Administrative Governance in Times of Crisis:
How the IT System Aging Process Impacts Program Administration

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Abstract

High stress periods, such as crisis events, offer unique challenges for effectively implementing government programs. A key consideration in meeting such challenges is the aging process associated with administrative systems. Competing aging process theories are evaluated to assess how the aging process of IT systems impact both timeliness and quality program performance during the COVID-19 crisis. Panel data on U.S. state unemployment insurance programs reveals strong empirical support for depreciation theory in explaining the timeliness of nonmonetary determinations' (NMD) task processing, while the quality of NMD task processing is consistent with life cycle theory. Adverse IT system aging effects are more deleterious for performing highly complex tasks in a timely manner relative to attaining quality. When pressures on government administration are acute, nascent technological systems perform low complexity tasks in an expeditious manner, but this comes at the expense of both task performance quality and timeliness of high complexity tasks.

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INTRODUCTION

Effective government operations rely on administrative systems that are stable, while undertaking requisite change, through time. Changing administrative systems ensures adaptability to technological, political, and policy conditions. Stability is crucial for developing bureaucratic expertise (Cingolani and Fazekas 2020) and buffering environmental shocks to ensure continuity in public service delivery (Meier and O'Toole 2009). Reforms of administrative systems often take time to yield observable effects, while political pressures for quick results are acute (Choi and Chandler 2020). The tension involving stability versus change in administrative systems is most acute during times of crisis. Crises are characterized by "*surprising, inconsistent, unpredictable*" events (Ansell, et al. 2021: 949). Such unanticipated crises often transcend an agency's policy functions, while impacting the caliber of agency operations and performance in a systemic manner.

Administrative systems are often adversely impacted by unpredictable new challenges posed by crises. For example, the COVID-19 pandemic disrupted administrative routines and procedures involving new emergency relief programs (Thompson, et al. 2020), change in work environments and management styles (Schuster, et al. 2020), and increased interorganizational networking (Wang and Fan 2024). This negative shock on administrative systems also led to unprecedented demand for social service and health government programs (Gofen, et al. 2021; Mikkelsen, et al. 2024), as well as service delivery delays (Rein 2022), decreased employee motivation (Lee and Na 2023), and performance reductions (Dandalt 2021).

This study seeks to understand how 'aging' administrative systems perform in executing core administrative tasks in response to the information technology (IT) system aging process. Although technology rapidly evolves, major reforms of public agencies' IT systems are

infrequent, if not rare, due to both pecuniary and transaction costs associated with such systemic change. This is because reforms are costly—both politically, as entrenched constituencies favor status quo (Pierson 2000); and administratively, as they disrupt established structures and routines (March and Simon 1958). Once instituted, administrative system reforms remain in place for extended periods of time. This focus on the aging process of IT systems evaluates competing theories regarding how stability and change in administrative systems shape task performance during periods of crisis compared to non-crisis. This study's application focuses on how the IT system aging process conditionally impacts both the timeliness and quality of non-routinized nonmonetary (eligibility) determination (NMD) tasks due to the COVID-19 pandemic crisis by U.S. state unemployment insurance program (UIP) agencies between 2002-2023.

These competing theories emphasize the performance benefits of stability (*Experiential Learning Theory*), change (*Depreciation Theory*), and the balance between these characteristics (*Life Cycle Theory*). The evidence offers support for depreciation theory with respect to the timeliness of NMD task processing in response to the COVID-19 pandemic crisis. Yet, the findings offer support for life cycle theories since the highest quality NMD task processing in response to COVID occurs for both moderate-aged and older IT systems. The drop in timely task processing is more pronounced with aging IT systems, particularly for the more complex NMD separation tasks compared to the less complex NMD non-separation tasks. Although reforming administrative systems holds the promise of improved efficiency, the impact of crisis events differs based on the task performance goal (timeliness versus quality), as well as the varying complexity of these tasks.

Performance Benefits of IT Modernization in State Unemployment Insurance Programs

Non-Routinized Task Performance in State UIPs: Nonmonetary Determinations

The U.S. Department of Labor (DoL) sets baseline eligibility criteria and quality control standards (including national performance reporting systems and uniform performance benchmarks), while states administer their own UI programs within this framework, retaining broad discretion to determine benefit levels and define eligibility rules within each federally established eligibility criteria (U.S. Department of Labor 1999). **Figure 1** presents a task process flow chart of claims processing in state unemployment insurance program (UIP) administration.[1] The pair of distinct primary tasks involve case processing of state unemployment insurance benefit claims involve monetary determinations (MDs) and nonmonetary determinations (NMDs). MDs are defined as "*whether a claimant, who has filed a new initial claim, has sufficient base period wages and/or employment to establish a benefit year under the state unemployment compensation program."* (U.S. Department of Labor 2017: I – 2- 23). MDs involve simple, routinized 'first pass' task activities such as determining "*.... the number of base period employers, amount of base period wages, amount of high quarter wages, number of weeks worked, number of dependents and allowance.*" (U.S. Department of Labor 2013: A-16). Because of the routine nature of MD tasks, these are less likely to be affected by crisis events and the IT system aging process.[2]

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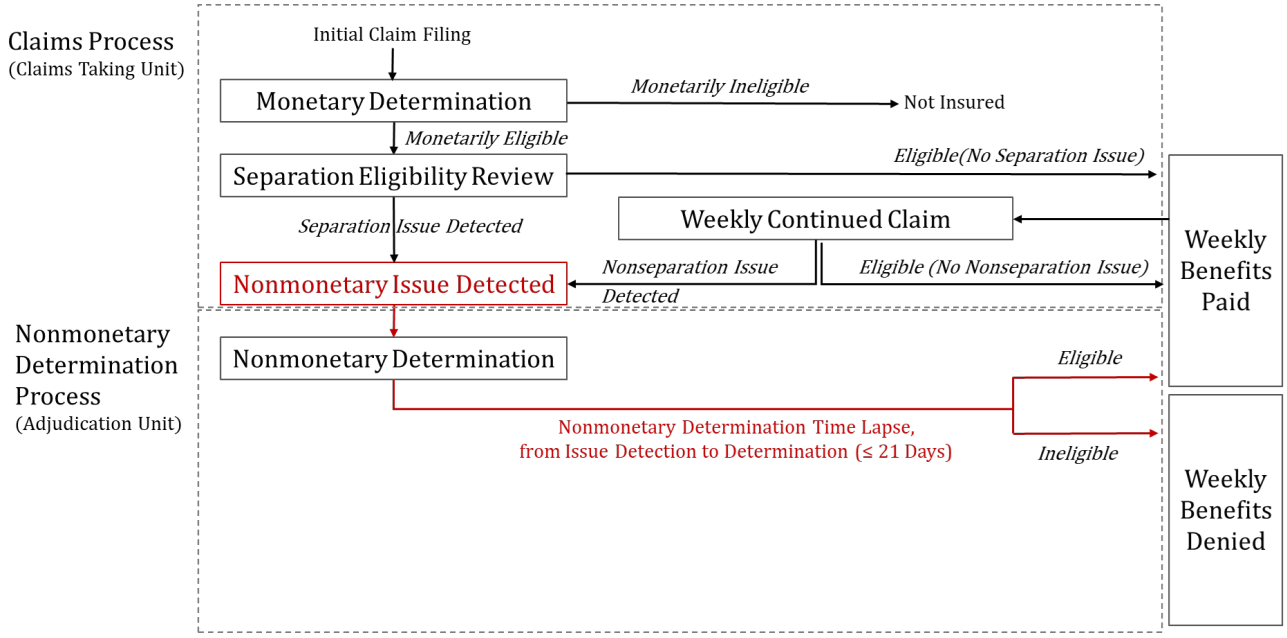
[1] See Virginia Joint Legislative Audit and Review Commission (2021: 20), with other details verified from U.S. Department of Labor (2017), Section I-1. Nonmonetary Determination Activities Report.

[2] Wenger, et al. (2008: 178): Monetary determination "…. *involves a relatively simple check to verify that the claimant previously earned enough income over the relevant period to qualify for benefits. Monetary determinations are conducted before any other decisions and are highly automated*. "

NMDs occur only for non-routinized cases that make it through the 'first pass' of MDs. NMDs refer to a determination made on any nonmonetary issue that is detected by state UIP agency "*which had the potential to affect the claimant's past, present, or future benefit rights; and for which a determination of eligibility was made.*" (U.S. Department of Labor 2017: V-6-265) among those who are monetarily eligible. NMDs are only initiated when UIP staff responsible for processing claims detect a potential disqualifying issue that is sent to an adjudicating unit for further review. NMDs isolate problems relating to either (1) circumstances surrounding the claimant's previous employment such as voluntary quits or discharges (*Separation NMDs*), or (2) circumstances related to continuing eligibility such as being able to and available for work, or work search requirements (*Nonseparation NMDs*). As shown in **Figure 1**, both NMD types require nontrivial information search and judgment on distinct types of eligibility-criteria and arise at different stages (initial claim eligibility vs. continued claim eligibility). For example, if a claimant indicates separation from employment for reasons

FIGURE 1: Overview of Task Processing: State Unemployment Insurance Benefit Claims
[*Source: Virginia Joint Legislative Audit and Review Commission (2021: 20)*]



other than lack of work (e.g., quit, discharge), the system flags the separation issue and refers the case to the adjudication unit for additional investigation to determine eligibility. Separation and nonseparation NMDs are effectively independent administrative tasks.[3]

Administrative Effectiveness in Times of Crisis: UIP Agencies and the 'Aging' of IT Reforms

The COVID-19 pandemic experienced a historic level of job loss and surge in unemployment claims, causing state UIP (unemployment insurance program) agencies to face severe case overloads as they struggled to meet excess demand for these program benefits (Government Accountability Office 2023). For instance, between February 2020 to April 2020, state UIP agencies processed 15 times as many claims as compared to the same time in 2019 (Pandemic Response Accountability Committee 2024). This overburdening of UI task processes generated greater mass fraudulent activities (Mahr and Petrella 2022), a surge in administrative delays and errors in payments (Rogoway 2020), and frequent system outages (Martz 2021). The COVID pandemic therefore constitutes an adverse shock to the administration of state UIPs.

State UIP agencies have invested in technological reforms to address the challenges of limited administrative capacity in the event of such crises well prior to the COVID-19 crisis (Government Accountability Office 2023; National Association of State Workforce Agencies 2010). IT modernization reforms rely on "*.....application technology that inherently supports web-based services and object-oriented paradigms in combination with relational database technology.*" (National Association of State Workforce Agencies 2010: 7). Contrasted with either

[3] Based on the Benefits Accuracy Measurement (BAM) sample covering this study's data, only 0.059% of the NMD nonseparation issues sample (n = 166,162) also had separation issues. Similarly, only 0.103% of the NMD separation issues sample (n = 168,967) also had nonseparation issues.

manual or earlier generation automated processes, IT systems that leverage web-based services and relational database technology improve both timelines and accuracy of task processing by providing instant validation and processing of unemployment claims (U.S. Department of Labor Office of Inspector General 2021). State UIP agencies lacking IT modernization reforms must rely on separate platforms for filing, validating, and updating claimant information. Older automated processing systems are susceptible to greater personnel effort, but also more error-prone decision-making (National Association of State Workforce Agencies 2010: 10-11; U.S. Government Accountability Office 2021: 22). IT modernization does improve administrative performance. Introduction of federal-state integrated employment records database has reduced overall improper payment rates in state UI programs (Greer and Bullock 2018). Compton, et al. (2023) finds that race-based administrative errors are sharply reduced when state UIP agencies process claims via Information and Communication Technologies (ICT).

Although IT modernization yields performance benefits, only 25 of the fifty American states had successfully implemented IT reforms as of March 2020 when the COVID-19 crisis began.[4] Technological reform of administrative processes involves operational challenges ranging from system disruptions to being incompatible with pre-existing administrative systems. For example, the Tennessee Department of Labor's UI program performance declined due to the implementation of a new IT system for processing claims in May 2016. This state UIP agency stated that "*we had to change our business process in order to process claims properly*," which initially overwhelmed, rather than benefitted the agency (Tennessee Department of Labor and Workforce 2018: 23). These reforms initially impact the timeliness of benefit payment disbursements to claimants since they strain agency capacity in the short-term. For example,

[4] New Mexico (November 2002, March 2013) and Nebraska (July 2007, July 2015) have two such IT reforms.

Virginia encountered a week-long backlog in case processing during the temporary shutdown of the old IT system to transition to the new system soon after modernizing their UIP agency's IT system in 2021 (Martz 2021). Simply, managing IT reforms in administrative settings involves a difficult challenge of balancing the need to avoid obsoletion against the desire to exploit continuity-based benefits from existing IT systems.

Competing Theories of the IT System Aging Process on Task Performance

Adaptability of administrative systems in response to future changes is a core motivation for state UIP agencies to undertake IT modernization reforms. This is because "*the biggest obstacle states face is the high cost of adapting systems to meet changing needs, due to how those systems are designed and managed.*" (U.S. Department of Labor 2023). Because the COVID-19 crisis required rapid policy implementation under a period of high stress on state UI programs, it is critical to evaluate how administrative performance differs between this crisis event versus normal conditions in relation to IT system age.

Figure 2 presents three competing theories to explain how IT reforms influence administrative performance over time in response to crisis conditions.[5] First, *experiential learning theory* predicts a continuous increase involving the crisis −non-crisis performance differential through time, as represented by the upward-sloping solid curve in **Figure 2**. Upon implementing technological reform, agency personnel often encounter challenges in learning the new system and adapting their practices until they fully realize the potential benefits from the new technology (Schwab 2007; Tyre and Orlikowski 1994). That is, adopting new technology

[5] The functional forms offered in **Figure 2** represent stylized depictions of each theory. The ensuing statistical analyses does not impose functional form ('shape') assumptions regarding these functions.

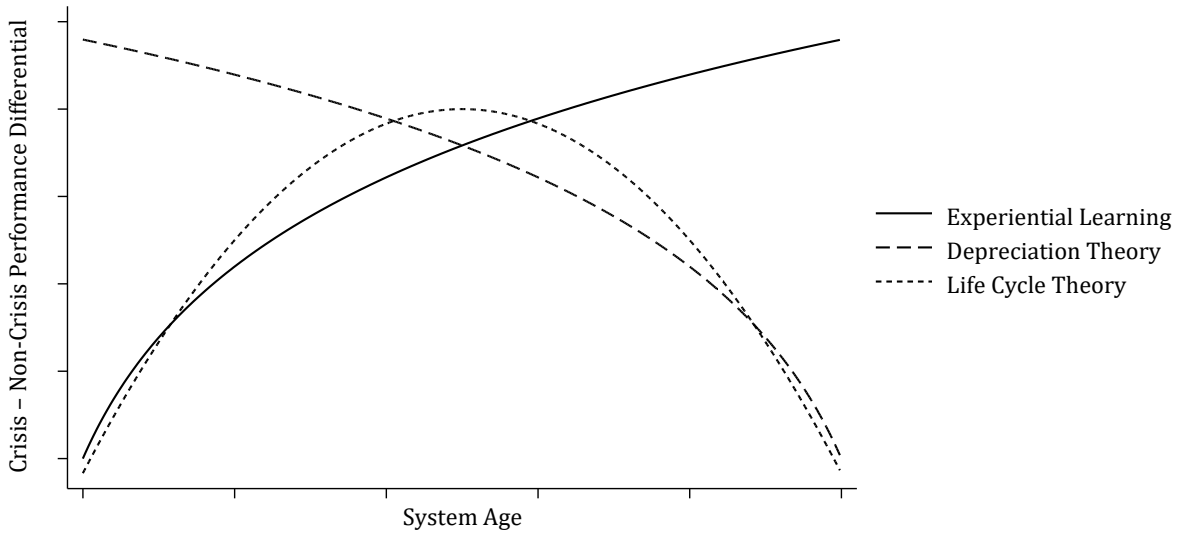
involves a substantial learning process for effective integration into administrative systems. Administrators improve their performance over repetitions of the same task, or "*learning from experience*" (Levinthal and March 1993: 96). These experiential learning benefits are comparatively greater when operating under high stress crisis conditions vis-à-vis non-crisis conditions. As a result, state UIP agency personnel will become increasingly effective over time in processing claims as they acquire and update their expertise with repeated use of a given IT system during crisis conditions. During the COVID pandemic, the Maine Department of Labor swiftly hired and trained additional staff to manage the surge in unemployment claims but was unable to reap immediate benefits because "*many individuals (citizens) were filing for UI benefits for the first time and were not familiar with the related technology for filing claims*" (Government Accountability Office 2023: 60). The Tennessee Department of Labor also explained that changing business process required more than two years of "*training staff on the GUS system, hiring new staff, and promoting staff to new positions,*" which "*created an abundance of issues that initially overwhelmed the agency, creating a backlog of claims.*" (Tennessee Department of Labor and Workforce 2018: 23). In the context of crisis conditions, experiential learning theory offers the following testable prediction:

> **H1a [*Experiential Learning* Crisis Hypothesis]:** *The Impact of Crisis on the Caliber of Task Performance is Increasing in IT System Age.*

Capital depreciation theory is premised on the notion that newer IT reforms involving capital equipment are better suited to transition to administrative overload compared to older systems (denoted by the large dashed, downward sloping curve in **Figure 2**). The underlying rationale of this theory is that, over time, technological reforms are eventually made obsolete by the emergence of newer, more advanced technologies (Caballero and Jaffe 1993). Information

technology (IT) capital usually demonstrates the exceptionally fastest capital depreciation rate due to the rapidly changing nature of the field (Boucekkine, et al. 2009).

FIGURE 2.
Competing Theories of the IT System
Aging Process on Administrative Performance



Recent IT reforms have incorporated advanced technologies of cloud computing, streamlined interstate communication (Deloitte 2022), and predictive analytics (Simon-Mishel, et al. 2020). Aging technological reforms will become less valuable when technologies evolve (Caballero and Jaffe 1993), as maintenance costs rise (Gylafson and Zoega 2001), and older systems represent a primary source of organizational inertia (Levinthal and March 1993). According to the National Association of State Workforce Agencies (2010: 2), 75 percent of states faced major challenges because in-house IT staff are retiring rapidly and there is a scarcity of IT staff skilled in older technologies in 2010 (on average 22 years since operating the mainframe system). Therefore, it is hardly surprising that maintaining and supporting aging UI IT systems—each requiring separate patches and updates according to Federal and State legislative changes—becomes increasingly costly over time and causes operational delays (ITSC 2010: 2). For instance, Montana pathbreaking IT modernization reform in 2002 gave way to

obsoletion with the passage of time. During the COVIC pandemic, this IT system was referred to as "*a decades-old legacy benefits system which had exceeded its functional life cycle.*" due to incompatibility with modern web services—unlike two decades ago, "……*when most Montanans were using dial-up modems with their home telephone lines……*" (Montana Department of Labor and Industry, 2023). One thus might infer that such obsoletion effects will become acute during high stress periods such as COVID-19 pandemic compared to non-crisis periods. This logic yields the following hypothesis:

> **H1b [*Depreciation* Crisis Hypothesis]:** *The Impact of Crisis on the Caliber of Task Performance is Decreasing in IT System Age.*

Life Cycle Theory predicts that a technological reform goes through a life cycle from its initial adoption (*Developmental Phase*), exploitation (*Exploitation Phase*), and its eventual decline (*Decline Phase*) (Rink and Swan 1979). Life Cycle Theory is graphically depicted by the small-dashed concave parabolic curve appearing in **Figure 2**. In the developmental phase, few administrative personnel are knowledgeable about the new IT system, and hence it contributes less to performance. As agency personnel become more experienced with the new system, the exploitation phase emerges as performance improves through the experience-based knowledge gained from repeated trials and errors (Levinthal and March 1988) and routinization of previously successful practices (Levitt and March 1993). Older IT system's depreciation rate accelerates beyond a certain age, as more cutting-edge technologies emerge. Past the inflection point, technology becomes antiquated, any gains from learning depreciates, and hence, becomes obsolete (Peltoniemi 2011; Rink and Swan 1979). This implication of life cycle theory yields the hypothesis:

H1c [*Life Cycle* Crisis Hypothesis]: *The Impact of Crisis on the Caliber of Task Performance is Initially Increasing in More Recently Adopted IT Systems Prior to Decreasing for Older IT Systems.*

At a given system age, highly complex tasks make it more challenging to achieve high-quality performance compared to less complex tasks (Andrews, et al. 2005). Task complexity reflects information interrelationships and information load (i.e., uncertainty) (March and Simon 1958: 139-141). That is, these tasks demand more extensive coordination due to the need for gathering information from multiple sources (March and Simon 1958: 182-189).

Determining eligibility regarding NMD separation issues is a more complex task than NMD nonseparation issues due to the higher information costs involved in adjudicating the former (U.S. Department of Labor 1999: 38089). Adjudication for NMD separation issues (e.g., voluntary quits or discharges) requires more detailed fact-finding from multiple sources of information, as they "*require that the agency contact and gather information from the claimant, one or more employers, and, in some instances, third parties in order to decide eligibility.*" In contrast, NMD nonseparation issues generally rely on information directly provided by the claimant or from existing agency records, reducing the amount of fact-finding required. Examples of such tasks may be determining his or her ability and availability to work (U.S. Department of Labor 2012: VI-11), active work search efforts (U.S. Department of Labor 2012: VI-11), reason for refusal of the job offer (U.S. Department of Labor 2012: VI-18), receipt of disqualifying income during the spell (U.S. Department of Labor 2012: VI-23), record of compliance with reporting requirements (U.S. Department of Labor 2012: VI-28). Therefore, NMD separation tasks require greater information costs than NMD nonseparation tasks. The consequences of these different types of administrative processing tasks on performance should

be exacerbated during crisis periods relative to non-crisis periods. This logic yields the final testable hypothesis of interest:

> ***H2 [Task Complexity Crisis Hypothesis]:*** *The Impact of Crisis Lowers the Caliber of Separation NMD Task Performance Relative to Nonseparation NMD Task Performance, conditional on IT System Age.*

Data and Empirical Strategy

The State UIP NMD task performance data comes from ETA-9052 Nonmonetary Determination Time Lapse Data and ETA-9056 Nonmonetary Determination Separations Quality Score Data from the U.S. Department of Labor between January 2002-June 2023.[6] The data are arrayed as state agency-month panel observations. These data seek to analyze the effect of COVID crisis on state UIP NMD task timeliness and quality, conditional on administrative system age – operationalized as the time (in months) elapsed since a major IT modernization reform was instituted by state UIP agencies. The sample is restricted to IT modernization reform states (N = 27 states, including twice for Nebraska and New Mexico; See **Figure 4** below).

Non-IT modernization reform adopting states (N = 20) are purposely omitted to offer a comparable baseline to compare IT system aging process effects both prior and following the enactment of these IT reforms. Including non-adopting state UIP agencies in the pre- IT reform adoption baseline conflates those state UIP agencies who undertook IT reforms with those that

[6] States may request a data waiver to their U.S.DOL regional office (U.S. Department of Labor 2012). No state requested a waiver for ETA-9052 data, while 23 out of 27 IT modernization reform states requested a wavier for ETA-9056 for 2020: Q1 and 2020: Q2 at the beginning of the COVID crisis, thus producing missing observations for NMD quality score data from these 23 waiver states in these two quarters.

did not.[7] In addition, five states (N = 5) are omitted from the sample who instituted IT reforms during COVID to eliminate possible reverse causality effects in relation to NMD task performance.[8] The descriptive statistics for the variables analyzed in this study (excluding unit effect covariates) appear in the ***Online Appendix*** (**Table A1**).

Dependent Variables: Measurement of Timeliness and Quality of NMD Tasks

The first pair of dependent variables, *Task Timeliness*, is the proportion of determinations made within 21 days since the agency's detection of a NMD separation issue (*Task Timeliness: Separations*) and nonseparation issue (*Task Timeliness – Nonseparations*) in state i, month *t*. The 21 day limit is a federal performance benchmark set for all state UIP agencies (U.S. Department of Labor 2017: I-2). Any state whose late determination percentage determinations exceed 20% are mandated to submit a Corrective Action Plan to the U.S. Department of Labor (U.S. Department of Labor 1998). Adjudicating a separation issue (e.g., voluntary quits or discharges) generally takes longer than addressing a nonseparation issue since the former often requires cross-inspection from multiple parties' reasons for separation (U.S. Department of Labor 2012: VI-4, VI-6). In contrast, nonseparation issues require less fact-finding since they rely on information directly provided by the claimant or from existing agency records (U.S. Department of Labor 2012: VI-4, VI-6).

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[7] In supplementary analyses (**Online Appendix D**), these non-IT reform states are included in the sample.

[8] The omitted states are Maryland (2020), Colorado (2020), Pennsylvania (2021), Virginia (2021), and Connecticut (2022). Alabama (January 2020 adoption) panel observations are included in both monthly and quarterly effective samples since reforms do not take place with the advent of COVID (3/15/2020). **Online Appendix C** reports sensitivity analyses including post-COVID-19 IT reform states.

Figures 3A and **3B** display recent historical trends of U.S. state-level monthly averages of *Task Timelines* on NMD separations and nonseparations tasks. Although these graphics reveal a decline following 'The Great Recession' of 2008, this dip in timeliness of NMD case processing is not nearly as steep as what is evinced from the COVID-19 pandemic era shock a decade later.[9] Despite fluctuations, *Task Timeliness* for NMD nonseparation tasks shows a higher mean (Overall Mean: 0.77, Pre-COVID Mean: 0.80 - Post-COVID Mean: 0.57, Difference: $t = 40.25$, $p < 0.001$) than *Task Timeliness for NMD* Separation tasks (Overall Mean: 0.62, Pre-COVID Mean: 0.65 -Post-COVID Mean: 0.32, Difference: $t = 45.36$, $p < 0.001$). NMD nonseparations (SD: 0.09) are less variable than NMD Separations (SD: 0.13). *Task Timeliness* reveals a stark decline during COVID, dropping from 0.65 to 0.46 for NMD Separations and from 0.86 to 0.66 for NMD nonseparations.

The second pair of dependent variables, *Task Quality*, is measured as the proportion of determinations receiving quality scores exceeding 95 points respectively for NMD separations and nonseparations for a given state-quarter. According to the U.S. Department of Labor (2012), these 100 points are distributed across the following five evaluative components: (1) *Claimant Information* (Adequate: 15, Inadequate: 10, Not Obtained: 0, Not Applicable: 15), (2) *Employer Information* (Adequate: 15, Inadequate: 10, Not Obtained: 0, Not Applicable: 15), (3) *Facts from Others* (Adequate: 15, Inadequate: 10, Not Obtained: 0, Not Applicable: 15), (4) *Meeting State Law & Policy* (Meets: 45, Questionable: 30, Does Not Meet: 0), and (5) *Adequacy of the Written Determination* (Adequate: 10, Inadequate: 5, Wrong: 0). Inadequate determinations receive a score below 95 points. These problems can be attributable to lacking more than one of these

[9] Evaluating the IT system aging process is infeasible for The Great Recession crisis event in 2008 since only a handful of states (N = 5) had adopted IT reforms during the sample period in which we have data.

components, failure to meet state law and policy requirements, or involve an erroneous application of state law. If disagreement arises among two independent reviewers on any of these subcomponents, a third-party reviewer intervenes and follow the majority rule for determining the score of any of these subcomponents (U.S. Department of Labor 2005: IV-2).

The U.S. federal DoL's benchmark for effective performance measure is set at 75% or more of determinations exceeding 95 points in a given state-quarter. *Task Quality*, like *Task Timeliness*, is a core performance measure set by the U.S. Department of Labor, and states failing to meet this benchmark must submit a Corrective Action Plan to the department (U.S. Department of Labor 1998). **Figures 3C** and **3D** show the time trends of U.S. average *Task Quality* for NMD Separations tasks and NMD nonseparations tasks, respectively. On average, NMD Separations received lower Task Quality scores (Overall Mean: 0.72, Pre-COVID Mean: 0.72 - Post-COVID Mean: 0.63, Difference: $t = 10.23$, $p < 0.001$) compared to NMD Nonseparations (Overall Mean: 0.78, Pre-COVID Mean: 0.79 - Post-COVID Mean: 0.75, Difference: $t = 4.13$, $p < 0.001$). Following the emergency declaration, Task Quality shows a steep decline of by almost 30% compared to the previous quarter (NMD Separations: from 0.78 to 0.55, NMD Nonseparations: from 0.87 to 0.63). One also notices that the change in task quality in the aftermath of 'The Great Recession' of 2008 is negligible.

Primary Covariates: COVID-19 Crisis and Aging of IT Systems

COVID Indicator is a binary indicator that equals '1' for months in between March 2020, the time states declared public health emergency for COVID-19, and the month when a given state declares an end of this public health emergency; and equals '0' otherwise in months in the absence of state declaring COVID-19 as a public health emergency (i.e., both pre and post-COVID 19 pandemic public health emergency declarations). States exhibit staggered timing

FIGURE 3: Time Series Patterns of NMD Task Performance – Separations/Nonseparations & Timeliness/Quality Distinctions
[*U.S. Monthly/Quarterly State Averages, January 2002–June 2023*]

FIGURE 3A
NMD Separations Meeting Timeliness Performance Benchmark (≤ 21 Days)
(Jan 2002 - June 2023, U.S. Average)

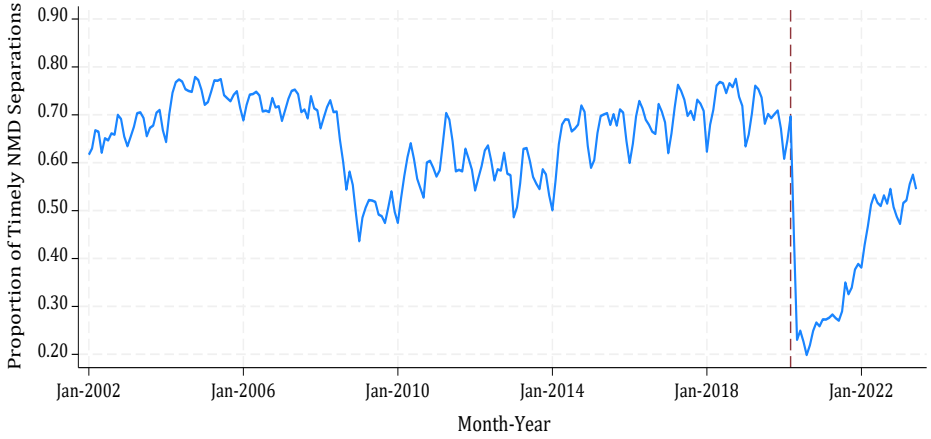


FIGURE 3B
NMD Non-Separations Meeting Timeliness Performance Benchmark (≤ 21 Days)
(Jan 2002 - June 2023, U.S. Average)

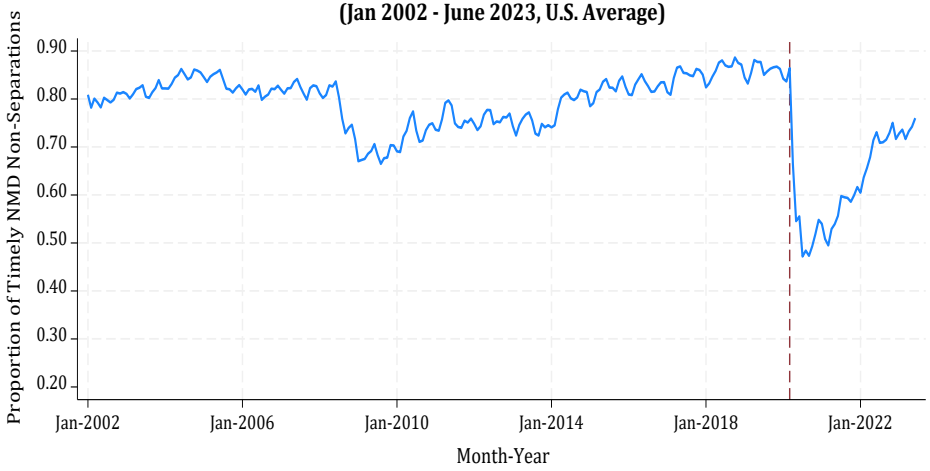


FIGURE 3C
NMD Separations Meeting Quality Score Performance Benchmark (≥ 95 Points)
(Q1 2002 - Q2 2023, U.S. Average)

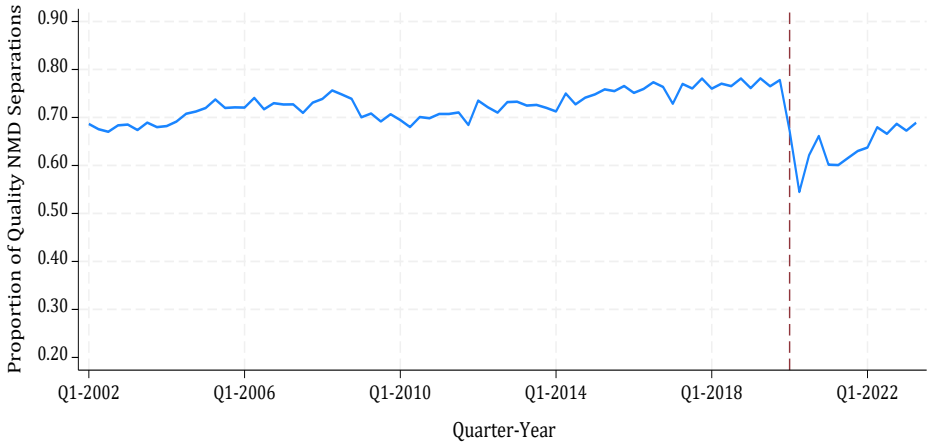
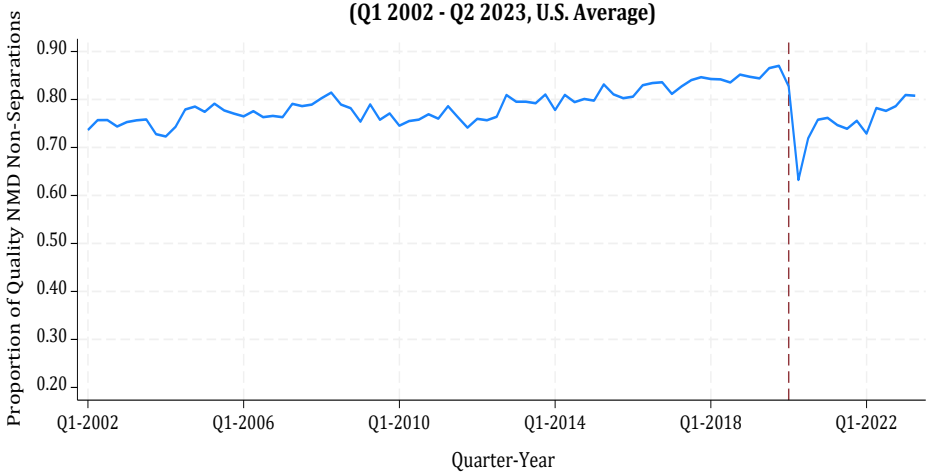


FIGURE 3D
NMD Non-Separations Meeting Quality Score Performance Benchmark (≥ 95 Points)
(Q1 2002 - Q2 2023, U.S. Average)



when ending their public health emergency orders, ranging from the earliest state to end the emergency in October 2020 (Michigan) to the last state in June 2023 (New York).

IT System Age is measured as the number of months that a given state's IT modernization reform has been in operational use, with a value of zero being assigned to months prior to the institution of this reform.[10] The two core features of these IT modernization reforms are transitions to *".....technology that inherently supports web-based services and object-oriented paradigms in combination with relational database technology."* (National Association of State Workforce Agencies 2010: 7). Many vendors offer products with overlapping features (e.g., four vendor products contain only web-based service and object-oriented design; five vendor products offer only web-based service, object-oriented design, and fraud detection predictive analytics), while seven of the 11 vendors cover only 1-2 states.[11] **Figure 4** reveals that IT systems age varied significantly at the start of the COVID pandemic in March 2020 ─ ranging between three months in Alabama to 228 months (or 19 years) for Montana.

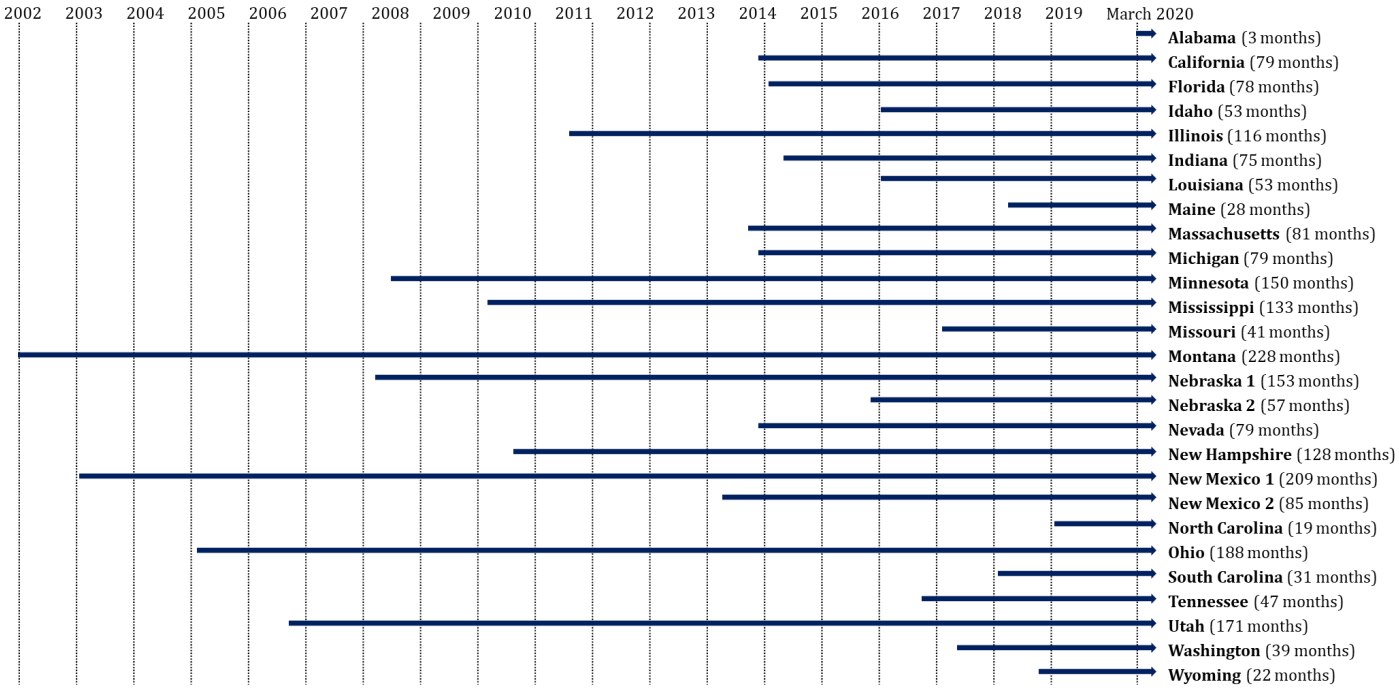
Control Covariates and Unit Effects

Task performance might also be shaped by task specific factors that may potentially confound the impact of the IT system aging process in response to COVID crisis conditions. By each NMD separation and nonseparation issue types, *Determination Rate* is measured as the proportion of cases referred to the NMD process for further review relative to the total number of monetarily eligible claims. We adopt the widely used measure of program generosity used by the

[10] The first year-month of each state's introduction of the new automated system is determined by the time when the new automated system was adopted and went 'live' (i.e., instituted).

[11] See **Appendix A** (**Table A2)** for more information on technological features by vendor and states.

FIGURE 4: Age of IT Modernization Systems at Time of COVID-19



U.S. Department of Labor (Fishman et al., 2003: 63), where a high *Determination Rate* indicates an agency's active effort to identify potentially disqualifying separation/nonseparation issues, while a low *Determination Rate* suggests that the agency processes more payments based solely on monetary eligibility, without holding them for NMD. *Workload* is measured as the number of determinations by each issue type. This variable accounts for non-COVID factors that may also contribute to administrative overload and is hypothesized to correlate negatively with task performance. *Personnel Capacity* is a generic measure of total number of positions for NMD function as reported by state UIP agency's annual budget requests. Higher levels of *Personnel Capacity*. The caliber of NMD function personnel (*Quality of Personnel*) is measured as the inflation-adjusted average salary amount for the NMD function per position by fiscal year-state. Both NMD related personnel covariates should be positively associated with task performance.

A set of control covariates account for agency-state specific factors affecting task performance. *Agency Head Tenure* measures the number of months that the state UIP agency head has been in office within a given state-month. *Administrative Management Capacity* is defined as the state UIP agency's administrative quality, operationalized as the average real dollar amount of salary of positions assigned for administration and supervision functions of the UI program in a given fiscal year. *Automation Rate* is measured as the percentage of claims filed through internet as opposed to in-person, telephone, and postal mail methods. This covariate is simply the estimated proportion of each filing method based on a randomly drawn sample of the states' claims processing records, ranging from 360 to 480 cases annually. This control covariate is hypothesized as exhibiting a positive correlation with task performance, as an increasing proportion of claims filed via the internet should indicate greater reliance on modernized IT systems for administrative processes. *ln(Agency Budget*) is measured as the log-transformed total administrative expenditure in real dollar amount reported by the state UIP agency in a given fiscal year. Greater agency resources should yield economies of scale effects that facilitate task performance. *State Unemployment Rate* is measured as the proportion of seasonally adjusted unemployment rates in a given month-state. The unemployment rate is expected to be negatively correlated with task performance since it places greater strain on state UIP agencies.

In addition, a respective set of binary indicators account for unobserved heterogeneity based on separate state and year unit effects. The state unit effects controls for systematic unobserved performance differences between states, as well as nets out cost-of-living variations that might vary across states (e.g. *Quality of Personnel* covariate defined in the preceding paragraph). The time unit effects account for performance shocks that are unique to each year but common across states (e.g., The Great Recession period of 2008-2010). In addition, a vector of

reform-year cohort time-varying enactment unit effects is specified to account for the highly irregular, staggered sequence when states adopt IT reforms, and its corresponding heterogeneous impact on agency performance (Wooldridge 2021). This covariate vector is operationalized as a series of reform year cohort binary indicators that equal 1 when state *i* institutes an IT modernization reform in year T interacted with the precise month *m* IT reform was instituted, and 0 otherwise. These 'saturated' unit effects ensure that the COVID effects of IT system aging on task performance are not attributable to the temporal sequence of reform adoptions. That is, the reform-year cohort time-varying enactment unit effects ensure that the performance effects attributable to the IT system aging process will not be confounded by reform cohort effects reflecting variable technologies contained in IT reforms that dynamically vary through time.

Methodology

A semi-parametric modeling strategy is implemented that employs nonparametric estimation of a flexible functional form using B-splines to evaluate competing theories of the performance consequences associated with the aging of administrative systems resulting from crisis events (see **Figure 1**). This semiparametric modeling approach circumvents the 'curse of dimensionality' problem common in nonparametric models by estimating all control and unit effect covariates using standard linear-parametric (OLS) methods, while estimating the primary covariates of interest using nonparametric methods. This modeling approach not only permits an agnostic adjudication among these competing theories for understanding task performance, but also allows for an unconstrained evaluation of interaction effects between covariates (Hainmueller and Hazlett 2014). In turn, this reduces the likelihood of false-positive hypothesis tests compared to parametric models (Beiser-McGrath and Beiser-McGrath 2020). Unlike parametric models specifying conditional (multiplicative) relationships, a nonparametric

modeling approach can generate both unconditional (additive) and conditional (multiplicative) estimates from the same model. The general form of the estimating equation is:

$$Performance_{it} = \overbrace{\delta_1 Crisis_{it} + \delta_2 Age_{it}}^{Nonparametric\ Component} + \overbrace{\beta_k X_{k\,i,t} + \gamma_i S_i + \lambda_T T_T + \eta_{i,T} C_{i,T} + \varepsilon_{i,t}}^{Parametric\ Component} , \qquad \textbf{(1)}$$

where task performance (*Performance*) is a nonlinear [$g(x_{i,\,t})$] function of both the COVID pandemic period (*Crisis*) and IT system age (*Age*), plus a linear-parametric estimated vector of control covariates ($\boldsymbol{X_{k\ i,t}}$), state unit effects ($\boldsymbol{S}_i$), year unit effects ($\boldsymbol{T_T}$), and reform year-cohort time-varying enactment unit effects ($\boldsymbol{C}_{i,\,T}$), plus a regression disturbance term ($\varepsilon_{i,t}$). Specifically, the primary hypotheses are evaluated by analyzing the differential performance effects between the COVID and Non-COVID eras (*Crisis*), conditional on the IT system aging process (*Age*). The nonparametric B-spline estimates employ a cross-validation criterion to select the number of optimal knots in estimation.[12] Evaluation of **H2** (***Task Complexity Crisis Hypothesis***) involves the estimated differential between COVID and Non-COVID era performance as IT system aging process varies based on the cross-task (model) estimated differential between NMD Separation [**Models 1** & **3**] and NMD Nonseparation [**Models 2** & **4**] tasks.

Statistical Findings

For purposes of brevity, the discussion is limited to the primary statistical relationships of interest centering on how IT system age affects the relationship between COVID and task performance in state UIP agencies. The full set of regression estimates appear in a tabular format at the end of this document (**Appendix Table A1**). It should be noted, however, that the

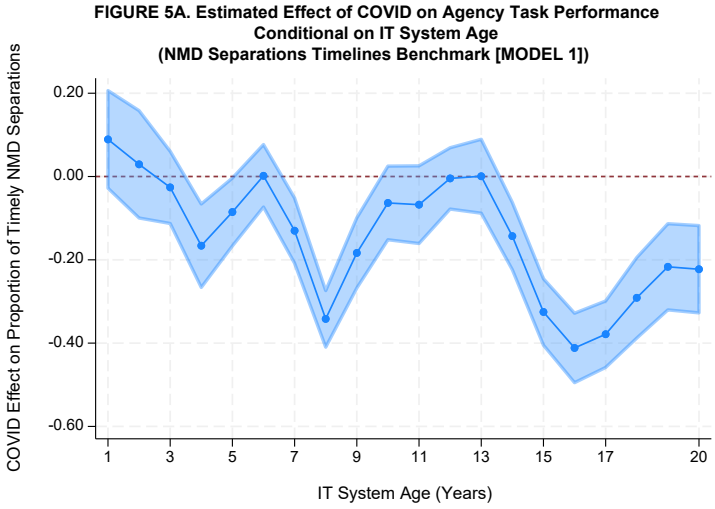
[12] Model estimation using Stata 18's ***npregress series*** function reveals that a single knot is optimal for estimating B-Splines in **Models 2−4**, while 31 knots are optimal for **Model 1** based on cross validation.

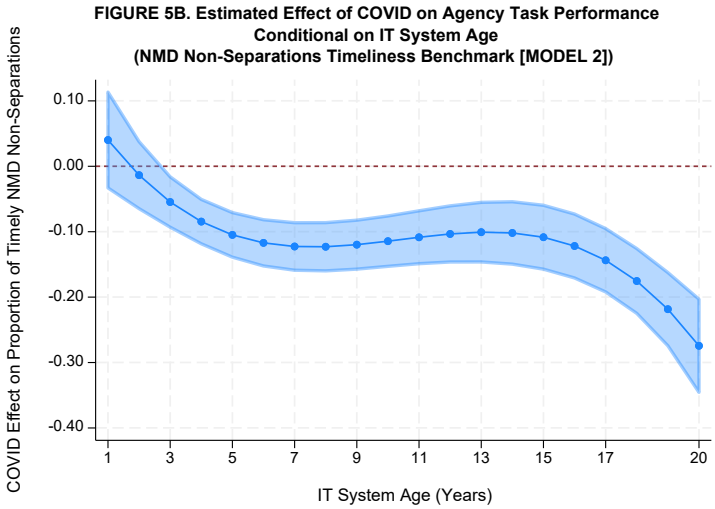
nonparametric regression estimates of primary interest in **Appendix Table A1** are not informative for evaluating our hypotheses since they represent average effects over the parameter space for a weighted combination of both unconditional and conditional effects. To gauge substantively meaningful estimates, one must derive the relevant substantive quantities of interest using post-estimation analyses. **Figure 5A** displays how IT systems aging process conditionally impacts the effect of COVID on the timeliness of administrative tasks – measured as the proportion of NMD Separations that meet the 21 day performance benchmark for a given state-month observation. The maroon dashed horizontal line at the Y-axis value of zero indicates the point where there is performance difference estimate between COVID and non-COVID observations are zero. These findings indicate that the COVID crisis event has a null effect on NMD Separation timeliness for more recently instituted IT reforms (*IT System Age* ≤ 3 years), thus suggesting newer IT systems can prevent a reduction in processing speed for tasks are carried out in response to the COVID shock. This pattern for moderate-aged and older IT reforms oscillates while declining in a non-monotonic manner with respect to IT reform age. For moderately-aged (i.e., moderately young to moderately older) IT reforms: 4 years ≤ *IT System Age* ≤ 13 years), the average performance decline in NMD Separation timeliness attributable to COVID is 10.40 percentage points (–0.1040) below the non-COVID mean average for this outcome variable. For older IT reforms (*IT System Age* ≥ 14 years), the average NMD Separation timeliness performance drop due to COVID is 28.42 percentage points (–0.2842) below the non-COVID mean average for this outcome variable. NMD separations timeliness is most consistent with the depreciation crisis hypothesis (**H1B**). This finding implies that capital improvements for technology systems are most likely to become obsolete, thus vastly outweighing any performance benefits from experiential learning when engaging in NMD separation tasks.

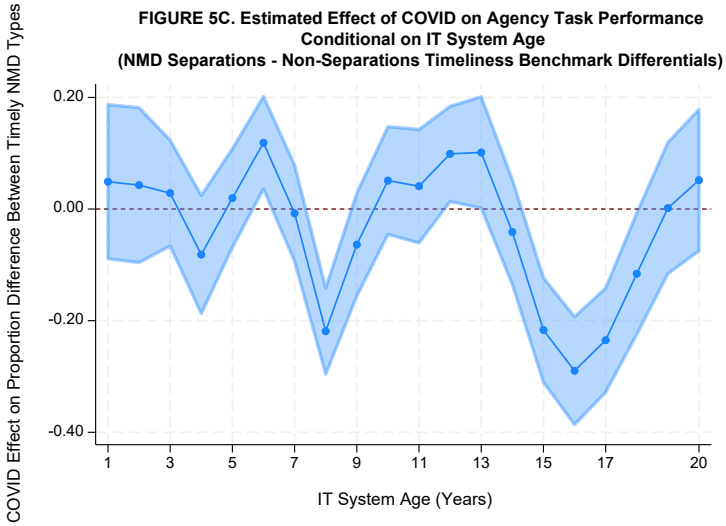
Figure 5B displays the nonparametric estimates analyzing the effect of COVID shock on NMD nonseparation timeliness (with the same 21 day performance benchmark). Once again, IT systems that are three years of age or less do not translate into a drop in administrative performance resulting from the COVID crisis. Yet, both statistically discernible and consistent nonlinear performance declines do occur with respect to the age of IT systems. The average performance decline for moderately aged IT systems (4 years ≤ *IT System Age* ≤ 13 years) is 10.99 percentage points (–0.1099) – this is similar to the conditional COVID effects for NMD separation timeliness noted above (−10.40 percentage points). Although the older IT systems (*IT System Age* ≥ 14 years), are associated with a more deleterious COVID-based decline in NMD nonseparations task timeliness (–16.43 percentage points, –0.1643). This effect, however, is roughly half the size for more complex NMD separation tasks denoted in **Figure 5A**. (i.e., –28.42 percentage points, –0.2842). IT obsoletion has adverse consequences for the timely task processing by state UIP agencies per the depreciation crisis hypothesis (**H1B**).

Figure 5C evaluates **H2** (*Task Complexity Crisis Hypothesis*) that focuses on the impact of COVID on cross-task (model) differences involving NMD timeliness conditional on IT system age. The evidence displayed this graphic uncovers only a single instance where more complex NMD separations result in a statistically more deleterious COVID shock effect on task timeliness than compared to less complex NMD nonseparation tasks (*IT System Age* = 8 years: –21.88 percentage points, –0.2188). For older IT systems between 15 and 18 years of age, the difference is substantial and statistically discernible from zero. Specifically, the average performance difference between separation and nonseparation tasks is −21.43 percentage points (−0.2143) for this subset of older IT systems. This suggests that IT obsoletion yields greater processing speed costs for more complex tasks (*NMD Separations*) than compared to less

FIGURE 5: Nonparametric Estimates of COVID Effect on State UIP Agency NMD *Timeliness* Benchmark Performance, Conditional on IT System Age







complex tasks (*NMD Nonseparations*) in response to crisis events consistent with **H2**.

The estimates of NMD performance quality appear in **Figure 6**. This analysis predicts variations in the proportion of NMD tasks that attain a performance benchmark score of 95 or higher. **Figure 6A** evaluates the effect of COVID on NMD separation task quality, conditional on IT systems age. Because these set of estimates are based on quarterly data, and not monthly data, they are more imprecise. Quality performance attributable to the COVID crisis initially drops, with a maximum decline of −5.26 percentage points (−0.0526) when *IT System Age* = 5 years. Moderately older IT systems yield average marginal performance improvements of +6.48 percentage points (+0.0648) in response to the COVID shock for IT systems that are aged between 13 and 15 years — albeit ones that barely lie below the 95% confidence level.[13] This pattern is most compatible with the life cycle hypothesis (**H1C**), whereby, state UIP agency personnel become increasingly more effective at task quality while operating under a given IT system, before obsoletion offsets any performance gains resulting from crisis situations.

The corresponding set of estimates evaluating the quality of NMD nonseparation tasks appears in **Figure 6B**. Although the COVID-induced performance quality dip for IT systems aged ten years or less is higher for nonseparation tasks compared to separation tasks, the subsequent dynamic paths are similar with respect to IT system age, albeit with a sharper performance quality drop for the oldest set of IT systems (IT *System* Age ≥ 18 years). Specifically, for the subset of moderate-age and older set of IT systems (8 years ≤ *IT System Age* ≤ 17 years), average performance quality rises by +9.42 percentage points during COVID compared to non-COVID periods. This evidence is broadly consistent with the life cycle hypothesis (**H1C**) since performance quality gains during COVID are both transitory, as well as

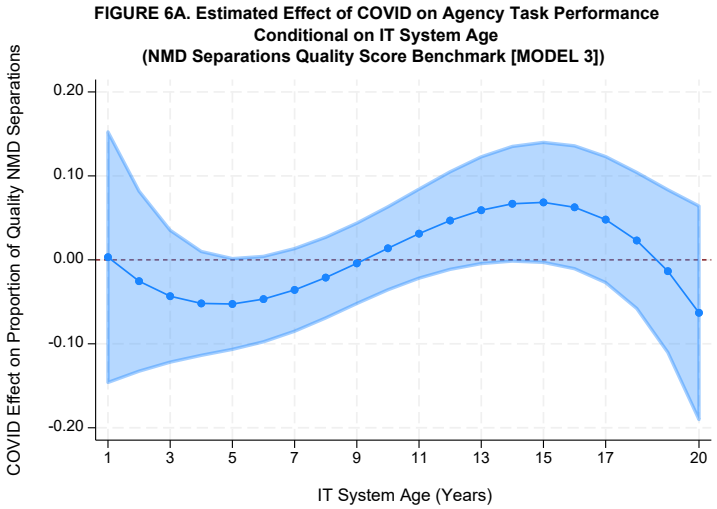
[13] The density of the 95% confidence interval containing positive values lies between 94% and 95%.

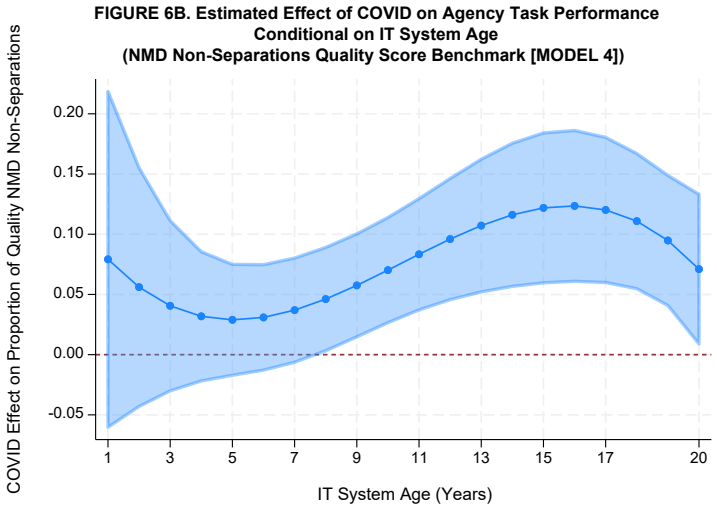
being restricted to IT systems that are sufficiently ingrained into the task processing activities performed by state UIP agencies.

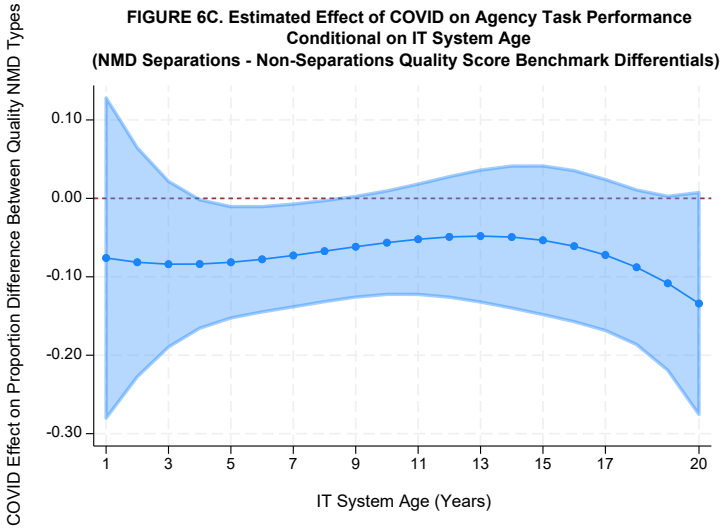
Figure 6C evaluates the differences in performance quality resulting from the COVID crisis event for each type of NMD task, conditional on IT system age. Although these are imprecise effects, the point estimates indicate that NMD separation task performance quality is lower than compared to NMD nonseparation task performance quality ranging anywhere between a minimum difference of –4.81 percentage points (*IT System Age* = 13 Years) and a maximum difference of –13.41 percentage points (*IT System Age* = 20 Years). These differences are significant at the 95% level in support of the *Task Complexity Hypothesis* (**H2**) for moderately younger IT systems (4 years ≤ *IT System Age* ≤ 8 years). Although the quality of task performance follows a life cycle hypothesis pattern for both more complex (*NMD Separations*) and less complex (*NMD Nonseparations*) tasks, the former set of tasks is more adversely affected than the latter.

In the **Online Appendix** document submitted with this manuscript, we present the sensitivity analyses' results from these primary hypotheses. **Appendix B** accounts for potential post-treatment bias by omitting standard control covariates, sans unit effects. The estimate effect sizes of interest are generally larger when omitting control covariates compared to the reported model estimates (but see **Figure 6A– Model 3**, cf**. Figure B2A –Model B3** for an exception). **Appendix C** alters the set of state panel of observations by jointly (1) omitting second IT reform state panels (see *Note 4*), and (2) inclusion of potential endogenous IT adopting states (see *Note 8*). This sensitivity analysis reveals substantively similar estimates to the reported estimates with respect to NMD task timeliness, as well as more pronounced effects consistent with **H1C** regarding NMD task quality (but see **Figure 6A–Model 3**, cf**. Figure C2A–Model C3** for an exception). Finally, **Appendix D** analyzes model specifications that include non–IT modernization reform

FIGURE 6: Nonparametric Estimates of COVID Effect on State UIP Agency NMD *Quality* Benchmark Performance, Conditional on IT System Age







states (control group) excluded from the reported samples. Inclusion of these control group states yields substantively similar effects of interest to those excluding non–IT modernization reform states from the sample.

The analysis of IT modernization reforms indicates that although task processing speed reflects technological obsoletion with older IT systems adversely impact performance, the quality of task processing benefits is higher during COVID for moderate-aged to older IT systems. This evidence suggests the importance of stability in technological-based administrative systems since agencies accrue high levels of proficiency when utilizing a given system for a protracted amount of time. Interestingly, the deficiencies for timely task processing become more acute as IT systems age for more complex NMD separations tasks compared to less complex NMD nonseparations tasks. Yet, the observed task complexity differences involving task quality is relatively stable across the aging process for IT systems used for program administration of state unemployment insurance benefits.

DISCUSSION

Public administration scholarship has offered a host of different explanations to understand why administrative reforms often fail to deliver on their promise for improved performance (e.g., Knott and Miller 1987; Moynihan 2006). This study has proposed a novel general theoretical framework for understanding the different ways administrative reforms can dynamically impact administrative performance in times of crisis. The evidence finds that the impact of COVID pandemic public health emergency on state UIP agencies' ability to perform core program eligibility tasks in a timely manner is inferior for older IT systems. This adverse depreciation effect is more acute for more complex administrative tasks (NMD separations) than less complex ones (NMD nonseparations). The evidence on task quality resulting from the COVID shock indicates that experiential learning yields performance gains before obsoletion effects begin to offset such gains

consistent with the life cycle theory of administrative system effectiveness. Older technological systems pose considerably greater performance risks for expeditiously performing tasks compared to effective task performance. Although Wenger, et al. (2008) finds interdependence between task timeliness and task quality in UI program performance, our findings indicate that managerial practices and information technologies that enhance one type of performance might not necessarily yield improvements for a different performance metric.

The broader lesson from this study is that performance consequences attributable to stability and change in administrative systems are complex and systematically vary based on the type of reforms and the nature of tasks. Administrative system change is likely to be more desirable when obsoletion is a threat to task performance. Administrative system stability, however, is preferred for enhancing task performance in those settings that rely more heavily on human judgment and decision-making. In these latter instances, administrative system stability is conducive to the mastery of "learning by doing" (Levinthal and March 1993). In settings that emphasize human judgment and interactions more than automated processes in the execution of administrative tasks, older IT systems may offer greater benefits for enhancing the caliber of administrative performance in response to crisis conditions, while more nascent IT systems fare worse than the evidence presented in this study.

Future inquiry into the performance consequences associated with administrative system stability and change can provide additional insights resulting from the tension between experiential learning by agency personnel and depreciation of capital equipment. Examples include performance management reforms (Moynihan 2006) and human resource management reforms (Hameduddin and Fernandez 2019), which involve varying degrees of reliance on personnel and capital compared to the aging process of IT systems attributable to such major reforms.

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APPENDIX TABLE 1: Hybrid Semi-Parametric Models of Task Performance: State Unemployment Insurance Nonmonetary Determinations (2002-2023)

	Task Timeliness		Task Quality	
Task Type	NMD Separations	NMD Nonseparations	NMD Separations	NMD Nonseparations
Covariates	Model 1	Model 2	Model 3	Model 4
COVID Indicator	**−0.460**	**0.015**	**0.016**	**0.086**
	(290.175)	**(10.694)**	**(0.736)**	**(0.472)**
IT System Age	**−34.913****	**0.003**	**0.004**	**0.005**
	(11.854)	**(43,143.720)**	**(10.528)**	**(7.276)**
Determination Rate	0.056**	−0.017	0.044	0.007
	(0.027)	(0.018)	(0.029)	(0.019)
ln(Workload)	−0.010	0.053***	−0.046***	0.001
	(0.008)	(0.005)	(0.012)	(0.008)
ln(Personnel Capacity)	0.071***	0.068***	0.035***	0.027**
	(0.011)	(0.009)	(0.013)	(0.012)
ln(Personnel Quality)	−0.133***	−0.057***	0.066**	0.056*
	(0.028)	(0.020)	(0.033)	(0.029)
ln(Agency Head Tenure)	0.014***	0.009***	0.000	0.001
	(0.003)	(0.002)	(0.003)	(0.003)
ln(Administrative Management Capacity)	0.077***	0.087***	−0.020	−0.103***
	(0.022)	(0.017)	(0.030)	(0.024)
Automation Rate	−0.174***	−0.086***	−0.051**	−0.033
	(0.018)	(0.012)	(0.023)	(0.021)
State Unemployment Rate (%)	−0.008***	−0.006***	−0.013***	−0.010***
	(0.002)	(0.002)	(0.003)	(0.003)
ln(Agency Budget)	0.067***	0.026*	0.023	−0.024
	(0.018)	(0.015)	(0.021)	(0.020)
State Unit Effects	YES	YES	YES	YES
Year Unit Effects	YES	YES	YES	YES
Reform Cohort−Time-Varying Enactment Unit Effects	YES	YES	YES	YES
Total Number of Observations	6,966	6,962	2,220	2,220
Post-Reform Observations	3,469	3,467	1,082	1,082

NOTES: Bootstrapped Standard Errors (1,000 Replications) reported in parentheses. **Boldface Type** Entries are Nonparametric B-Spline Estimates. Regular Typeface Entries are Linear (OLS) Estimates. * $p \leq 0.10$ ** $p \leq 0.05$ *** $p \leq 0.01$.

APPENDIX FOR

Administrative Governance in Times of Crisis:

How the IT System Aging Process Impacts Program Administration

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APPENDIX A: Descriptive Statistics; Data Source and Description

APPENDIX B: Sensitivity Analyses: Omit Standard Control Covariates for Eliminating Potential Post-Treatment Bias

APPENDIX C: Sensitivity Analyses: Omit Both 2nd IT Modernization Reform States [Nebraska and New Mexico] & Inclusion of Post-COVID IT Reform Adopting States (N=5)

APPENDIX D: Sensitivity Analyses: Inclusion of Non-IT Reform Adopting States as Control Group Observations

APPENDIX A

TABLE A1

Descriptive Statistics for Variables Analyzed in Manuscript

Variable	N	Mean	SD	Min	Max	Source
Dependent Variables						
Task Timeliness – NMD Separations	6,966	0.60	0.27	0.01	1.00	U.S. Department of Labor ETA-9052 Monthly Report, January 2002 – June 2023
Task Timeliness – NMD Nonseparations	6,962	0.78	0.20	0.01	1.00	
Task Quality – NMD Separations	2,220	0.72	0.17	0.08	1.00	U.S. Department of Labor ETA-9056 Quarterly Report, Q1 2002 – Q2 2023
Task Quality – NMD Nonseparations	2,220	0.79	0.16	0.18	1.00	
IT System Age & COVID Indicator Covariates[1]						
IT System Age	6,966	39.20	56.69	0.00	267.00	Compiled by authors from online sources. A comprehensive list of sources is available upon request.
COVID Indicator	6,966	0.09	0.29	0.00	1.00	Compiled by authors from online sources. A comprehensive list of sources is available upon request.
Control Covariates						
Determination Rate - NMD Separations	6,966	0.20	0.00	1.73	0.32	U.S. Department of Labor ETA-207 Quarterly Report, Q1 2002 – Q2 2023
Determination Rate - NMD Nonseparations	6,966	0.33	0.01	2.61	0.39	
ln(Workload – NMD Separations)	6,966	8.26	1.04	3.14	11.14	
ln(Workload – NMD Nonseparations)	6,962	8.24	1.07	4.45	12.16	
ln(Personnel Capacity)	6,966	4.03	1.01	1.15	7.69	U.S. Department of Labor. "Resource Justification Model," FY2002 – FY2023.
ln(Quality of Personnel)	6,966	10.71	0.23	9.48	11.26	
ln(Agency Head Tenure)	6,966	3.07	1.10	0.00	5.52	Compiled by authors from online sources. A comprehensive list of sources is available upon request.
ln(Administrative Management Capacity)	6,966	11.00	0.21	10.05	11.55	U.S. Department of Labor. "Resource Justification Model," FY2002 – FY2023.
Automation Rate	6,966	0.54	0.33	0.00	1.00	U.S. Department of Labor. "Benefit Accuracy Measurement Survey. 2002-2021." Publicly Available Upon Request.
State Unemployment Rate (%)	6,966	5.60	2.34	1.20	30.30	U.S. Bureau of Labor Statistics. "Local Area Unemployment Statistics. 2002-2023."
ln(Agency Budget)	6,966	17.54	0.93	15.77	20.42	U.S. Department of Labor. "Resource Justification Model," FY2002 – FY2023.

[1] The descriptive statistics are based on the larger estimation sample (**Model 1** & **Model 2**) from the monthly database.

Detailed Description of Variables: Measures, Data Construction, and Data Source

i. Task Timeliness – NMD Separations & Task Timeliness – NMD Nonseparations

Nonmonetary Determinations: Nonmonetary determination refers to a determination made on any non-monetary issue that is detected by state UIP agency "*which had the potential to affect the claimant's past, present, or future benefit rights; and for which a determination of eligibility was made.*" (U.S. Department of Labor 2017: V-6-265) among those who are monetarily eligible. Therefore, nonmonetary determination is initiated only when there is a potentially disqualifying issue detected by a claims processing staff and directed to adjudicating unit for further review. Such non-monetary eligibility issues may involve either separation issues (circumstances surrounding the claimant's previous employment such as voluntary quits or discharges) or nonseparation issues (Federal Issue Codes that fall under nonseparation issues: (12) Able, Available, Actively Seeking Work (13) Disqualifying/Deductible Income (14) Refusal of Suitable Work (15) Reporting Requirement Call-ins and Other (16) Refusal Profiling Referrals (17) Other (Aliens, Athlete School) (U.S. Department of Labor 2017: I-1-8).

Task Timeliness: Timeliness of nonmonetary determinations for each issue type is one of the four core performance measures of state UIP agencies monitored by the U.S. Department of Labor (U.S. Department of Labor **nd**). The acceptable level of performance is 80% within 21 days for both types of NMD (U.S. Department of Labor **nd**). It is measured as the percentage of nonmonetary determinations (separations and nonseparation issues separately) made within 21 days from the date of detection of the issue that has potential to affect the claimant's benefit rights to the date of notice to claimant[2]. This 21 day limit is restricted only to the NMDs (i.e., the

[2] See U.S. Department of Labor UI Performs Measures and Calculations (https://oui.doleta.gov/unemploy/pdf/Core_Measures.pdf) for greater detail.

time lapse between the date of detection of that specific NMD issue and the date the determination was made by the agency). Therefore, separate time limits exist for NMD separations versus NMD nonseparations. Not combined for both types of NMDs (U.S. Department of Labor 2017: V-3-6).

a. **Definition of Timeliness: The time lapse between the date on issue detection** (i.e., "the earliest date that the agency is in possession of information indicating the existence of a nonmonetary issue." (U.S. Department of Labor 2017: V-3-6).) — the date on the determination (i.e., "the date printed on the determination notice, or, if no notice is required, the date payment is authorized, waiting week credit is given, or an offset is applied." (U.S. Department of Labor 2017: V-3-6).). Therefore, time lapse between the time when "the SWA (state agency) had knowledge and control of the issue (U.S. Department of Labor 2005: V-8)" and the time when the agency makes an eligibility decision on that specific issue.

b. **Sample Period:** 50 [52 State Panels] American States (N = 52), Monthly Data: 2002: M1 — 2023: M6 (T = 258): Balanced Panel: N × T = 13,416[3]

c. **Data Construction:**

- Data Source: U.S. Department of Labor. ETA-9052 Nonmonetary Determination Time Lapse (https://oui.doleta.gov/unemploy/DataDownloads.asp#ETA_9052).
- *Task Timeliness – NMD Separations* = Columns (c9 + c17+c25)/c1
- *Task Timeliness – NMD Nonseparations* = Columns (c105 + c113+c121)/c97

[3] The estimation sample is a subset of the full sample (N × T = 6,966), restricted to IT reform adopting states (27 State Panels, including second reforms for Nebraska and New Mexico).

- Note: Only includes nonmonetary determinations of 'intra-state' claims for a 'regular UI' program. Does not include inter-state claims or claims by federal employees.

ii. **Task Quality – NMD Separations & Task Timeliness – NMD Nonseparations**

Task Quality: % Non-Monetary Determinations on a Potentially Disqualifying Separation Issue That Exceed 95 out of 100 Points as Evaluated by the Quality Reviewer. The acceptable level of performance is equal to or greater than 75% of determinations that receive above 95-points (U.S. Department of Labor **nd**).

a. **Quality Evaluation Method:** This review must be conducted in at least one quarter each year by a tripartite review team comprised of one BTQ (Benefits Timeliness and Quality) expert from the state being reviewed, one BTQ expert from another state, and one BTQ expert from the federal government. If disagreement arises among two independent reviewers on any of the below subcomponent scores, a third-party reviewer intervenes and follow the majority rule for determining the score (U.S. Department of Labor 2005: IV-2).

b. **Definition of Quality:** A nonmonetary determination that receives a quality score equal to or greater than 95 out of 100 points. According to the U.S. Department of Labor (2012), these 100 points are made up of the following five evaluative components: (1) Claimant Information (Adequate: 15, Inadequate: 10, Not Obtained: 0, Not Applicable: 15), (2) Employer Information (Adequate: 15, Inadequate: 10, Not Obtained: 0, Not Applicable: 15), (3) Facts from Others (Adequate: 15, Inadequate: 10, Not Obtained: 0, Not Applicable: 15), (4) Meeting State Law & Policy (Meets: 45, Questionable: 30, Does Not Meet: 0), and (5) Adequacy of the Written Determination (Adequate: 10, Inadequate: 5, Wrong: 0).

c. **Sample Period:** 50 [52 State Panels] American States (N = 52), Quarterly Data: 2002: Q1 − 2023 (T=86): Q2. Unbalanced Panel (Due to COVID Waivers & Temporary State Waivers[4]) T_Bar = 82.67: N × T = 4,299[5].

d. **Data Construction:**

- Data Source: ETA-9056 Nonmonetary Determination Separations & Nonseparations Quality Score Data (https://oui.doleta.gov/unemploy/nonmon_determinations.asp). ETA-9056 has separate data for NMD separations and nonseparations quality that match the NMD Timeliness data (ETA-9052).
- *Task Quality – NMD Separations*: Already given from the database.
- *Task Quality – NMD Nonseparations*: Already given from the database.

[4] **Alabama:** 2005:Q3, 2020:Q1, 2020:Q2, 2021:Q1; **Alaska:** 2020:Q1, 2020:Q2, 2020:Q4; **Arizona:** 2020:Q1, 2020:Q2, 2020:Q4; **Arkansas:** 2020:Q1, 2020:Q2; **California:** 2020:Q1, 2020:Q2, 2020:Q4; **Colorado:** 2020:Q1, 2020:Q2, 2020:Q4; **Connecticut:** 2020:Q1, 2020:Q2; **Delaware:** 2020:Q1, 2020:Q2, 2021:Q1; **Florida:** 2004:Q3, 2008:Q3, 2008:Q4, 2009:Q2, 2009:Q3, 2009:Q4, 2013:Q4, 2020:Q2, 2020:Q4; **Georgia**: 2020:Q1, 2020:Q2, 2021:Q1; **Hawaii:** 2020:Q1, 2020:Q2, 2020:Q4; Idaho: 2020:Q1, 2020:Q2, 2020:Q4; **Illinois**: 2020:Q1; **Indiana**: 2020:Q4, 2021:Q1, 2021:Q2; **Iowa:** 2020:Q1, 2020:Q2, 2020:Q3; Kansas: 2020:Q1, 2020:Q2; **Kentucky:** 2020:Q1, 2020:Q2, 2021:Q1; **Louisiana**: 2005:Q3, 2005:Q4, 2020:Q1, 2020:Q2, 2020:Q4, 2021:Q3, 2021:Q4; **Maine:** 2020:Q1, 2020:Q2; **Maryland:** 2020:Q1, 2020:Q2, 2020:Q4; **Massachusetts:** 2009:Q1, 2011:Q4, 2020:Q1, 2020:Q2, 2020:Q4; **Michigan:** 2009:Q1, 2009:Q2, 2020:Q1, 2020:Q2; **Minnesota**: 2020:Q1, 2020:Q2, 2021:Q1; **Mississippi:** 2005:Q3, 2005:Q4, 2020:Q1, 2020:Q2, 2020:Q4; **Missouri:** 2020:Q1, 2020:Q2, 2020:Q4; **Montana**: 2008:Q4, 2020:Q1, 2020:Q2, 2020:Q4; **Nebraska**: 2020:Q1, 2020:Q2, 2021:Q1; **Nevada:** 2020:Q1, 2020:Q2, 2021:Q1; **New Hampshire**: 2009:Q2, 2020:Q1, 2020:Q2, 2020:Q4; **New Jersey:** 2012:Q4, 2020:Q1, 2020:Q2, 2021:Q1; **New Mexico**: 2020:Q1, 2020:Q2, 2021:Q1; **New York**: 2012:Q4, 2020:Q2; **North Carolina**: 2020:Q1, 2020:Q2, 2020:Q4; **North Dakota:** 2020:Q1, 2020:Q2, 2020:Q3; **Ohio**: 2009:Q1, 2009:Q2, 2020:Q1, 2020:Q2, 2021:Q1; **Oklahoma**: 2020:Q1, 2020:Q2; **Oregon:** 2020:Q1, 2020:Q2, 2020:Q4; **Pennsylvania**: 2013:Q3, 2020:Q2, 2020:Q4; **Rhode Island**: 2020:Q1, 2020::Q2; **South Carolina**: 2009:Q1, 2020:Q1, 2020:Q2, 2020:Q4; **South Dakota:** 2020:Q1, 2020:Q2, 2020:Q4; **Tennessee:** 2008:Q4, 2009:Q2, 2016:Q2, 2016:Q3, 2020:Q1, 2020:Q2, 2021:Q1; **Texas:** 2020:Q1, 2020:Q2, 2020:Q4; **Utah:** 2020:Q1, 2020:Q2, 2020:Q4; **Vermont:** 2009:Q2, 2020::Q1, 2020:Q2; **Virginia:** 2020:Q1, 2020:Q2; **Washington:** 2020:Q1, 2020:Q2, 2020:Q4; **West Virginia:** 2020:Q1, 2020:Q2, 2020:Q4; **Wisconsin:** 2009:Q1, 2009:Q2, 2020:Q1, 2020:Q2, 2020:Q4; **Wyoming**: 2020:Q1, 2020:Q2.

[5] The estimation sample is a subset of the full sample (N × T = 2,322), restricted to IT reform adopting states (27 State Panels, including second reforms for Nebraska and New Mexico).

Information on IT Modernization Reform Indicator Variable (*IT System Age)*

We evaluate how the timely provision of UI program benefits for vulnerable citizens is impacted by agency performance, in response to Information Technology (IT) modernization reforms adopted by 28 state UI agencies since 2002. The *IT System Age* variable is defined as a time counter variable that equals "*0*" before the activation of a new automated system for state i, month t−ι (where $\iota \geq 0$); "*1*" for the first month of the new automated system is in effect for state i, month t+1; ……..; and "*m*" for state I in m^{th} month that such a system has been in effect for state i year t.

For the purposes of the study, the first year-month of each state's introduction of the new automated system is determined by the time when the new automated system went live, as this indicates the point at which the system began to influence the agency's operations. The go-live dates and vendor information of the new automated system in these states were collected by the authors. Major source of information comes from the official website of the UI Information Technology Support Center (http://www.itsc.org/Pages/UIITMod.aspx), which is an organization under the National Association of State Workforce Agencies (NASWA) that provides the status of state UI IT modernization projects since 2013. Sources include news articles, state legislature audit reports, state RFP documents, and from inquiries to the agency's IT unit. A comprehensive list of sources by each state and agency head is available upon request.

The new automated systems adopted by these 27 states—despite being state-initiated and driven reforms (i.e., IT modernization projects)—share the following two key components. The system "uses an application technology that inherently supports (a) web-based services and (b) object-oriented paradigms in combination with a relational database technology (National Association of State Workforce Agencies 2010: 2)." **Table A2** provides greater detail on the partner states and technological features of vendor products involved in the IT modernization reforms. Although some heterogeneity exists across vendors and products, many vendors offer systems with overlapping features, including the two core components: (a) web-based services and (b) object-

oriented design. For example, four vendor products contain only web-based service and object oriented design; five vendor products offer only web-based service, object oriented design, and fraud detection predictive analytics), while most of the 11 vendors cover only 1-2 states (N = 7 vendors). Also, these states faced common federal incentives to comply with several components in the IT modernization project to be eligible for federal funding (U.S. Department of Labor 2023: VI-1 – VI-3). Therefore, IT modernization reforms were only considered that contained both web-based services and object-oriented design features, as defined by the National Association of State Workforce Agencies' Information Technology Support Center (NASWA 2010[6]: 7). Other minor updates to the existing system were excluded and thus not coded as the launch of a new system.

[6] National Association of State Workforce Agencies. 2010. "National View of UI IT Systems." https://www.naswa.org/reports/a-national-view-of-ui-it-systems [Accessed: October 17, 2024].

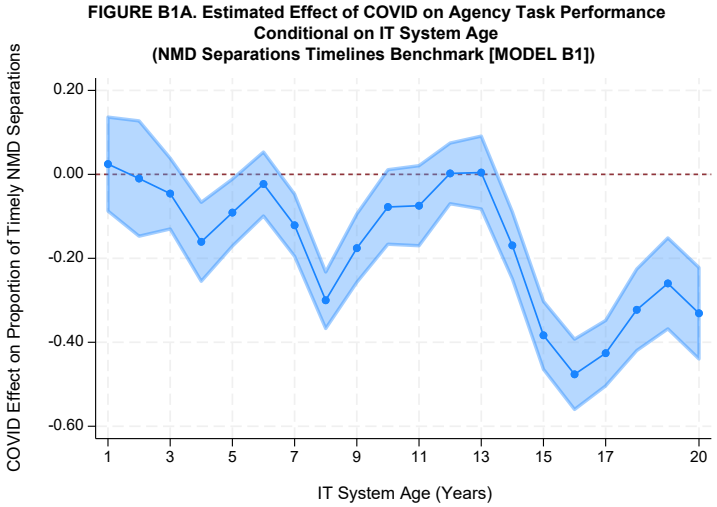
TABLE A2. Summary of Technological Features in IT System Reforms by Vendor

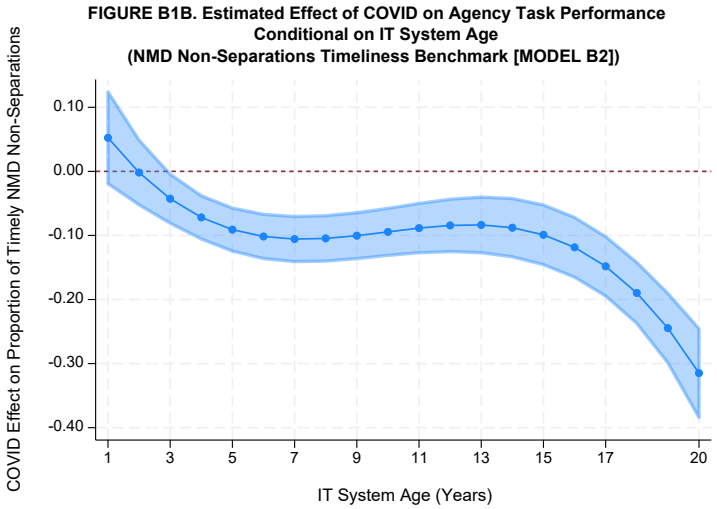
Company/Vendor	Product Name/ Technological Features	(a) Web-Based Service	(b) Object-Oriented Design	(c) Cloud Integration	(d) Fraud Detection Predictive Analytics	States
Deloitte	Deloitte FACTS 0.0	yes	yes	no	no	OH, UT
	Deloitte FACTS 1.0 (2007-)	yes	yes	no	no	MN
	Deloitte FACTS 2.0 (2009-)	yes	yes	no	yes	NH, MA, NM (2013), FL
	Cloud and Program Integration (2019-)	yes	yes	yes	yes	CO
Netacent	Data Station	yes	yes	yes	yes	AL, ID
KSM	UpLink	yes	yes	no	yes	IN
SAGITEC	Neosurance solution	yes	yes	yes	no	CA, MD
Tata Consulting Services	ReEmployUSA	yes	yes	yes	no	ME, MO, MS, NE (2007), NM (2002), WY
FAST Enterprises	FASTUI	yes	yes	no	yes	WA
Capgemini	SCUBI Consortium	yes	yes	yes	no	NC, NV, SC
Geographic Solutions	Geographic Solutions Unemployment System (GUS)	yes	yes	no	yes	LA, NE (2015), PA, TN
HCL America	HCL America	yes	yes	no	no	VA
Accenture	Benefit Information System	yes	yes	no	no	IL
CSG Government Solutions	CSG Government Solutions	yes	yes	no	yes	MI

APPENDIX B: Sensitivity Analyses: Omit Standard Control Covariates for Eliminating Potential Post-Treatment Bias

Appendix B presents reduced model specifications omitting standard control covariates (excluding state, year, and reform year-cohort time-varying enactment unit effects) to assess the sensitivity of core estimates and address concerns that the manuscript's findings may result from overfitting due to these additional covariates, and potential post-treatment bias. All coefficients are substantively identical with the reported manuscript findings in terms of their estimated direction and statistical significance. However, the size of the estimates is generally larger compared to those reported in the manuscript. For example, **Figure B1A** shows a 33.83% decline in NMD Separation timeliness attributable to COVID for older IT systems (*IT System Age* ≥ 14 years), which is marginally greater than the 28.42% decline reported in **Figure 5A** of the manuscript. An exception is observed in **Figure B2A (Model B3)**, where the average effect size is somewhat smaller for IT systems aged 13 to 15 years is 3.90% compared to 6.48% in **Figure 6A (Model 3)**, as well as falling short of statistical significance in the former instance. Yet, the estimated performance differentials between NMD Separation and NMD Non-Separation tasks (**H2**) are less conservative than those reported in the manuscript when omitting control covariates (**Figure B1C** [**Models B1 & B2**] & **Figure B2C** [**Models B3 & B4**]; cf. **Figure 5C** [**Models 1 & 2**] & **Figure 6C** [**Models 3 & 4**]). With one exception, these sensitivity analyses reveal that the estimated IT system age conditional effects on NMD task performance reported in the manuscript with the full set of control covariates are more conservative compared to these estimates generated from the restricted model specifications displayed in **Appendix B**.

FIGURE B1: Nonparametric Estimates of COVID Effect on State UIP Agency NMD *Timeliness* Benchmark Performance, Conditional on IT System Age





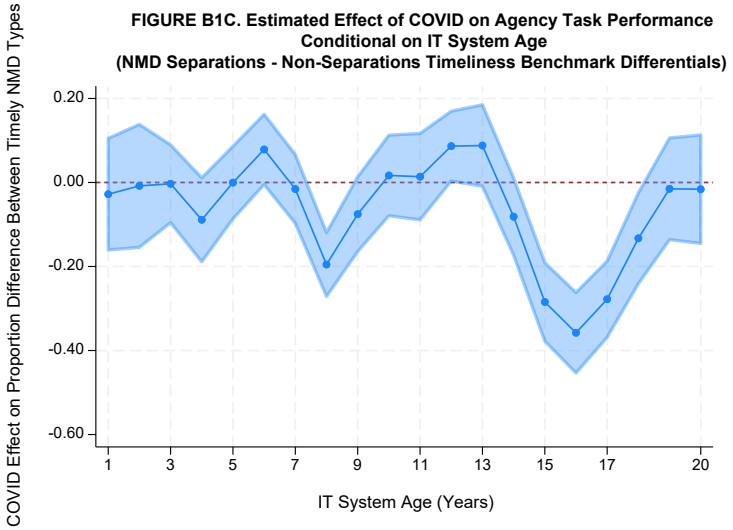
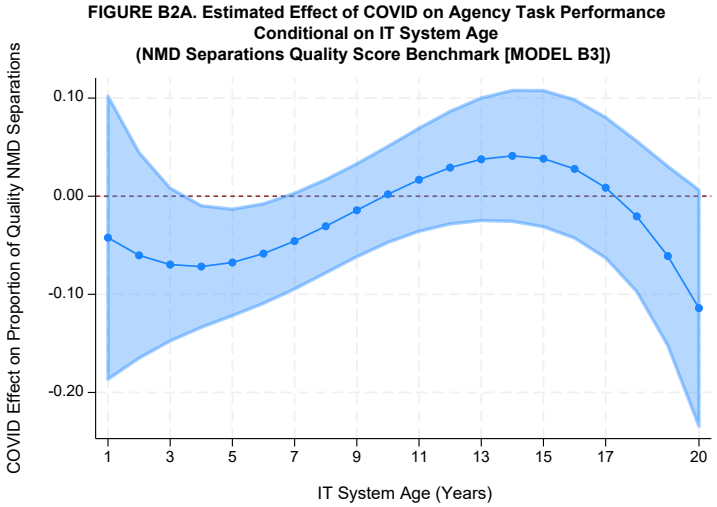
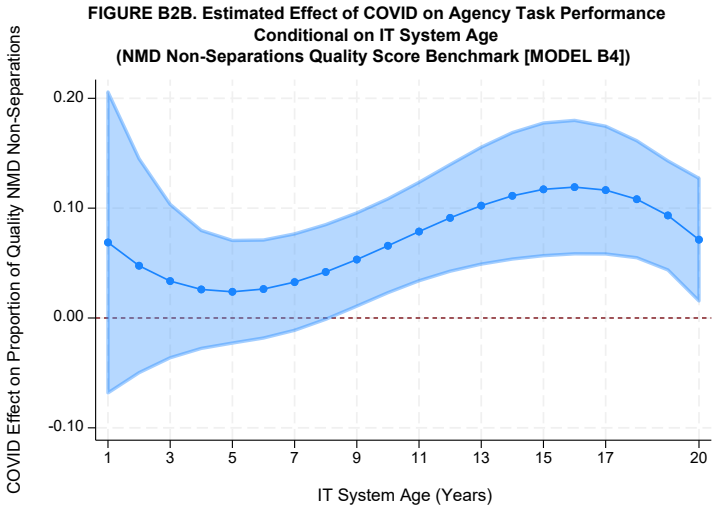
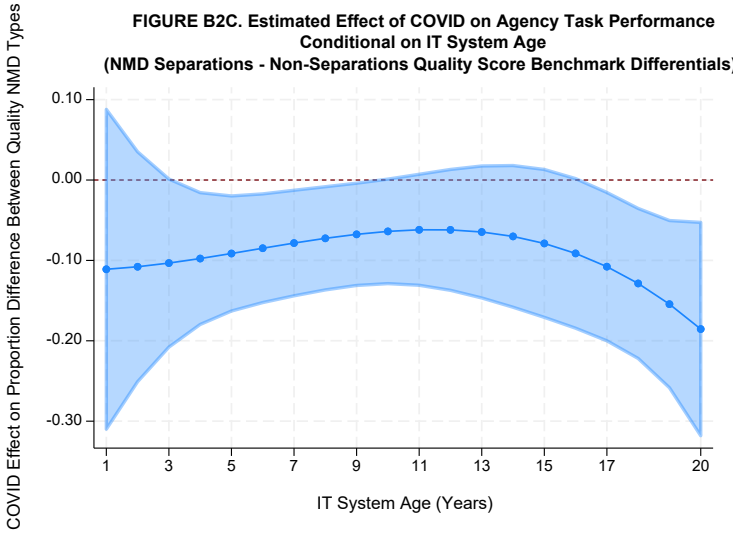


FIGURE B2: Nonparametric Estimates of COVID Effect on State UIP Agency NMD *Quality* Benchmark Performance, Conditional on IT System Age







APPENDIX C: Sensitivity Analyses: Jointly Omit Both 2nd IT Modernization Reform States [Nebraska and New Mexico] & Inclusion of Post-COVID IT Reform Adopting States (N=5)

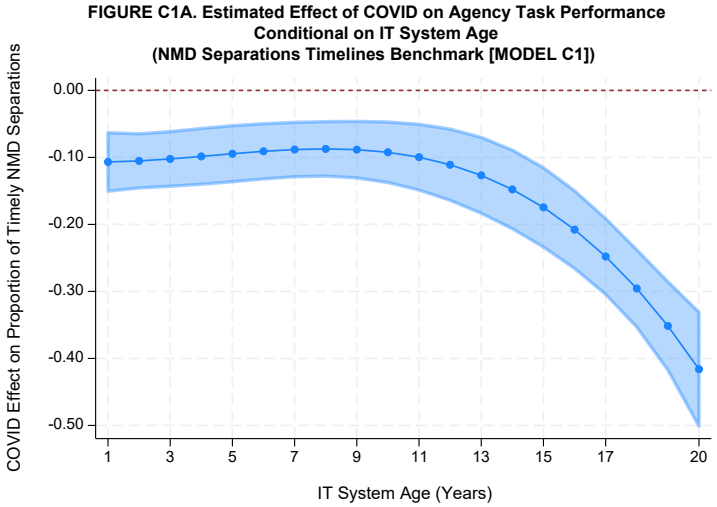
Appendix C presents a sensitivity analysis that excludes states where IT reform took place more than once during the sample period (January 2002 to June 2023), to accurately assess how the IT system aging process influences the state UIP agencies' performance during an administrative crisis. The excluded state—panels include the second IT modernization reforms adopted by New Mexico and Nebraska, respectively. Additionally, this sensitivity analysis also includes five states that adopted IT reforms after March 2020, when COVID-19 was declared a public health emergency: Colorado (December 2020), Connecticut (July 2022), Maryland (September 2020), Pennsylvania (June 2021), and Virginia (November 2021). These five states were excluded from the main models due to concerns about potential endogeneity between the states' IT reform and the performance declines attributable to COVID.

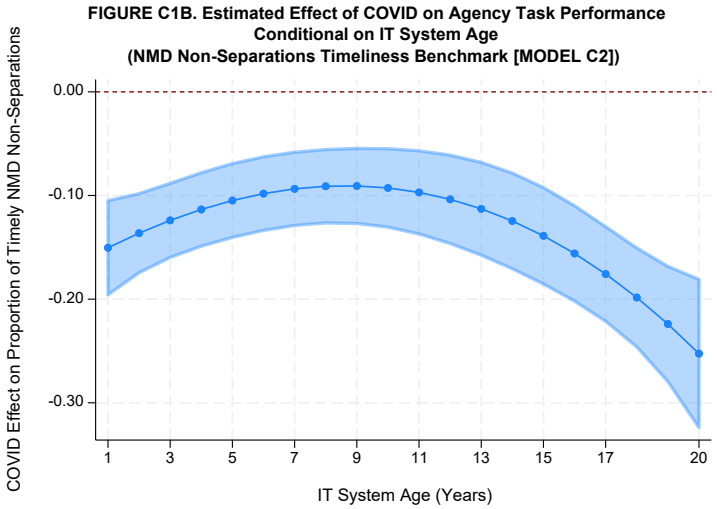
Appendix C models yield substantively similar estimates to those reported in the manuscript. For task timeliness models (**Figures B1A – B1C, Models B1 & B2**), depreciation effects of IT system age (**H1B**) become more pronounced in **Appendix C** estimates by omitting second IT modernizations and including post-COVID IT reform states, for NMD Separations timeliness (**Figure C1A, Model C1**) and NMD Non-Separations timeliness (**Figure C1B, Model C2**). The COVID effect differentials between these NMD task types on timeliness are attenuated for older IT systems (15 years $\leq$ *IT System Age* $\leq$ 18 years) from -21.43% (**Figure 5C, Models 1 & 2)** to -6.42% (**Figure C1C, Models C1 & C2**).

For quality of NMD Separations and Non-Separations task types, the increase in effect sizes is most pronounced for moderately aged and older IT systems in terms of both NMD Separations (**Figure C2A, Model C3**) and NMD Non-Separations task quality (**Figure C2B, Model C4**). As IT system ages (*IT System Age* $\geq$ 11 years), NMD Separations tasks exhibit a steeper rise in their task quality, reaching a maximum increase of 9.69% improvement at *IT System Age* $=$15 years in **Figure**

C2A (Model C3), during COVID compared to non-COVID periods. These estimates are larger and more statistically precise than the reported estimates in the manuscript (**Figure 6A, Model 3**) where NMD Separations quality shows a maximum 6.84% increase during the same period at *IT System Age* =14 years. Similarly, NMD Non-Separations quality shows a maximum increase of 8.67% for moderately aged IT systems (8 years ≤ *IT System Age* ≤ 17 years) in **Figure C2B (Model C4)**, which is smaller than **Figure 6B**'s (**Model 4**) estimate of 9.42% increase within the same age range of these IT systems. One notable exception is observed in **Figure C2A** (**Model C3**) for newer IT systems (*IT System Age* ≤ 5 years), where the maximum quality decline attributable to COVID is attenuated from 5.26% (−0.0526, cf. **Figure 6A, Model 3**) to 3.24% (−0.0324, cf. **Figure C2A, Model C3**) at *IT System Age* = 5 years, with greater statistical imprecision. These observed differences can be attributed to the inclusion of the five post-COVID IT reform adopting states, where the average IT system age is relatively much lower – on average, a nascent 4.9 months since adoption during COVID.

FIGURE C1: Nonparametric Estimates of COVID Effect on State UIP Agency NMD *Timeliness* Benchmark Performance, Conditional on IT System Age





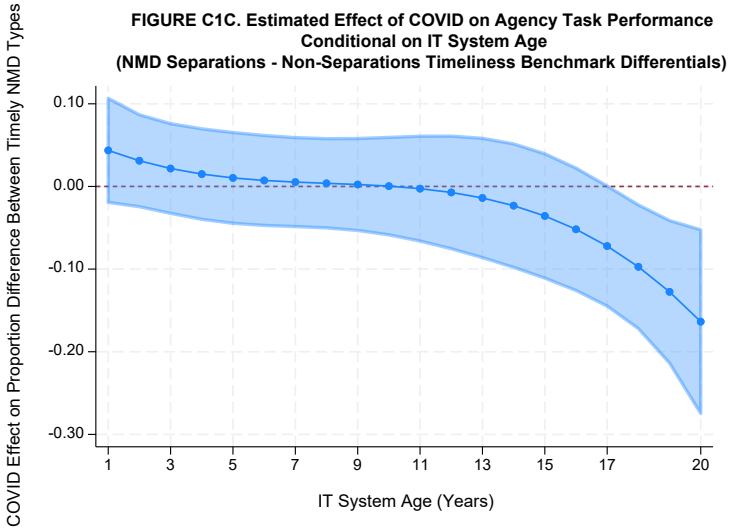
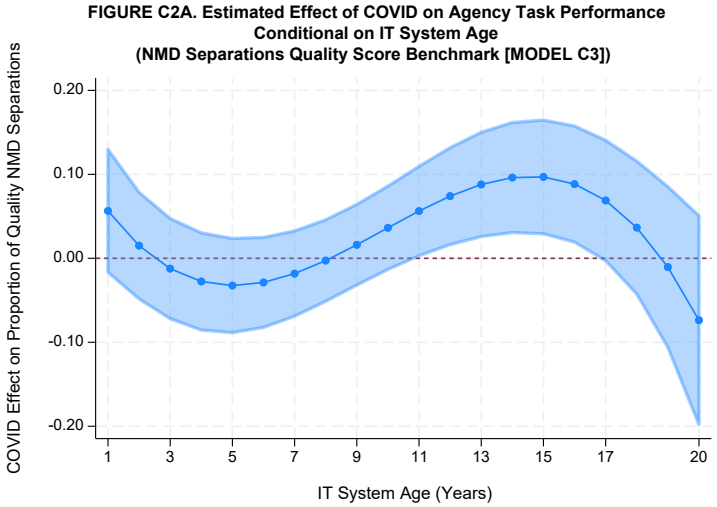
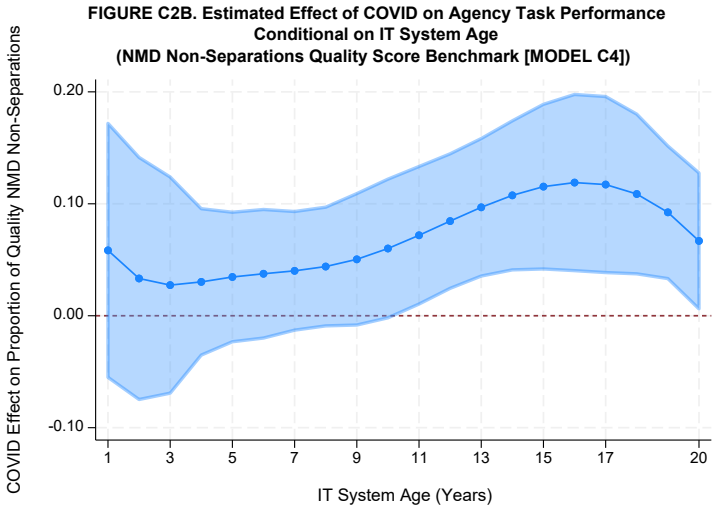
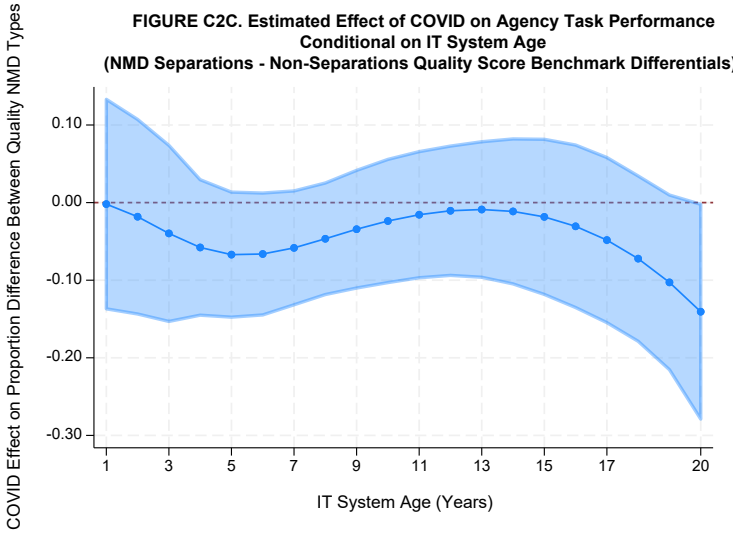


FIGURE C2: Nonparametric Estimates of COVID Effect on State UIP Agency NMD *Quality* Benchmark Performance, Conditional on IT System Age







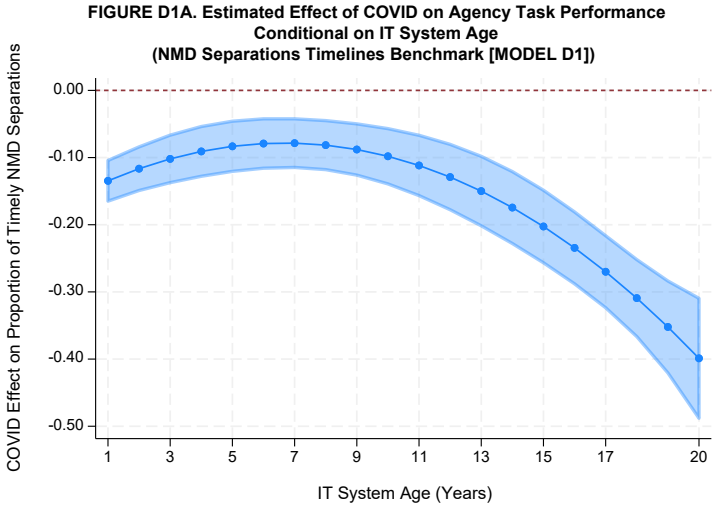
APPENDIX D: Sensitivity Analyses: Inclusion of Non-IT Reform Adopting States as Control Group Observations

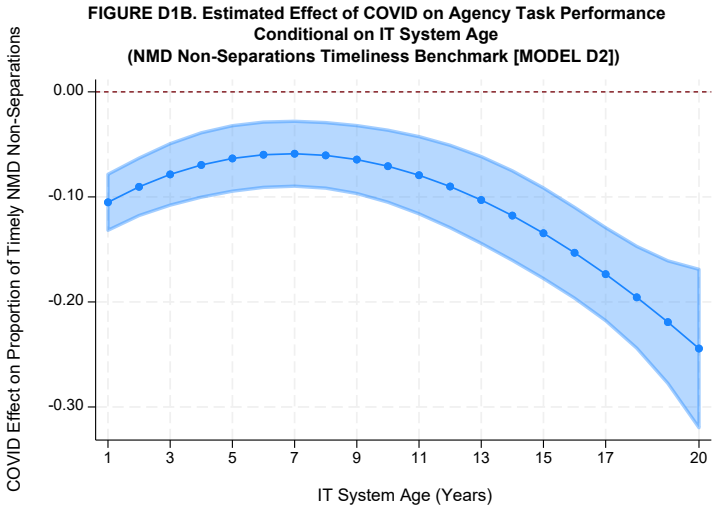
Appendix D incorporates the remaining 20 non-IT adopting states in the estimation sample as a sensitivity check for the primary effects of interest relating to evaluation of **H1a/H1b/H1c** and **H2**. Inclusion of these control group cases alters the baseline comparison for "0" IT system (reform) age observations to include not only untreated state-month/quarter observations in the treatment group (i.e., IT reform states prior to instituting modernization reforms), but also untreated observations in the control group which never receive the treatment (i.e., non-IT reform adopting states). The results are substantively similar compared to the analogous estimates reported in the manuscript that only account for the 25 IT adopting states (27 state panels: with Nebraska and New Mexico undertaking two separate IT modernization reforms during the sample period). Compared to the estimates and findings reported in the manuscript, these supplementary estimates offer stronger support for the ***Life Cycle Crisis Hypothesis*** (**H1C**) compared to the findings reported in the manuscript. Specifically, moderately aged IT systems exhibit least disruption to task timeliness by a minimum difference at IT System Age $= 7$ years with -7.85% decline for NMD Separations timeliness (**Figure D1A, Model D1**) and -5.89% decline for NMD Non-Separations timeliness (**Figure D1B, Model D2**) during COVID compared to non-COVID period.

Although the task quality attributable to the COVID crisis exhibits a similar pattern providing consistent support for **H1C**, the performance improvements yield smaller effects compared to the estimates reported in the manuscript. Moderately older IT systems (13 years $\leq$ *IT System Age* $\leq$ 15 years) yield average marginal performance improvements of 3.47% in NMD Separations tasks (**Figure D2A, Model D3**), compared to 6.48% reported in **Figure 6A** (**Model 3**) for the same age range. For NMD Non-Separations quality (**Figure D2B, Model D4**), the subset of moderate and older IT systems (8 years $\leq$ *IT System Age* $\leq$ 17 years) shows an average performance quality increase of 5.65% during COVID compared to non-COVID periods, compared to

9.42% in **Figure 6B (Model 4)** for the same range of IT system age in years. In short, although inclusion of non-IT modernization reform adopting states provides a non-comparable baseline to evaluate the performance effects of IT modernization reform for adopting states, these results are substantively similar to those reported in the manuscript that excludes those non-adopting states.

FIGURE D1: Nonparametric Estimates of COVID Effect on State UIP Agency NMD *Timeliness* Benchmark Performance, Conditional on IT System Age





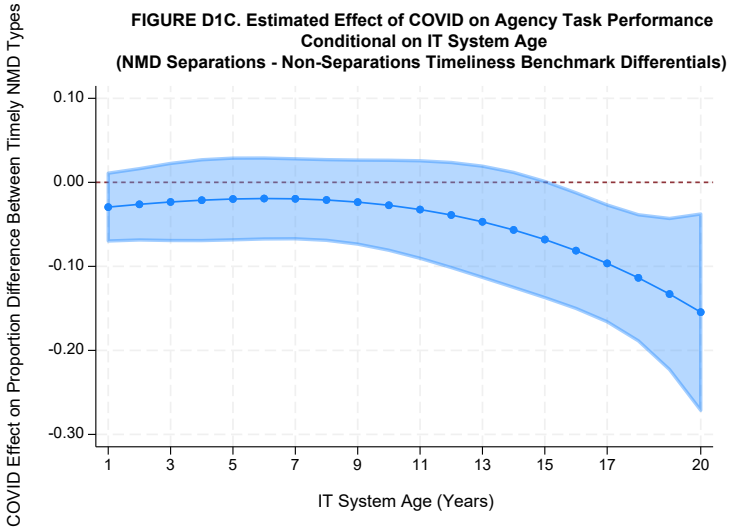


FIGURE D2: Nonparametric Estimates of COVID Effect on State UIP Agency NMD *Quality* Benchmark Performance, Conditional on IT System Age