CRA Charles River Associates

Presented to:

Massachusetts Department of Public Health

Independent Cost Analysis for:

Mass General Brigham Incorporated
DoN Application #MGB-20121716-HE

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[*] The views expressed herein are the views and opinions of the author and do not reflect or represent the views of Charles River Associates or any organizations with which the author is affiliated.

Table of Contents

I. Executive Summary

1.   Mass General Brigham filed a Determination of Need Application that proposes constructing a five-story addition to Brigham and Women's Faulkner Hospital. The proposed addition would contain 78 new beds, resulting in an increase in the number of licensed beds at the hospital by the same amount. The project also proposes adding an eight-bed observation unit at the hospital, relocating the hospital's endoscopy procedure rooms and adding an advanced endoscopy procedure room, and acquiring a 3-Tesla Magnetic Resonance Imaging unit. The total proposed expenditure associated with the project is approximately $150.1 million.

2.   The Massachusetts Department of Public Health has required an independent cost analysis for the project to assist in determining whether the project would be consistent with the health care cost containment goals of Massachusetts. As directed by the Determination of Need program, the two primary elements to be addressed in the analysis are (i) the effects of the proposed project on prices of and competition for health care services in Massachusetts and (ii) the effects of the proposed project on the utilization of health care services in Massachusetts and the capacity of health care providers in Massachusetts to render those services. Our analysis in connection with the independent cost analysis supports the following conclusions.

3.   Patient days associated with inpatient and observation stays at Brigham and Women's Faulkner Hospital increased by almost 40 percent between 2015 and 2019. We further predict that demand will increase by 21 percent for inpatient services at the hospital over the next decade. We also predict a 15 percent increase in demand for outpatient magnetic resonance scans at Brigham and Women's Faulkner Hospital over the next decade. These increases are driven by the projected population growth in the service area of the hospital and the aging of that population. In particular, the number of residents in the hospital's inpatient service area age 65 and older is projected to grow by 30 percent over the next decade.

4.   The predicted changes in Mass General Brigham's shares associated with the proposed project are modest and unlikely to meaningfully change the system's bargaining leverage with health insurers. Rather, the weight of the economics literature suggests that allowing hospitals to expand lowers health care prices and reduces expenditures on health care services.

5.   The proposed project will reduce expenditures on inpatient health care services for patients who switch to receiving care at Brigham and Women's Faulkner Hospital. If these patients otherwise would have received care at Brigham and Women's Hospital, the reductions in expenditures will be larger than if patients switch from competing hospitals. The provision of advanced endoscopic procedures at Brigham and Women's Faulkner Hospital will also lower health care expenditures, but the provision of additional Magnetic Resonance Imaging at the hospital will result in higher expenditures on these services. In all cases, the overall changes in health care expenditures represent a small fraction of spending on the relevant service across health care providers in Massachusetts.

6.   The proposed project will decrease expenditures on inpatient health care services (by at least by three percent) but increase expenditures on outpatient magnetic resonance scans (11 percent) for patients who switch to receiving care at Brigham and Women's Faulkner Hospital. However, because expenditures on inpatient services far exceed expenditures on outpatient magnetic resonance scans and because the choices of most patients would be unaffected by the proposed project, the overall decrease in health care expenditures across all the service lines associated with the proposed expansion is only 0.02 percent.

7.   For these reasons, we believe that the proposed project is consistent with the Commonwealth of Massachusetts' health care cost-containment goals.

II.   Introduction and Background

A. Introduction

8.   Mass General Brigham Incorporated ("MGB" or "the Applicant") filed a Determination of Need Application for project number MGB-20121716-HE on January 21, 2021 ("BWFH DoN"). In this project, the Applicant proposes constructing a five-story addition to Brigham and Women's Faulkner Hospital ("BWFH") that would contain 78 new medical/surgical beds,[1] resulting in an

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[1] mass-general-brigham-incorporated-bwfh-application-form-and-attachments.pdf [hereinafter, BWFH DoN], Appendix 2, Section 2.1, p. 1.

increase in the number of medical/surgical beds at the hospital from 133 to 211.[2] The project also proposes adding an eight-bed observation unit at BWFH, relocating the hospital's endoscopy procedure rooms and adding an advanced endoscopy procedure room, acquiring a 3-Tesla Magnetic Resonance Imaging ("MRI") unit, and other renovation projects on the BWFH campus.[3] The total proposed expenditure associated with the project is approximately $150.1 million.[4]

9.   The Massachusetts Department of Public Health ("DPH") has required an independent cost analysis ("ICA") for the project to assist in determining whether the project will be consistent with the health care cost containment goals of Massachusetts. The ICA is being conducted by Charles River Associates ("CRA") to provide an independent analysis at the direction of the Determination of Need ("DoN") program of DPH. As described by DPH:

> The purpose and objective of the DoN program is to encourage competition with a public health focus; to promote population health; to support the development of innovative health delivery methods and population health strategies within the health care delivery system; and to ensure that resources will be made reasonably and equitably available to every person within the Commonwealth at the lowest reasonable aggregate cost. In this way the Department [of Public Health] hopes to advance the Commonwealth's goals for cost containment, improved public health outcomes, and delivery system transformation.[5]

While MGB is paying for CRA's services in conducting the ICA, CRA does not represent MGB. CRA also conducted the ICA analyses independently of the staff of the DoN program at the Massachusetts DPH. In the next subsection, we briefly describe the questions that the DoN program asked CRA to address in its ICA for this project.

B. Elements of the ICA

10.   As directed by the DoN program at the Massachusetts DPH, the two primary elements the ICA must address are (i) the effects of the proposed project on prices of and competition for health care services in Massachusetts and (ii) the effects of the proposed project on the utilization of

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[2] BWFH DoN, Appendix 2, Section 2.1, pp. 1-2 and BWFH DoN, Appendix 7, p. 1.

[3] BWFH DoN, Appendix 2, Section 2.1, pp. 1-3.

[4] BWFH DoN, Appendix 1, Q12, p.3.

[5] Massachusetts Department of Public Health. "Determination of Need (DoN)," *available at* https://www.mass.gov/determination-of-need-don.

health care services in Massachusetts and the capacity of health care providers in Massachusetts to render those services.

11.   Regarding the first element, the DoN program asked that CRA address specific questions in the ICA. Among other things, the ICA answers the following questions:

- How will each Project change utilization at higher versus lower priced providers, and what will be the subsequent impact on health care prices/spending for commercial and public payors?

- How will each Project change price levels for the Applicant's relevant services, and what will be the subsequent impact on health care prices/spending for commercial and public payors?

- How will each Project impact the Applicant's relevant market share for services and its negotiating leverage, and what will be the subsequent impact on health care prices/spending for commercial and public payors?

In addition to setting forth these general issues and questions, the DoN program set forth specific areas of inquiry related to prices and competition for the proposed project that inform the more general questions described above.

12.   Regarding the second element, the DoN program also asked that CRA address specific questions in the ICA. Among other things, the ICA should:

- Evaluate the Applicant's calculation of need for the proposed project. The ICA should document current service availability in the project region, the current population and demographics of the region, and expected changes in the population and demographics of the region. The ICA should also analyze current and potential utilization of the services and shifts from existing providers and subsequent cost impacts, including assessing MGB's and competitors' patient profiles (*e.g.*, demographics, insurance coverage, and acuity levels).

- Evaluate potential shifts in utilization of services by patients, including assessing changes from lower-cost to higher-cost services or health care providers.

- Evaluate access to the project services by MassHealth Accountable Care Organization participants and individuals in subsidized insurance products through the Health Connector Authority (*i.e.*, ConnectorCare health plans).[6]

- Evaluate the potential for the project to lead to "supply-induced demand" for health care service.

In addition to setting forth these general issues and questions, the DoN program set forth specific areas of inquiry related to capacity and utilization for the project that inform the more general questions described above.

13.   The DoN program also asked that the ICA address two overarching questions in addition to the price and competition questions and the capacity and utilization questions. The first such question asks: If costs increase under the project, who bears the consequences of that increase in costs: third-party payors, patients, or health plan sponsors (*e.g.*, employers)? The second such question parallels the first: If savings are realized under the project, who benefits from those savings? Before turning to the ICA questions, in the next subsection we briefly summarize the key elements of the proposed project. A more detailed description of the proposed project is contained in the DoN application itself.

C. Brigham and Women's Faulkner Hospital Project

14.   In its DoN application for BWFH, MGB proposes construction of a five-story addition to BWFH's existing hospital facility.[7] The proposed project would add 78 medical/surgical beds to the 133 currently licensed medical/surgical beds at BWFH.[8] While approval of the DoN

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[6] We note that the data we rely on throughout the ICA distinguish between commercial and Medicare health plans, but do not distinguish between individuals enrolled in health plans offered through the Health Connector Authority and employer-sponsored group health plans. Rather, the data typically identify the insurer or claims administrator, but not the specific type of plan in which the patient was enrolled (*e.g.*, we cannot distinguish between Tufts commercial group health plans and Connector plans—the data simply identify the patient as being covered by a Tufts plan). As such, throughout our analyses we only distinguish between patients enrolled in Original Medicare, Medicare health plans, MassHealth non-managed care, MassHealth managed care, and commercial health plans (including both ConnectorCare and employer-sponsored group health plans).

[7] BWFH DoN, Appendix 2, Section 2.1, p. 1.

[8] BWFH DoN, Appendix 2, Section 2.1, p.1 and BWFH DoN, Appendix 7.

application would increase the number of medical/surgical beds at BWFH, the application does not propose to change the number of beds in the hospital's coronary care unit (14 beds according the Cost Report filed with the Centers for Medicare and Medicaid Services by BWFH) nor the number of beds in the hospital's psychiatric unit (24 beds according to the same source).[9] In total, if the project were approved as submitted, the number of medical/surgical beds available for patient care at BWFH would increase by 78 beds from 133 to 211 beds;[10] the total number of beds at the hospital would increase from 171 (133 medical/surgical beds, 14 coronary intensive care beds, and 24 psychiatric beds) to 249 beds.[11]

15.   The Applicant also proposes to establish an eight-bed observation unit at BWFH.[12] The hospital currently does not have a dedicated observation unit, so this represents a new increase of eight observation beds at the hospital.[13] As described by the Applicant, the observation unit would be used to care for patients recovering after surgical procedures or interventional nephrology or radiology procedures, thereby reducing the number of patients who recover in medical/surgical beds in the hospital's inpatient units or in the hospital's post-anesthesia care unit.[14]

16.   The Applicant proposes to relocate its existing five endoscopy procedure rooms and add an advanced endoscopy procedure room (which it currently lacks) that would be used for procedures currently performed at other facilities or in BWFH's operating rooms.[15] This corresponds to a net increase in the number of endoscopy procedure rooms at BWFH from five to six.[16]

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[9] Cost Report filed with the Centers for Medicare and Medicaid Services by BWFH for the fiscal period ending September 30, 2020 accessed through the American Hospital Directory.

[10] BWFH DoN, Appendix 2, Section 2.1, p.1 and BWFH DoN, Appendix 7.

[11] Cost Report filed with the Centers for Medicare and Medicaid Services by BWFH for the fiscal period ending September 30, 2020 accessed through the American Hospital Directory.

[12] BWFH DoN, Appendix 2, Section 2.1, p. 1.

[13] BWFH DoN, Appendix 2, Section 2.1, p. 14.

[14] BWFH DoN, Appendix 2, Section 2.1, pp. 2 and 14-15.

[15] BWFH DoN, Appendix 2, Section 2.1, pp. 16-17.

[16] BWFH DoN, Appendix 2, Section 2.1, p. 16.

17.   Lastly, the Applicant proposes to add one 3-Tesla MRI unit to supplement the one 1.5-Tesla MRI unit currently located at BWFH.[17] This corresponds to a net increase in the number of MRI units from one to two.

18.   While we do not discuss them in detail in this ICA, the DoN application for BWFH also includes several smaller renovation projects, including renovation of the hospital's radiology department and construction of "shell space" that could be used to accommodate future need for expanded clinical services.[18]

III.   Data Sources, Service Line Definitions, and Prices for Health Care Services

19.   In this section we discuss the data sources, service line definitions, and information on prices for health care services that we use throughout this report to respond to the ICA questions posed by the DoN program.

A. Data Sources Used for Analyses

1. CHIA Hospital Inpatient Discharge Database

20.   The Hospital Inpatient Discharge Database maintained by the Center for Health Information and Analysis ("CHIA") contains all inpatient discharges from Massachusetts acute care hospitals.[19] Acute care hospitals provide inpatient and outpatient medical care and related services for surgery, acute medical conditions, or injuries. Unlike other types of hospitals, such as chronic care hospitals, rehabilitation hospitals, and specialty care hospitals, acute care hospitals generally provide services for shorter episodes of care.

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[17] BWFH DoN, Appendix 2, Section 2.1, pp. 3 and 19-21.

[18] BWFH DoN, Appendix 2, Section 2.1, pp. 1 and 3.

[19] CHIA, "Massachusetts Case Mix: Hospital Inpatient Discharge Data (HIDD) Documentation Manual, Fiscal Year 2019," *available at* https://www.chiamass.gov/assets/docs/r/hdd/FY19-Case-Mix-Hospital-Inpatient-Discharge-Documentation-Guide.pdf, p. 3.

21.   Each record in the Hospital Inpatient Discharge Database corresponds to a single inpatient hospital stay.[20] The database includes a variety of information about each hospital stay, including:[21]

- The name of the hospital.

- The source of each admission (*e.g.,* whether the patient was admitted after originally receiving care in the emergency department or was transferred from another facility).

- Diagnostic information, including primary and secondary diagnosis codes.

- The diagnosis related group ("DRG") for each stay. DRGs group together similar inpatient hospital stays based on diagnoses, procedures, and patient characteristics. Private and government payors commonly utilize DRGs in payment schedules for inpatient hospital stays.

- The major diagnostic category ("MDC") for each stay. MDCs group diagnosis codes into 25 broad categories based on condition type and body region.

- The length of the patient's hospital stay.

- Whether the hospital stay was covered by private insurance, Medicare, MassHealth, or other types of payors.[22]

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[20] CHIA, "Massachusetts Case Mix: Hospital Inpatient Discharge Data (HIDD) Documentation Manual, Fiscal Year 2019," *available at* https://www.chiamass.gov/assets/docs/r/hdd/FY19-Case-Mix-Hospital-Inpatient-Discharge-Documentation-Guide.pdf, p. 6.

[21] CHIA, "Massachusetts Case Mix: Hospital Inpatient Discharge Data (HIDD) Documentation Manual, Fiscal Year 2019," *available at* https://www.chiamass.gov/assets/docs/r/hdd/FY19-Case-Mix-Hospital-Inpatient-Discharge-Documentation-Guide.pdf, pp. 9-12.

[22] In the Hospital Inpatient Discharge Database, we assign discharges to payor types based on the primary payor. According to CHIA's submission guide, MassHealth should be recorded as the secondary payor if the inpatient is also covered by another insurer. (CHIA, "Hospital Inpatient Discharge Data: File Submission Guide, October 2016," *available at* https://www.chiamass.gov/assets/docs/p/case-mix/FY17-Inpatient-Submission-Guide.pdf, p.18.) This is because Medicaid generally pays for covered services after commercial, Medicare, and MediGap plans have paid. (Centers for Medicare and Medicaid Services, "Medicaid," *available at* https://www.medicare.gov/your-medicare-costs/get-help-paying-costs/medicaid.)

- Patient demographic information, such as the patient's age, gender, ethnicity, race, and ZIP Code of residence.

22.   In our analyses, we focus on discharges from general acute care ("GAC") hospitals.[23] We exclude discharges from temporary facilities or facilities that have closed or transitioned away from providing acute care services. In particular, we exclude stays at the following hospitals from our analysis:

- North Shore Medical Center–Union Campus, which transitioned to an urgent care center in Fall 2019 and closed in 2020.[24]

- UMass Memorial Field Hospital and Boston Hope Field Hospital, both of which were temporary facilities to treat COVID-19 patients. UMass Memorial Field Hospital closed in March 2021 and Boston Hope Field Hospital closed in June 2020.[25]

- MetroWest Medical Center–Leonard Morse Campus, which has transitioned to a behavioral health care center.[26]

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[23] We exclude discharges from the following non-GAC hospitals: MelroseWakefield Healthcare's Lawrence Memorial Hospital Campus (psychiatric hospital), MiraVista Behavioral Health Center, and Steward Good Samaritan Medical Center's NORCAP Lodge (substance abuse disorder treatment facility). We also exclude discharges from the following children's hospitals: Boston Children's Hospital and Shriner's Hospitals for Children in Springfield and Boston.

[24] Steve Krause, "Union Hospital Selects New Developer," *Itemlive.com* (June 9, 2020), *available at* https://www.itemlive.com/2020/06/09/union-hospital-selects-new-developer/.

[25] Monica Madeja, "Field Hospital at Worcester's DCU Center Closes Monday," *NBC Boston* (March 15, 2021), *available at* https://www.nbcboston.com/news/local/field-hospital-at-worcesters-dcu-center-closes-monday/2328677/; Juli McDonald, "Boston Hope Field Hospital Releases Final 2 Coronavirus Patients," *CBS Boston*, (June 3, 2020), *available at* https://boston.cbslocal.com/2020/06/03/boston-hope-field-hospital-closes-final-patients-oger-julien-joseph-murphy/.

[26] MetroWest Medical Center, "Leonard Morse Hospital," *available at* https://www.mwmc.com/locations/detail/leonard-morse-hospital?pagestyle=card; Henry Swan, "New role for Leonard Morse Hospital," *MetroWest Daily News* (October 22, 2020), *available at* https://www.metrowestdailynews.com/story/lifestyle/health-fitness/2020/10/22/starting-sunday-leonard-morse-hospital-in-natick-becomes-behavioral-health-center/114464988/.

23.   Our analyses do not include newborn, obstetric, or pediatric hospital stays.[27] Hospital stays associated with behavioral health, substance use disorder, or rehabilitation major diagnostic categories are also excluded, as are discharges with missing, invalid, or ungroupable DRGs, and discharges with missing patient age or gender, or payor information. We further restrict our analyses to patients who reside in Massachusetts and remove transfers from intermediate care facilities, other hospitals' emergency rooms, another unit within the same hospital, court or law enforcement facilities, hospice facilities, and other institutions' ambulatory surgery centers.

24.   Our analyses utilize the 2019 Hospital Inpatient Discharge Database in conjunction with CHIA's Relative Price Database[28] to study the relationship between inpatient utilization and differences in case mix adjusted prices across facilities. We also rely on the 2015 through 2019 Hospital Inpatient Discharge Databases to examine trends in inpatient utilization at BWFH.

2. CHIA Outpatient Observation Database

25.   Prior to an inpatient admission, a patient may undergo an observation period where the need for additional care, including the need for inpatient services, is assessed. Hospital stays where an acute care hospital provides these observation services but do not result in an inpatient admission are reflected in the CHIA Outpatient Observation Database.[29]

26.   Similar to the inpatient data, the outpatient observation database includes patient demographic information, such as the patient's age, gender, and home ZIP Code.[30] The database

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[27] Obstetric discharges are identified based on the presence of MDC 14 and newborn discharges are identified based on the admission type field or the presence of MDC 15. Pediatric stays are identified based on the patient being younger than eighteen.

[28] CHIA, Relative Price and Provider Price Variation, October-RP-Databook-12.28.2020-Update.xlsx, reflecting relative price data for 2018 was downloaded from https://www.chiamass.gov/relative-price-and-provider-price-variation/. It appears however that file is no longer available for download and was replaced with a file containing 2019 relative prices.

[29] Outpatient observation stays that resulted in an inpatient admission would be reflected in the Hospital Inpatient Discharge Database, but not in the Outpatient Observation Database. (*See* CHIA, "Massachusetts Case Mix: Outpatient Observation Data (OOD) Documentation Manual, Fiscal Year 2019," *available at* https://www.chiamass.gov/assets/docs/r/hdd/FY19-Case-Mix-OOD-Documentation-Guide.pdf, pp. 3-4).

[30] CHIA, "Massachusetts Case Mix: Outpatient Observation Data (OOD) Documentation Manual, Fiscal Year 2019." *available at* https://www.chiamass.gov/assets/docs/r/hdd/FY19-Case-Mix-OOD-Documentation-Guide.pdf, pp. 9-11).

also records the primary payor type for each observation stay, patient diagnosis information, and procedure codes that correspond to each of the services the hospital provided.[31] Unlike inpatient stays, DRGs are not assigned to observation stays, nor are they utilized in calculating reimbursements for these stays.

27.　　Although distinct from inpatient discharges, observation stays may utilize beds located in hospital inpatient departments. Therefore, we incorporate observation stays into our analysis of historical utilization rates at BWFH.

3. CHIA All-Payer Claims Database

28.　　The Massachusetts All-Payer Claims Database ("APCD") includes medical claims submitted by a variety of public and private payors, including Medicare, MassHealth, and commercial health plans.[32, 33] All fully insured commercial health plans with membership in Massachusetts are required to submit claims data for inclusion in the APCD.[34] Self-insured commercial plans that are preempted by the Employee Retirement Income Security Act of 1974 are no longer required to submit their claims data for inclusion in the database but may choose to participate on a voluntary basis.[35] The majority of Massachusetts residents with public or private health coverage are enrolled in plans that submit claims data to the APCD.

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[31] CHIA, "Massachusetts Case Mix: Outpatient Observation Data (OOD) Documentation Manual, Fiscal Year 2019." *available at* https://www.chiamass.gov/assets/docs/r/hdd/FY19-Case-Mix-OOD-Documentation-Guide.pdf, pp. 9-11).

[32] CHIA, "The Massachusetts All-Payer Claims Database: Medical Claim File Submission Guide, February 2019," *available at* https://www.chiamass.gov/assets/docs/p/apcd/2019-apcd-submission-guides/2019-apcd-medical-claim-file-submission-guide-FINAL-Revision-1.0.pdf, p. 3.

[33] In addition to medical claims, the APCD also includes information on pharmacy and dental claims. However, we limit our analysis to the claims included in the APCD's medical claims files.

[34] CHIA, "The Massachusetts All-Payer Claims Database: Medical Claim File Submission Guide, February 2019," *available at* https://www.chiamass.gov/assets/docs/p/apcd/2019-apcd-submission-guides/2019-apcd-medical-claim-file-submission-guide-FINAL-Revision-1.0.pdf, p. 9.

[35] Prior to 2016, self-insured plans were required to submit claims data for inclusion in the APCD. The APCD does not include claims submitted to workers' compensation plans, claims submitted through TRICARE or the Veterans Health Administration, or claims submitted to the Federal Employees Health Benefits Plan. (CHIA, "Overview of the Massachusetts All-Payer Claims Database, September 2016," *available at* https://www.chiamass.gov/assets/docs/p/apcd/APCD-White-Paper-2016.pdf, p. 2).

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29.   The APCD includes claim line-level data for each adjudicated claim from a contributing health plan. These data include the following:[36]

- For claims associated with facility charges, the type of facility, such as hospital outpatient department, hospital inpatient department, or critical access hospital.[37]

- For claims for services provided by a professional, the place of service, such as an office or clinic, on-campus or off-campus hospital outpatient department, inpatient hospital department, or hospital emergency room.

- The procedures performed (*e.g.*, Current Procedural Terminology ("CPT") and Healthcare Common Procedure Coding System ("HCPCS") procedure codes).

- Diagnostic information, including primary and secondary diagnosis codes.

- The identity of the reporting payor and the type of plan (*e.g.*, commercial, MassHealth managed care, MassHealth non-managed care, Medicare health plans).

- The amount charged by the provider as well as the amount allowed by the plan.[38]

- The payment arrangement type (*e.g.*, fee-for-service, capitation, bundled payment).

- Patient demographic information, including birth year, gender, and ZIP Code of residence.

- The ZIP Code of the service provider.

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[36] A list of the fields contained in the APCD medical claims is available on CHIA's website: CHIA, "The Massachusetts All-Payer Claims Database: Medical Claim File Submission Guide, February 2019," *available at* https://www.chiamass.gov/assets/docs/p/apcd/2019-apcd-submission-guides/2019-apcd-medical-claim-file-submission-guide-FINAL-Revision-1.0.pdf.

[37] The *Type of Bill* field for each claim indicates the type of facility that provided care.

[38] The allowed amount represents the maximum amount the health plan (or plan sponsor) is expected to pay for the service. For claims associated with contracted providers in a health plan's network who have agreed to negotiated rates, the allowed amount corresponds to the applicable negotiated fee. For providers where the health plan does not have an advanced negotiated rate, the allowed amount generally represents the rate that the health plan or plan sponsor determines as the usual, customary, and reasonable fee for the service. The amount that a health plan or plan sponsor pays the provider may be less than the allowed amount due to patient cost-share obligations (*e.g.*, deductible, coinsurance, and copayment).

- The National Provider Identifier ("NPI")[39] associated with the servicing, rendering, and billing provider.

- Provider identification numbers that can be linked to the APCD's provider file to determine the location of the facility where the service was provided and the identity of the rendering provider.

30.   The provider file that accompanies the APCD claims data contains various demographic information for each provider (*e.g.*, clinician, hospital, off-campus hospital outpatient department ("HOPD"), clinic, physician group), including:[40]

- The name of the provider.

- The address of the provider.

- The provider's NPI.

- The provider's association with another entity or to a specific facility, and the start and end dates of that affiliation.

- The entity type of the provider (*e.g.,* person, facility, financial parent).

31.   A single claim may be adjudicated by a payor multiple times. For example, a claim that was originally denied may be reprocessed by a payor following the receipt of additional information from a plan member or provider. Similarly, the allowed amount for a claim may be adjusted by a payor following the claim's initial adjudication. Because re-adjudication of a claim can create additional records in the APCD, the data must be limited to final adjudicated claim lines prior to analysis.

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[39] *See* Section III.A.9 for additional discussion about NPIs.

[40] A list of the fields contained in the provider file is available on CHIA's website: CHIA, "The Massachusetts All-Payer Claims Database: Provider File Submission Guide, February 2019," *available at* https://www.chiamass.gov/assets/docs/p/apcd/2019-apcd-submission-guides/2019-apcd-provider-file-submission-guide-FINAL.pdf.

32.   For each of the largest carriers (*i.e.*, payors) in the APCD, CHIA has developed carrier-specific logic that the agency uses to flag the most recent version of each claim.[41] When available, we rely on this flag to identify final adjudicated claim lines. For payors where the CHIA versioning flag is not available, we implement steps similar to those described in CHIA documentation to identify the most recent version of each claim.[42] These steps include (1) identifying duplicate entries and void records, (2) removing records with certain claim statuses, and (3) narrowing the remaining records based on the *Type of Claim* field. We also remove any claims where the total charge or the allowed amount is negative.[43]

33.   After determining the final adjudicated claim lines, we next identify the ZIP Code where the service was provided and the owner of the facility.

- To identify the ZIP Code where the service was provided, we first rely on the *Service Provider ZIP Code* field in the claims data. For some claims, this ZIP Code differs from the ZIP Code associated with the provider location identification number in the APCD provider file. When the ZIP Code in the provider file is unique or if it aligns with the primary business practice ZIP Code associated with the NPI in the claims data, we use the ZIP Code in the provider file (to the extent it differs from the *Service Provider ZIP Code* field in the claims data) to determine the location where the service was provided.

- To determine the ownership for the facility, we first identify the organization name associated with the facility where the service was provided using the service, rendering,

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[41] CHIA applies payor-specific logic to determine the final "highest" version of each claim line among the largest contributors to the APCD. (*See* CHIA, "Overview of the Massachusetts All-Payer Claims Database, September 2016," *available at* https://www.chiamass.gov/assets/docs/p/apcd/APCD-White-Paper-2016.pdf, p. 5; and CHIA, "Massachusetts All-Payer Claims Database: Release 8.0; 2014-2018 Documentation Guide," *available at* https://www.chiamass.gov/assets/docs/p/apcd/apcd-8.0/APCD-Release-8-Documentation-Guide.pdf, pp. 21-22.)

[42]   CHIA,   "Medical   Claims   Versioning   Brief,"   *available   at* https://www.bidnet.com/bneattachments?/489972194.docx.

[43] Specially, we exclude claims where either the allowed amount field or the sum of values in the plan payments and patient cost-share fields, aggregated to the claim-level, is negative.

and billing provider NPIs recorded in the claims data.[44] We then assign each facility its parent or owner based on online research.[45]

34.   Finally, we limit the APCD claims data to patient care episodes with start dates in 2018 where care was provided to a MassHealth beneficiary or to a member of a commercial or Medicare health plan.[46] We also exclude claims from out-of-state providers and limit to patients residing in one of the following Massachusetts counties: Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, and Worcester.

35.   When analyzing relative prices, we also remove any claims from the APCD where the total charge or allowed amount aggregated across claim lines is zero or missing.[47] Additionally, we exclude any claims where the claim-level allowed amount was (1) greater than claim-level charges or (2) less than ten percent of claim-level charges. Finally, we exclude claims with a non-zero coordination of benefits amount (*i.e.*, when a secondary payor is involved), and claims associated with capitated, global or bundled payments, as well as other payment arrangements.[48]

4. Medicare Claims Data

36.   While the APCD includes information on claims submitted by Medicare health plans, it does not include data on care provided to beneficiaries enrolled in Original Medicare. Unlike

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[44] We use these three NPI fields in an iterative approach. If the service provider NPI is an organizational NPI, we use the provider name and business practice address as recorded in the National Plan and Provider Enumeration System database for that NPI. If the service provider NPI is not an organizational NPI, we then rely on the provider name and address associated with the rendering provider NPI (to the extent that it is an organizational NPI), followed by the billing provider NPI. (The National Plan and Provider Enumeration System database is discussed in Section III.A.9.)

[45] We are unable to assign facility ownership for some claims. These include claims where the service, rendering, and billing provider NPIs are not organizational NPIs or if those NPIs did not appear in the National Plan and Provider Enumeration System database (*i.e.*, they are invalid NPIs).

[46] We rely on the APCD for information on care provided to members of Medicare health plans (*i.e.*, Medicare Advantage (Part C) and supplemental Medicare plans). For care provided to beneficiaries enrolled in Original Medicare, we rely on the Medicare Claims data described in the following section.

[47] We exclude claims where either the allowed amount field or the sum of values in the plan payments and patient cost-share fields, aggregated to the claim-level, is zero.

[48] We also exclude claims associated with payment amount per episode, enhanced ambulatory patient grouping, other, or missing payment arrangement information.

Medicare health plans, where a beneficiary receives Medicare benefits through a health benefits company who in turn reimburses providers, Original Medicare reimburses providers directly.

37.   We rely on two Medicare Claim files in our analysis:[49]

- The Medicare Outpatient File includes facility claims submitted by institutional outpatient providers, including hospital outpatient departments, outpatient rehabilitation facilities, and renal dialysis facilities.[50]

- The Medicare Carrier File includes claims submitted by professional providers and certain facility claims.[51] Professional claims include claims submitted by physicians, physician assistants, clinical social workers, and nurse practitioners. Among the facility claims included in the Carrier File are claims submitted by independent clinical laboratories, ambulance providers, freestanding ambulatory surgery centers, and freestanding radiology centers.[52]

38.   Similar to the APCD, the Medicare Claims data reflect detailed claim line-level data with various information, including:[53]

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[49] In addition to the Outpatient and Carrier Files, the Medicare Claims data also includes a separate Inpatient File that contains facility claims submitted by inpatient hospital providers. However, we use the Hospital Inpatient Discharge Database when analyzing utilization of inpatient services for Original Medicare beneficiaries.

   Although we do not discuss it in detail here, we use the Medicare Inpatient File to calculate the total allowed amounts for inpatient services provided to Original Medicare beneficiaries. We use these allowed amounts to weight the estimated cost impacts across service lines in Section XI.

[50] Research Data Assistance Center, "Outpatient (Fee-for-Service)," *available at* https://resdac.org/cms-data/files/op-ffs.

[51] Research Data Assistance Center, "Carrier (Fee-for-Service)," *available at* https://resdac.org/cms-data/files/carrier-ffs.

[52] Facility claims in the Carrier File include claims submitted on Centers for Medicare and Medicaid Services claim form 1500 (or its electronic equivalent), which is also used for the submission of professional claims. Hospitals and other facilities whose claims are included in the Medicare Outpatient Claim File submit claims to Medicare using Centers for Medicare and Medicaid Services claim form 1450 (sometimes referred to form UB-04).

[53] Lists of the fields contained in the Medicare Carrier and Outpatient files are available on the Research Data Assistance Center's website: Research Data Assistance Center, "Outpatient (Fee-for-Service)," *available at* https://resdac.org/cms-data/files/op-ffs. Research Data Assistance Center, "Carrier (Fee-for-Service)," *available at* https://resdac.org/cms-data/files/carrier-ffs.

- For professional claims, the place of service (such as an office or clinic, on-campus or off-campus hospital outpatient department, or hospital emergency room), service location, and NPIs for the performing physician, the billing provider, and the site of service.

- For outpatient facility claims, the facility's Centers for Medicare and Medicaid Services ("CMS") certification number and ZIP Code, as well as the organization/group practice and attending physician NPIs.

- The procedure performed (*e.g.*, CPT or HCPCS code) and the date of service.

- The provider's billed charge for each claim, the amount reimbursed by Medicare, and any cost-share amounts owed by the beneficiary.

- Diagnostic information, including primary and secondary diagnosis codes.

- Patient demographics, including the patient's gender, date of birth, race, and ZIP Code of residence.

39.   We rely on 2018 Medicare Outpatient and Carrier Files, in conjunction with the APCD, to analyze outpatient utilization. Following an approach similar to the APCD, we first identify the relevant set of outpatient claims based on the facility type for institutional outpatient claims and the place of service for professional claims.

40.   For each claim, we then identify the ZIP Code where the service was provided and the owner of the facility.

- To identify the ZIP Code where the service was provided, we use the *Claim Service Facility ZIP Code* field in the Medicare Outpatient File and the *Line Place of Service ZIP Code* in the Medicare Carrier File.

- To determine the ownership for the facility, we first identify the name of the facility where the service was provided. We use the CMS certification number in the Medicare

Outpatient File[54] and the site of service, rendering physician, and billing provider NPIs in the Medicare Carrier File[55] to determine the identity of the providing facility. We then assign each facility its parent or owner based on online research.[56]

41.   Finally, we limit to claims for patients residing in Massachusetts and who received care in the following Massachusetts counties: Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, and Worcester.

5. CHIA Inpatient Relative Price Data

42.   CHIA publishes an annual analysis of relative prices intended to evaluate variation in reimbursement across providers after controlling for patient acuity, service mix, and health plan product differences.[57] To perform this analysis, CHIA collects information regarding payments to in-network providers from commercial health plans and Medicare health plans in the state as well as MassHealth managed care programs.[58]

43.   To calculate relative inpatient prices paid to hospitals, CHIA collects data from payors on the number of inpatient discharges, total claims payments, total non-claims payments (such as bonuses for financial performance or for meeting quality scores), and case mix index separately by hospital, insurance category (*e.g.*, commercial, Medicare health plan, or MassHealth managed

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[54] We rely on the CMS Provider of Services File to identify the provider name associated with each CMS certification number. (CMS, December 2018 POS OTHER CSV File and Layouts, *available at* https://downloads.cms.gov/files/pos_other_csv_dec18.zip.)

[55] We use these three NPI fields in an iterative approach. If the site of service NPI is an organizational NPI, we use the provider name and primary business practice address as recorded in the National Plan and Provider Enumeration System database for that NPI. If the site of service NPI is not an organizational NPI, we then rely on the provider name and address associated with the rendering physician NPI (to the extent that it is an organizational NPI), followed by the billing provider NPI.

[56] We are unable to assign facility ownership for some claims. These include claims where the site of service, rendering physician, and billing provider NPIs are not populated, are not organizational NPIs, or did not appear in the NPPES database.

[57] CHIA, Relative Price and Provider Price Variation website, *available at* https://www.chiamass.gov/relative-price-and-provider-price-variation/.

[58] A list of payors required to submit Relative Price data to CHIA is *available at* https://www.chiamass.gov/list-of-payers-required-to-report-data.

care), and product type (*e.g.,* Preferred Provider Organization or Health Maintenance Organization/Point of Service).[59]

44.   Separately by payor, insurance category, and product type, CHIA calculates an "adjusted base rate" for each hospital as the sum of total payments to the hospital (both claims payment and non-claims payments) divided by the product of the number of discharges and the case mix index.[60] The average of these adjusted base rates is then calculated across all hospitals within the same payor/insurance category/product type combination, with the relative price for each hospital within each combination calculated as the adjusted base rate divided by this average.[61]

45.   The relative price measures published by CHIA can therefore be thought of as measuring relative differences in reimbursement across hospitals within the same health plan network.[62] For example, the CHIA Relative Price report for 2018 shows that among inpatient hospital claims submitted by members of its commercial health plans, Blue Cross Blue Shield of Massachusetts' ("BCBS-MA") BWFH relative price was 1.08. In other words, BWFH received reimbursements that on average were eight percent higher than BCBS-MA's average case mix adjusted reimbursement for inpatient hospital care provided to commercial health plan members. The relative price for Brigham and Women's Hospital was higher: 1.36 for the same "network." Using these two relative prices, BCBS-MA's payments to BWFH on average were 21 percent less than its payments to Brigham and Women's Hospital for inpatient care provided to members of its commercial health plans (*i.e.,* 1.08 is 21 percent less than 1.36).

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[59] CHIA, "Relative Price and Provider Price Variation in the Massachusetts Commercial Market, June 2021, Methodology Report," *available at* https://www.chiamass.gov/assets/docs/r/pubs/2021/Relative-Price-Methodology-2019.pdf, pp. 3-4.

[60] CHIA, "Relative Price and Provider Price Variation in the Massachusetts Commercial Market, June 2021, Methodology Report," *available at* https://www.chiamass.gov/assets/docs/r/pubs/2021/Relative-Price-Methodology-2019.pdf, p. 5.

[61] CHIA, "Relative Price and Provider Price Variation in the Massachusetts Commercial Market, June 2021, Methodology Report," *available at* https://www.chiamass.gov/assets/docs/r/pubs/2021/Relative-Price-Methodology-2019.pdf, p. 5.

[62] CHIA's relative price methodology defines a "network" as a unique combination of (a) insurance payor, (b) provider type, (c) insurance category, and (d) product type. (CHIA, "Relative Price and Provider Price Variation in the Massachusetts Commercial Market, June 2021 Methodology Report," *available at* https://www.chiamass.gov/assets/docs/r/pubs/2021/Relative-Price-Methodology-2019.pdf, p. 3.

46.   CHIA's relative price information does not contain the actual amounts that payors reimburse hospitals for providing inpatient care. However, the relative prices calculated by CHIA are sufficient to measure the percentage impact that shifts in health care utilization would have on a particular payor's inpatient spending. For example, suppose that 100 members of BCBS-MA's commercial health plans are admitted to Brigham and Women's Hospital each year. Assume that following BWFH's planned expansion, ten of these 100 patients are instead admitted to BWFH. Since BCBS-MA reimburses BWFH 21 percent less than it does Brigham and Women's Hospital, this substitution from Brigham and Women's Hospital to BWFH would reduce BCBS-MA's expected spending on the 100 enrollees in question by approximately 2.1 percent.[63] While this calculation is hypothetical, we implemented similar calculations discussed later in this ICA to quantify the effect of the proposed projects on inpatient spending.

47.   To utilize the CHIA relative price data, we combined relative price information for 2018 with records from the Hospital Inpatient Discharge Database by payor, insurance type, and hospital.[64, 65] We identified a corresponding relative price entry for approximately 58 percent of the commercial discharges contained in the Hospital Inpatient Discharge Database (after implementing the aforementioned exclusions to the data).[66]

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[63] Suppose that prior to the hypothetical shift, BCBS-MA paid Brigham and Women's Hospital $136 on average for each of the 100 members admitted to Brigham and Women's Hospital, for a total of $13,600. After ten of these members switch to BWFH, BCBS-MA's spending on the 100 members decreases to $13,320, calculated as $136 for each of the 90 members who are admitted Brigham and Women's hospital plus $108 for each of the ten members who are admitted to BWFH. $13,320 in total spending is a 2.1 percent reduction from $13,600.

[64] The CHIA relative price information includes the following insurance types: commercial plans, Medicare health plans, MassHealth managed care plans, Dual Eligibles 18-64 plans, and Dual Eligibles 65+ plans. The Hospital Inpatient Discharge Database allows us to distinguish claims submitted by commercial plans, Medicare health plans, and MassHealth managed care plans. Therefore, we rely on data for commercial, Medicare health plans, and MassHealth managed care from CHIA's inpatient relative price data.

[65] Although the relative price data also summarizes prices by product (such as Preferred Provider Organization or Health Maintenance Organization), a similar field is not available in the Hospital Inpatient Discharge Data. Therefore, we rely on the relative prices from the "all product" product type.

[66] The majority of commercial discharges where we could not identify a corresponding value in the relative price data are associated with payors that do not submit relative price information to CHIA, such as the Kaiser Foundation and Liberty Mutual.

48.   We use these relative prices and the Hospital Inpatient Discharge Database when determining the net effect on health care expenditures from shifting inpatients (*i.e.*, inpatient discharge volume) between GAC hospitals, separately for patients with commercial, MassHealth managed care, and Medicare health plans.

6. Medicare Inpatient Prospective Payment System Tables

49.   To determine the relative rates paid to hospitals for providing inpatient care to beneficiaries enrolled in Original Medicare, we utilize files published by CMS as part of the Inpatient Prospective Payment System.[67] Tables 1A through 1E, which are published each year as part of the final rules for the Inpatient Prospective Payment System, contain the national payment rates used by CMS in calculating payments to hospitals. We also rely on the annual Impact File published by CMS for information on hospital-specific adjustments to the national payment rates.[68]

50.   Using these files, we calculate Medicare base reimbursement rates for inpatient hospital stays separately for each GAC hospital in Massachusetts. Because these base Medicare payment rates can vary across hospitals, shifts in inpatient utilization patterns among beneficiaries enrolled in Original Medicare may result in differences in health care expenditures for inpatient services.

7. Medicare Outpatient Prospective Payment System Tables

51.   Throughout our analysis, we analyze the rates paid to facilities for providing outpatient care relative to Medicare reimbursement rates, which are commonly used as benchmarks in health care economics. There are many advantages to benchmarking reimbursement rates relative to Medicare payment rates. First, Medicare reimbursement rates account for differences in complexity across services. Second, these rates account for differences in costs across different

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[67] CMS, Files for FY 2019 Final Rule and Correction Notice, *available at* https://www.cms.gov/medicaremedicare-fee-service-paymentacuteinpatientppsacute-inpatient-files-download/files-fy-2019-final-rule-and-correction-notice; CMS, FY 2019 Final Rule and Correction Notice Data Files, *available at* https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/FY2019-IPPS-Final-Rule-Home-Page-Items/FY2019-IPPS-Final-Rule-Data-Files.

[68] The base rates for individual hospitals vary due to local variation in labor or capital costs and costs associated with providing graduate medical education. Hospitals serving a disproportionately high share of low-income patients may also receive an upward adjustment in the amounts reimbursed by CMS.

types of outpatient facilities and across geographies. Third, these rates are updated annually to account for changes in costs and medical practice over time. The methodology used by CMS to calculate these rates is known as the Outpatient Prospective Payment System ("OPPS"). The OPPS methodology is described in further detail below.[69]

52.   First, to account for differences in complexity across services, OPPS assigns each procedure that is reimbursable by Medicare to an Ambulatory Payment Classification ("APC"). APCs are numeric codes utilized by CMS to group together outpatient services with similar costs and clinical characteristics. For each APC, CMS calculates a "relative weight" that measures the resources required for providing care for that APC relative to the resources necessary for an average outpatient episode of care. This relative weight is applied when calculating Medicare reimbursement amounts so that a procedure assigned to an APC with a relative weight of 2 will receive twice the reimbursement of a procedure assigned to an APC with a relative weight of 1. These relative weights are published quarterly by CMS in "Addendum B," which also includes a listing of which CPT procedure codes are assigned to each APC.[70]

53.   Second, to account for differences in costs across outpatient facilities, OPPS incorporates a wage index calculated by CMS separately for each Core-Based Statistical Area ("CBSA").[71] This reflects, for example, differences in labor costs between the Boston area and the Worcester area, which are each assigned to different CBSAs. Further adjusting for differences across outpatient facility providers, Medicare reimbursements to freestanding ambulatory surgery centers are approximately 40 percent less than reimbursements to hospital outpatient departments.[72]

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[69] Medicare Payment Advisory Commission, "Outpatient Hospital Services Payment System" (Revised: November 2021), *available at* https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_opd_final_sec.pdf.

[70] CMS, Addendum A and Addendum B Updates, *available at* https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalOutpatientPPS/Addendum-A-and-Addendum-B-Updates

[71] CBSAs are geographical areas (either metropolitan statistical areas or micropolitan statistical areas) with at least one urbanized area with a minimum population of 50,000 (metropolitan) or 10,000 (micropolitan) and adjacent territory with a "high degree of social and economic integration with the core as measured by commuting ties." (U.S. Census Bureau, "Core-Based Statistical Areas," *available at* https://www.census.gov/topics/housing/housing-patterns/about/core-based-statistical-areas.html.)

[72] The methodology used by CMS to calculate Medicare reimbursement rates to ambulatory surgery centers is similar to the OPPS methodology. Both methods utilize the same APC-level relative weights and adjust for differences in

54.   Third, CMS revises the APCs and relative weights used in the OPPS each year to reflect changes in medical practice and technology, new services, and changes in the cost of providing care.[73] While we focus on 2018 OPPS payment rates, the regular annual updates to OPPS to reflect changes in costs over time are an additional reason why these rates are widely used in health care economics as a benchmark when comparing payment rates. In our analysis, we utilize the prices paid by commercial plans, Medicare health plans, and MassHealth managed care plans relative to Original Medicare reimbursement rates when estimating the price-cost effects of potential shifts in outpatient facility utilization patterns.

8. Medicare Physician Fee Schedule

55.   Similar to our analysis of rates paid for outpatient facility services, we calculate health plan reimbursements to physicians relative to Original Medicare rates when analyzing rates paid to the Brigham and Women's Physician Organization and the BWFH community physicians for inpatient and outpatient services provided at BWFH. Original Medicare's reimbursement rates for physician services are reflected in the Medicare Physician Fee Schedule.

56.   Like the OPPS, the Medicare Physician Fee Schedule accounts for differences in costs across services and across geographies.[74] The Medicare Physician Fee Schedule is also updated annually to reflect changes in these costs over time. To reflect differences in costs across services, the Medicare Physician Fee Schedule includes three sets of relative value units that vary by CPT or HCPCS procedure code: (1) the "work" relative value unit accounts for relative levels of time, effort, and skill associated with providing the service; (2) the "practice expense" relative value unit accounts for expenses associated with maintaining a practice (*e.g.*, renting office space, buying supplies and equipment, hiring administrative staff); and (3) the "malpractice" relative value unit

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labor costs across CBSAs, although the wage adjustment is slightly smaller for ambulatory surgery centers. (MedPAC Payment Basics, "Ambulatory Surgical Center Services Payment System," (Revised: November 2021), *available at* https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_asc_final_sec.pdf.)

[73] MedPAC Payment Basics, "Outpatient Hospital Services Payment System," (Revised: November 2021), *available at* https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_opd_final_sec.pdf, p 4.

[74] MedPAC Payment Basics, "Physician and Other Health Professional Payment System," (Revised: November 2021), *available   at*   https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_physician_final_sec.pdf.

reflects premiums clinicians typically pay for malpractice insurance.[75] Each of these relative value units is multiplied by a corresponding geographic practice cost index to reflect the price of inputs in each local area. For many procedures, the practice expense relative value unit differs based on whether the care is provided in a facility setting (such as a HOPD) or outside of a health care facility (such as in a doctor's office). This adjustment reflects the higher overhead costs that office-based physicians may incur compared to physicians who provide care in a facility setting.

57.   We rely on 2018 Medicare Fee Schedule files that are published by CMS and reflect these relative value unit and geographic practice cost index calculations.[76] These files include Medicare payment amounts by CPT or HCPCS revenue code, Medicare locality, and by whether the service was performed in a facility or non-facility setting.[77]

9. National Plan and Provider Enumeration System

58.   Every health care provider in the United States must obtain an NPI in order to electronically submit claims to payors or participate in Medicare. This requirement includes individual physicians and practitioners, physician groups, and hospital departments. CMS's National Plan and Provider Enumeration System ("NPPES") assigns NPIs and maintains an updated database of providers that is available for download.[78, 79]

59.   Each record in the NPPES downloadable file reflects a unique NPI,[80] and contains, among other things, the following information about the health care provider:

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[75] CMS, "How to Use the MPFS Lookup-Up Tool," *available at* https://www.cms.gov/files/document/2020-physician-fee-schedule-guide.pdf, p. 5.

[76] CMS, "PFS Carrier Specific Files," *available at* https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeeSched/PFS-Carrier-Specific-Files.

[77] These files also include Medicare payment rates reflecting certain "modifier" codes. The modifier code contains additional information about the services provided, and certain modifiers affect the amount that Medicare reimburses.

[78] For additional details regarding NPIs, *see* CMS, "NPI: What You Need to Know," *available at* https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/NPI-What-You-Need-To-Know.pdf.

[79] The NPPES downloadable file is *available at* https://download.cms.gov/nppes/NPI_Files.html. The complete database of all NPIs is updated on a monthly basis with incremental NPI files published weekly.

[80] A provider is assigned one NPI, which never expires (and can remain active even if a provider retires or is no longer in clinical practice) and is never recycled or assigned to a different health care provider. Providers are able to update

- The name of the health care professional or organization.

- Entity type (*i.e.*, individual or organization).

- Primary specialty.

- Primary business address.

As discussed above, we rely on the NPPES database in determining the ownership of facilities and each facility's ZIP Code.

10. UMass Donahue Institute Population Projections

60. The UMass Donahue Institute ("UMDI") produces population projections for Massachusetts, with the most recently available estimates extending to the year 2040 in five-year increments.[81] The projections include breakdowns by age group and gender for each municipal civil division ("MCD"), *i.e.*, each city and town, in the state.

61. We rely on UMDI's modeling for demographic projections of patients residing in the service areas of MGB's DoN projects in 2025 and 2030.[82] These projections are also incorporated into our estimates of future demand for inpatient and outpatient services that are relevant to each of the MGB DoN projects.

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information associated with their NPI (*e.g.*, their name, credentials, address, taxonomy codes, etc.) but their NPI will remain the same. (CMS, "NPI Fact Sheet," *available at* https://www.cms.gov/Regulations-and-Guidance/Administrative-Simplification/NationalProvIdentStand/Downloads/NPIFactSheet012606.pdf.)

[81] UMass Donahue Institute, "Massachusetts Population Estimates Program," *available at* https://donahue.umass.edu/business-groups/economic-public-policy-research/massachusetts-population-estimates-program/population-projections.

[82] We define patient service areas based on patient ZIP Codes, which are smaller geographic units than MCDs. We allocate UMDI's MCD-level population estimates to ZIP Codes based on each ZIP Code's share of the total land area of an MCD. Land area measurements for each MCD-ZIP Code pair are obtained from the U.S. Department of Housing and Urban Development's County Subdivision to ZIP Code crosswalk file, *available at* https://www.huduser.gov/portal/datasets/usps_crosswalk.html. For ZIP Codes that span multiple MCDs, we aggregate the MCD/ZIP Code-specific demographic estimates across MCDs to the ZIP Code-level.

B. Service Lines Definitions Used for Analyses

1. Inpatient Services

62.   As described earlier, we focus on adult inpatient services and exclude discharges related to obstetrics, newborns, pediatrics (patients under age 18), non-GAC services (*i.e.*, behavioral health, substance use disorder, and rehabilitation/other factors influencing health status). We also exclude discharges either missing important information (*e.g.*, patient or payor information) or with DRGs indicating an invalid diagnosis or ungroupable condition. In addition, we exclude discharges associated with certain types of transfers.[83] Finally, we exclude patients who do not reside in Massachusetts.[84]

2. Outpatient Services

63.   We use the APCD and Medicare Claims data for our analysis of outpatient services. We rely on the type of bill fields[85] in the APCD and the Medicare Outpatient File to limit to facility charges associated with claims from hospital outpatient departments or ambulatory surgery centers, and the place of service fields[86] in the APCD and Medicare Carrier file for services rendered at an ambulatory surgery center ("ASC"). For diagnostic imaging services, we also include professional claims from the APCD or Medicare Carrier File with a place of service indicating office, clinic, or urgent care settings because radiology services are often provided at these locations. [87] As previously mentioned, we limit our analyses to patients who reside in

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[83] These include transfers from an outside hospital emergency room, another unit within the same hospital, court/law enforcement, hospice facility, or another institution's ambulatory surgery center.

[84] It appears that the inpatient service analyses in the BWFH DoN applications do not limit to patients living in Massachusetts. As such, their numbers are often higher than those in our analyses.

[85] The type of bill is reflected in the *Type of Bill - on Facility Claims* field in the APCD. The type of bill in the Medicare Outpatient File is determined by combining the *Claim Facility Type Code* field with the *Claim Service Classification Type Code* field.

[86] The place of service is reflected in the *Site of Service* and *Place of Service* fields in the APCD and Medicare Carrier File, respectively.

[87] The facility fees (*i.e.*, the technical component) associated with diagnostic imaging services provided at these locations are submitted on CMS claim form 1500 (or its electronic equivalent), which is also used for the submission of professional claims. Our analysis excludes the professional fees (*i.e.*, the radiologist's fee billed with modifier 26) associated with claims from these locations.

Massachusetts and received care in either Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, or Worcester Counties.

<p style="text-align: center;">*i.   Diagnostic Imaging Services*</p>

64.   To identify diagnostic imaging services in the APCD and Medicare Claims data, we first review CPT codes and associated descriptions to categorize relevant values into one of the following services: Computed Tomography or CT, MRI or MR Scan, Positron Emission Tomography/Computed Tomography or PET/CT, and Positron Emission Tomography/Magnetic Resonance or PET/MR. We then limit the processed APCD and Medicare Claims data to any claim line belonging to one of the above imaging services to create the data used in our analysis of diagnostic imaging services.

<p style="text-align: center;">*ii.   Advanced Endoscopy Services*</p>

65.   To identify advanced endoscopy services in the APCD, we first review CPT codes and associated descriptions to categorize relevant values into one of the following services: Endoscopic Ultrasound, Endoscopic Retrograde Cholangiopancreatography, and Unsuccessful Endoscopic Retrograde Cholangiopancreatography. We then retain any claim line with one of the relevant CPT codes for use in our analysis of advanced endoscopy services.

C. Prices for Health Care Services Used for Analyses

66.   Addressing the elements of the ICA requires estimating how the forecasted changes in where patients choose to receive health care services affects the total cost for those services. To do so, we construct the necessary relative price information for services provided at health care facilities in Massachusetts.

1. Relative Prices for Commercial, Medicare Health Plans, and MassHealth Managed Care Plans

<p style="text-align: center;">*i.   Inpatient Services*</p>

67.   To estimate the cost effect (*i.e.*, price differences) of changes where inpatient care is provided for commercial insurance, MassHealth managed care, and Medicare health plans we utilize the CHIA Inpatient Relative Price Data. As discussed above, the CHIA Inpatient Relative Price Data "facilitates comparison of average provider prices, accounting for differences in patient

acuity, the types of services providers deliver to patients, and the different insurance product types that payors offer to their members."[88]

ii. Outpatient Services

68.   To estimate the effect of changes where outpatient care is provided on prices paid by commercial insurance, MassHealth managed care, and Medicare health plans we utilize the APCD in conjunction with Addendum B of the OPPS. For diagnostic imaging services, we calculate a reimbursement rate (*i.e.*, the allowed amount) for each facility, payor, and insurance type combination relative to the amount Original Medicare would pay for the same service.[89] As discussed previously, expressing reimbursement rates relative those to paid by Original Medicare allows us to compare prices at facilities despite differences in service mix.[90] We determine the amount that Original Medicare would pay for each CPT code identified in Section III.B.2 using the values indicated in Addendum B to calculate the relative prices.

69.   As recorded in the APCD, MassHealth managed care plan reimbursement rates for some diagnostic imaging procedures are substantially higher than the corresponding reimbursement rates for Original Medicare (which we use for our relative prices). However, we understand that MassHealth managed care reimbursement levels are similar to MassHealth non-managed care

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[88] CHIA, "Relative Price and Provider Price Variation," *available at* https://www.chiamass.gov/relative-price-and-provider-price-variation/.

[89] To calculate the overall reimbursement rate for a given outpatient service, facility, payor, and insurance type combination, we restrict the set of reimbursements to those we could assign an Original Medicare payment. For example, suppose a facility received $10,000 in reimbursements for MR scans performed on enrollees in BCBS-MA commercial health plans, but we can only assign an Original Medicare reimbursement rate to claims underlying $9,000 of the $10,000 in reimbursements. The overall reimbursement rate then equals the ratio of these restricted reimbursements (*e.g.,* $9,000) to what Original Medicare would have paid the facility for the same set of claims. If Original Medicare would have reimbursed the facility $6,000 for the $9,000 in MR scan claims BCBS-MA reimbursed the facility, the overall MRI scans reimbursement rate for the facility, payor, and insurance type combination would be 1.50 (= $9,000 / $6,000).

[90] Addendum B indicates the rates that Original Medicare pays for services in HOPDs and not the rates paid for services provided at other types of facilities. However, expressing prices as a ratio to the HOPD rate allows us to capture differences in the relative prices across facilities. To remove potential outliers, we exclude claims with charges relative to Original Medicare payments that fall into the top and bottom five percent across outpatient diagnostic imaging claims.

rates,[91] and that MassHealth non-managed care rates are generally less than Original Medicare fee schedule rates. Given our concern about the reliability of the price information for outpatient diagnostic imaging services covered by MassHealth managed care plans, when we calculate the predicted cost impact of the DoN application on the overall cost of outpatient diagnostic imaging services, we assume that each health care provider would be paid the MassHealth non-managed care fee schedule amount for the outpatient diagnostic imaging service at issue.

2. Relative Prices for MassHealth Non-Managed Care

i. *Inpatient Services*

70.   For inpatient care provided at in-state hospitals, MassHealth non-managed care uses a standardized adjudicated payment amount per discharge. This amount is an all-inclusive payment that covers the entire acute inpatient stay for MassHealth non-managed care beneficiaries. The base payment amount reflects the statewide operating standard per discharge amount (adjusted by each hospital's wage area) and the statewide capital standard per discharge amount.[92] We utilize the base payments made to in-state hospitals to construct the relative prices for inpatient care for MassHealth non-managed care plan beneficiaries at each Massachusetts hospital.[93,94]

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[91] While we are not aware of any study that compares MassHealth managed care rates with MassHealth non-managed care rates, a related study documents that Medicare Advantage rates are similar to Original Medicare's fee schedule amounts. (Robert A. Berenson, Jonathan H. Sunshine, David Helms, and Emily Lawton. "Why Medicare Advantage Plans Pay Hospitals Traditional Medicare Prices." *Health Affairs* (2015).)

[92] MassHealth: Payment for In-State Acute Hospital Services and Out-of-State Acute Hospital Services, effective November 1, 2021. p. 7, *available at* https://www.mass.gov/doc/notice-of-final-agency-action-masshealth-payment-for-in-state-acute-hospital-services-and-out-of-state-acute-hospital-services-effective-november-1-2021-0.

[93] MassHealth: Payment for In-State Acute Hospital Services and Out-of-State Acute Hospital Services, effective November 1, 2021. Attachment B, *available at* https://www.mass.gov/doc/notice-of-final-agency-action-masshealth-payment-for-in-state-acute-hospital-services-and-out-of-state-acute-hospital-services-effective-november-1-2021-0.

[94] To calculate the specific payment for each in-state discharge, the base payment for the hospital is multiplied by the MassHealth DRG relative weight assigned to each discharge. This discharge specific weight scales up (or down) the base payment to account for differences in the cost of treatment associated with each All Patients Refined-DRG. To compare relative rates between hospitals this final scaling is not necessary.

ii. Outpatient Services

71.   For outpatient care provided at in-state hospitals, MassHealth non-managed care has a standardized adjudicated payment amount per episode of care (*i.e.*, per outpatient visit).[95] We utilize this standardized adjudicated payment amount per episode of care to construct relative prices at in-state hospitals for outpatient services. [96]

72.   For outpatient diagnostic imaging services provided in a non-hospital setting, MassHealth non-managed care has a single fee schedule where reimbursement for the same diagnostic imaging service is the same regardless of where the service was provided.[97] As such, we do not expect any changes to health care expenditures for MassHealth non-managed care related to changes in where diagnostic imaging services are rendered, when rendered outside of a hospital.

73.   We estimate cost savings associated with instances when a MassHealth non-managed care patient shifts from receiving outpatient diagnostic imaging services at an HOPD to an ASC.[98] To do so we compare the technical component indicated in the MassHealth radiology fee schedule to the rates for the same services paid to in-state hospitals described above.

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[95] MassHealth: Payment for In-State Acute Hospital Services and Out-of-State Acute Hospital Services, effective November 1, 2021. pp. 10-11, *available at* https://www.mass.gov/doc/notice-of-final-agency-action-masshealth-payment-for-in-state-acute-hospital-services-and-out-of-state-acute-hospital-services-effective-november-1-2021-0.

[96] MassHealth: Payment for In-State Acute Hospital Services and Out-of-State Acute Hospital Services, effective November 1, 2021. p. 57, *available at* https://www.mass.gov/doc/notice-of-final-agency-action-masshealth-payment-for-in-state-acute-hospital-services-and-out-of-state-acute-hospital-services-effective-november-1-2021-0.

To calculate the specific payment for each in-state outpatient episode of care, a wage adjusted outpatient standard amount is multiplied by the MassHealth Enhanced Ambulatory Patient Group ("EAPG") relative weight assigned to each claim line and the result is aggregated to the episode level. This EAPG specific weight scales up (or down) the wage adjusted outpatient standard amount to account for differences in the cost of treatment associated with each EAPG. To compare relative rates for outpatient services between hospitals this final scaling is not necessary. We do not adjust the standardized amount to account for hospitals wage areas as this would necessitate identifying the wage rate for every individual facility in the APCD data.

[97] Rates for Radiology Services (effective August 1, 2021), *available at* https://www.mass.gov/doc/rates-for-radiology-services-effective-august-1-2021-0, p. 1.

[98] Shifts from ASCs to HOPDs by MassHealth non-managed care patients incur a corresponding increase in cost.

3. Relative Prices for Original Medicare

i. Inpatient Services

74.   For inpatient care provided at short-term acute care hospitals, Original Medicare pays a standardized per-discharge amount under the Inpatient Prospective Payment System. This amount reflects the national standardized base operating and base capital payment amounts. This standardized per-discharge amount is then adjusted to reflect hospital-specific differences in costs to determine each hospital's base payment.[99] We utilize each hospital's base payment to construct the relative prices for inpatient care for Original Medicare.[100]

ii. Outpatient Services

75.   Original Medicare pays for services rendered in HOPDs using the OPPS.[101] Under the OPPS, the fees paid to HOPDs are adjusted for regional variation in wage rates, but all HOPDs in our analysis have the same wage rate.[102] We therefore do not estimate any savings related to changes in which HOPDs outpatient services are rendered.

76.   Under CMS's payment methodology for services rendered at ambulatory surgery centers, Original Medicare reimbursements are set at approximately 59 percent of what Original Medicare pays for the same service if the service was provided at an HOPD in an area with the same wage rate.[103] Therefore, we estimate a cost savings of 41 percent for Original Medicare due to the shift of services from HOPDs to ASCs.

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[99] Rates to individual hospitals may vary due to local variation in labor or capital costs, graduate medical education, or having a disproportionately high share of low-income patients among other adjustments.

[100] To calculate the specific payment for each discharge, the base payment is multiplied by the DRG relative weight that is assigned to each discharge. This discharge specific weight scales up (or down) the base payment to account for differences in the cost of treatment associated with each DRG. To compare relative rates between hospitals this final scaling is not necessary.

[101] MedPAC Payment Basics, "Outpatient Hospital Services Payment System," (Revised: November 2021), *available at* https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_opd_final_sec.pdf.

[102] CMS, FY 2019 Final Rule and Correction Notice Data Files, *available at* https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/FY2019-IPPS-Final-Rule-Home-Page-Items/FY2019-IPPS-Final-Rule-Data-Files.

[103] MedPAC Payment Basics, "Ambulatory Surgical Center Services Payment System," (Revised: November 2021), *available at* https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_asc_final_sec.pdf, p. 1.

IV. BWFH's Patient Panel and Utilization of Health Care Services

77.   In connection with our evaluation of the DoN application, the DoN program asked us to analyze the current utilization of MGB's facilities. As part of this analysis, for the services referenced in the DoN application for BWFH, we were asked to compare the profiles of patients who received care at BWFH with the profiles of the broader population of patients who sought care for those services. For these comparisons, the DoN program asked that we provide information on patients' demographics, insurance coverage, and the acuity levels of patients who received care at BWFH. We also document changes in utilization of inpatient services at BWFH between 2015 and 2019.

A. Inpatient Services

78.   As described earlier, we limit our analyses of inpatient services to adult inpatient services (*i.e.*, excluding pediatrics and newborns), excluding inpatient discharges related to obstetrics, behavioral health, substance use disorder, and rehabilitation services. We also exclude patients who do not live in Massachusetts because we lack information on the characteristics of patients who reside outside of Massachusetts and choose to receive care in their local communities. Lastly, we exclude patients who were transferred from intermediate care facilities, other hospitals' emergency rooms, another unit within the same hospital, court/law enforcement facilities, hospice facilities, and other institutions' ambulatory surgery centers. These limitations and exclusions apply to all analyses we discuss in this section and we do not repeat them for the sake of brevity.

79.   We first describe the characteristics of patients who received care at BWFH in 2019 and compare the characteristics of these patients to the broader population of patients who resided in the hospital's service area. To provide context for assessing MGB's proposal to expand the number of inpatient beds at BWFH, we also document changes in the utilization of the hospital's inpatient services (both in terms of discharges and patient days) between 2015 and 2019. The figures discussed below are created using the 2019 Hospital Inpatient Discharge Database.

1. Patient Profiles

80.   Figure BWFH1 summarizes patient characteristics (*i.e.*, gender, race/ethnicity, age, insurance coverage, and acuity) for all BWFH inpatients, BWFH inpatients who resided in the hospital's 75 percent service area, and inpatients who resided in the hospital's 75 percent service

area regardless of their choice of hospital. The first column of the figure summarizes patient characteristics for all BWFH inpatients.

- In 2019, approximately 57 percent of BWFH inpatients were female.

- White patients accounted for nearly 68 percent of BWFH's inpatients. Among the remaining inpatients, 15 percent of patients were Black, two percent were Asian/Pacific Islander/American Indian/Alaska Native, and 16 percent were of other or unknown race. Approximately 12 percent of inpatients at BWFH were Hispanic.

- The figure also shows the distribution of ages for BWFH inpatients. Approximately 52 percent of BWFH's inpatients were 65 and older and approximately 28 percent were between the ages of 50 and 64.

- For insurance coverage, approximately 48 percent of inpatients had Original Medicare, 28 percent had commercial coverage (which will include some Health Connector Authority plans), 12 percent had MassHealth (ten percent with MassHealth managed care plans and two percent with MassHealth non-managed care plans), eight percent had Medicare health plans, and five percent had other coverage (*e.g.*, self-pay patients, other government insurance, workers' compensation, auto insurance, free care, etc.).

- The case mix index (or "CMI")—which is calculated as the average of the Medicare Severity-DRG relative weights [104] across inpatients at the hospital—for BWFH's inpatients was 1.42.

81.   The second column of the figure summarizes patient characteristics for those BWFH patients who resided in the hospital's 75 percent service area. This service area is created by

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[104] The Medicare Severity-DRG relative weight "represents the average resources required to care for cases in that particular DRG, relative to the average resources used to treat cases in all DRGs." (CMS, "MS-DRG Classifications and Software," *available at* https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/MS-DRG-Classifications-and-Software.)

identifying the smallest set of ZIP Codes that comprised at least 75 percent of BWFH's discharges for the relevant inpatient services. BWFH's 75 percent service area is shown in Figure BWFH2.[105]

82.   The third column of Figure BWFH1 provides a summary of the characteristics of all patients admitted to Massachusetts hospitals who resided within BWFH's 75 percent service area. Broadly speaking, the profiles of BWFH's patients who resided in the hospital's 75 percent service were similar, although we note several differences below.

- Relative to BWFH's patients in its 75 percent service area, patients in BWFH's service areas (regardless of which hospital they chose) were less likely to be female (52 percent compared to 56 percent), slightly more likely to be Black (20 percent compared to 18 percent), more likely to be White (69 percent compared to 63 percent), and less likely to be Hispanic (seven percent compared to 14 percent).[106]

- Relative to BWFH's patients in its 75 percent service area, patients in BWFH's service area were less likely to be covered by Original Medicare (46 percent compared to 52 percent) and were slightly more likely to be covered by Medicare health plans (13 percent compared to nine percent) or MassHealth non-managed care plans (six percent compared to two percent). Otherwise, BWFH's patients and the broader population of patients who resided in the hospital's service area had similar health insurance coverage.

- The age distribution in the two groups was also similar, the largest difference being that the broader population had a lower share of inpatients age 85 and older (14 percent compared to 17 percent).

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[105] Figure BWFH2 identifies GAC hospitals in the mapped geographic area based on information obtained from Massachusetts DPH's directory of licensed healthcare facilities *available at* https://www.mass.gov/doc/list-of-health-care-facilities-licensed-or-certified-by-the-division/download. The map excludes closed hospitals and facilities that have transitioned away from providing acute care services (*See* Section III.A.1). MGB's GAC hospitals are separately labeled on the map: BWH = Brigham and Women's Hospital, MEE = Mass Eye and Ear, MGH = Mass General Hospital, NWH = Newton-Wellesley Hospital, and SH = Salem Hospital (formerly North Shore Medical Center).

[106] The differences in the racial composition of BWFH's patients and other patients who resided in BWFH's service area may be affected by the number of inpatients at BWFH with a recorded race of "Other/Unknown" (18 percent at BWFH compared to eight percent in the hospital's service area).

- Lastly, reflecting BWFH's status as a community hospital, acuity levels (as measured by the case mix index) for patients who received care at BWFH were lower than overall acuity levels in the area (a case mix index of 1.34 compared to 1.67).

2. Changes in Utilization

83.   Figure BWFH3 shows both the total discharges and patient days for BWFH's patients for each year between 2015 and 2019.[107] Following MGB's approach in its DoN application for BWFH, we include both inpatient discharges and observation stays, which are outpatient visits rather than inpatient stays, because a patient receiving observation care may occupy an inpatient bed during their hospital stay and consequently affect BWFH's capacity.[108, 109]

84.   Both inpatient discharges and observation stays at BWFH increased substantially from 2015 to 2019. Inpatient discharges at the hospital grew by 30 percent (5,825 to 7,596 discharges) and observation stays increased by 15 percent (1,715 to 1,978 stays) over this period. The growth rate in patient days was even larger over this period: Patient days associated with inpatient discharges and observation stays grew by 39 percent from 2015 to 2019, indicating both the number of patients receiving care at the hospital and the average length of stay for those patients increased during this period.

B. Outpatient Diagnostic Imaging Services

85.   For the analyses in this section, we adopt the definitions of outpatient service lines that we previously described in Section III.B.2. As we described earlier, we also limit the data we use for these analyses (*i.e.*, the APCD and Medicare Claims data) to patients who reside in Massachusetts and to claims for health care providers located in Suffolk, Essex, Middlesex, Norfolk, Bristol,

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[107] This figure uses the 2019 Hospital Inpatient Discharge Database.

[108] The average length of stay for observation stays is substantially shorter than for inpatient stays. For example, in 2019 BWFH's 1,978 observation stays accounted for 2,768 patient days, corresponding to an average length of stay of 1.4 days. In the same year, BWFH's 7,596 inpatient discharges accounted for 30,370 patient days, corresponding to an average length of stay of four days.

[109] The 2019 discharges reported in Figure BWFH3 are slightly lower than those reported in Figure BWFH1 because the latter includes discharges with unknown MDCs and unknown patient gender. We retain these discharges in Figure BWFH1 so that the patient panels capture BWFH's patient characteristics more completely.

Plymouth, and Worcester Counties. These limitations and exclusions apply to all analyses we discuss in this section. As we noted earlier, the APCD may not include claims for all self-insured commercial health plans. As such, our analyses in this section may understate the fraction of patients covered by commercial health insurance.

86.   In what follows, we describe the characteristics of patients who received care at BWFH in 2018 for outpatient MR scans and compare the characteristics of these patients to the broader population of patients who resided in the hospital's service area. The DoN application for BWFH also proposes the addition of an advanced endoscopy room at the hospital.[110] While the proposed addition would allow the hospital to provide a greater volume of advanced endoscopy services to patients, the APCD and Medicare Claims data contained records for approximately 200 such procedures at BWFH in 2018. Given the low historical volumes of these procedures at BWFH, we do not provide a description of the characteristics of the patients who received these services at the hospital.

87.   Among patients who received outpatient MR scans in 2018, Figure BWFH4 summarizes the characteristics of BWFH patients, of BWFH patients who resided in the hospital's 75 percent service area, of all patients who resided in the hospital's 75 percent service area regardless of where the patient received care. The first column of the figure summarizes patient characteristics for all BWFH patients who received an outpatient MR scan.

- Approximately 65 percent of these patients were female.

- Information on patients' race and ethnicity is only available for Original Medicare patients, but the available data indicate that White patients accounted for 76 percent of BWFH's outpatient MR scans. Among the remaining patients, approximately 12 percent were Black, five percent were Hispanic, and six percent were of other or unknown race.

- The figure also shows the distribution of ages for BWFH outpatients who received MR scans. 40 percent of BWFH's patients were 65 and older and approximately 31 percent were between the ages of 50 and 64.

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[110] BWFH DoN, Appendix 2, Section 2.1, pp. 16-17.

- For insurance coverage, approximately 37 percent of patients were covered by Original Medicare, 36 percent had commercial insurance (which will include some Health Connector Authority plans), three percent had MassHealth non-managed care plans, 16 percent had MassHealth managed care plans, five percent had Medicare health plans, and two percent had other coverage (*e.g.*, self-pay patients, other government insurance, disability, etc.).

88.   The second column of the figure summarizes patient characteristics for those BWFH outpatients receiving MR scans who resided in the hospital's 75 percent service area. This area is created by identifying the smallest set of ZIP Codes that comprise at least 75 percent of BWFH's outpatient MR scans. BWFH's 75 percent service area is shown in Figure BWFH5.[111]

89.   The third column of Figure BWFH4 provides a summary of the patient characteristics for all patients who received an outpatient MR scan and who resided in BWFH's 75 percent service area (regardless of which health care provider those patients chose). The profiles of BWFH's patients who resided in the hospital's 75 percent service area and the profiles of all patients who resided in that area were similar, although we note several differences in what follows.

- Relative to BWFH's patients in its 75 percent service area, patients in the hospital's service area (regardless of which provider they chose) were less likely to be female (59 percent compared to 65 percent) and less likely to be Hispanic (two percent compared to seven percent).

- The age distribution in the two populations is similar, the largest difference being that the broader population has a lower share of people age 20 and younger (one percent compared to seven percent).

- Relative to BWFH's patients, the broader population was more likely to have commercial insurance (41 percent compared to 34 percent) and less likely to be covered by Original Medicare (31 percent compared 37 percent).

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[111] Figure BWFH5 shows BWFH's 75 percent service area for outpatient MR scans. The map identifies facilities that provided at least 300 diagnostic imaging visits (across all modalities) in the 2018 APCD and Medicare Claims data after applying the aforementioned exclusions

V. Five- and Ten-Year Estimates of Demand for BWFH Services

90.   The DoN program requested that we provide short-term (*i.e.*, five years) and long-term (*i.e.*, ten years) estimates of expected changes in total population and projected demographic shifts in BWFH's service area. In addition, the DoN program requested that we project increases in demand at BWFH for inpatient services and outpatient MRI services. We discuss each of these considerations in what follows.

A. Inpatient Services

1. Changes in Demographics in Five and Ten Years

91.   Figure BWFH6 summarizes short-term and long-term estimates of expected changes in total population and projected demographic shifts in BWFH's 75 percent service area for inpatient services. These population projections include projections by gender and age group; however, estimates by race and ethnicity are not available. Within BWFH's 75 percent inpatient service area, the total population is projected to grow from 1.47 million to 1.56 million by 2030, an increase of seven percent. During this period, the number of residents age 65 and older is expected to grow at a faster rate than the overall population, increasing by 30 percent from 235 thousand in 2020 to 306 thousand in 2030.

2. Changes in Demand Using Predicted Demographics in Five and Ten Years

92.   To estimate future demand for inpatient hospital services, we combine the UMDI population projections with data from the Hospital Inpatient Discharge Database on current demand for inpatient hospital services. Specifically, we tabulate the current number of discharges and patient days by patient age, gender, and ZIP Code for BWFH. We then apply the expected population growth rate for the same age group, gender, and ZIP Code based on UMDI's projections to calculate the corresponding increase in discharges and patient days.[112] Figure BWFH7 summarizes the resulting estimates of demand in 2025 and 2030 for inpatient services. This method does not account for changes in patients' demand for inpatient hospital care that might arise from,

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[112] For example, BWFH discharged 12 female patients from ZIP Code 02136 in the 40-44 age group. According to the UMass Donahue Population Projections, this demographic group will grow by 30 percent between 2020 and 2025 and by 43 percent between 2020 and 2030. Therefore, we predict that BWFH will discharge 16 female patients from ZIP Code 02136 in the 40-44 age group in 2025 and 17 in 2030.

for example, changes in the incidence of diseases or disorders, changes in treatment patterns, or entry or expansion of competitors to BWFH. Importantly, our method also does not account for changes in inpatient demand or capacity at BWFH associated with the proposed project, including an increase in the number of patients who receive care at BWFH instead of Brigham and Women's Hospital.

93.   We project that total discharges at BWFH will increase by nine percent between 2019 and 2025, with a ten percent increase in associated patient days. By 2030, discharges are projected to increase by 18 percent, with a 21 percent increase in patient days. These projections are consistent with increased short- and long-term demand for inpatient services at BWFH.[113]

94.   In the DoN application for BWFH, MGB provides its own projections of future inpatient demand at BWFH. MGB explains that its projections account for population changes and assume that BWFH would be providing care for which it was the "most appropriate" facility.[114] BWFH's projections also assume it has been allowed to increase capacity by adding inpatient beds.[115] This stands in contrast to our projections, which only reflect expected changes in the population and demographic shifts but hold other factors affecting the demand for and supply of inpatient hospital services constant.

95.   BWFH projects that its total patient days will increase by ten percent between 2019 and 2027, implying a slightly lower annual growth rate than our projections.[116, 117] However, these projections do not include additional inpatient volume that may result from Brigham and Woman's

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[113] We perform the same analysis for patients living within BWFH's 75 percent service area who sought inpatient services at any hospital in Massachusetts to measure total projected demand for inpatient services for patients residing in BWFH's service area. These growth rates are similar to the growth rates we project for BWFH itself. For patients residing within BWFH's 75 percent service area, we project a growth rate from 2019 to 2030 of 19 percent and 20 percent for total discharges and patient days, respectively.

[114] BWFH DoN Appendix 2, pp. 12-14.

[115] BWFH DoN Appendix 2, pp. 12-14.

[116] Brigham & Women's Faulkner Hospital - DoN Application MGB-20121716-HE - Bed Summary Response.docx [hereinafter, BWFH Bed Summary Response], p. 2.

[117] Assuming a constant rate of annual growth, BWFH's estimate of a ten percent increase in patient days between 2019 and 2027 implies an annual growth rate of 1.3 percent. Our projection of a ten percent increase in patient days between 2019 and 2025 implies an annual growth rate of 1.7 percent, and a 21 percent increase between 2019 and 2030 implies an annual growth rate of 1.9 percent.

Hospital shifting patients and services to BWFH following the proposed increases in BWFH's inpatient capacity. With these additional patients include in the projections, MGB projects that total patient days at BWFH will increase by 70 percent between 2019 and 2027.[118]

96.   In summary, we predict substantial increases in demand for inpatient services at BWFH in the next five to ten years. This increase is driven by the projected population growth in the service area of the hospital and the aging of that population. For inpatient services, our projections are consistent with the projections that MGB included in its DoN application—excluding the possible additional inpatient volume from shifting patients and services from Brigham and Women's Hospital to BWFH—although we rely on a different method to arrive at our projections.

B. Outpatient Services

1. Changes in Demographics in Five and Ten Years

97.   Figure BWFH8 summarizes short- and long-term estimates of expected changes in total population and projected demographic shifts in BWFH's 75 percent service area for outpatient MR scans. As with our projections for inpatient services in BWFH's 75 percent inpatient service area, these projections include estimates by gender and age group, but estimates by race and ethnicity are not available. Within BWFH's 75 percent service area for outpatient MR scans, the total population is projected to grow from 1.2 million in 2020 to 1.3 million in 2030, an increase of seven percent. During this period, the number of residents age 65 and older is expected to grow at a faster rate than the overall population, increasing by 29 percent from 191 thousand in 2020 to 246 thousand in 2030.

2. Changes in Demand Using Predicted Demographics in Five and Ten Years

98.   To estimate future demand for outpatient MR scans at BWFH, we combine the UMDI population projections with data from the APCD and Medicare Claims data on current demand for outpatient MRIs. Specifically, we tabulate the current volume for outpatient MR scans by patient age, gender, and ZIP Code for BWFH. We then apply the expected population growth rate for the

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[118] BWFH Bed Summary Response, p. 2.

same age group, gender, and ZIP Code based on UMDI's projections to calculate the corresponding increase in outpatient service volume.[119] Figure BWFH9 summarizes the resulting estimates of demand in 2025 and 2030 for outpatient MR scans.[120] This method does not account for changes in patients' demand for outpatient MR scans that might arise from, for example, changes in the incidence of diseases or disorders, changes in treatment patterns, or entry or expansion of competitors to BWFH. Importantly, our method also does not account for changes in outpatient demand or capacity at BWFH associated with the proposed project.

99.   Using this approach, we project that outpatient MR scans at BWFH will increase by eight percent between 2018 and 2025 and by 15 percent between 2018 and 2030.[121]

100.   In the DoN application for BWFH, MGB provides its own projections of future demand for outpatient MR scans at BWFH. MGB explains its projections account for expected population changes, that BWFH would be providing care for which it was the "most appropriate" facility, current wait times, and the need to have a 3-Tesla MRI unit at the hospital.[122] This stands in contrast to our projections, which only reflect expected changes in the population and demographic shifts but hold other factors affecting the demand for and supply of outpatient MR scans constant. MGB projects that MR scans at BWFH will increase by 24 percent from 2019 to 2027,[123] which is higher than our projection of 15 percent from 2018 to 2030.

101.   In summary, we predict a substantial increase in demand for outpatient MR scans at BWFH in the next five to ten years. This increase is driven by the projected population growth in the service area of the hospital and the aging of that population. While we predict a substantial increase

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[119] The APCD data we use for these analyses may not include claims for all self-insured commercial health plans. As such, our estimates of the number of outpatient MR scans currently provided by BWFH is likely understated.

[120] For example, BWFH performed 24 outpatient MR scans on women aged 65-69 from ZIP Code 02026 in 2018. According to the UMass Donahue Population Projection, this demographic group is predicted to grow 15 percent through 2025 and 27 percent through 2030. Therefore, we predict that BWFH will perform 27.6 outpatient MR scans on this group in 2025 and 31.8 outpatient MR scans on this group in 2030.

[121] We perform the same analysis for patients living within BWFH's 75 percent service area who sought outpatient MRI services from any provider in Massachusetts to measure total projected demand for outpatient MR scans for patients residing in BWFH's service area. The growth rates are similar to the growth rates we project for BWFH itself. For patients residing within BWFH's 75 percent service area, we project a growth rate from 2018 to 2025 of seven percent and a growth rate from 2018 to 2030 of 13 percent.

[122] BWFH DoN Appendix 2, pp. 9-14 and 19-22.

[123] BWFH DoN Appendix 2, p. 21.

in demand for outpatient MR scans, our projections are somewhat lower than the projections that MGB included in its DoN application. However, we rely on a different method to arrive at our projections that does not account for the same factors that MGB considered.

VI. Models of Patients' Demand for Health Care Services

A. Inpatient Services

102. Addressing the elements of the ICA requires forecasting how the proposed project will affect where patients choose to receive health care services. To forecast how the proposed project will impact patients' demand for inpatient services, we use the CHIA Hospital Inpatient Discharge Database to estimate a model of Massachusetts patients' demand for inpatient hospital services. The framework for this model assumes that patients have preferences over hospitals and hospitals' characteristics, and that patients' hospital choices that we observe in the Hospital Inpatient Discharge Database reflect these preferences. The framework we use to develop this model was peer-reviewed[124] and is flexible enough to estimate projections of consumer demand for inpatient hospital services that allow us to address the elements of the ICA.

103. In estimating our model, we restrict the Hospital Inpatient Discharge Database to those patients whose demand for inpatient hospital care may be affected by the additional inpatient bed capacity requested by MGB in the proposed project. Because the proposed additional inpatient bed capacity would be used for adult patients, we exclude discharges for pediatric patients (including newborns). We also exclude discharges for obstetrics patients and patients receiving care for substance use disorder, behavioral health, or inpatient rehabilitation services. Lastly, we exclude discharges for patients who reside outside of Massachusetts, transfers from intermediate-care facilities, transfers from other hospitals' emergency departments, transfers from another unit within the same hospital, transfers from law enforcement agencies, transfers from hospice facilities, and transfers from ambulatory surgery centers operated by another health care provider.

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[124] Devesh Raval, Ted Rosenbaum, and Steven A Tenn. "A Semiparametric Discrete Choice Model: An Application to Hospital Mergers." *Economic Inquiry* (2017).

104.   Using these data, we assume that patients' preferences over hospitals vary based on, among other things, where the patients live (*e.g.*, the ZIP Code of their residence), the health condition for which they seek inpatient care (*e.g.*, the patients' DRG), their health insurance coverage (*e.g.*, Original Medicare), and demographics (*e.g.*, age and gender). [125] In our model, patients' preferences over hospitals implicitly depend on the characteristics of hospitals from which the patients are choosing (*e.g.*, the hospitals' reputation for clinical quality, the locations of the hospitals, or the amenities offered by the hospitals). [126]

105.   Our estimation proceeds in two steps. In the first step, we identify groups of patients who are similar in terms of the aforementioned characteristics and who are, therefore, likely to have similar preferences across hospitals. [127] In the second step, we estimate hospital preferences within each group. We assume that patients grouped together have the same preferences across hospitals and estimate these preferences based on the observed hospital choices made by patients assigned to the group. In particular, we assume that the likelihood a patient in the group chooses a hospital is equal to the share of patients within the group who actually chose that hospital, and that substitution pattern across hospitals for patients in the group are proportional to these group-level shares. We estimate this model of patient demand for inpatient hospital services using approximately 525 thousand discharges from Massachusetts hospitals.

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[125] More specifically, patient preferences in our model of demand for inpatient hospital services depend on (i) the patient's county and ZIP Code of residence; (ii) the DRG or MDC associated with the patient's care; (iii) whether the admission is for surgical care or an emergency admission; (iv) the quartile of the DRG relative weight associated with the admission; (v) the patient's health insurance coverage (commercial, Original Medicare, Medicare health plan, MassHealth non-managed care, MassHealth managed care, or other types of coverage such as self-pay); (vi) gender; and (vii) age category (18-45, 46-62, and 63 and older).

[126] We use a "semi-parametric" method to estimate demand that does not require that we explicitly specify the hospital characteristics that affect patients' preferences. Instead, we assume that patients' preferences within each group are determined by a semi-parametric logit demand model. Then, for each hospital, the method estimates one parameter for each group of patients that measures the overall attractiveness of that hospital to that group of patients. This parameter implicitly reflects all the characteristics of that hospital that affect the preferences of patients in that group.

[127] We use an iterative procedure to allocate patients into groups subject to a minimum group size of 20 discharges. When possible, the procedure allocates patients into the most granular category, *e.g.*, male patients aged 18-44 with commercial insurance coverage who reside in ZIP Code 02118 who were admitted to an inpatient hospital for DRG 694 (urinary stones without complications). If there are not 20 such patients who share those characteristics, the iterative procedure allocates patients into broader categories, *e.g.*, patients who reside in Suffolk County admitted to an inpatient hospital for MDC 11 (Diseases and Disorders of the Kidney and Urinary Tract).

106.   We use the results of this model to calculate "diversion ratios" between MGB hospitals and hospitals affiliated with other health systems.[128] In the context of our model, diversion ratios answer the question: If a patient wanted to receive inpatient hospital care at BWFH but could not because of capacity constraints at the hospital, what competing hospitals might that patient choose, and how likely is that patient to choose each one of those competing hospitals? Suppose, for example, that the estimated diversion ratio from BWFH to Beth Israel Deaconess Medical Center was 50 percent, the diversion ratio to Boston Medical Center was 30 percent, and the diversion ratio to Tufts Medical Center was 20 percent. If a patient could not receive care at BWFH, the model then predicts that there is a 50 percent chance the patient chooses Beth Israel Deaconess Medical Center instead, a 30 percent chance the patient chooses Boston Medical Center instead, and a 20 percent chance that the patient chooses Tufts Medical Center instead. Equivalently, each discharge lost by BWFH would increase the expected number of discharges at Beth Israel Deaconess Medical Center, Boston Medical Center, and Tufts Medical Center by 0.5, 0.3, and 0.2 discharges, respectively.

107.   Conversely, the diversion ratios can be used to predict which competing hospitals BWFH would attract patients from if the proposed project to expand the number of inpatient beds at the hospital were approved. Using the example, if the proposed project increased the number of inpatient admissions at BWFH by one, the diversion ratios tell us that the number of expected discharges at Beth Israel Deaconess Medical Center, Boston Medical Center, and Tufts Medical Center would decrease by 0.5, 0.3, and 0.2, respectively.

108.   The estimated model can also be used to calculate diversion ratios for specific groups of patients, for example, patients receiving cancer care or patients from ZIP Code 02116. In the previous example, overall diversion from BWFH to Boston Medical Center is 30 percent. This overall measure is a summation of patient-specific diversions that will vary across patients.

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[128] Diversion ratios are commonly used in assessing competition between firms in differentiated product markets. *See*, for example, U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010)*, §* 6.1.

Perhaps, for example, diversion from BWFH to Boston Medical Center is 35 percent for patients receiving cancer care and less than 30 percent for all other patients.

109.   Our forecasts of the effect of the proposed project on demand for inpatient hospitals are based, in part, on the estimated diversion ratios from the inpatient choice model. MGB anticipates the proposed expansion at BWFH would increase the number of inpatient patient days at the hospital from 33,544 today to 57,191 in fiscal year 2027.[129] To address ICA questions related to shifts in hospital utilization if the proposed project were approved, we use the inpatient demand model to predict which patients would switch to BWFH following the proposed expansion. We simulate these predictions in two ways. First, we assume that whenever possible, BWFH admits patients that would have otherwise been admitted to Brigham and Women's Hospital. In the second simulation, we allow BWFH to draw its incremental patients from any hospital. In both

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[129] BWFH Bed Summary Response, p. 2.

simulations, we calibrate the demand model so that the predicted increase in inpatient volume at BWFH exactly matches MGB's inpatient volume projections in the BWFH DoN.[130,131,132]

B. Outpatient Services

110.   In addition to our model of patients' demand for inpatient hospital services, we estimate a model of demand for outpatient health care services using the APCD and Medicare Claims data. We use a framework for this purpose that is similar to the framework that we use to model demand for inpatient hospital services.

111.   Because the DoN application for BWFH proposes expanding the hospital's diagnostic imaging equipment by adding a 3-Tesla MRI unit,[133] we estimate a model of patient demand for

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[130] We assume that when BWFH increases its capacity and admits more inpatients, the characteristics of the incremental patients that BWFH admits will be like those of patients previously admitted to BWFH. Within the context of the patient demand model, this means the proposed project increases every patient's probability of choosing BWFH by the same relative amount.

    For example, consider two groups of patients. The first group includes patients from a ZIP Code close to BWFH for a service that BWFH is known for, and the second group includes patients from a ZIP Code more distant from BWFH for a service that is provided by many other community hospitals. Assume that 50 percent of the first group chooses BWFH but only one percent of the second group chooses BWFH. Our calculations assume that if BWFH expands, its shares within the two groups increase by the same relative amounts. For example, if BWFH's share in the first group increases from 50 percent to 55 percent (*i.e.*, by ten percent), then BWFH's share in the second group increases from one percent to 1.1 percent (*i.e.,* by ten percent).

    We assume that this relationship holds so long as it is feasible (*i.e.*, BWFH cannot attract more than 100 percent of some group of patients). To expand on our previous example, if 95 percent of a third group of patients chooses BWFH, then when BWFH's shares in the first two groups are expanded by ten percent to 55 percent and 1.1 percent, respectively, BWFH's share in the third group can only increase from 95 percent to 100 percent, which is less than a ten percent increase.

    Implicitly, our simulations assume that BWFH will admit more of the types of patients that currently value BWFH the most, according to the estimated patient demand model, where "value" is reflected in the BWFH group shares.

[131] To adjust the simulations to incorporate the assumption that BWFH's incremental patients will be drawn from patients who otherwise would have received care at Brigham and Women's Hospital, we allow BWFH's share within different patient groups (*e.g.,* the three groups in the prior footnote) to increase at the expense of the share of Brigham and Women's Hospital in those groups.

[132] When we perform this exercise, we increase BWFH inpatient patient days by 21,409 instead of by 23,647, as indicated in the text (= 57,191 – 33,544). We scale down the BWFH expansion to reflect the fact that we scaled down the raw discharge data by the same proportion when preparing it (*e.g.,* removing out-of-state discharges) for the analyses here.

[133] BWFH DoN, Appendix 2, Section 2.1, p. 1.

outpatient diagnostic imaging.[134] As such, we restrict the APCD and Medicare Claims data to those patients whose demand for outpatient diagnostic imaging may be affected by the proposed project. The DoN application for BWFH also proposes to establish an eight-bed observation unit[135] at the hospital, but utilization of these beds would be incidental to other types of care provided by the hospital (*e.g.*, the observation unit beds would be used to care for patients recovering after outpatient surgical procedures), and so we do not separately model demand for these observation-unit beds. In addition, the DoN application for BWFH also proposes the addition of an advanced endoscopy room at the hospital.[136] While the proposed addition would allow the hospital to provide a greater volume of advanced endoscopy services to patients, the number of advanced endoscopy procedures historically provided at BWFH is too low to permit us to reliably estimate a model of patients' demand for these procedures at the hospital.

112.   As we noted in our discussion of the APCD, not all commercial health plans in Massachusetts are required to submit their claims data for inclusion in the database.[137] Because of this, the volume of any outpatient procedure calculated using these data will be incomplete and will not match the volume of outpatient procedures that MGB—or any other health care provider in Massachusetts—would calculate using its own internal records of outpatient procedure (or visit) volume, including any volume calculations referenced by MGB in its DoN application.

1. Diagnostic Imaging Services

113.   In estimating our model of demand for outpatient diagnostic imaging services, we restrict the APCD and Medicare Claims data to those patients who received outpatient CT, MRI, or PET/CT diagnostic imaging services. We exclude claims associated with patients who reside

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[134] The proposed additional MRI unit may also be used by inpatients who receive care at BWFH, but this demand would be reflected in our inpatient hospital model, and we do not address it separately here.

[135] BWFH DoN, Appendix 2, Section 2.1, p.1.

[136] BWFH DoN, Appendix 2, Section 2.1, pp. 16-17.

[137] Specifically, self-insured health plans are not required to, but may voluntarily, submit their claims data to CHIA's APCD.

outside of Massachusetts, and we limit to claims with service locations in Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, and Worcester Counties in Massachusetts.[138]

114.   Using these data, we assume that patients' preferences over outpatient diagnostic imaging services vary based on, among other things, where the patients live (*e.g.*, the ZIP Code of their residence), the type of outpatient imaging procedure they require (*e.g.*, the CPT or HCPCS code associated with the procedure), their health insurance coverage (*e.g.*, Original Medicare), and their demographics (*e.g.,* age and gender).[139] In our model, patients' preferences over outpatient diagnostic imaging facilities also implicitly depend on the characteristics of the facilities from which the patients are choosing (*e.g.*, the outpatient facilities' reputation for quality, the locations of the facilities, or the amenities offered by the facilities).[140] Based on these preferences, patients choose at which facility they receive their diagnostic imaging scans.[141,142]

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[138] We restrict the data to these seven counties because it is unlikely that patients who might receive care from BWFH for outpatient diagnostic imaging services would travel outside of this region for these services, except under unusual or exceptional circumstances.

[139] More specifically, patient preferences in our model of demand for outpatient diagnostic imaging services depend on (i) the patient's county and ZIP Code of residence; (ii) the CPT or HCPCS code associated with the imaging services the patient received; (iii) the region of the body (*e.g.*, breast, spine, pelvis, chest) associated with the imaging services the patient received; (iv) whether the patient received a CT, MR, or PET/CT scan; (v) the patient's health insurance coverage (commercial, Original Medicare, Medicare health plan, MassHealth non-managed care, MassHealth managed care, or other types of coverage such as self-pay); (vi) the patient's gender; and (vii) the patient's age category (18-45, 46-62, and 63 and older).

[140] We use a "semi-parametric" method to estimate demand that does not require we explicitly specify the facility characteristics that patients care about. Instead, for each facility, the method estimates one parameter for each group of patients that measures the overall attractiveness of the facility to that group of patients. This parameter implicitly reflects all the characteristics of that facility that affect the utility of patients in that group.

[141] The unit of observation in our model of patient demand for diagnostic imaging services is a single CT, MR, or PET/CT scan because patients in the APCD and Medicare Claims data choose to receive different types of advanced imaging services at different facilities.

[142] Our model combines claims for outpatient diagnostic imaging facilities that share the same facility type (*e.g.*, physician offices and clinics or HOPDs), have the same owner, and are located in the same ZIP Code. This means the patients in our model do not choose between specific locations (*e.g.,* a Shields clinic at 40 Allied Drive in Dedham, MA 02026). Instead, this choice is represented as Shields – Office/Clinic – 02026 in the demand model. We aggregate the data in this way because it is not feasible to reliably identify the exact facility address where health care services were provided in the APCD and Medicare Claims data. Therefore, we are unable to calculate the facility-level shares needed to reliably estimate a facility-level demand model. Aggregating the data to the owner – facility type – ZIP Code-level (*e.g.,* Shields – Office/Clinic – 02026) mitigates this issue. Consequently, we cannot distinguish between demand for outpatient facilities of the same type with the same owner in the same ZIP Code.

115.   Our estimation proceeds in two steps. In the first step, we identify groups of patients who are similar in terms of the aforementioned characteristics and who are, therefore, likely to have similar preferences across outpatient diagnostic imaging facilities. [143] In the second step, we estimate patients' preferences for imaging facilities within each group. We assume that patients grouped together have the same preferences across imaging facilities and estimate these preferences based on the observed choices made by patients assigned to the group. In particular, we assume that the likelihood a patient in the group receives an imaging service at a particular facility is equal to the share of patients within the group who actually chose that facility, and that substitution patterns across facilities for patients in the group are proportional to these group-level shares. We estimate this model of demand for outpatient diagnostic imaging using approximately 1.2 million CT, MR, and PET-CT scans performed at Massachusetts outpatient facilities.

116.   We use our model of demand for outpatient imaging services to calculate diversion ratios between competing providers of diagnostic imaging services in a manner analogous to the way in which we previously described calculating diversion ratios for inpatient hospital services. These diversion ratios can then be used to predict which competing diagnostic imaging providers BWFH would attract patients from if the proposed project to expand the number of imaging units at the hospital were approved. [144]

117.   Our forecasts of the effect of the proposed project on demand for diagnostic imaging services are derived as follows. In its DoN application, MGB proposes to add one 3-Tesla MRI unit to supplement the 1.5-Tesla MRI unit that BWFH currently operates, which would double the hospital's capacity to provide MR scans. [145] To address the ICA questions related to shifts in utilization of diagnostic imaging facilities if the proposed project were approved, we use the

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[143] We use an iterative process to allocate patients into groups subject to a minimum group size of 30 claims with diagnostic imaging. When possible, the process allocates patients into the most granular category, *e.g.*, male patients aged 18-44 with commercial insurance coverage who reside in ZIP Code 02118 (located in Suffolk County) who received an MR scan with CPT code 73221 (shoulder, elbow, or wrist MRIs without contrast). If there are not 30 such patients who share those characteristics, the iterative process allocates patients into broader categories, *e.g.*, patients who reside in Suffolk County who received any type of MRI.

[144] We use the same methodology to perform these simulations as when simulating the effects of BWFH's additional inpatient capacity on utilization of inpatient GAC services. As with the inpatient demand model, we assume that when BWFH completes the proposed project and is able to perform more MR scans, the incremental patients BWFH performs these scans on will resemble the patients to which BWFH already provides diagnostic imaging services.

[145] BWFH DoN, Appendix 2, Section 2.1, p. 3.

outpatient demand model to predict which patients would switch to BWFH for MR scans after the expansion. We calibrate the demand model so that the predicted increase in MR scans (in percentage terms) at BWFH exactly matches the percentage increase in MR scans MGB proposes in the DoN application for BWFH.

VII.   Predicted Changes in MGB's Shares and Bargaining Leverage

118.   As part of our evaluation of the proposed project on health care costs in Massachusetts, the DoN program asked that we evaluate MGB's market share for the services addressed in its DoN application and that we assess how those shares might change if MGB's DoN application were approved. Related to this, the DoN program also asked that we consider how changes in MGB's share might affect the prices it negotiates with third-party payors (*i.e.*, its negotiating leverage with third-party payors). In this section we discuss the economic literature related to market shares and concentration in health care and the relationship between market structure and health care prices. We then turn to an assessment of MGB's current share for the services addressed in its DoN and use our models of patient demand for health care services to predict how those shares might change if the proposed project were approved.

119.   Before turning to this discussion, we provide a brief overview of the bargaining dynamics between health insurers and health care providers that determine the rates they negotiate for inpatient and outpatient services. Economists generally view the competition between health care providers as occurring in two stages.[146] Negotiations over prices occur in the first stage, when providers negotiate with insurers to be included as in-network providers. In the second stage, after health insurers have formed these networks, in-network providers compete (primarily over non-price terms) to attract the patients that have in-network access to them. The two stages of competition among health care providers are closely related: the factors that may allow a health care provider to negotiate better rates with a health insurer in the first stage also typically make the provider more attractive to patients in the second stage.

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[146] Robert Town and Gregory Vistnes. "Hospital Competition in HMO Networks." *Journal of Health Economics* (2001); Cory Capps, David Dranove, and Mark Satterthwaite. "Competition and market power in option demand markets." *RAND Journal of Economics* (2003).

120. In models of the first stage, the reimbursement rates that a provider and health insurer negotiate are determined by the value to each of reaching an agreement to include the provider in the insurer's network and the prospects of each if they fail to reach an agreement. To the health insurer, the extra value from adding a provider to its network depends on the extra value the insurer's enrollees derive from a network that includes the provider relative to one that excludes it. The greater this extra value, the more the insurer is willing to pay the provider to participate in its network. For example, providers that offer a broad range of services, have a superior reputation or clinical quality, are conveniently located, or offer desirable amenities have more bargaining leverage with insurers and receive higher rates. In contrast, providers for which there are reasonable or superior alternatives in the eyes of consumers (in terms of location, services, reputation, and so on) have less bargaining leverage with insurers and receive lower rates. Much of the economics literature we discuss below explicitly or implicitly relies on the same two-stage framework to assess the relationship between prices and concentration in health care markets. When considering the potential impact to prices from a change in market structure such as an acquisition or the proposed project, economists consider how the change will affect the values that providers and insurers put on reaching an agreement.

A. Competition Between Health Care Providers

121. Turning first to the economics literature on the relationship between market structure and health care prices, we note that most of this literature focuses on prices paid by commercial health insurers for health care services. This is because while commercial insurers typically negotiate reimbursement rates with health care providers like MGB, reimbursement for government programs like Original Medicare or MassHealth non-managed care is set by regulation rather than through negotiation with providers and would be unaffected by any changes in MGB's bargaining leverage. [147] Although government-sponsored health plans like Medicare Advantage plans

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[147] *See* MedPAC Payment Basics, "Hospital Acute Inpatient Services Payment System," (Revised: November 2021), *available at* https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_hospital_final_sec.pdf.; MedPAC Payment Basics, "Outpatient Hospital Services Payment System" (Revised: November 2021), *available at* https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_opd_final_sec.pdf; Massachusetts Executive Office of Health and Human Services (EOHHS), Office of Medicaid. "Notice of Final Agency Action. MassHealth: Payment for In-State Acute Hospital Services and Out-of-State Acute Hospital Services,

negotiate prices with hospitals, research has found that the prices negotiated by these plans are typically comparable to the corresponding Medicare fee schedule amounts.[148]

122.   In assessing the effect of the proposed project on MGB's bargaining leverage, we rely on a measure of hospital market concentration known as the Herfindahl-Hirschman Index ("HHI"), which is calculated as the sum of the squares of shares of the firms that compete in the market.[149] Federal and state antitrust agencies often include analyses of HHIs in their evaluations of the competitive effects of mergers, and the standards used by the federal agencies in these analyses are described in the *Horizontal Merger Guidelines* promulgated by the Federal Trade Commission and Department of Justice.[150] We also note that the HHI has been adopted by the Massachusetts Health Policy Commission in assessing the competitive effects of recent Cost and Market Impact Reviews.[151]

123.   As the *Guidelines* describe, the Federal Trade Commission and Department of Justice generally classify markets into three types depending on the HHI: unconcentrated markets, which are those with an HHI below 1,500; moderately concentrated markets, which are those with an HHI between 1,500 and 2,500; and highly concentrated markets, which are those with an HHI

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effective November 1, 2021," *available at* https://www.mass.gov/doc/notice-of-final-agency-action-masshealth-payment-for-in-state-acute-hospital-services-and-out-of-state-acute-hospital-services-effective-november-1-2021-0, pp. 1-6.

[148] Robert A. Berenson, Jonathan H. Sunshine, David Helms, and Emily Lawton. "Why Medicare Advantage Plans Pay Hospitals Traditional Medicare Prices." *Health Affairs* (2015).

[149] For example, if there were four firms competing in the market and each firm had a share of 25 percent, the HHI would be calculated as $2,500 = 25^2 + 25^2 + 25^2 + 25^2$. In the case of a single firm competing in the market, the HHI is 10,000. In the case of a large number of firms competing in the market where each such firm has a small share, the HHI would be close to zero. In general, if there are n equally sized firms competing in the market, the HHI is $10,000 \div n$.

[150] U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010).

[151] *See*, for example, Massachusetts Health Policy Commission Review of The Proposed Merger of Lahey Health System; CareGroup and its Component Parts, Beth Israel Deaconess Medical Center, New England Baptist Hospital, and Mount Auburn Hospital; Seacoast Regional Health Systems; and Each of their Corporate Subsidiaries into Beth Israel Lahey Health; AND The Acquisition of the Beth Israel Deaconess Care Organization by Beth Israel Lahey Health; AND The Contracting Affiliation Between Beth Israel Lahey Health and Mount Auburn Cambridge Independent Practice Association (HPC-CMIR-2017-2), Final Report (September 27, 2018), pp. 47-48.

above 2,500.[152] Because mergers typically increase concentration,[153] the *Guidelines* also describe the circumstances in which a proposed merger may give rise to competitive concerns. Among other things, the *Guidelines* state that mergers resulting in a change in HHI of less than 100 points or which maintain an unconcentrated market are unlikely to lead to adverse competitive effects.[154] (Of course, non-merger transactions can result in *decreases* in concentration, which would be either competitively neutral or may lead to procompetitive effects based on HHI calculations.) While the *Guidelines* provide a "safe harbor" for horizontal mergers that increase concentration by less than 100 points, in practice many mergers involving health care providers that result in substantially higher changes in concentration are not challenged by state or federal enforcement agencies. To our knowledge, no hospital merger resulting in a change in HHI of less than 700 points has been challenged (either successfully or unsuccessfully) by antitrust enforcement agencies in the last 15 years.[155]

124.   In addition to the general guidance contained in the *Horizontal Merger Guidelines* on the relationship between the competitiveness of markets and HHI, the HHI has also been used in studies of the relationship between market structure and the prices of inpatient hospital services.[156] We review this literature next and describe how to use the results of a recent study to simulate the price effect of MGB's proposed expansion in inpatient services on its bargaining leverage with

[152] U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010)*, § 5.3.

[153] The change in HHI associated with a merger is equal to twice the product of the shares of the merging firms. For example, the merger of firms with a five percent share and a ten percent share would increase the HHI by $100 = 2 \times 5 \times 10$.

[154] U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010)*, § 5.3.

[155] The Federal Trade Commission unsuccessfully challenged the acquisition of Albert Einstein Healthcare Network by Thomas Jefferson University in 2020. In its complaint, the Federal Trade Commission alleged that the transaction would increase concentration in the market for the provision of inpatient general acute care hospital services in Montgomery County, Pennsylvania by at least 700 points to more than 3,500 points. (Complaint, *In the Matter of Thomas Jefferson University and Albert Einstein Healthcare Network*, Docket No. 9392, ¶ 50.) The administrative complaint was later dismissed after the Commission voted to voluntarily dismiss its appeal of the District Court's decision declining to preliminarily enjoin the transaction. (Federal Trade Commission, Case Summary. "Thomas Jefferson University, In the Matter of." *available at* https://www.ftc.gov/enforcement/cases-proceedings/181-0128/thomas-jefferson-university-matter.)

[156] Studies of the relationship between market structure and prices are commonly referred to as Structure-Conduct-Performance or "SCP" studies. While we do not discuss it here, economists have noted that the "SCP approach has a number of well-recognized problems when price is the dependent variable" as is the case in the studies reviewed here. (Martin Gaynor, Kate Ho, and Robert J. Town. "The Industrial Organization of Health-Care Markets." *Journal of Economic Literature* (2015), p. 246.)

commercial payors. Because the proposed project also represents an expansion of MGB's existing inpatient and outpatient capacity in eastern Massachusetts, we also review studies of the effect of entry and expansion on market dynamics in health care.

1. The Relationship Between Hospital Concentration and Inpatient Prices

125.   In this section we review recent economic studies that examine the time-series or cross-sectional relationship between hospital market concentration and negotiated prices for inpatient services. The most relevant of these studies use large, nationwide databases of commercial health care claims, while older studies focus on hospital markets in California and Florida where administrative data on hospitals prices were publicly available. The evidence in these studies on the relationship between concentration and hospital prices is mixed: some studies find statistically significant, positive associations, while others find no relationship. These findings are consistent with a more recent article that noted that most "high-price" hospitals are not in concentrated markets, suggesting that other factors may be more important determinants of variation in hospital prices.[157] While hospital mergers may lead to changes in market concentration, we do not review studies of the effects of hospital mergers on prices because the proposed project involves the *expansion* of an existing competitor rather than the *exit* of an existing independent competitor (as would be in the case if one hospital were acquired by another).

126.   Cooper *et al.* (2019) use a large, nationwide database of commercial health care claims covering the period 2007 to 2011 to examine the sources of differences in health care spending for commercially insured patients and to analyze variation in health care prices.[158] The authors find that half of the regional variation in health care spending for commercially insured patients is explained by differences in the quantity of services received and half is explained by differences in the prices of those services. The authors also study the relationship between hospital market structure and the prices that commercial payors negotiate with hospitals in those markets, finding that hospital market structure is "strongly associated" with prices: prices at monopoly hospitals

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[157] Maximillian J. Pany, Michael E. Chernew, and Leemore S. Dafny. "Regulating Hospital Prices Based on Market Concentration Is Likely to Leave High-Price Hospitals Unaffected." *Health Affairs* (2021).

[158] Zack Cooper, Stuart V. Craig, Martin Gaynor, and John Van Reenen. "The Price Ain't Right? Hospital Prices and Health Spending on the Privately Insured." *Quarterly Journal of Economics* (2019).

(*i.e.*, where the HHI would be 10,000) are 12 percent higher than in markets where there are four or more competitors.

127.   While the authors' primary results examine the relationship between the number of competitors and inpatient prices, in an online appendix the authors also regress the logarithm of the price of inpatient services on the logarithm of the HHI in geographic markets for inpatient services. The authors find a statistically significant, positive relationship between concentration and prices, with the coefficient on the logarithm of HHI ranging between 0.047 where the size of the market depended on whether the hospital was in a large urban, urban, or rural location; and 0.100 where the size of the market was fixed at a 30-mile radius.[159] So, for example using these estimates, a five percent increase in HHI from 2,000 to 2,100 points would be predicted to increase prices for inpatient hospital services by approximately between 0.24 and 0.50 percent.[160] Conversely, a decrease in concentration as measured by the HHI would lead to a predicted decrease in prices. We later discuss using the results of this study to predict changes in inpatient prices that may be associated with changes in MGB's bargaining leverage that result from its expansion. (We focus on this study because, to our knowledge, it is the most recent peer-reviewed study of the relationship between hospital prices and market structure. The study also relies on a national database that includes commercial health care claims for more than one-quarter of individuals enrolled in employer-sponsored health plans.)

128.   Moriya *et al.* (2010) also use a large, nationwide database of commercial health insurance claims covering the period 2001 to 2003 to study the relationship between hospital and insurer concentration on negotiated pries for inpatient services.[161] The authors regress the logarithm of inpatient prices on concentration in the hospital market (measured using the HHI for inpatient

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[159] Zack Cooper, Stuart V. Craig, Martin Gaynor, and John Van Reenen. "The Price Ain't Right? Hospital Prices and Health Spending on the Privately Insured." *Quarterly Journal of Economics* (2019), Online Appendix, Appendix Table XVI.

[160] Because both the dependent variable (inpatient prices) and HHI are expressed as logarithms in this regression, the estimated coefficient on the logarithm of HHI can be interpreted as an elasticity. That is, if the estimated coefficient on the logarithm of HHI is β and HHI increases by p percent, the predicted increase in prices is approximately $\beta \times p$. For example, 0.24 percent is calculated as the product of 0.05 (the five percent increase in HHI) and the coefficient of 0.047 from the authors' estimate. Similarly, 0.50 percent is calculated as the product of 0.05 (the five percent increase in HHI) and the coefficient of 0.100 from the authors' estimates.

[161] Asako Moriya, William B. Vogt, and Martin Gaynor. "Hospital prices and market structure in the hospital and insurance industries." *Health Economics, Policy and Law* (2010).

services in a geographic market corresponding to CMS's Hospital Service Areas), concentration in the insurance market, hospital characteristics (*e.g.*, teaching status), patient demographics, and health plan characteristics. In their primary specification, the authors find a positive but statistically insignificant relationship between hospital prices and hospital concentration. The authors note, however, that their results appear sensitive to the inclusion of claims data for hospitals in Michigan and Georgia. If their data are limited to claims for just these two states, the coefficient on hospital concentration becomes positive and marginally statistically significant, providing some evidence that higher concentration is associated with higher prices in those states.

129.   Dranove *et al.* (2008) hypothesize that the growth of managed care plans in the 1990s allowed insurers to limit increases in negotiated hospital prices, but that consumer preferences for broad provider networks in the late 1990s and early 2000s diminished this ability.[162] That is, consumers' demand for inclusive hospital networks may limit the ability of insurers to negotiate lower prices because insurers cannot credibly threaten to exclude hospitals from their network. To study this question, the authors use data on hospital prices in California and Florida in 1990, 1995, 1999, 2001, and 2003 to estimate the relationship between hospital concentration and prices. Hospital prices are measured using the average reimbursement for a set of ten common inpatient services, while concentration is measured using a hospital-specific measure of concentration. Using this approach, the authors find a weak, negative relationship between concentration and prices in 1990 and 1995 (*i.e.*, more concentrated hospital markets are associated with lower prices). In later years the relationship between prices and HHI becomes positive and statistically significant, with the magnitude of the relationship being largest in 2001. The authors conclude that, despite the "managed care backlash," insurers appeared to be successful in negotiating lower prices with hospitals in more competitive markets.

130.   Melnick and Keeler (2007) analyze growth in California hospital prices between 1999 and 2003, a period that was marked by significant growth in these prices.[163] The authors' primary research question concerns whether being part of a multi-hospital system was associated with

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[162] David Dranove, Richard Lindrooth, William D. White, and Jack Zwanziger. "Is the impact of managed care on hospital prices decreasing?" *Journal of Health Economics* (2008).

[163] Glenn Melnick and Emmett Keeler. "The effects of multi-hospital systems on hospital prices." *Journal of Health Economics* (2007).

faster rates of growth in a hospital's prices. To address this question, the authors construct a measure of hospital reimbursement for a bundle of ten common inpatient services, and regress that measure of inpatient prices on controls for whether the hospital was part of a system (distinguishing between "small" systems comprised of between two and fourteen hospitals and "large" systems with at least fifteen hospitals), hospital characteristics, and a hospital-specific measure of concentration. In their baseline specification the authors find a positive, statistically significant relationship between inpatient prices and concentration; however, adding controls for time-invariant county attributes (*i.e.*, county fixed effects) reduces the magnitude of the price-concentration relationship and causes it to become statistically insignificant. As such, the study provides, at best, only weak evidence that more concentrated hospital markets are associated with higher prices.

131.   Antwi *et al.* (2009) assess changes in hospital prices in California between 1992 and 2006. The authors note that hospital prices for commercially insured patients in California *decreased* between the early and late 1990s but then increased sharply between 1999 and 2006.[164] The annual average increase in inpatient prices over this later period was 10.6 percent, so that hospital prices in 2006 were nearly double what they had been in 1999. To determine whether the sharp increase in hospital prices starting in 1999 might be attributed to changes in hospital concentration, the authors calculate hospital HHIs using counties as assumed geographic markets. While the authors note that county-level HHIs increased between 1999 and 2006—from an average of 2,046 in 1992 to 2,824 in 2003—they conclude that the observed pattern of price increases and concentration is not consistent with the hypothesis that growth in hospital concentration led to growth in hospital prices. Specifically, the authors note that if increases in concentration led to increases in prices, one would expect to see prices rising most in markets where concentration rose the most. However, the largest price increases were observed in relatively concentrated markets where the HHI changed little over this period, while markets with large changes in concentration experienced moderate growth in prices.

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[164] Yaa Akosa Antwi, Martin S. Ganor, and William B. Vogt. "A Bargain at Twice the Price? California Hospital Prices in the New Millennium." *Forum for Health Economics & Policy* (2009).

2. Effect of Entry and Expansion on Competition in the Provision of Health Care Services

132.   There is an extensive health economics literature on the effect of hospital acquisitions on hospitals' negotiating leverage with commercial insurers and hospital prices. While this literature does not speak directly to the effect of entry or expansion on health care providers' bargaining leverage, it is potentially relevant for evaluating the competitive impact of the proposed project because acquisitions of health care providers are the inverse of health care provider entry. That is, while hospital acquisitions remove an independent competitor from the market (the acquired hospital does not close, but ceases to exist as a separate firm), entry achieves the opposite effect. As such, if there is some symmetry in the effects of removing and adding a competitor, studying the effects of health care provider acquisitions may provide useful guidance as to the likely competitive effects of provider entry or expansion.

133.   Gaynor and Town (2012) summarize less recent research on the impact of hospital mergers on price and the quality of care provided by the hospitals.[165] Based on their review of the empirical economics literature, the authors conclude that the consensus view is that "hospital consolidation generally results in higher prices" and that competition improves the quality of care provided by hospitals. Gaynor *et al.* (2015) is a more recent critical review of the empirical evidence on the effect of hospital competition on prices.[166] Based on their review, the authors conclude that "mergers between rival hospitals are likely to raise the price of inpatient care and these effects are larger in concentrated markets. The estimated magnitudes are heterogenous and differ across market settings, hospitals, and insurers."

134.   We are aware of one study that provides evidence on the effects of expansions of health care providers and the effects of these expansions on negotiating leverage with commercial insurers and prices. Ho (2009) finds that capacity-constrained hospitals negotiate, on average, payments from health insurers that are $6,900 more than hospitals that are not capacity-

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[165] Martin Gaynor and Robert Town. "The impact of hospital consolidation—Update." Robert Wood Johnson Foundation: The Synthesis Project (2012).

[166] Martin Gaynor, Kate Ho, and Robert J. Town. "The Industrial Organization of Health-Care Markets." *Journal of Economic Literature* (2015).

constrained. [167, 168] The author argues that capacity-constrained hospitals are able to negotiate higher rates with health insurers because demand for those hospitals' services exceeds what the hospital can supply. The author also notes that health care providers might intentionally underinvest in capacity so as to benefit from the advantages this provides in negotiations with health insurers. Conversely, relaxing providers' capacity constraints through entry or expansion decreases their negotiating leverage with health insurers and may result in lower prices for health care services.

135.   While there have been relatively few studies of the effects of entry and expansion by health care providers on prices, there is a large literature that addresses the effects of certificate-of-need programs on health care prices and expenditures. As described by the Federal Trade Commission and Department of Justice, these programs "generally prevent firms from entering certain areas of the health care market unless they can demonstrate to state authorities that there is an unmet need for their services."[169] If certificate-of-need programs prevent entry and expansion, then estimates of the effects of these program on market outcomes may be informative regarding the effect of entry and expansion on health care market outcomes. (Of course, certificate-of-need programs may have benefits or costs that are not captured solely by examining health care expenditures or the prices of health care services.)

136.   We note that federal antitrust enforcers have generally been opposed to certificate-of-need programs because of a belief that such programs are ineffective in controlling health care costs and

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[167] Kate Ho. "Insurer-Provider Networks in the Medical Care Market." *The American Economic Review* (2009).

[168] The author defines a hospital as capacity-constrained if, according to their model of patient hospital demand, the hospital's expected utilization in terms of patient days exceeds 85 percent of its maximum capacity, calculated as its bed count times 365 days.

     The author also finds that "star" hospitals are able to negotiate payments from health insurers that are $6,700 more than hospitals that are not "stars," which is similar to their finding on capacity-constrained hospitals. The author explains that capacity-constrained hospitals tend to be stars (and vice versa), but that the effect from capacity-constraints is important because "capacity constraints seem to give the hospital additional leverage in the bargaining process, perhaps by acting as a commitment device to persuade plans that it will choose to contract selectively."

[169] Federal Trade Commission and Department of Justice, "Improving Health Care: A Dose of Competition." (July 2004), Chapter 8, p. 1.

present a risk of anticompetitive outcomes that may outweigh the benefits of these programs.[170] This position is supported by reviews of the health economics literature on the effects of certificate-of-need regulations. Mitchell (2016) synthesizes the findings of 19 peer-reviewed studies on the effects of certificate-of-need programs.[171] Based on this review, the author concludes that "the overwhelming weight of evidence suggests that [certificate-of-need] laws are associated with both higher per unit costs and higher total expenditures,"[172] although the number of studies that address the effect of certificate-of-need programs on health care expenditures—which take into account both price and quantity effects—is much greater than the number of studies that address the effect of these programs on per-unit prices.

137.   Conover and Bailey (2020) is a comprehensive review of the certificate-of-need literature that synthesizes 90 articles on the effects of certificate-of-need programs on regulatory costs, expenditures on health care services, health outcomes, and access to care.[173] In addition, the authors use the results of these studies to conduct an analysis of the cost-effectiveness of certificate-of-need programs. The authors find that evidence on the effect of certificate-of-need programs on health care expenditures is mixed, but that the weight of the evidence is that these programs increase health care expenditures. These higher expenditures are offset by beneficial effects that certificate-of-need programs have in reducing mortality rates for some patients and procedures. The authors conclude that the costs of certificate-of-need programs somewhat outweigh the benefits, although there is considerable uncertainty in their estimates.

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[170] *See*, for example, Federal Trade Commission and Department of Justice, "Improving Health Care: A Dose of Competition." (July 2004), Executive Summary, p. 22; Joint Statement of the Antitrust Division of the U.S. Department of Justice and the Federal Trade Commission on Certificate-of-Need Laws and Alaska Senate Bill 62; Federal Trade Commission Office of Policy Planning, Bureau of Competition, and Bureau of Economics Comment Before the Georgia Department of Community Health (October 16, 2017); Statement of Commissioner Christine S. Wilson, Joined by Commissioner Noah Joshua Phillips, *In the Matter of Methodist Hospital/Tenet St. Francis Hospital*, File No. 1910-0189 (November 13, 2020); Maureen K. Ohlhausen, "Certificate of Need Laws: A Prescription for Higher Costs." *Antitrust* (2015).

[171] Matthew D. Mitchell. "Do Certificate-of-Need Laws Limit Spending?" Mercatus Working Paper, Mercatus Center, George Mason University (2016).

[172] Matthew D. Mitchell. "Do Certificate-of-Need Laws Limit Spending?" Mercatus Working Paper, Mercatus Center, George Mason University (2016), p. 29.

[173] Christopher J. Conover and James Bailey. "Certificate of need laws: a systematic review and cost-effectiveness review." BMC Health Services Research (2020).

138.   In summary, while there is little economic literature that is directly relevant to the effects of expansion by BWFH on the prices for inpatient and outpatient health care services, the weight of the evidence—including the hospital merger literature and certificate-of-need literature—suggests that expansion in health care markets is likely to lower prices for consumers.

B. Inpatient Services

139.   For inpatient services, we calculate the shares of MGB and its competitors in the service area of BWFH in two steps.[174] First, using the Hospital Inpatient Discharge Database, we calculate hospital systems' shares of inpatient discharges and the resulting HHIs in each ZIP Code in Massachusetts. Second, we calculate the weighted averages of these shares and HHIs across ZIP Codes in Massachusetts, where each ZIP Code is weighted by BWFH's discharges in that ZIP Code. This measure of market concentration is commonly used in the hospital competition literature because it does not require precisely delineating the boundaries of a specific geographic market (*e.g.*, the primary service area or secondary service area of a health care provider).[175] The use of this approach also avoids potentially misleading conclusions about changes in providers' competitive significance and bargaining leverage if the geographic market is defined too narrowly or broadly.[176] Rather, the approach we employ reflects MGB's significance in all ZIP Codes in Massachusetts, but we weight more heavily MGB's shares in the ZIP Codes that account for a greater fraction of BWFH's discharges.

140.   Using this approach, Figure BWFH10 reports inpatient shares in BWFH's service area.

- MGB has the highest share (38 percent) in BWFH's own service area. However, Brigham and Women's Hospital's share in BWFH's service area (14 percent) is slightly higher than BWFH's share in its own service area (13 percent).

- Beth Israel Lahey Health has the second-to-highest share in BWFH's service area, with a share of 24 percent.

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[174] All calculations in this section adopt the inpatient service line definitions we described in Section III.B.1.

[175] *See*, for example, Christopher Garmon. "The accuracy of hospital screening methods." *RAND Journal of Economics* (2017).

[176] U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010), Section 4.

- Other health systems with a share in BWFH's service area exceeding five percent are Boston Medical Center (share of nine percent) and Steward Health Care (share of 12 percent).

141.   As we noted above, in addition to assessing MGB's current market shares, the DoN program asked that we consider how those shares might change if MGB's DoN were approved, and how changes in MGB's shares might affect its negotiating leverage with third-party payors. To address this question, we first use our model of demand for inpatient hospital services and the method for simulating the effect of the proposed expansion of BWFH on patients' demand for inpatient services that we described in Section VI.A. Using this approach, we assess the impact of the project on MGB's shares and market concentration by comparing current shares and concentration to the predicted shares and concentration resulting from our simulation. Using the economics literature that we summarized in Section VII.A, we then relate the predicted change in concentration to determine how MGB's negotiating leverage might change as a result of the proposed project.

142.   Figure BWFH11 reports each hospital's share of inpatient admissions in BWFH's service area and the implied concentration levels before and after the proposed project under two scenarios.

- First, we assume that the proposed additional medical/surgical beds at BWFH would be used to, where possible, provide care to patients who otherwise would have been admitted to Brigham and Women's Hospital.[177]

- In the second simulation, we allow BWFH to draw its incremental patients from any hospital.

143.   In the first scenario—shown in the left panel of Figure BWFH11—we predict that BWFH's share of discharges in its service area would increase by seven percentage points from 13 percent to 20 percent. However, MGB's overall share increases by less than this amount because most of the additional BWFH discharges are patients who otherwise would have received care at Brigham and Women's Hospital (whose share in BWFH's service area declines by six percentage points).

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[177] BWFH Bed Summary Response, pp. 1-2.

The competing hospital whose share in BWFH's service area declines by the largest amount is Beth Israel Deaconess Medical Center; its share is predicted to decline by only 0.4 percentage points. Because BWFH's expansion in this scenario largely results in the transfer of patients from Brigham and Women's Hospital (an academic medical center) to BWFH (a community hospital), the effect on concentration in BWFH's service area is an increase of 80 points from 3,864 to 3,945. As we noted earlier, according to the *Horizontal Merger Guidelines*, transactions resulting in a change in HHI of less than 100 points are unlikely to lead to adverse competitive effects.[178] As such, we believe that the proposed project is unlikely to affect MGB's negotiating leverage with third-party payors in this scenario.

144.   In the second scenario—shown in the right panel of Figure BWFH11—we predict that BWFH's share of discharges in its service area would increase by approximately eight percentage points from 13 percent to 22 percent. MGB's overall share increases by somewhat less than this amount because some of the additional BWFH discharges are patients who otherwise would have received care at Brigham and Women's Hospital (whose share in BWFH's service area declines by two percentage points) and Massachusetts General Hospital (whose share in BWFH's service area declines by one percentage point). The non-MGB competing hospitals whose share in BWFH's service area decline by the largest amounts are Beth Israel Deaconess Medical Center and Boston Medical Center, whose shares in BWFH's service area are predicted to decline by, respectively, two percent and one percent. While these changes in shares are modest, the effect on concentration in BWFH's service area in this scenario is an increase of 412 points from 3,864 to 4,276. While this exceeds the safe-harbor threshold in *Horizontal Merger Guidelines*, it is well below the threshold at which prior hospital transactions have been challenged.[179] In addition, as we discuss in Section IX.A, BWFH's expansion in this scenario would move patients from higher-cost academic medical centers—Brigham and Women's Hospital, Massachusetts General Hospital, Beth Israel Deaconess Medical Center, and Boston Medical Center—to a lower-cost

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[178] U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010)*, § 5.3.

[179] For example, using the estimates of Cooper *et al.* (2019), an increase in HHI of 412 from 3,864 to 4,276 represents an approximately 11 percent increase in concentration that would be predicted to increase inpatient prices by between approximately 0.5 and 1.1 percent.

community hospital. The direct effect of these cost savings would likely outweigh any indirect effect resulting from an increase in MGB's negotiating leverage.

C. Outpatient Services

145. In this section we assess BWFH's current share for outpatient MRI services in the hospital's service area and how those shares might change if MGB's DoN were approved. We also assess how changes in BWFH's share of outpatient MR scans in its service area might affect its negotiating leverage with third-party payors.

146. For outpatient diagnostic imaging services, we use the same general approach that we used in analyzing BWFH's share for inpatient services and the effect of the proposed project on those shares. Specifically, we use the 2018 APCD and Medicare Claims data to calculate the shares of MGB and its competitors in BWFH's service area for outpatient diagnostic imaging services in two steps. First, we calculate health care providers' share of outpatient MR scans and the resulting HHIs in each ZIP Code in Massachusetts. Second, we calculate the weighted averages of these shares and HHIs across ZIP Codes, where each ZIP Code is weighted by the number of outpatient MR scans that BWFH provided in that ZIP Code.

147. In addition to assessing MGB's current market shares, the DoN asked that we consider how those shares might change if MGB's DoN were approved, and how changes in MGB's shares might affect its negotiating leverage with third-party payors. To address this question, we use our model of demand for outpatient diagnostic imaging services and the method for simulating the effect of the proposed project on patients' demand for those services that we described in Section VI.B. Using this approach, we assess the impact of the project on MGB's shares and market concentration by comparing current shares and concentration to the predicted shares and concentration resulting from our simulation. We do this for outpatient MR scans in BWFH's service area. Using the economics literature that we summarized in Section VII.A, we then relate the predicted change in concentration to determine how MGB's negotiating leverage for outpatient diagnostic imaging services might change as a result of the proposed project.

148. Using this approach, Figure BWFH12 reports shares for outpatient MR scans in BWFH's service area. If the proposed project were approved, we predict that BWFH's share of outpatient MR scans in its service area would increase by 0.6 percentage points from 7.1 percent to 7.7

percent.[180] MGB's overall share increases by less than this amount because some of the additional BWFH volume comes from patients who otherwise would have received services at other MGB facilities (*i.e.*, the share of other MGB facilities in BWFH's service area decreases by 0.2 percentage points from 25.5 percent to 25.3 percent). Given the small increase in BWFH's share in its own service area, the predicted effects of the proposed project on other providers' shares are *de minimis*: The shares of competing providers in BWFH's service area change by no more than 0.1 percentage points. Using the predicted change in shares, the bottom panel of Figure BWFH12 shows that the HHI in BWFH's service area is projected to increase by only 25 points from 2,159 to 2,184. As we noted earlier, according to the *Horizontal Merger Guidelines*, transactions resulting in a change in HHI of less than 100 points are unlikely to lead to adverse competitive effects.[181] As such, we believe that the proposed expansion of BWFH's MR imaging capacity would not meaningfully increase MGB's bargaining leverage with third-party payors.

VIII. Reimbursement Rates for Brigham and Women's Physician Organization Community Physicians

149.   As part of the ICA for the BWFH project, the DoN program ask that we analyze the cost impact associated with a greater amount of care being provided at BWFH rather than at Brigham and Women's Hospital. We address this potential change in costs for institutional reimbursement (*i.e.*, the amount the hospital itself is paid for providing inpatient care) in Section IX.A. In this section, we address the potential change in costs for physician reimbursement (*i.e.*, the amount that is paid to physicians who provide care at Brigham and Women's Hospital or BWFH). In particular, the DoN program asked us to compare the rates of the academic Brigham and Women's Physician Organization ("BWPO") physicians who practice at Brigham and Women's Hospital and BWFH with the rates of community physicians who practice at BWFH.

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[180] The BWFH DoN proposes adding a 3-Tesla MRI unit at the hospital to supplement to the hospital's existing 1.5-Tesla MRI unit, which effectively doubles the hospital's capacity for MR scans. (BWFH DoN, Appendix 2, Section 2.1, p. 3.) However, MGB projects a smaller increase in the number of MR scans performed at the hospital: from 6,096 MR scans in fiscal year 2019 to a projected 6,647 MR scans in fiscal year 2024, which represents a 9 percent increase. (BWFH DoN, Appendix 2, Table 8.) We use this projected increase in MR scan volume at BWFH as the basis for our simulations rather than the proposed increase in MRI capacity, which results in a smaller predicted change in BWFH's share.

[181] U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010)*, § 5.3.

150.   Based on our analysis of the APCD, BWPO physician rates do not depend on whether care was provided at Brigham and Women's Hospital or BWFH. (This is not true of the institutional rates paid to the hospital itself; those rates are generally higher for academic medical centers like Brigham and Women's Hospital than for community hospitals like BWFH.) As such, an increase in the number of MGB patients who receive care at BWFH rather than Brigham and Women's Hospital would have no effect on the physician component of cost if BWPO physicians provided care in both circumstances.

151.   However, as we describe below, our analysis shows BWPO rates are typically higher than the rates of community physicians who practice at BWFH. As such, if the proposed BWFH project allowed patients who otherwise would have received care at Brigham and Women's Hospital to receive care at BWFH, and if those patients were treated by community physicians at BWFH instead of BWPO academic physicians, we conclude that costs related to the physician component of care may be reduced.

152.   To evaluate potential cost savings from physician reimbursement if patients were to shift from Brigham and Women's Hospital to BWFH, we use the APCD data to compare professional fees for services provided at BWFH by BWPO physicians with the professional fees for services provided at BWFH by community physicians. To do this, we limit the APCD to professional claims related to inpatient and outpatient services provided at BWFH and identify which claims were associated with BWPO physicians or with community physicians.[182]

153.   To account for differences in reimbursement rates among third-party payors, we segment our analysis into commercial insurance, Medicare health plans, and MassHealth managed care plans. We exclude physician reimbursement rates for Original Medicare and MassHealth non-managed care from this analysis:

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[182] To distinguish between BWPO and BWFH community physicians we rely on the 2019 physician roster data from the Massachusetts Registration of Provider Organizations ("MA-RPO"), which identifies, among other things, the medical group that each physician belongs to. We consider claims where the rendering physician is not part of BWPO or does not appear in the MA-RPO data to correspond to services offered by community physicians. (Additional information on the MA-RPO data, including reporting requirements for provider organizations, is *available at* https://www.mass.gov/doc/ma-rpo-program-overview/download. The MA-RPO data is available upon request from the Massachusetts Health Policy Commission.)

- Original Medicare pays for physician services using the Medicare Physician Fee Schedule. This fee schedule pays the same rate to physicians providing the same service at the same location regardless of physician group membership.[183]

- MassHealth non-managed care also pays the same rate to physicians providing the same service at the same location regardless of physician group membership.[184]

154. Lastly, to account for any differences in the services provided by BWPO and BWFH community physicians, we express reimbursement rates for each service relative to the Medicare Physician Fee Schedule amount for that service.[185]

155. Our analysis suggests that if patients were to shift from Brigham and Women's Hospital to BWFH and receive care from BWFH community physicians, overall costs (*i.e.*, across all payor categories) for the physician component of care would be slightly lower.

- For commercial insurance, we find that reimbursement rates for BWFH community physicians are, on average, 14 percent lower than BWPO rates.

- For MassHealth managed care plans, we find that reimbursement rates for BWFH community physicians are, on average, eight percent lower than BWPO rates.

- For Medicare health plans, we find that reimbursement rates for BWFH community physicians are, on average, five percent higher than BWPO rates.

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[183] MedPAC Payment Basics, "Physician and Other Health Professional Payment System," (Revised: November 2021), *available* *at* https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_physician_final_sec.pdf.

[184] Rates for Medicine Services (effective August 1, 2021), *available at* https://www.mass.gov/doc/rates-for-medicine-services-effective-august-1-2021-0; Rates for Radiology Services (effective August 1, 2021), *available at* https://www.mass.gov/doc/rates-for-radiology-services-effective-august-1-2021-0; Rates for Surgery and Anesthesia Services (effective August 1, 2021), *available at* https://www.mass.gov/doc/rates-for-surgery-and-anesthesia-services-effective-august-1-2021-0. We understand that supplemental payments may be made to physicians associated with UMASS Medical school provided at affiliated teaching hospitals.

[185] To account for potential outliers, we also exclude claims, separately for BWPO and BWFH community physicians and by insurance type, with charges relative to the Medicare fee schedule that fall into the top and bottom five percent of claims.

IX. Predicted Changes in Health Care Expenditures

156. As part of our evaluation of the proposed project on health care costs in Massachusetts, the DoN program asked that we evaluate how the project might change utilization of relatively higher- and lower-priced health care providers, and to assess the effect of any changes in utilization on health care expenditures in Massachusetts. To answer this question, we use our models of patients' demand for health care services to predict how patients' choices of health care providers would change if the proposed project were approved. We then use our measures of the relative prices of health care services—separately by health care provider, service line, and third-party payor—to estimate the cost impact of changes in where patients choose to receive care if the proposed project were approved.

A. Inpatient Services

157. For inpatient services, we forecast changes in health care expenditures associated with the proposed project using (i) the simulations we described in Section VI.A that forecast inpatient hospital utilization after the proposed project, and (ii) the CHIA Inpatient Relative Price Data described in Section III.A.5. Specifically, the simulations summarized in Figure BWFH11 predict which patients would switch to BWFH to receive care after the proposed project. For each patient who would switch to BWFH, the Hospital Inpatient Discharge Data identify the source of the patient's health insurance coverage. We then use the CHIA Inpatient Relative Price Data to compare the prices—which are specific to the patient's health insurance coverage—for the inpatient service at the hospital utilized by the patient to prices for the same inpatient service at BWFH. If the price for the service is higher at BWFH than at the hospital the patient previously utilized, health care expenditures will increase. If the price for the service at BWFH is lower than the price at the hospital the patient previously utilized, health care expenditures will decrease. For patients whose choice of hospital is unaffected (*i.e.*, the patient continues to receive care at BWFH or one of its competitors after the completion of the proposed project), there is no impact on health care expenditures.

158. As we remarked above, the Hospital Inpatient Discharge Database that we use to estimate demand for inpatient hospital services reports the type of insurance coverage for each patient (*e.g.*, commercial, Original Medicare, MassHealth) and the payor that insures or administers the patient's health plan. For example, the simulations summarized in the left panel of Figure

BWFH11 show that BWFH's share of inpatient discharges in its service area is predicted to increase by seven percentage points as a result of the proposed project, primarily at the expense of Brigham and Women's Hospital, whose share in BWFH's service area decreases by six percentage points. The Brigham and Women's Hospital patients who are predicted to switch to BWFH are covered by many different payors. Nearly half are covered by Original Medicare, another 15 percent are covered by a BCBS-MA commercial health plan or Medicare Advantage plan, and so on.

159.   The overall effect of these switches on inpatient hospital expenditures depends on the relative prices of BWFH and the hospitals that patients are switching from. For example:

- CHIA reports that BCBS-MA pays BWFH commercial rates that are two percent lower than BCBS-MA's average commercial rates across its hospital network. CHIA also reports that BCBS-MA pays Brigham and Women's Hospital commercial rates that are 36 percent higher than BCBS-MA's average commercial rates across its hospital network. Based on CHIA's calculations, this implies that BCBS-MA will incur a 28 percent decrease (= 0.98 ÷ 1.36 - 1) in expenditures on average for each patient enrolled in a commercial plan who switches to BWFH from Brigham and Women's Hospital.

- CHIA reports that Tufts Health Plan pays BWFH Medicare Advantage rates that are 14 percent lower than Tufts' average Medicare Advantage rates across its hospital network. CHIA also reports that Tufts pays Brigham and Women's Hospital Medicare Advantage rates that are 77 percent higher than Tufts' average Medicare Advantage rates across its hospital network. This implies that Tufts will incur a 51 percent decrease (= 0.86 ÷ 1.77 - 1) in expenditures on average for each patient enrolled in a Medicare Advantage plan who switches to BWFH from Brigham and Women's Hospital.

In these examples, the overall effect on a payor's inpatient hospital expenditures then depends on how many patients of each type would switch to BWFH after the proposed project. Suppose that we use discharge information for 100 BCBS-MA commercial patients to estimate our model of demand for inpatient services. If ten of these patients switch from Brigham and Women's Hospital to BWFH following the project, BCBS-MA's overall expenditures on inpatient hospital services would decrease by 2.8 percent (= -28 percent × 10 ÷ 100). If only one of these patients switch,

BCBS-MA's overall expenditures on inpatient hospital services would decrease by 0.28 percent (= -28 percent × 1 ÷ 100).

160. The above illustrative examples calculated inpatient hospital expenditure changes separately by payor. We do not report payor-specific results and instead summarize our calculations for each type of payor (*e.g.*, commercial, Medicare health plans, MassHealth managed care, MassHealth non-managed care, and Original Medicare). For example, if ten BCBS-MA commercial enrollees and five Tufts Medicare Advantage enrollees are predicted to switch to BWFH after the proposed project and these are the only enrollees predicted to switch, then we would calculate the effect on all payors' inpatient hospital expenditures as an average of -35.7 percent per switch (= -28 percent × 10 - 51 percent × 5 ÷ 15).

161. Figure BWFH13 summarizes the results of this calculation using our model's full predictions of which patients would switch to BWFH and the relative prices for those patients' care at BWFH and at the hospital they are switching from.[186] As shown in the left panel of this figure, if we assume that, whenever possible, BWFH admits patients that would otherwise have been admitted to Brigham and Women's Hospital, we predict that commercial payors' average expenditure for inpatient services will decrease by 20.3 percent for each patient who switches to BWFH. Similarly, we predict that the average expenditure will decrease by 31.7 percent for each Medicare health plan member who switches to BWFH and 30.3 percent for each MassHealth managed care plan member who switches. Changes in expenditure for patients covered by MassHealth non-managed care and Original Medicare—where prices are set administratively rather than negotiated—are smaller. We predict that Original Medicare's and MassHealth non-managed care's average expenditure will decrease by 8.7 percent and increase by 0.2 percent, respectively, for each patient who switches to BWFH. Overall, across all coverage types, we predict that the average expenditure for inpatient services will decrease by 11.3 percent for each patient who switches to BWFH.

162. These decreases in expenditures on inpatient hospital services are limited to patients who we predict would switch to BWFH following the proposed project. However, the choices of most

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[186] Using CHIA's Inpatient Relative Price Data, we were able to determine the relative prices for 58 percent of the discharges in the Hospital Inpatient Discharge Data used to estimate our model of demand for inpatient hospital services (excluding patients enrolled in Original Medicare or MassHealth non-managed care plans).

patients who receive inpatient hospital care would be unaffected by project. Because there would be no change in inpatient health care expenditures for these patients, the total effect on expenditures for inpatient services will be smaller than the size of the effect we calculate for patients who switch. These total effects are reported in Figure BWFH13 and represent total expenditure effects across patients residing in Massachusetts and who received relevant inpatient services within the state. Across all coverage types, we predict that the average expenditure per person for inpatient hospital services (*i.e.*, including both patients who switch to BWFH and patients whose choices are unchanged) would decrease by 0.10 percent.

163.   The right panel of Figure BWFH13 shows the results of the cost impact calculations if we assume that, post-expansion, BWFH attracts patients from all the other hospitals that it competes with (rather than prioritizing patients who otherwise would have been admitted to Brigham and Women's Hospital). In this scenario, we predict that commercial payors' average expenditure on inpatient services will decrease by 0.4 percent for each patient who switches to BWFH. Similarly, we predict that Medicare health plans' and MassHealth managed care plans' average expenditure on inpatient services will decrease by 16.7 percent and 13.3 percent, respectively, for each patient who switches to BWFH. As before, changes in expenditures for patients covered by MassHealth non-managed care and Original Medicare—where prices are set administratively rather than negotiated—are smaller. On average, we predict that Original Medicare and MassHealth non-managed care expenditure on inpatient services will decrease by 2.8 percent and increase by 0.6 percent, respectively, for each patient who switches to BWFH. Overall, across all coverage types, we predict that average expenditure on inpatient services will decrease by 2.8 percent for each patient who switches to BWFH. While we still predict a net decrease in expenditures for inpatient health care services due to the lower relative prices associated with BWFH, these effects are attenuated because the price differential between BWFH and competing hospitals is smaller than the price differential between BWFH and Brigham and Women's Hospital.

164.   The total effect on expenditures for inpatient services will be smaller than the expenditure effect for patients who would switch to BWFH. Across all coverage types, Figure BWFH13 shows that predicted average expenditure per person (*i.e.*, including both patients who switch to BWFH and patients whose choices are unchanged) for inpatient hospital services would decrease by 0.02 percent under our second scenario.

B. Outpatient Services

165.   Similar to our approach for inpatient services, for outpatient services we forecast changes in health care expenditures associated with the proposed project using (i) the simulations we describe in Section VII.C that forecast utilization of outpatient health care services after the proposed project, and (ii) estimates of the relative prices of outpatient health care providers—which are based on, among other things, the prices we observe in the APCD—that we discussed in Section III.C. For example, the simulations summarized in Figure BWFH12 predict which patients would switch to receiving outpatient MR scans at BWFH after the proposed project. For each patient who would switch to BWFH, the APCD and Medicare Claims data identify the source of the patient's health insurance coverage. We then use our relative price measures to compare the prices—which are specific to the patient's health insurance coverage—for the outpatient MR scan at the facility the patient is switching from to the prices for the same outpatient MR scan at BWFH. If the price for the service is higher at BWFH than at the facility the patient is switching from, health care expenditures will increase. If the price for the service at BWFH is lower than at the facility the patient is switching from, health care expenditures will decrease. If a patient's choice of outpatient diagnostic imaging facility is unaffected (*i.e.*, the patient continues to receive care at BWFH or one of its competitors), there is no impact on health care expenditures.

166.   For example, the simulations summarized in Figure BWFH12 show that BWFH's share of outpatient MR scans in its service area is predicted to increase by 0.6 percentage points as a result of the proposed project, partially at the expense of Beth Israel Lahey Health, whose share in BWFH's service area decreases by 0.1 percentage points. While not reported in Figure BWFH12, the APCD and Medicare Claims data we use for these simulations contain information on the source of health insurance coverage for each patient predicted to switch from Beth Israel Lahey Health to BWFH. Among patients switching from Beth Israel Lahey to BWFH, 43 percent have Original Medicare or MassHealth non-managed care coverage. As we explained in Section III.C, health care expenditures will not change for patients covered by Original Medicare or MassHealth non-managed care who switch to receiving an outpatient MR scan at BWFH instead of a Beth Israel Lahey HOPD, since the price for outpatient MR scans should be the same across HOPDs

located in the same geography.[187] The remainder of patients switching from Beth Israel Lahey to BWFH are covered by commercial health plans, Medicare health plans, or MassHealth managed care plans. BCBS-MA commercial plans, for example, cover ten percent of the patients predicted to switch from Beth Israel Lahey Health to BWFH. Because we can directly observe in the APCD data the amount that BCBS-MA reimburses BWFH and Beth Israel Health for the same outpatient MR scans, we can predict the change in BCBS-MA expenditures when its members switch to receive an outpatient MR scans at BWFH instead of Beth Israel Lahey Health. We perform this exercise separately for each outpatient facility that BWFH is predicted to draw patients from and for each third-party payor that covers the patients predicted to switch to BWFH from these facilities.[188] Aggregating these calculations across facilities and payors for each patient predicted to switch to BWFH yields an estimate of how health care expenditures will change following the proposed project.[189]

167. In addition to calculating the effect of the proposed project on changes in expenditures associated with outpatient MR scans, we also calculate the effect of the proposed project on expenditures for advanced endoscopy procedures using a somewhat different approach discussed in Section IX.B.2 below.

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[187] Since BWFH and Beth Israel Lahey HOPD are located in the same wage rate area (and geography), they get the same reimbursement rates for outpatient services from Original Medicare (or MassHealth non-manage care).

[188] To determine relative prices, we calculate the allowed amounts for outpatient MR scans relative to the Medicare fee schedule by health insurer, type of health plan coverage (*e.g.*, commercial or Medicare health plan), health system (*e.g.*, MGB or Beth Israel Lahey Health), facility type (*e.g.*, HOPD or freestanding diagnostic imaging center), and facility ZIP Code. For some patients who are predicted to switch from a competing provider to BWFH, there was an insufficient amount of pricing data in the APCD to reliably calculate relative price of BWFH and the competing provider. We do not use the relative price information for these patients for our per-procedure estimate of the change in expenditures on outpatient MR scans.

[189] We calculate the overall change in health care expenditures as a weighted average of the changes in health care expenditures for the patients who are predicted to switch.

For example, suppose that 50 percent of the patients switching to BWFH for outpatient MR scans are BCBS-MA commercial health plan members who switched from a Shields Health Care Group facility and 30 percent are Tufts Health plan Medicare health plan members who switched from a Beth Israel Lahey Health HOPD. Further suppose that we lack reliable information on the relative prices for the remaining 20 percent of patients predicted to switch to BWFH.

If, hypothetically, BWFH's prices for BCBS-MA commercial health plan members are ten percent higher than Shield's Health Care Group's prices for these patients, and BWFH's prices for Tuft's Health Plan Medicare health plan members are five percent higher than Beth Israel Lahey Health's prices for these patients, we would calculate the average change in health care expenditures for each patient who switches to BWFH as (0.50 × 0.10 + 0.30 × 0.05) ÷ (0.50 + 0.30) = 0.081, or 8.1 percent.

1. Diagnostic Imaging Services

168. Figure BWFH14 summarizes the changes in health care expenditures associated with the expansion of outpatient MRI capacity at BWFH.

- We predict that commercial payors' expenditures on these services will increase by 3.2 percent for each patient who switches to BWFH. Commercial patients comprise 36.0 percent of the patients predicted to switch to BWFH.

- We predict that expenditures for each patient covered by Original Medicare or a Medicare health plan who switches to BWFH will increase by 22.8 percent. Among patients who are predicted to switch to BWFH, 36.1 percent are covered by Original Medicare and 6.4 percent are covered by a Medicare health plan.

- We predict that expenditures for each patient covered by MassHealth non-managed care who switches to BWFH will increase by 0.5 percent and expenditures for each patient covered by a MassHealth managed care plan who switches will increase by 1.8 percent. Among patients who are predicted to switch to BWFH, 2.5 percent are covered by MassHealth non-managed care and 15.6 percent are covered by a MassHealth managed care plan.

- Overall, across all coverage types, we predict that expenditures on outpatient MR scans will increase by an average of 11.3 percent for each patient who switches to BWFH. We also predict the total effect on expenditures for patients—regardless of whether they switch to BWFH—who reside in Massachusetts and receive MR scans from facilities in Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, and Worcester Counties. Our estimate indicates that total expenditure will increase by a negligible amount due to the small numbers of patients who would switch to BWFH.

2. Advanced Endoscopic Services

169. In its DoN application for BWFH, MGB proposed to build an advanced endoscopy room at BWFH. According to MGB, this would allow BWFH to provide care for patients requiring these procedures rather than transferring those patients to Brigham and Women's Hospital; it would also allow BWFH to accept transfer patients from Brigham and Women's Hospital who might require

advanced endoscopic procedures.[190] While BWFH currently offers advanced endoscopy at the hospital, those procedures are performed in the hospital's operating rooms, which MGB argues is suboptimal.[191]

170.   As we noted earlier, the number of advanced endoscopy procedures historically provided at BWFH is too low to permit us to reliably estimate a model of patients' demand for these procedures at the hospital and to use that model to estimate the cost impact of adding an advanced endoscopy room at BWFH. As an alternative, to assess the cost impact of MGB's proposal we use the APCD to compare the prices of advanced endoscopy procedures at BWFH and Brigham and Women's Hospital.[192]

171.   We use the APCD to compare reimbursement rates for advanced endoscopic procedures at Brigham and Women's Hospital and BWFH separately by procedure code, health insurer (*e.g.*, BCBS-MA), and health plan type (*e.g.*, commercial, MassHealth managed care, or Medicare health plans). For commercial, MassHealth managed care, and Medicare health plans, we find that reimbursements for advanced endoscopic procedures were ten percent lower at BWFH than at Brigham and Women's Hospital.

172.   For patients covered by Original Medicare or MassHealth non-managed care plans, there would be no change in reimbursement rates if advanced endoscopic procedures were performed at BWFH instead of Brigham and Women's Hospital. Medicare pays for care rendered in HOPDs, including advanced endoscopies, using the Outpatient Prospective Payment System.[193] Under this system, payments at Brigham and Women's Hospital and BWFH for the same outpatient

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[190] BWFH DoN, Appendix 2, Section 2.1.C and MGB-BWFH_DoN-Questions_MGB-20121716-HE - Applicant Response.docx [hereinafter, BWFH Applicant Responses], Q15.c.

[191] BWFH Applicant Responses, Q4.

[192] BWFH identifies advanced endoscopies as Endoscopic Retrograde Cholangiopancreatography and Endoscopic Ultrasound procedures, which it indicates require specialized equipment that is not used in standard endoscopy. (BWFH Applicant Responses, Q15.a-b.)

[193] MedPAC Payment Basics, "Outpatient Hospital Services Payment System," (Revised: November 2021), *available at* https://www.medpac.gov/wp-content/uploads/2021/11/medpac_payment_basics_21_opd_final_sec.pdf.

procedures will be identical.[194] Similarly, MassHealth non-managed care pays for care rendered in HOPDs, including advanced endoscopies, using a standardized adjudicated payment amount per episode of care. [195] Under this system, payments at Brigham and Women's Hospital and BWFH for the same outpatient procedures will be identical.[196]

173.   In summary, we find that rates for advanced endoscopy at BWFH are either lower than or the same as rates for the same procedures at Brigham and Women's Hospital. As such, providing advanced endoscopic procedures at BWFH rather than Brigham and Women's Hospital would result in lower health care expenditures.

X.   Other Considerations

A. Effect on Demand for Health Care Services

1.   The Potential for Supply-Induced Demand

174.   In connection with our evaluation of the effects of the proposed project on utilization of health care services in Massachusetts, the DoN program asked that we consider the potential for the project to lead to "supply-induced demand." Supply-induced demand is generally defined by economists as a "physician providing care that a fully informed patient would not choose for [themself]."[197] While we cannot estimate the extent to which utilization of the health care services referenced in the DoN application might increase as a result of supply-induced demand, we review the existing health economics literature on this subject.

175.   Assuming for this purpose that the proposed project would be associated with increased service utilization for the Applicant's facilities, the relevant question is how to distinguish between

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[194] While payments under the Outpatient Prospective Payment System are adjusted for differences in area wage rates, Brigham and Women's Hospital and BWFH are located in the same area.

[195] MassHealth: Payment for In-State Acute Hospital Services and Out-of-State Acute Hospital Services, effective November 1, 2021. Attachment B, *available at* https://www.mass.gov/doc/notice-of-final-agency-action-masshealth-payment-for-in-state-acute-hospital-services-and-out-of-state-acute-hospital-services-effective-november-1-2021-0.

[196] Standardized rates under the MassHealth non-managed care fee schedule are adjusted to reflect differences in area wages, but BWFH and Brigham and Women's Hospital are located in the same wage area.

[197] Mark V. Pauly, Thomas G. McGuire, and Pedro Pita Barros (eds). *Handbook of Health Economics*, Volume 2. North Holland, Elsevier (2012) [hereinafter, HANDBOOK], Chapter 6: Amitabh Chandra, David Cutler, and Zirui Song. "Who Ordered That? The Economics of Treatment Choices in Medical Care." p. 414. This article provides a good overview of the underlying economic models of supply-induced demand.

an increase in utilization that is attributable to, on the one hand, the new capacity for MGB to serve demand that was previously unmet due to capacity constraints and, on the other hand, MGB providing more services to patients once the complementary resources (*e.g.*, hospital beds, operating rooms, imaging equipment) are available to do so. This second category of increased utilization corresponds to a supply-induced demand effect.

176. The standard simplified economic model of supply-induced demand assumes that physicians have two motivations: primarily to provide care that maximizes patients' health and secondarily to increase earnings. The presence of a financial motivation for physicians combined with patients' lack of expertise regarding treatment efficacy creates the potential for supply-induced demand. Under this model, observed variation in service utilization in different parts of the country may be at least in part due to how physicians are reimbursed. Physicians who are paid for each service that they provide may be more susceptible to financial motivations than salaried physicians—such as those employed by MGB—and physicians reimbursed under alternative payment models or as part of accountable care organizations.

177. It is also critical to recognize that physicians' views about the efficacy of particular treatments, willingness to adopt new technologies, risk aversion, or access to complementary resources (which can affect or be affected by local practice norms) vary. This variability is attributable to physicians' views about *what* services maximize patient health rather than to the characteristics typically linked to supply-induced demand: variability in the importance of financial incentives combined with patients' imperfect information on treatment efficacy. In assessing the potential for variation in utilization, services can be categorized into three groups:[198]

- Treatments that are known (and generally perceived) to be highly effective, *e.g.*, beta blockers for heart attacks. These services may be costly, but they are generally highly productive for well-defined categories of patients, or they are reasonably productive across a wide range of patients and low cost. As a result, utilization of these services is not likely to exhibit much variability (or be susceptible to supply-induced demand).

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[198] HANDBOOK: Chapter 2: Jonathan Skinner. "Causes and Consequences of Regional Variation in Health Care.", pp. 54-56.

- Treatments for which there is substantial heterogeneity in the benefit across different types of patients, *e.g.,* stents that work well for patients with recent heart attacks but are much less effective later in the patients' recovery, or back surgery. Differences of opinions across physicians regarding the likely patient benefit may lead to different utilization patterns for these services.

- Treatments for which evidence of benefit is small or unknown.

This last category is most likely to exhibit substantial variability and be most susceptible to supply-induced demand. However, a service for which clinical guidance is lacking, the scope of harm (the risk) from providing the service is small, or the benefit is idiosyncratic across patients is, all else equal, more likely to exhibit variation in utilization because of differing physician beliefs regarding treatment efficacy.[199]

178.   In assessing the causes of regional variation in observed utilization—either in aggregate or for individual services—the empirical economic literature tends to attempt to distinguish between variation in direct patient demand due to differences in health status, ability to pay, and supply-induced factors. This literature typically finds that both demand and supply factors are relevant in explaining variation in utilization of health care services, but that more variation is explained by supply factors than by demand factors. This finding alone, however, does not support the conclusion that construction or expansion of health care facilities will lead to supply-induced demand because differences in utilization are also often attributable to substantial variation in physician beliefs about treatment effectiveness.

179.   There are limitations to many of the existing studies that attempt to distinguish between demand- and supply-driven factors. These studies are often based on the experiences of Medicare beneficiaries because utilization data are more readily available for this patient cohort; however, findings for the Medicare cohort may not be generalizable to the broader population of patients. Many studies are also of limited use because they are descriptive rather than attempt to sort out

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[199] Mark V. Pauly, Thomas G. McGuire, and Pedro Pita Barros (eds). *Handbook of Health Economics*, Volume 2. North Holland, Elsevier (2012) [hereinafter, HANDBOOK], Chapter 6: Amitabh Chandra, David Cutler, and Zirui Song. "Who Ordered That? The Economics of Treatment Choices in Medical Care." pp. 402-403.

causation: for example, does the high utilization and lower mortality in McAllen, Texas imply that the additional health care services offered to patients in that community produce "good outcomes," or are those additional services unnecessary because the population's underlying health status is greater?[200] Some recent studies have used a more robust empirical approach to address the issue of causation. I describe findings from a few such studies below.

180.   Cutler *et al.* (2019) use vignette-based physician and patient surveys linked with Medicare claims to assess whether physician or patient characteristics can explain variation in Medicare expenditures across geographic areas.[201] The authors survey both primary care physicians and cardiologists using vignettes that describe elderly patients with particular conditions and medical histories and ask the physicians how they would provide care for such patients. Based on their responses, surveyed physicians are characterized non-exclusively as "cowboys" (physicians who routinely recommend care beyond what clinical guidelines suggest) and "comforters" (those who consistently recommend palliative care for severely ill patients). The surveys also measure the frequency with which physicians recommend that patients return for follow-up visits and collect information on the physicians' compensation arrangements and practice structure. Patient preferences are measured by asking patients about whether they would choose aggressive or palliative end-of-life care and whether they would seek additional testing or cardiac referrals for new chest pain.

181.   The authors estimate models that attempt to explain either total health care expenditures in the last two years of life or spending following heart attacks as a function of provider-specific factors and patient preferences. They use data from the Dartmouth Atlas on Medicare spending across the largest Hospital Referral Regions and aggregate physician and patient survey responses to this level. They also estimate a model using individual patient-level expenditures for heart attacks. Using this approach, the authors find that end-of-life spending is positively related to the

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[200] Atul Gawande. "The Cost Conundrum," *The New Yorker* (June 1, 2009), *available at* https://www.newyorker.com/magazine/2009/06/01/the-cost-conundrum; *See also*, HANDBOOK, Skinner, p. 62.

[201] David Cutler, Jonathan S. Skinner, Ariel Dora Stern, and David Wennberg. "Physician Beliefs and Patient Preferences: A New Look at Regional Variation in Health Care Spending." *American Economic Journal of Economic Policy* (2019).

proportion of cowboys, negatively related to the proportion of comforters, and positively related to the fraction of physicians who recommend more frequent follow up than is suggested by clinical guidelines. [202] Demand-based factors and patient preferences are generally not significant, although physicians' expressed "pressure to accommodate" patients (or their referring physicians) has a small but statistically significant relationship with physician beliefs about appropriate care patterns.

182.   The authors also estimate models that attempt to explain variation in expenditures on heart attack patients across Hospital Referral Regions. They find that high proportions of cowboys and high-follow-up physicians are associated with higher expenditures and the opposite is true for comforters and low-follow-up physicians. They also find that Hospital Referral Regions with larger proportions of cowboys and high-follow-up physicians experience higher-quality care for acute myocardial infarction. While this evidence might be interpreted as indicating supply-induced demand (if physicians become motivated as cowboys due to financial considerations), the authors note the limited role of financial factors in explaining variation in physician practice patterns.[203] Rather, the authors find that surveyed physicians express very different beliefs about the efficacy of particular treatments. Most importantly, the variation in health care expenditures in this study was linked to differences in physician practice patterns, not to differences in the number or capacity of health care facilities in each region.

183.   Clemens and Gottlieb (2014) investigate the extent to which physicians' compensation arrangements affect their treatment recommendations.[204] They use a natural experiment based on a 1997 change in the way the Medicare program adjusted physician payment rates geographically to analyze how physician treatment decisions change when their reimbursement changes.[205] The

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[202] The local proportion of cowboys/comforters explains 36 percent of variation; when the frequency of high- or low-follow-up recommenders is added, the regressions explain 62 percent of variation.

[203] The authors do find that practice type is associated with treatment recommendations. Solo or two-person practices—practicing in an environment that is dissimilar to MGB-employed physicians—are more likely to be cowboys and high-follow-up physicians.

[204] Jeffrey Clemens and Joshua Gottlieb. "Do Physicians' Financial Incentives Affect Medical Treatment and Patient Health?" *American Economic Review* (2014).

[205] CMS varies the fee schedule amounts for physicians using "Geographic Adjustment Factors" that account for differences in where physicians practice. In 1997, CMS consolidated the regions in which these Geographic

authors estimate both the aggregate effect on the amount of care provided to patients as well as the effect on the number of individual services offered to patients. They find that Medicare services in aggregate indicate a long-run wage elasticity of approximately 0.6 (*i.e.*, the quantity of services provided by physicians increases as their reimbursement for providing those services increases).[206] The authors also assess the effect of the reimbursement change on the provision of particular services. They develop a model of physician incentives based on both perceptions of what maximizes patient health and financial considerations. They posit that elective procedures are more likely to offer moderate benefits for many patients, while other services such as emergency department treatment or chemotherapy benefit only specific patients and may have substantial negative effects as well as benefits. As a result, they predict that elective procedures are more likely to respond to changes in reimbursement. Classifying services into specific categories, they find evidence consistent with their theory: approximately two-thirds of the supply response is attributable to the one-third of services that are relatively "elective."

184.   Finally, the authors focus on two specific services: the provision of MRIs and cardiac care. They find that the provision of MRIs did respond positively to price changes, but their finding was only marginally statistically significant. Moreover, they found that almost the entire effect was attributable to the increased supply of MRIs by non-radiologists performing services in their offices and not in diagnostic imaging centers. The authors also find a positive supply response for elective cardiac services such as catheterization and angioplasty, with most of the response focused on increased services provided to populations already receiving relatively intensive care.

185.   Ikegami *et al.* (2021) assess how physicians at one hospital change their use of MRIs when a neighboring hospital purchases a new MRI.[207] Using administrative panel data on Japanese hospitals' ownership and usage of MRIs between 2005 and 2014, they find that a hospital's MRI patient count falls by up to 6.6 percentage points when a surrounding hospital purchases an

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Adjustment Factors were calculated. As a result, some physicians experienced increases in Medicare reimbursements while others experienced decreases.

[206] Specifically, the authors estimate a long-run elasticity of 1.5 but note that Medicare reimbursement rates compensate physicians for the costs they incur in addition to their own efforts. Using an average of about 40 percent of Medicare reimbursement attributable to physician work, they calculate a wage elasticity of 0.6.

[207] Kei Ikegami, Ken Onishi, and Naoki Wakamori. "Competition-driven physician-induced demand." *Journal of Health Economics* (2021).

additional MRI. They also find that the hospital that loses patients compensates by offering more of its remaining patients MRIs than it had previously. They attribute this response to "competition-driven physician-induced demand." The authors note that in the Japanese health system, physicians and hospitals cannot affect the reimbursement they receive for health care services, so the primary competitive response that they can make is in volume. They also note that it is possible that the greater number of patients receiving MRIs could be beneficial to patients if it is attributable to the freeing up of formerly capacity-constrained equipment.

186.   Finkelstein *et al.* (2016) use another type of natural experiment to assess regional variation in health care utilization.[208] They study Medicare beneficiary utilization patterns between 1998 and 2008 following patients' relocation from an area of high utilization to one of low utilization (or *vice versa*). The authors posit that if patient characteristics drive most of the variation in health care utilization, then patients who relocate should maintain their pre-existing utilization patterns regardless of whether they move to an area with utilization patterns that differ from their own. However, instead what they observe is a sharp change in utilization patterns the year that a patient moves. The change in utilization is equal to about half of the difference between the average utilization patterns across the origin and destination locations of the patients' moves, regardless of the direction of the move. Patient characteristics such as health status are important, but the authors find that these characteristics explain, on average, about 47 percent of regional variation in utilization. They also find substantial variation in the effects that patient characteristics have on demand for individual services. Patient characteristics play a stronger role in explaining variation in services such as emergency department care or preventive care and a smaller role in explaining variation in diagnostic testing. Supply-side factors are particularly pronounced in areas with more "cowboy" physicians (using the data collected in Cutler *et al.* (2019) discussed above) and more for-profit hospitals, as well as in areas with more women patients, less-educated patients, and sicker patients.

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[208] Amy Finkelstein, Matthew Gentzkow, and Heidi Williams. "Sources of Geographic Variation in Health Care: Evidence from Patient Migration." *Quarterly Journal of Economics* (2016).

187.   Finally, Young *et al.* (2021) examine whether physicians who become hospital employees change their usage of MRIs following employment.[209] The authors suggest that physicians who are employed by a hospital system may be more likely to refer their patients for services that benefit the hospital financially, particularly for those services for which efficacy is uncertain or disputed. Using the Massachusetts APCD, they assess health insurance claims between 2009 and 2016. They combine these data with information on physician employment derived from Medicare claims data and physicians' Taxpayer Identification Numbers (TINs). They classify MRIs used to diagnose causes of lower back pain, knee pain, and shoulder pain as appropriate or inappropriate based on clinical guidelines issued by the American College of Radiology. They find that the odds of a patient receiving a referral for an MRI increased by 31 percent, relative to a comparison group, following hospital employment of the patient's physician, while the likelihood of receiving an inappropriate referral increased by 22 percent, relative to the comparison group. As the authors acknowledge, however, identifying "inappropriateness" solely on claims data, rather than through a review of the medical record has its limitations. In addition, the composition of the patient panels may have changed as the physicians transferred to hospital employment, making the results more difficult to interpret.

188.   On balance, the health economics literature finds that both demand- and supply-related factors are important in explaining variability in the utilization of health care services and health care expenditures. However, the literature that examines the causes of supply-related variation in demand for health care services finds that most evidence is consistent with the role of physicians' differing beliefs about the efficacy of alternative treatments and differing practice patterns in explaining that variation, rather than on the availability of the types of complementary inputs that are sought by MGB in its DoN application.

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[209] Gary J. Young, E. David Zapada, Stephen Flaherty, and Ngoc Thai. "Hospital Employment Of Physicians In Massachusetts Is Associated With Inappropriate Diagnostic Imaging." *Health Affairs* (2021).

2. The Effect of Reduced Boarding Time in Hospital Emergency Departments or Post-Anesthesia Care Units

189.   In its application, MGB notes that an increase in the number of beds at the hospital may reduce the amount of time that patients spend boarding in BWFH's emergency department. A recent Kaiser Health News analysis documented long average lengths of stay in hospital emergency departments across many states and found that Massachusetts has among the longest emergency department lengths.[210] Assessing the experience of hospitals in California in particular, the analysis noted that emergency department crowding has led to an increase in the number of patients who leave the emergency department without having their care completed. In California, the number of such patients increased by 57 percent between 2012 and 2017.

190.   In its DoN application for BWFH, MGB noted that the total number of emergency department boarder hours increased by eight percent from fiscal year 2017 to fiscal year 2019, with average emergency department boarder hours increasing from 1.17 hours to 1.47 hours over the same period.[211] In addition, MGB proposes establishing an 8-bed observation unit that MGB argues would help, among other things, alleviate capacity constraints in the hospital's post-anesthesia care unit ("PACU").[212] In this section, we briefly review the health literature on the effects of emergency department boarding on patient outcomes and health care expenditures. Generally, this literature finds that reducing emergency department boarding times improves patient outcomes and reduces hospital lengths of stay; a related literature finds that reducing emergency department waiting times also lowers costs and improves outcomes. While less research has been done on the effects of boarding in the PACU, we also describe the conclusions of one study that addressed this question. The study found that PACU boarding had no effect on patient outcomes but did increase postoperative length of stay for some patients.

191.   Several studies have addressed the effect of emergency department boarding on patient outcomes. Liu *et al.* (2009) assessed the frequency of undesirable events associated with patients

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[210] Phillip Reese. "As ER Wait Times Grow, More Patients Leave Against Medical Advice," *Kaiser Health News* (May 2019)*, available at* https://khn.org/news/as-er-wait-times-grow-more-patients-leave-against-medical-advice/.

[211] BWFH DoN, Appendix 2, p. 10.

[212] BWFH DoN, Appendix 2, pp. 14-15.

who boarded in the emergency department of a large, urban academic medical center.[213] The undesirable events reflected in the study design included missed home medications, missed laboratory test results, and arrhythmias. Using retrospective chart analyses, the authors found that 28 percent of patients who boarded in the emergency department experienced an undesirable event and 3.3 percent had a preventable adverse event. Undesirable events were more common among older patients and those with more comorbidities.

192.   Boulain *et al.* (2020) assessed whether emergency department boarding for more than four hours prior to admission increased the risk of in-hospital mortality or lengthened inpatient stay.[214] The authors used a retrospective analysis of all patients admitted through the emergency department of a large academic medical center in France. They found that the odds of in-hospital mortality were significantly higher for those patients who boarded in the emergency department for more than four hours. In addition, the authors found that admitted patients who boarded in the emergency department for more than four hours remained hospitalized longer: the median length of stay for these patients was two days longer, and the mean length of stay for these patients was 1.15 days longer.

193.   Van Loveren *et al.* (2021) assessed the likelihood that patients admitted to a hospital through the emergency department experienced delirium during their hospital stays after boarding in a hospital hallway.[215] The authors used a retrospective chart review of all patients admitted to an academic medical center through the hospital's emergency department who did not initially present in the emergency department with cognitive impairment. They found that those patients who were subsequently diagnosed with delirium while in the hospital had spent a larger proportion

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[213] Shan W. Liu, Stephen H. Thomas, James A. Gordon, Azita G. Hamedani, and Joel S. Weissman. "A Pilot Study Examining Undesirable Events Among Emergency Department–Boarded Patients Awaiting Inpatient Beds." *Annals of Emergency Medicine* (2009).

[214] Thierry Boulain, Anne Malet, and Olivier Maitre. "Association between long boarding time in the emergency department and hospital mortality: a single-center propensity score-based analysis." *Internal and Emergency Medicine* (2020).

[215] Kate van Loveren, Arnav Singla, Liron Sinvani, Christopher Calandrella, Thomas Perera, Martina Brave, Lance Becker, and Timmy Li. "Increased Emergency Department Hallway Length of Stay is Associated with Development of Delirium." *Western Journal of Emergency Medicine* (2021).

of their emergency department boarding time in a hospital hallway and boarded in the emergency department longer before being admitted.

194.   While not a study of boarding times, Woodworth and Holmes (2020) used the quasi-random assignment of patients to triage nurses with varying proclivities to classify patients as requiring urgent or semi-urgent assistance to measure the effect of emergency department wait times on costs and outcomes.[216] Classification by triage nurses affects patients' locations in the emergency department queue and, thus, the times that they are likely to wait. Reviewing the electronic medical records for patients at large academic urban emergency departments, the authors found that for a person arriving with the most severe conditions, waiting an additional ten minutes increased the hospital's cost to care for the patient by six percent on average. For patients with moderately severe conditions, waiting an additional ten minutes increased costs by three percent on average, while for relatively healthy patients additional waiting time did not appear to affect costs. Gruber *et al.* (2021) studied how physicians responded to the adoption of a United Kingdom policy that imposed strong incentives to treat patients presenting in the emergency department within four hours.[217] The authors found that the policy reduced emergency department wait times by 21 minutes, increased the intensity of emergency department treatment, and increased inpatient admissions to hospitals. The authors also found a significant 14 percent reduction in mortality, which their analysis indicated resulted from the reduced wait times rather than increased hospital admissions.

195.   Less has been written about the effect of longer PACU boarding times on patient outcomes or cost. One analysis by Charsha (2016) analyzed the effect of PACU boarding on critically ill patients awaiting an intensive care unit bed.[218] Using data from 2002 to 2010, the author compared outcomes for patients who spent more than six hours in the PACU with those who spent less time before transferring to another location. She found no statistically significant differences between

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[216] Lindsey Woodworth and James F. Holmes. "Just a Minute: The Effect of Emergency Department Wait Time on the Cost of Care." *Economic Inquiry* (2020).

[217] Jonathan Gruber, Thomas P. Hoe, and George Stoye. "Saving Lives by Tying Hands: The Unexpected Effects of Constraining Health Care Providers." *The Review of Economics and Statistics* (2021).

[218] Diane Susan Charsha. "Impact on Health Outcomes of Boarding Postoperative Critically Ill Stable Older Patients." Thesis submitted to Drexel University Faculty (March 2016), *available at* https://idea.library.drexel.edu/islandora/object/idea%3A6658.

the two groups with respect to functional status decline or hospital mortality. However, she did find that PACU boarders were more likely to have a longer postoperative length of stay for those patients who stayed more than nine days in the hospital.

B. Who Bears the Burden of Higher Costs or Benefits from Cost Savings?

196.   As we noted earlier, the DoN program asked that the ICA address the question of if costs were to increase because of the proposed project, who bears the burden of that change in costs: third-party payors, patients, or health-plan sponsors? Similarly, if costs were to decrease because of the proposed project, who benefits from those savings? We focus our discussion of these questions on commercially insured patients for whom the link between health care expenditures, out-of-pocket costs, health plan premiums, and earnings is most direct. We do not address this question for government-sponsored health insurance such as Medicare or MassHealth because health care provider reimbursement for these programs is typically not negotiated.

197.   Assessing who bears health care cost increases or decreases requires an understanding of how, and to what extent, those changes are passed on to various parties. That is, to the extent that the proposed project results in a reduction of health care costs because care is delivered more efficiently, are these cost reductions passed on to third-party payors, and do those payors, in turn, pass them onto employers that purchase health plans on behalf of their workers? Conversely, if the proposed project increases the bargaining leverage of MGB with commercial payors and negotiated prices increase commensurately, do those payors increase premiums for the health plans they insure? An additional, related question is whether patients who receive care are directly affected, either through the out-of-pocket payments (*i.e.*, coinsurance amounts or deductible payments) they make or through changes in their wages or the proportion of health plan premiums that they must pay.

198.   Starting with the question of whether increases in health care expenditures are passed on by third-party payors in the form of higher premiums, we note that expenditures on health care services received by plan members comprise almost all health plan expenses. An analysis conducted by CMS found that slightly fewer than 90 percent of premiums for private health

insurance in 2019 were used to pay for health care services received by plan members.[219] As expenditures on health plan benefits, such as hospital services, increase—either because of an increase in utilization of health care services or an increase in reimbursement for those services— so do health plan premiums. As a general matter of economics, increased costs are passed on to consumers in the form of higher prices, with the precise magnitude of the increase in prices resulting from an increase in costs depending on the cost pass-through rate.[220]

199.   The pass-through of costs is particularly evident for self-insured health plans. In such plans, the health plan administrator will receive and process claims, but the employer sponsoring the plan is ultimately responsible for paying those claims. In the United States, 64 percent of people enrolled in private employer-sponsored health plans are enrolled in self-insured plans.[221] For fully insured health plans, the premiums for the plan are typically established at the beginning of the plan year and cannot be subsequently adjusted during the plan year. However, this does not mean that participants in those plans are insulated from the effects of increases in expenditures on health care services. Premiums for fully insured plans are often determined on an annual basis, and claims incurred by plan participants in the previous year can affect premiums for the plan in subsequent years.[222]

200.   The relationship between health plan premiums and expenditures on health care services is evident in longitudinal data compiled by CMS on premiums and health care service expenditures that is shown in Figure BWFH15.[223] Two features of these data are noteworthy. First, as we noted

[219] Centers for Medicare and Medicaid Services, National Health Expenditure Accounts, Table 20, *available at* https://www.cms.gov/files/zip/nhe-tables.zip.

[220] *See* Complaint, *In the Matter of Methodist Le Bonheur Healthcare and Tenet Healthcare Corporation*, Federal Trade Commission Docket No. 9396, ¶ 4. In that complaint, the Federal Trade Commission discussed the loss of competition that would have allegedly resulted from a proposed hospital merger and the effect of increased hospital prices on consumers: "Commercial insurers will have to pass on at least some of those higher healthcare costs to employers and their insurance plan members in the form of increased premiums, co-pays, deductibles, and other out-of-pocket expenses. 'Self-insured' employers that pay the cost of their employees' healthcare claims directly will bear the full and immediate burden of higher reimbursement rates and other less favorable terms."

[221] Kaiser Family Foundation, "Employer Health Benefits: 2021 Annual Survey," Figure 10.1, *available at* https://files.kff.org/attachment/Report-Employer-Health-Benefits-2021-Annual-Survey.pdf.

[222] *See* Peter R. Kongstvedt (ed.). *The Managed Health Care Handbook,* Fourth Edition. Gaithersburg, Aspen Publishers (2001), Chapter 49.

[223] Centers for Medicare and Medicaid Services. National Health Expenditure Accounts, Table 20, *available at* https://www.cms.gov/files/zip/nhe-tables.zip.

above, in 2019 almost 90 percent of health plan premiums were used to pay participants' claims—almost all premiums collected by health plans were used to pay for health care services. Second, CMS's data show that expenditures on health care services increased substantially between 2010 and 2019, and health plan premiums increased at almost the same rate. Expenditures on health care services increased by an average annual rate of 4.4 percent over this period, while health plan premiums increased by an average annual rate of 4.3 percent (*i.e.*, slightly less than the rate of increase of health care costs). These data show, therefore, that health care expenditures are the primary determinant of health plan premiums, and as those expenditures increase (or decrease), so do premiums.

201.   Given the strong relation between health care expenditures and health plan premiums, we turn next to the incidence of increases in employer-sponsored health insurance premiums on employers and their workers. This question has been addressed in several economic studies, which are based on models that recognize that this incidence depends on elasticities of labor supply and demand, regulatory and institutional constraints on wages (*e.g.*, minimum hourly wages), and the value that workers place on health insurance. These studies recognize that workers consider their total compensation (*i.e.*, wages plus non-wage benefits) in evaluating alternative employment opportunities and how many hours to work at the prevailing level of compensation. These analyses generally find that workers bear most of the increase in the cost of health insurance premiums through reduced wages—either directly or indirectly through increased required contribution to health insurance premiums—or hours. While there does not appear to be any published literature on the effect of premium reductions because premiums generally increase year-over-year, one would expect that these would also pass on to workers primarily in the form of higher wages.

202.   Kolstad and Kowalski (2016) analyzed Massachusetts' adoption of individual and employer mandates in 2006.[224] The authors found that annual wages for workers with employer-sponsored insurance were lower by about $2,800 relative to what these same workers would have been paid without employer-sponsored insurance. They calculated that this reduction in wages was

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[224] Jonathan T. Kolstad and Amanda E. Kowalski. "Mandate-based health reform and the labor market: Evidence from the Massachusetts reform." *Journal of Health Economics* (2016).

slightly less than the amount that employers typically spent on insurance coverage (*i.e.*, the cost of health insurance was largely borne by workers in the form of lower wages).

203.   Anand (2017) assessed the relationship between the rising costs of employer-sponsored insurance cost and worker compensation between 2003 and 2010, analyzing separately the effects on wages, non-health fringe benefits, and worker contributions to health plan premiums.[225] The author finds that total hourly compensation decreases by $0.52 for every $1 increase in the cost of employer-sponsored insurance, with almost all the decrease attributable to higher worker contributions to health plans, while hourly wages and non-health benefits remain relatively unchanged.

204.   Baicker and Chandra (2006) examined the effect of rising health insurance premiums between 1996 and 2002 on wages, employment, and the proportions of full- and part-time workers employed by firms.[226] The authors use variation in medical malpractice premiums across states and its effect on health insurance premiums to measure the incidence of cost increases in health care services. (As we discussed above, the authors assume, based on the economic literature, that the demand for medical services is inelastic so that increases in malpractice premiums are passed on to health insurers, who in turn pass them on to their customers.) They find that a ten percent increase in health insurance premiums reduces the likelihood of being employed by 1.2 percentage points, reduces hours worked by 2.4 percent, and increases the likelihood that a worker is employed part-time by 1.9 percentage points. For workers covered by employer-sponsored insurance, the increase in premiums reduces wages by 2.3 percent. All told, the authors conclude that the cost of rising health plan premiums is borne primarily by workers.

205.   Gruber (1994) examined changes in state and federal laws during the mid- and late 1970s that mandated that insurance plans cover maternity benefits to assess who bears the increased cost

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[225] Priyanka Anand. "Health Insurance Costs and Employee Compensation: Evidence from the National Compensation Survey." *Health Economics* (2017).

[226] Katherine Baicker and Amitabh Chandra. "The Labor Market Effects of Rising Health Insurance Premiums." *Journal of Labor Economics* (2006).

associated with benefit mandates. [227] The author finds that the costs of the mandates are shifted completely to workers, with little effect on net labor input.

206.   Lastly, a related question is how the cost of employer-sponsored insurance is shared by employers and workers. Rae *et al*. (2019) found that in 2018, large employers paid approximately two-thirds of the cost of family policies for their workers, while workers bore the remaining one-third of the cost. [228] Of the cost borne by workers, approximately two-thirds was related to premium contributions and one-third was related to cost-sharing in the form of out-of-pocket payments such as copayments, coinsurance, and deductibles. The percentage of total cost borne by workers increased from 32 to 34 percent between 2008 and 2018. This analysis is consistent with data from the National Compensation Survey compiled by the Bureau of Labor Statistics, which indicate a two-thirds employer and one-third worker split in the share of health insurance premiums for family plans, while employers pay 80 percent of the premiums for single coverage.[229]

207.   In summary, the economic evidence suggests that increases in health care expenditures associated with members of employer-sponsored health plans lead to higher health plan premiums, with the pass-through rate being close to one-for-one (*i.e.*, a one dollar increase in expenditures increases health plan premiums by one dollar). Economic studies of the incidence of increases in the cost of employer-sponsored insurance show that both employers and workers bear these costs, although the preponderance of evidence suggests that they are borne primarily by workers. While there does not appear to be any published literature on the effect of premium reductions on worker compensation, we would expect that the benefits of lower premiums would pass on to workers in the form of higher wages.

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[227] Jonathan Gruber. "The Incidence of Mandated Maternity Benefits." *American Economic Review* (1994).

[228] Matthew Rae, Rebecca Copeland, and Cynthia Cox. "Tracking the rise in premium contributions and cost-sharing for families with large employer coverage," Peterson-KFF Health System Tracker (2019), *available at* https://www.healthsystemtracker.org/brief/tracking-the-rise-in-premium-contributions-and-cost-sharing-for-families-with-large-employer-coverage.

[229] Bureau of Labor Statistics National Compensation Survey. "Table 4. Medical plans: Share of premiums paid by employer and employee for family coverage," (March 2021), *available at* https://www.bls.gov/news.release/ebs2.t04.htm; Bureau of Labor Statistics National Compensation Survey. "Table 3. Medical plans: Share of premiums paid by employer and employee for single coverage," (March 2021), *available at* https://www.bls.gov/news.release/ebs2.t03.htm.

XI. Conclusions

208.   The DoN program requested that we provide short-term (*i.e.*, five years) and long-term (*i.e.*, ten years) projections of changes in demand at BWFH for inpatient services and outpatient MR scans. Our projections account for the effects of expected changes in population and demographic shifts, but hold other factors affecting the demand for and supply of health care services constant. Our projections are summarized in Figure BWFH16 below. As shown in the figure, we project that demand for adult inpatient services (excluding obstetrics, behavioral health, substance use disorder, and rehabilitation services) at BWFH will increase by 21 percent over the next ten years, while demand for outpatient MR scans will increase by 15 percent over the same period.

Figure BWFH16

Service Line (Units)	Projected Increase in Demand at BWFH
Adult Inpatient (Patient Days)	21%
Outpatient MR (Scans)	15%

209.   In both cases, these predicted increases are driven by the projected population growth in the service area of the hospital and the aging of that population. In particular, the number of residents in the hospital's inpatient service area age 65 and older—who tend to require more health care services—is projected to grow by 30 percent over the next decade. These projected increases in demand for care at BWFH are in addition to a 39 percent increase in patient days at the hospital (including both inpatient and observation stays) that occurred between 2015 and 2019.

210.   The DoN program asked that we evaluate MGB's market share for the services addressed in the DoN application and that we assess how those shares might change if MGB's DoN application were approved. For inpatient services, we model changes in BWFH's share under two scenarios. First, we assume that the proposed additional medical/surgical beds at BWFH would be used to, where possible, provide care to patients who otherwise would have been admitted to Brigham and Women's Hospital. Second, we allow BWFH to attract patients from any competing hospital (including other MGB hospitals). This first approach results in smaller changes to MGB's share in BWFH's service area because most patients are simply switching their site of care from

Brigham and Women's Hospital to BWFH. Our calculations are summarized in Figure BWFH17 below. As shown in the figure, MGB's current share in BWFH's service area is between 33 and 38 percent. The proposed project would increase MGB's share in these service areas by between 1.0 and 5.2 percentage points for adult inpatient services and by 0.4 percentage points for outpatient MR scans.

Figure BWFH17

Service Line	MGB's Share Before Proposed Project	Change in MGB's Share After Proposed Project (From BWH)	Change in MGB's Share After Proposed Project (From All Comp.)
Adult Inpatient Discharges	38%	1.0%	5.2%
Outpatient MR Scans	33%	N/A	0.4%

211.   Accordingly, we conclude that the predicted changes in MGB's shares and the corresponding changes in concentration associated with the proposed project are modest and unlikely to meaningfully change the system's bargaining leverage with health insurers. Rather, the weight of the economics literature suggests that allowing health care providers—especially health care providers that are constrained in terms of capacity—to expand puts downward pressure on health care prices and reduces expenditures on health care services.

212.   The DoN program asked that we evaluate how the proposed project might change utilization of relatively higher- and lower-priced health care providers, and to assess the effect of any changes in utilization on health care expenditures in Massachusetts. We present our estimates of the effect of the proposed project on health care expenditures using two approaches. First, we measure the impact of the proposed project on the cost of health care services for only those patients who would switch to receiving care at BWFH after the hospital's proposed expansion. Second, we measure the impact of the proposed project on the cost of health care services for all patients who received the relevant service (*i.e.*, including both the patients who would switch to BWFH and the patients who would not change their health care provider). The second approach produces substantially smaller estimates of the cost impact of the proposed project because the choices of most patients would be unaffected by BWFH's expansion. We provide these estimates separately for each service line addressed in the DoN application and also combined across all

service lines.[230] Our estimates of the cost impact of the proposed project are based on current price differences between health care providers in Massachusetts and do not account for any downward pressure on prices that might result from MGB's proposed expansion.

213.   Our estimated cost impacts are summarized in Figure BWFH18 below. The first and second columns show our estimates on the change in spending per switch to BWFH (the first column shows estimates if patients mostly come from Brigham and Women's Hospital and the second column shows estimates if patients come from any competitor, including other MGB facilities); the third and fourth columns show the corresponding cost impact estimates across all patients who receive care in the relevant service line (*i.e.*, including patients who would switch to BWFH and those whose choices would be unaffected by the proposed expansion). We project cost decreases associated with the proposed inpatient expansion at BWFH but cost increases associated with the proposed expansion in outpatient MRI capacity at BWFH. Across both service lines, we project a reduction in overall health care expenditures.[231] These projected cost savings do not account for additional savings that might result from advanced endoscopic procedures being performed at BWFH instead of Brigham and Women's Hospital, or from an increase in the services provided by community physicians at BWFH rather than BWPO physicians.

Figure BWFH18

Service Line	Change in Spending Per Switch to BWFH	Change in Spending Per Switch to BWFH	Change in Spending Overall (Inpatient	Change in Spending Overall (Inpatient

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[230] To calculate the changes in expenditures across all service lines reported in Figure BWFH18, we weight the expenditure impact for each service line by the total allowed amounts for that service line. We calculate these allowed amounts using the APCD and Medicare Claims data for patients residing in eastern Massachusetts. The weights are used to measure the contribution of each service line to the total cost impact of the proposed project in order to give more weight to the cost impact associated with service lines with higher health care expenditures and less weight to service lines with lower health care expenditures.

[231] Because inpatient services comprise a much larger portion of total expenditures across both service lines than outpatient MR scans, the predicted percentage changes in spending across both service lines are similar, but not identical, to the predicted percentage changes in inpatient spending.

	(Inpatient From BWH)	(Inpatient From All Comp.)	From BWH)	From All Comp.)
Adult Inpatient Services	-11%	-3%	-0.10%	-0.02%
Outpatient MR Scans	11%	11%	0.01%	0.01%
Across All Service Lines	*-11%*	*-3%*	*-0.09%*	*-0.02%*

214.   In summary, we predict substantial increases in demand for inpatient services and outpatient MR scans at BWFH over the next decade. We also predict a small overall **decrease** in health care expenditures across the service lines associated with the proposed expansion of BWFH of at least 0.02 percent. Moreover, the economics literature predicts that allowing capacity-constrained providers such as BWFH to expand puts downward pressure on health care prices. For these reasons, we believe that the proposed project is consistent with the Commonwealth of Massachusetts' health care cost-containment goals.