimes reaching the statute of limitations even before reaching trial.

Our analysis ultimately uncovers a significant and positive correlation between prosecutors departing from their prosecutorial offices and the prevalence of time-barred criminal cases. An upswing in departing prosecutors coincides with a corresponding increase in the number of crimes approaching the statute of limitations, ultimately resulting in them becoming time-barred. As departing prosecutors take their knowledge and experience with them, their replacements may face challenges in effectively prosecuting cases. This can lead to delays in the prosecution process, ultimately resulting in cases reaching the statute of limitations.

Our empirical approach initially involved OLS regressions and later incorporated an instrumental variable strategy, combining 2SLS with SIVQR regressions. In summary, the results from 2SLS and SIVQR underscore the influence of various institutional and environmental factors on the performance of Italian criminal prosecutions. These factors include the availability of prosecutors, the location and size of tribunals, and the caseload complexity within prosecutorial offices, particularly involving minor offenses.

The insights from this study can inform policymakers about the interplay between prosecutors' turnover, prosecutorial workload, office size, and the prevalence of time-barred crimes in Italy. However, it's important to note that instead of extending the statute of limitations, lawmakers should focus on expediting criminal proceedings, as previously suggested (Romano, 2016).

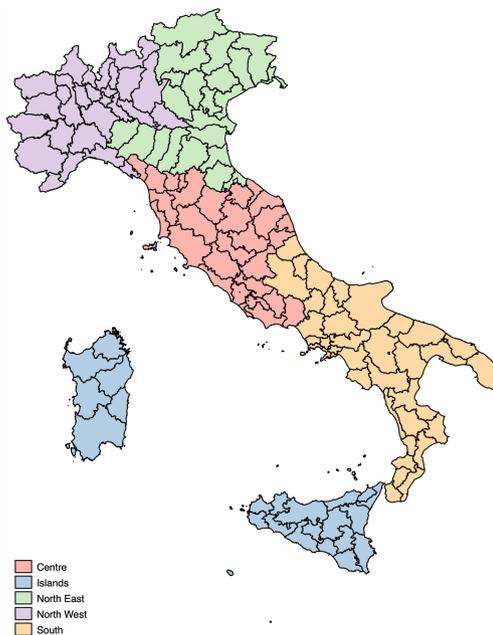
Time-barred crimes in Italy should be recognized as a significant issue that hinders the administration of justice, introduces disparities in the treatment of defendants, and carries broader societal implications. Addressing this problem may involve statutory limitations reform, increased resources for law enforcement agencies, and enhanced public education about the importance of promptly reporting crimes.

Appendix

In this appendix, we present several figures to help readers understand the Italian criminal justice system better. In particular, we show the rate of crimes per prosecutor across Italian provinces, and the rate of prosecutors per province.

The first figure (Figure 2) is a map of the geographical nomenclature subdividing the economic territory of the European Union (EU) into regions – so called Nomenclature of Territorial Units for Statistics areas (NUTS) – in Italy, according to Eurostat/Istat. This map helps to identify the different regions in Italy – at Regional level – and understand the distribution of the jurisdictions across the country. Since the Italian system is regionally based in many instances, this map is useful in understanding how the jurisdiction of the different tribunals and courts are organized from North to South.

Figure 2: Regional areas according to Eurostat/Istat

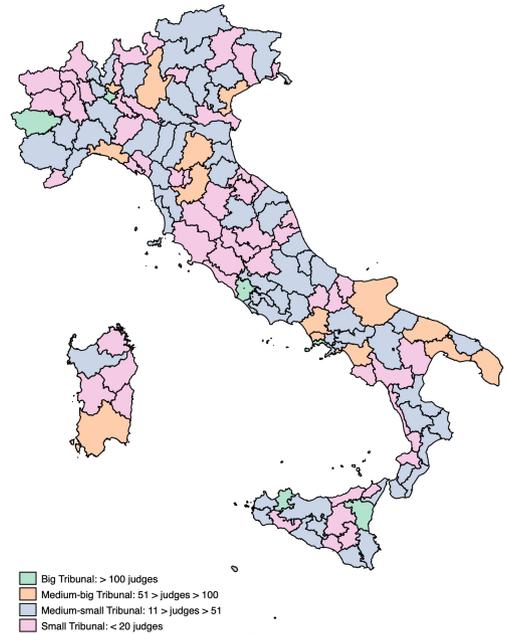


Note: The figure shows the different Nomenclature of Territorial Units for Statistics areas, at first level (Regional), according to the European Statistical Office (Eurostat) and the Italian National Institute of Statistics (ISTAT).

In Figure 3 we present is a visualization of the size of the tribunals in Italy according to the High Council of the Judiciary (CSM). This figure helps to illustrate the differences in size and capacity of the different tribunals across the country. By comparing the size and capacity of the tribunals, we are able to identify areas where resources are more scarce and eventually improve the efficiency and effectiveness of the criminal justice system.

Figure 4 shows – in white – which jurisdiction have Tribunals having the same location as the Court of Appeal. This information might be important because it can help identify areas where there may be a concentration of legal expertise and resources. In addition, this figure can also provide insight into the geographical distribution of the

Figure 3: Size of Tribunals according to the CSM



Note: The figures shows the different sizes of tribunals according to the High Council of the Judiciary (Consiglio superiore della magistratura, or CSM). Note that, in the figure, “big tribunals” (Catania, Palermo, and Turin) and “metropolitan tribunals” (Milan, Naples, and Rome) have the same green color, given that both have more than 100 judges in the staffing plan.

biggest jurisdictions and the accessibility of legal services to the population living in remote areas of the country.

Figure 4: Tribunals having the same location of the Court of Appeal (in white)

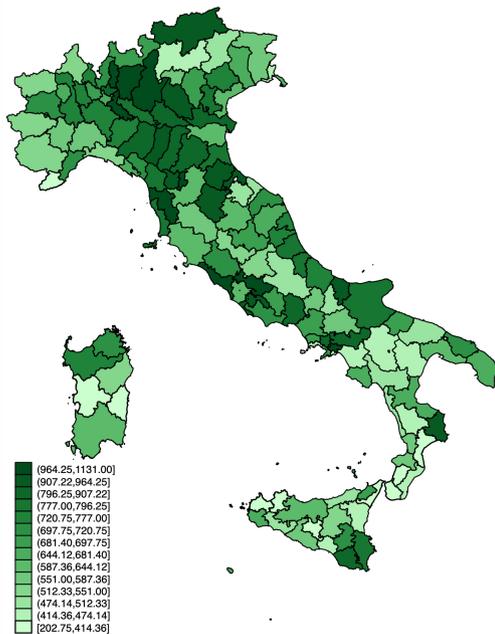


Note: The figure shows – in white – the distribution of Tribunals that are situated in the same location of the Court of Appeal

Figure 5 shows that the rate of crimes per prosecutor varies widely across Italian provinces. We might expect that

the highest rates would be observed in the southern part of the country, particularly in the provinces of Calabria and Sicily. However, the highest rates of crimes per prosecutor are observed in the north, in the Lombardy region. These differences in the workload of prosecutors may be due to several factors, such as differences in crime rates, the effectiveness of law enforcement, and the organization of the judiciary system.

Figure 5: Geographical distribution of crimes per prosecutor



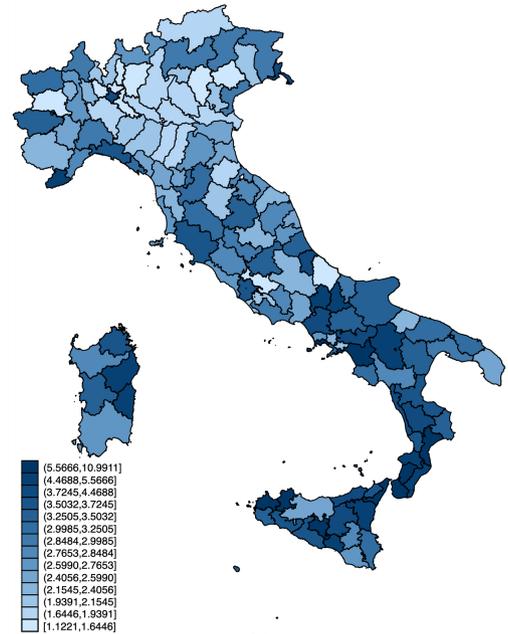
Note: The figure shows the average proportion of crimes per prosecutor, based on data from 2013-2021.

Figure 6 shows the number of prosecutors per 100,000 inhabitants in Italy. Unexpectedly, the number of prosecutor varies widely across Italian provinces and it is difficult to infer that some specific areas give. These variation may reflect differences in the allocation of resources and the organization of the judiciary system.

Together, these figures provide a broader context for our analysis of the relationship between the workload of prosecutors and the time-barred crimes. They highlight the significant variation in the workload of prosecutors across Italian provinces, which may have important implications for the effectiveness of the judiciary system in prosecuting crimes and reducing the number of time-barred cases.

In Figure 7 and Figure 8 – which reduces the sample excluding courts with a number of prosecutors below 5 and above 50 – we show graphically that as the number of prosecutors increases (implying a larger court system), the workload per magistrate decreases. The scatter plot illustrates the relationship between two variables: the number of registered and incoming cases per prosecutors (i.e., their workload) and the size of tribunals, which is dependent on the number of prosecutors (see above, Figure 3). The plot shows that as the number of prosecutorial offices increases, the workload per magistrate decreases. This apparent trend

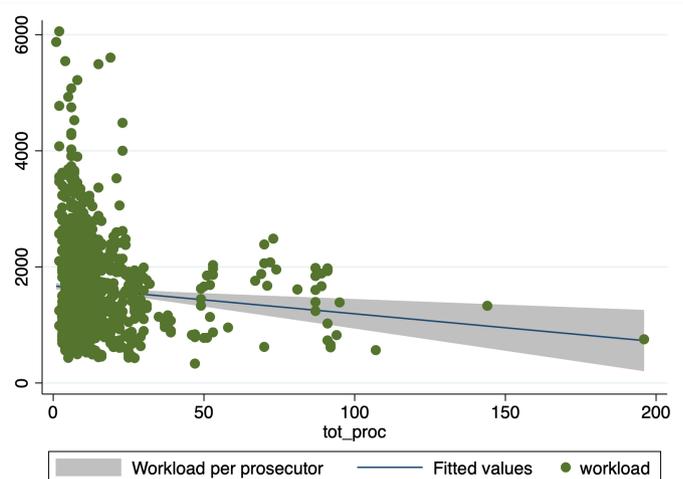
Figure 6: Geographical distribution of prosecutors



Note: The figure shows the average rate of prosecutors per 100,000 inhabitants, based on data from 2013-2021.

suggests that a larger court system with more prosecutors might handle more efficiently a higher volume of crimes, thereby reducing the pressure on individual judges, while courts congested with higher cases per prosecutor register a higher workload in comparison other prosecutorial offices.

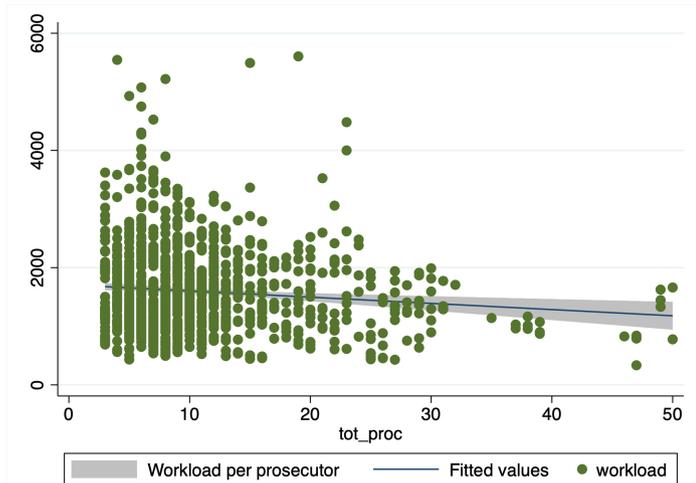
Figure 7: Workload of prosecutors



Note: The graph plots the number of registered and pending cases in the prosecution office (the workload) and the number of prosecutors, based on data from 2013-2021.

In Section 3, we acknowledged the possibility of multicollinearity, which arises when two or more independent variables are highly correlated. To quantify the extent of multicollinearity, we conducted a Variance Inflation Factors (VIF) test, and the results are presented in Figure 6. The standard guideline is that a VIF value exceeding 5 may raise

Figure 8: Workload of prosecutors



Note: The graph plots the number of registered and pending cases in the prosecution office (the workload) and the number of prosecutors, based on data from 2013-2021.

Table 12
Variance inflation factors

Variable	VIF	Sq. VIF	Tolerance	R-Squared
log(Population)	2.71	1.64	0.3696	0.6304
log(Time-barred crimes)	2.03	1.42	0.4927	0.5073
Trib. is small	1.85	1.36	0.5394	0.4606
Workload (IV)	1.75	1.32	0.5700	0.4300
Rate of aggrav. theft	1.60	1.26	0.6257	0.3743
Tribunal = Court Appeal	1.50	1.23	0.6647	0.3353
ihS(Turnover ass. pros.)	1.33	1.15	0.7527	0.2473
Tribunal is big	1.24	1.11	0.8097	0.1903
Geo-indicators	1.12	1.06	0.8894	0.1106
Time-indicators	1.21	1.10	0.8274	0.1726
Disposition Time	1.07	1.03	0.9352	0.0648
ihS(Turnover pros.)	1.03	1.01	0.9746	0.0254

Note: The table provides the centered variance inflation factors (VIF) for the independent variables specified in the model. The mean VIF is 1.58. The dataset is composed of a total sample of 165 courts across 8 years (2013-2021), based on the data provided by the Ministry of Justice and the High Council of the Judiciary.

concerns, while a VIF exceeding 10 indicates a systematic collinearity issue (Menard, 2001). More conservative recommendations propose even lower VIF thresholds, such as 4 or 2.5 (Johnston et al., 2017), as rough guidelines for detecting multicollinearity.

The results in Figure 6 indicate that, with the sole exception of the population variable, all other control factors remain comfortably below these established thresholds. It's important to note that, as recommended in the literature, these results should be interpreted in conjunction with other factors affecting the stability of the estimates. The exclusion of variables may actually decrease the variability of the regression coefficients more substantially than VIF inflates these estimates, even when VIF values are notably high, such as 10, 20, 40, or beyond (O'Brien, 2007).

In Section 4 we acknowledged the use of the exclusion restriction test proposed by D'Haultfoeuille et al. (2021), which – using 5,000 bootstrapped replications – suggest a rejection of the null hypothesis that exclusion restrictions are

Table 13

D'Haultfoeuille, Hoderlein & Sasaki exclusion restrictions test

Null hypothesis: Exclusion restriction is satisfied.	
	KS statistic 10.870
	p-value 0.160
Reject the null hypothesis at the significance level of 10%.	
Reject the null hypothesis at the significance level of 5%.	
Reject the null hypothesis at the significance level of 1%.	

Note: The table reports the D'Haultfoeuille, Hoderlein & Sasaki exclusion restrictions test for one single endogenous regressor.

Table 14

Montiel-Pflueger robust weak instrument test

Montiel-Pflueger test	Ass.ProS.	Pros.	Ass.ProS.	Pros
Effective F statistic	50.911	16.145	78.772	18.900
Critical values for 2SLS				
tau=5% of Worst Case Bias	37.418	37.418	37.418	37.418.
tau=10% of Worst Case Bias	23.109	23.109	23.109	23.109
tau=20% of Worst Case Bias	15.062	15.062	15.062	15.062
tau=30% of Worst Case Bias	12.039	12.039	12.039	12.039
Koenker & Basset trim level	none	none	10%	10%
Observations	1220	1220	1104	1104

Note: The table reports the weak instrument test of Montiel Olea and Pflueger (2013) that tests the null hypothesis of weak instruments for Two-Stage Least Squares (2SLS) with one single endogenous regressor.

satisfied at the significance level of 1%. Here, we present the results of the test that confirm that the exclusion restriction is satisfied.

In Section 4, we mentioned our use of the exclusion restriction test (see Table 14) proposed by D'Haultfoeuille et al. (2021). The results of this test, employing 5,000 bootstrapped replications, demonstrate the rejection of the null hypothesis that exclusion restrictions are met at a significance level of 1%. Thus, we confirm that the exclusion restriction is satisfied.

The minimum first-stage effective F statistic we obtained was 14.84, slightly exceeding the recommended threshold of tau=30%=12.039, which indicates the strength of our instrument according to Stock & Yogo's (2005) critical values. Nevertheless, it's worth noting that there may be a potential bias in the estimator of our instrumental variable regressions concerning head prosecutors, ranging between 10-20%, as suggested by the maximum level of Nagar's (1959) bias. It's important to mention that this test is particularly useful in cases of heteroscedasticity, autocorrelation, and/or clustering, as demonstrated by Olea and Pflueger (2013).

Given these test results, there's a concern that we may face the risk of potentially weak instrument bias. Weak instruments have the potential to lead to biased estimates and incorrect conclusions in instrumental variable regression. Therefore, it's crucial to evaluate their strength before proceeding further. To address this concern and ensure the robustness of our empirical strategy, we conducted two robust tests for weak instruments: the Anderson-Rubin (AR) test and the Wald test. These tests were performed to verify the null hypothesis that the beta coefficient of our instrument is zero, and the results are presented in Table 15.

We found that both the AR test and the Wald test yielded results in which they failed to reject the null hypothesis of a zero beta coefficient for our instrument. These results suggest that our instrument is not weak, and consequently,

Table 15

Weak IV robust tests and confidence intervals

Test	Statistic	p-value	Conf. level	Conf. Set
Assistant prosecutors				
Anderson-Rubin	chi2(1) = 79.18	0.0000	95%	[1.47534, 2.9539]
Wald	chi2(1) = 32.86	0.0000	95%	[1.32887, 2.7098]
Head prosecutors				
Anderson-Rubin	chi2(1) = 79.18	0.0000	95%	[5.37112, 15.9765]
Wald	chi2(1) = 14.39	0.0001	95%	[3.95993, 12.4271]

The table presents the results of the tests conducted to detect weak instruments and to obtain two-step identification-robust confidence sets for the coefficients on endogenous variables. This is achieved by comparing the nonrobust Wald confidence sets (Finlay & Magnusson, 2009) with the robust confidence sets obtained using the test proposed by Andrews (2016).

Table 16

Placebo tests

VARIABLES	TBC	TBC	TBC	TBC	TBC	TBC
ihsl(Turnover sub. pros.)	2.019*** (0.368)			-24.19 (51.88)		
Turnover sub. pros.		1.442*** (0.391)	1.813*** (0.583)		1.022 (0.370)	3.478 (3.754)
Cragg-Donald Wald F stat.	55.01	16.97	12.21	15.16	31.40	6.480
Montiel Olea and Pflueger effective F stat.	47.39***	16.47***	10.07***	7.377	7.455	0.809
IV	Workload	Workload	log(Workload)	Defined cases	Defined cases	log(Defined cases)
ihsl(Turnover head pros.)	7.857*** (2.062)			-38.47 (38.67)		
Turnover head pros.		6.925*** (1.818)	7.211*** (1.702)		-33.90 (34.09)	-101.4 (205.9)
IV	Workload	Workload	log(Workload)	Defined cases	Defined cases	log(Defined cases)
Cragg-Donald Wald F stat.	23.99	23.99	25.32	0.903	0.903	0.246
Montiel Olea and Pflueger effective F stat.	16.24***	16.24***	21.52***	0.980	0.980	0.802

The table presents a placebo test conducted by substituting the instrumental variables (workload of prosecutors) with defined cases in the preliminary investigation. The results are consistent with our hypothesis that an additional workload implies a higher turnover among prosecutors.

our findings remain robust even when all control variables are included.

To further address the potential concern that turnover is primarily influenced by the sheer number of cases rather than the increased workload faced by prosecutors, we devised a scenario in which the proposed cause (prosecutorial turnover) should theoretically have no direct effect on the outcome (time-barred cases). We achieved this by instrumenting turnover with a variable recommended by the Ministry of Justice, which is related to defined cases in the prosecution window. This methodology allowed us to assess whether the statistical model accurately identifies cases where no real causation is expected. The results (see Table 16) not only support our hypothesis that turnover is influenced by an additional workload but also refute the idea that time-barred cases and turnover are predominantly affected by the volume of criminal cases, as demonstrated in the placebo test using the number of defined cases.

In summary, our analysis confirms the strength of our instruments, providing a solid foundation for the application of instrumental variable regression in our study. These results offer a high degree of confidence in the robustness and reliability of our findings, reinforcing the validity of the causal relationship between the variables of interest. Employing rigorous statistical methods and comprehensive testing procedures is essential in econometric analysis to uphold the accuracy and dependability of our results.

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