

Presented to:

Massachusetts Department of Public Health

Independent Cost Analysis for:

Mass General Brigham Incorporated
DoN Application #MGB-20121612-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.

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I. Executive Summary

1. Mass General Brigham filed a Determination of Need Application that proposes construction of a new tower on the main campus of Massachusetts General Hospital. The proposed new tower would contain 482 private beds and increase the number of licensed beds at the hospital by 94 beds. The project also proposes consolidation of oncology and cardiovascular services at the new tower and acquisition of new diagnostic imaging equipment for the hospital. The total proposed expenditure associated with the project is approximately \$1.881 billion.

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. Inpatient days at Massachusetts General Hospital increased by almost five percent between 2015 and 2019; the increase in patient days for heart and vascular services was 17 percent. We predict further increases in demand for inpatient services across all service lines at the hospital in the next five to ten years. We also predict significant growth in demand for outpatient diagnostic imaging, cardiovascular services, and oncology visits at the hospital. 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—who tend to require more health care services—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 capacity-constrained health care providers such as Massachusetts General Hospital to expand puts downward pressure on health care prices and reduces expenditures on health care services.

5. The proposed project will increase expenditures on inpatient and outpatient health care services for patients who switch to receiving care at Massachusetts General Hospital. For each patient who switches to receiving care at the hospital following the proposed expansion, we predict that average health care expenditures will increase by 18 percent. However, the overall increase in health care expenditures across all the service lines associated with the proposed expansion is only 0.2 percent. This overall increase is substantially smaller than the increase in expenditures for patients who would switch to Massachusetts General Hospital because the choices of most patients would be unaffected by the proposed project.

6. 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

7. Mass General Brigham Incorporated ("MGB" or "the Applicant") filed a Determination of Need Application for project number MGB-20121612-HE on January 21, 2021 (the "MGH DoN"). In this project, the Applicant proposes constructing a new tower on the main campus of Massachusetts General Hospital ("MGH") that would contain 482 private medical/surgical and intensive care unit ("ICU") beds, corresponding to a net increase in the number of licensed beds at MGH of 94 and a net increase in the number of operational beds at MGH of 118.¹ The project also proposes consolidation of oncology and cardiovascular services at the new tower, acquisition of new diagnostic imaging equipment, and several small renovation projects at MGH's main campus and satellite locations.² The total proposed expenditure associated with the project is approximately \$1.881 billion.³

8. 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

¹ mass-general-brigham-incorporated-mgh-application-form-and-attachments.pdf [hereinafter, MGH DoN], Appendix 2, Section 2.1, pp. 1-4 and Massachusetts General Hospital - DoN Application MGB-20121612-HE - Bed Summary Response.docx [hereinafter, MGH Bed Summary Response], p. 2.

² MGH DoN, Appendix 2, Section 2.1 pp. 1-4.

³ MGH DoN, Appendix 1, Q12, p. 3.

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.⁴

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

9. As directed by the DoN program at the Massachusetts DPH, the two primary elements that 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 health care services in Massachusetts and the capacity of health care providers in Massachusetts to render those services.

10. 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?

⁴ Massachusetts Department of Public Health. “Determination of Need (DoN),” *available at* <https://www.mass.gov/determination-of-need-don>.

- 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.

11. 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).⁵

⁵ 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).

- 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.

12. 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. Massachusetts General Hospital Project

13. In its DoN application for MGH, MGB proposes construction of a new tower on MGH’s main campus.⁶ The tower would include 418 private medical/surgical beds and 64 ICU beds, with the corresponding closure of 388 existing semi-private beds in other buildings on MGH’s main campus.⁷ The increase of 94 licensed beds (from 388 to 482) would be comprised of 54 medical/surgical beds and 40 ICU beds.⁸ In addition to an increase in the number of licensed beds at MGH, the Applicant also proposes to bring into operation 24 beds that are currently licensed at MGH but that are not currently available for patient care.⁹ While approval of the DoN application would increase the number of medical/surgical and ICU beds at MGH, the application does not propose to change the number of licensed or operational beds in the obstetric unit (currently 27 beds), pediatric unit (currently 58 beds), neonatal intensive care unit (currently 21 beds), coronary

⁶ MGH DoN, Appendix 2, Section 2.1, pp. 1-2.

⁷ MGH DoN, Appendix 2, Section 2.1, pp. 1 and 17.

⁸ MGH DoN, Appendix 2, Section 2.1, p. 2.

⁹ MGH Bed Summary Response, p. 2.

care unit (currently 16 beds), burn unit (currently seven beds), or psychiatric unit (24 beds).¹⁰ In total, if the project were approved as submitted, the number of beds available for patient care at MGH's campus would increase by 118 beds from 1,019 to 1,137 beds.¹¹

14. The Applicant proposes to consolidate much of the cancer and cardiac care provided at MGH at the new tower on the hospital's main campus.¹² In addition to the aforementioned medical/surgical beds and ICU beds, 120 oncology exam rooms and 100 oncology infusion bays would be located in the tower.¹³ This corresponds to a net decrease in the number of oncology exam rooms on the MGH main campus from 123 to 120, and a net increase in the number of oncology infusion bays on the MGH main campus from 79 to 100.¹⁴ For cardiac services, MGB proposes locating 23 cardiac operating rooms in the new building; these rooms would be comprised of six conventional operating rooms dedicated to cardiology (a net increase of one on the MGH main campus) and 17 hybrid multipurpose operating rooms dedicated to cardiology (a net increase of 17 on the MGH main campus).¹⁵ In addition to the 23 cardiac operating rooms in the tower (a net increase of 18 operating rooms), the application proposes to include three new procedure rooms dedicated to cardiology in the tower.¹⁶

15. Lastly, MGB proposes to locate new diagnostic imaging equipment in the new tower. The proposed imaging equipment includes two new Computed Tomography ("CT") units (in addition to the 14 units currently on MGH's main campus), two new Magnetic Resonance Imaging ("MRI") units (in addition to the ten units currently on the campus), two new Positron Emission Tomography/Computed Tomography ("PET/CT") units (in addition to the three units currently on

¹⁰ MGH DoN, Appendix 7 and MGH Tower Questions - DoN #MGB-20121612-HE - Excel Submission Document 8.20.2021.xlsx [hereinafter, MGH Applicant Response – Excel Submission], Tab 3.a.

¹¹ MGH Applicant Response – Excel Submission, Tab 3.a.

¹² MGH DoN, Appendix 2, Section 2.1, p. 3.

¹³ MGH DoN, Appendix 2, Section 2.1, p. 3.

¹⁴ MGH Applicant Response – Excel Submission, Tab 3.b.

¹⁵ MGH Applicant Response – Excel Submission, Tab 3.b.

¹⁶ MGH Applicant Response – Excel Submission, Tab 3.b.

the campus), and one new Positron Emission Tomography/Magnetic Resonance (“PET/MR”) unit (in addition to the one non-operational unit currently on the campus).¹⁷

16. While we do not discuss them in detail in this ICA, the DoN application includes several smaller renovation projects on MGH’s main campus and at its satellite locations.¹⁸

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

17. 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

18. 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.

19. 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

¹⁷ MGH Applicant Response – Excel Submission, Tab 3.b. and MGH Tower Questions - DoN #MGB-20121612-HE - Applicant Response Final.docx [hereinafter, MGH Applicant Response], p. 19.

¹⁸ MGH DoN, Appendix 2, Section 2.1, pp. 4-5.

¹⁹ CHIA, “Massachusetts Case Mix: Hospital Inpatient Discharge Data (HIDD) Documentation Manual, Fiscal Year 2020,” *available at* <https://www.chiamass.gov/assets/docs/r/hdd/FY20-Case-Mix-Hospital-Inpatient-Discharge-Documentation-Guide.pdf>, p. 3.

²⁰ CHIA, “Massachusetts Case Mix: Hospital Inpatient Discharge Data (HIDD) Documentation Manual, Fiscal Year 2020,” *available at* <https://www.chiamass.gov/assets/docs/r/hdd/FY20-Case-Mix-Hospital-Inpatient-Discharge-Documentation-Guide.pdf>, p. 7.

²¹ CHIA, “Massachusetts Case Mix: Hospital Inpatient Discharge Data (HIDD) Documentation Manual, Fiscal Year 2020,” *available at* <https://www.chiamass.gov/assets/docs/r/hdd/FY20-Case-Mix-Hospital-Inpatient-Discharge-Documentation-Guide.pdf>, pp. 9-12.

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

20. 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

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>.)

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 Shriners’ Hospitals for Children in Springfield and Boston.

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

21. 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 (“ASCs”).

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/>.

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.

22. Our analyses utilize the 2019 Hospital Inpatient Discharge Database in conjunction with CHIA’s Relative Price Database²⁸ 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 MGH.

2. CHIA All-Payer Claims Database

23. 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.^{29, 30} All fully insured commercial health plans with membership in Massachusetts are required to submit claims data for inclusion in the APCD.³¹ 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.³² The majority of Massachusetts residents with public or private health coverage are enrolled in plans that submit claims data to the APCD.

24. The APCD includes claim line-level data for each adjudicated claim from a contributing health plan. These data include the following:³³

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 CHIA, “Massachusetts All Payer Claims Database,” *available at* <https://www.chiamass.gov/ma-apcd/>.

³⁰ 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.

³¹ 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.

³² 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).

³³ 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>.

- For claims associated with facility charges, the type of facility, such as hospital outpatient department, hospital inpatient department, or critical access hospital.³⁴
- 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.³⁵
- 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.
- The National Provider Identifier (“NPI”) associated with the servicing, rendering, and billing provider.³⁶
- 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.

³⁴ The “bill type” for each claim indicates the type of facility that provided care.

³⁵ 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).

³⁶ See Section III.A.7 for additional discussion about NPIs.

25. 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:³⁷

- 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).

26. A single claim may be adjudicated by a payor several 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.

27. 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.³⁸ 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.³⁹ These steps include (1) identifying duplicate

³⁷ 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>.

³⁸ CHIA, “Overview of the Massachusetts All-Payer Claims Database, September 2016,” p. 5, *available at* <https://www.chiamass.gov/assets/docs/p/apcd/APCD-White-Paper-2016.pdf>; and CHIA, “Massachusetts All-Payer Claims Database: Release 8.0; 2014-2018 Documentation Guide,” pp. 21-22, *available at* <https://www.chiamass.gov/assets/docs/p/apcd/apcd-8.0/APCD-Release-8-Documentation-Guide.pdf>.

³⁹ CHIA, “Medical Claims Versioning Brief,” *available at* <https://www.bidnet.com/bneattachments/?/489972194.docx>.

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.⁴⁰

28. 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, and billing provider NPIs recorded in the claims data.⁴¹ We then assign each facility its parent or owner based on online research.⁴²

29. 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.⁴³ We also exclude claims from out-of-state providers and limit to patients residing in

⁴⁰ 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.

⁴¹ 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.7.)

⁴² 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).

⁴³ 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.

one of the following Massachusetts counties: Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, and Worcester.

30. 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.⁴⁴ 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.⁴⁵

3. Medicare Claims Data

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

32. We rely on two Medicare Claim files in our analysis:⁴⁶

- The Medicare Outpatient File includes facility claims submitted by institutional outpatient providers, including hospital outpatient departments, outpatient rehabilitation facilities, and renal dialysis facilities.⁴⁷

⁴⁴ 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.

⁴⁵ We also exclude claims where the payment arrangement field indicated that the claim was paid on a per-episode basis or using enhanced ambulatory patient groupings, or was otherwise missing payment arrangement information.

⁴⁶ 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.

⁴⁷ Research Data Assistance Center, “Outpatient (Fee-for-Service),” *available at* <https://resdac.org/cms-data/files/op-ffs>.

- The Medicare Carrier File includes claims submitted by professional providers and certain facility claims.⁴⁸ 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 ASCs, and freestanding radiology centers.⁴⁹

33. Similar to the APCD, the Medicare Claims data reflect detailed claim line-level data with various information, including:⁵⁰

- 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.

⁴⁸ Research Data Assistance Center, "Carrier (Fee-for-Service)," *available at* <https://resdac.org/cms-data/files/carrier-ffs>.

⁴⁹ 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).

⁵⁰ 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>.

34. 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.

35. 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 File⁵¹ and the site of service, rendering physician, and billing provider NPIs in the Medicare Carrier File⁵² to determine the identity of the providing facility. We then assign each facility its parent or owner based on online research.⁵³

36. 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.

⁵¹ 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.)

⁵² 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.

⁵³ 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.

4. CHIA Inpatient Relative Price Data

37. 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.⁵⁴ 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.⁵⁵

38. 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 care), and product type (*e.g.*, Preferred Provider Organization or Health Maintenance Organization/Point of Service plans).⁵⁶

39. 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 payments and non-claims payments) divided by the product of the number of discharges and the case mix index.⁵⁷ 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.⁵⁸

⁵⁴ CHIA, Relative Price and Provider Price Variation website, *available at* <https://www.chiamass.gov/relative-price-and-provider-price-variation/>.

⁵⁵ 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>.

⁵⁶ 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.

⁵⁷ 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.

⁵⁸ 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.

40. 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.⁵⁹ 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’s (“BCBS-MA”) MGH relative price was 1.36. In other words, MGH received reimbursements that on average were 36 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 Faulkner Hospital was 1.08 for the same network. Using these two relative prices, BCBS-MA’s payments to Brigham and Women’s Faulkner Hospital were, on average, 21 percent less than its payments to MGH for inpatient care provided to members of its commercial health plans (*i.e.*, 1.08 is 21 percent less than 1.36).

41. 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 MGH each year and that ten of these 100 patients are instead admitted to Brigham and Women’s Faulkner Hospital. Because BCBS-MA reimburses Brigham and Women’s Faulkner Hospital 21 percent less than it does MGH, this substitution from MGH to Brigham and Women’s Faulkner Hospital would reduce BCBS-MA’s expected spending on the 100 enrollees in question by approximately 2.1 percent.⁶⁰ While this calculation is hypothetical, we implement similar calculations discussed later in this ICA to quantify the effect of the proposed project on inpatient spending.

⁵⁹ 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.)

⁶⁰ Suppose that prior to the hypothetical shift, BCBS-MA paid MGH \$136 on average for each of the 100 members admitted to MGH, for a total of \$13,600. After ten of these members switch to Brigham and Women’s Faulkner Hospital, BCBS-MA’s spending on the 100 members decreases to \$13,320, calculated as \$136 for each of the 90 members who are admitted to MGH plus \$108 for each of the ten members who are admitted to Brigham and Women’s Faulkner Hospital. The \$13,320 in total spending corresponds to a 2.1 percent reduction from \$13,600.

42. 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.^{61, 62} 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).⁶³

43. 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.

5. Medicare Inpatient Prospective Payment System Tables

44. 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.⁶⁴ 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.⁶⁵

⁶¹ 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.

⁶² 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.

⁶³ 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.

⁶⁴ CMS, Files for FY 2019 Final Rule and Correction Notice, *available at* <https://www.cms.gov/medicare/medicare-fee-service-payment/acuteinpatientpps/acute-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>.

⁶⁵ 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.

45. 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.

6. Medicare Outpatient Prospective Payment System Tables

46. 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 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.⁶⁶

47. 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.⁶⁷

⁶⁶ 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.

⁶⁷ 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>.

48. Second, to account for differences in costs across outpatient facilities, OPSS incorporates a wage index calculated by CMS separately for each Core-Based Statistical Area (“CBSA”).⁶⁸ 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 ASCs are approximately 40 percent less than reimbursements to hospital outpatient departments.⁶⁹

49. Third, CMS revises the APCs and relative weights used in the OPSS each year to reflect changes in medical practice and technology, new services, and changes in the cost of providing care.⁷⁰ While we focus on 2018 OPSS payment rates, the regular annual updates to OPSS 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.

7. National Plan and Provider Enumeration System

50. 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

⁶⁸ 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>.)

⁶⁹ The methodology used by CMS to calculate Medicare reimbursement rates to ASCs is similar to the OPSS methodology. Both methods utilize the same APC-level relative weights and adjust for differences in labor costs across CBSAs, although the wage adjustment is slightly smaller for ASCs. (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.)

⁷⁰ 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.

and Provider Enumeration System (“NPPEs”) assigns NPIs and maintains an updated database of providers that is available for download.^{71, 72}

51. Each record in the NPPEs downloadable file reflects a unique NPI,⁷³ and contains, among other things, the following information about the health care provider:

- 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.

8. UMass Donahue Institute Population Projections

52. 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.⁷⁴ The projections include breakdowns by age group and gender for each municipal civil division (“MCD”), *i.e.*, each city and town, in the state.

⁷¹ 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>.

⁷² 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.

⁷³ 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 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>.)

⁷⁴ 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>.

53. We rely on UMDI’s modeling for demographic projections of patients residing in the service areas of MGB’s DoN projects in 2025 and 2030.⁷⁵ 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.

B. Service Lines Definitions Used for Analyses

1. Inpatient Services

i. Adult Inpatient Services Excluding Obstetrics and Behavioral Health

54. 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.⁷⁶ Finally, we exclude patients who do not reside in Massachusetts.⁷⁷

ii. Cancer Services

55. To identify cancer services in the Hospital Inpatient Discharge Database, we rely on a list of ICD-9 and ICD-10 diagnosis codes that we identified as associated with oncology and cancer

⁷⁵ 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.

⁷⁶ These include transfers from an outside hospital emergency room, another unit within the same hospital, court/law enforcement, hospice facility, or another institution’s ASC.

⁷⁷ It appears that the inpatient service analyses in the MGH DoN application is not limited to patients living in Massachusetts. As such, MGB’s numbers are often higher than those in our analyses.

related care. If at least one of these diagnosis codes is among the first four unique diagnosis codes, then that discharge is considered a cancer-related inpatient.⁷⁸

iii. *Heart and Vascular Services*

56. We identify heart and vascular patients in the Hospital Inpatient Discharge Database based on whether the DRG for the discharge is associated with MDC 05, which reflects diagnosis areas related to diseases and disorders of the circulatory system. Based on our approach, some discharges could be identified as both cancer-related and heart and vascular-related based. In such cases, we treat the discharge as heart and vascular-related.

2. Outpatient Services

57. We use the APCD and Medicare Claims data for our analysis of outpatient services. We rely on the type of bill fields⁷⁹ in the APCD and the Medicare Outpatient File to limit to facility charges associated with claims from hospital outpatient departments or ASCs, and the place of service fields⁸⁰ in the APCD and Medicare Carrier file for services rendered at an 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.⁸¹ As previously mentioned, we limit our analyses to patients who reside in Massachusetts and received care in either Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, or Worcester Counties.

⁷⁸ We rely on the discharge, admitting, and as many secondary diagnosis codes (in the order they are submitted) as necessary to identify four unique diagnosis codes. These diagnosis codes appear in a separate table in the Hospital Inpatient Discharge Data where each record corresponds to a diagnosis code for a given discharge. (The *indicator* field separately identifies the admitting, discharge, and secondary diagnosis codes and the values in the *associatedindicator* field corresponds to the order in which the secondary diagnoses are submitted.)

⁷⁹ 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.

⁸⁰ The place of service is reflected in the *Site of Service* and *Place of Service* fields in the APCD and Medicare Carrier File, respectively.

⁸¹ 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.

i. Outpatient Cardiovascular Services

58. We identify outpatient cardiovascular services in the APCD and Medicare Claims data based on claim lines with surgical or non-surgical cardiovascular CPT codes.⁸² We categorize these cardiovascular CPT codes into three broad categories (*i.e.*, Cardiovascular Procedures, Surgical Procedures on Arteries and Veins, and Surgical Procedures on the Heart and Pericardium.) as well as into 69 more granular groupings. The granular groupings include, for example, Cardiac Assist Procedures, Repair Procedures for Aortic Anomalies, Pacemaker or Implantable Defibrillator Procedures, and Angioscopy Procedures on Arteries and Veins.

ii. Outpatient Oncology Services

59. To identify outpatient services related to oncology and cancer care, we follow a methodology that parallels the method we use to identify inpatient oncology services by relying on ICD-10 diagnosis codes.⁸³ In the Medicare Claims data, we identify any claim as related to oncology services if one of the cancer related diagnosis codes appears in the fields *Claim Diagnosis Code I* to *Claim Diagnosis Code IV*.⁸⁴ Similarly, in the APCD, we identify a claim as related to oncology services if one of the cancer related diagnosis codes appears on any claim line in the fields *Principal Diagnosis* and *Other Diagnosis 1* to *Other Diagnosis 3*.

60. We also assign each oncology diagnosis code to its associated region of the body when possible. These include: Breast, Endocrine, Gastrointestinal, Genitourinary, Gynecologic Oncology, Head and Neck, Hematology, Melanoma, Neuro Oncology, Sarcoma, and Thoracic Oncology.⁸⁵

iii. Diagnostic Imaging Services

61. 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

⁸² We do not treat vascular CPTs as part of cardiovascular in our analyses.

⁸³ We rely on the same set of diagnosis codes as in our analysis of inpatient oncology services.

⁸⁴ In the Medicare claims data, *Claim Diagnosis Code I* is also the *Principal Diagnosis Code*.

⁸⁵ Certain oncology-related diagnosis codes could not be assigned to a body part.

following services: CT, MRI, PET/CT, and PET/MR.⁸⁶ 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.

C. Prices for Health Care Services Used for Analyses

62. 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

i. Inpatient Services

63. 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.”⁸⁷

ii. Outpatient Services

64. 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 each outpatient service, 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.⁸⁸ As

⁸⁶ While the proposed project includes the addition of a PET/MR unit at MGH, the APCD and Medicare Claims reflect claims for 2018 and we understand that in 2018 there were no operational PET/MR units in Massachusetts.

⁸⁷ CHIA, “Relative Price and Provider Price Variation,” *available at* <https://www.chiamass.gov/relative-price-and-provider-price-variation/>.

⁸⁸ 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

discussed previously, expressing reimbursement rates relative those to paid by Original Medicare allows us to compare prices at facilities despite differences in service mix.⁸⁹ Below, we summarize the methods used to calculate the Original Medicare payment that are used to calculate the relative prices for each outpatient service discussed in this report.

- For outpatient cardiovascular services and diagnostic imaging services, 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.
- For outpatient oncology services, we first determine the amount that Original Medicare would pay for each claim line's CPT code based on the associated payment from Addendum B for that CPT code. We then aggregate these individual claim line payment amounts to the claim level to calculate what Original Medicare would pay for the visit.

65. 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 rates,⁹⁰ 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

example, suppose a facility received \$10,000 in reimbursements for CT 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 CT scan claims BCBS-MA reimbursed the facility, the overall CT scans reimbursement rate for the facility, payor, and insurance type combination would be 1.50 ($= \$9,000 / \$6,000$).

⁸⁹ 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 of claims, separately for each service line (*e.g.*, outpatient cardiovascular).

⁹⁰ 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).)

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

66. 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.⁹¹ 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.^{92,93}

ii. Outpatient Services

67. 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).⁹⁴ We

⁹¹ 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>.

⁹² 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>.

⁹³ 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.

⁹⁴ 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>.

utilize this standardized adjudicated payment amount per episode of care to construct relative prices at in-state hospitals or outpatient services.⁹⁵

68. 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.⁹⁶ 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.

69. We estimate cost savings specific to each service associated with instances when a MassHealth non-managed care patient shifts from receiving outpatient services at an HOPD to an ASC.⁹⁷ We estimate these cost savings using a combination of the APCD and MassHealth fee schedules. For outpatient services we limit the APCD to the relevant services as identified in Section III.B.2 for patients enrolled in MassHealth non-managed care. Then, separately for ASCs and HOPDs, we calculate the amount that MassHealth non-managed care plans reimbursed for each outpatient service relative to what Original Medicare would have paid for the same service at an HOPD. Finally, we construct a common basket of services that is offered at both ASCs and HOPDs and calculate the average ratio of ASC to HOPD relative prices. For diagnostic imaging services 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.

⁹⁵ 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.

⁹⁶ 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.

⁹⁷ 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

70. 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.⁹⁸ We utilize each hospital's base payment to construct the relative prices for inpatient care for Original Medicare.⁹⁹

ii. Outpatient Services

71. Original Medicare pays for services rendered in HOPDs using the OPPTS.¹⁰⁰ Under the OPPTS, the fees paid to HOPDs are adjusted for regional variation in wage rates, but all HOPDs in our analysis have the same wage rate.¹⁰¹ We therefore do not estimate any savings related to changes in which HOPDs outpatient services are rendered.

72. Under CMS's payment methodology for services rendered at ASCs, 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.¹⁰² Therefore, we estimate a cost savings of 41 percent for Original Medicare due to the shift of services from HOPDs to ASCs.

⁹⁸ 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.

⁹⁹ To calculate the specific payment for each discharge, the base payment is multiplied by the DRG 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.

¹⁰⁰ 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.

¹⁰¹ 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>.

¹⁰² 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. MGH's Patient Panel and Utilization of Health Care Services

73. In connection with our evaluation of the DoN application, the DoN program asked us to analyze the current utilization of MGH. As part of this analysis, for the services referenced in the DoN application for MGH, we were asked to compare the profiles of patients who received care at MGH 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 MGH. We also document changes in utilization of inpatient services at MGH between 2015 and 2019.

A. Inpatient Services

74. 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' ASCs. These limitations and exclusions apply to all analyses we discuss in this section and we do not repeat them for the sake of brevity.

75. We first describe the characteristics of patients who received care at MGH 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 MGH, 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 in what follows are created using the 2019 Hospital Inpatient Discharge Database.

1. Patient Profiles

76. Figure MGH1 summarizes patient characteristics (*i.e.*, gender, race/ethnicity, age, insurance coverage, and acuity) for all MGH inpatients, MGH 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 MGH inpatients.

- In 2019, approximately 47 percent of MGH’s inpatients were female.
- White patients accounted for 80 percent of MGH’s inpatients. Among the remaining 20 percent of inpatients, six percent of patients were Black, four percent were Asian/Pacific Islander, and ten percent were of other or unknown race. Approximately seven percent of inpatients at MGH were Hispanic.
- The figure also shows the distribution of ages for MGH inpatients. More than 50 percent of MGH’s inpatients were 65 and older and approximately 27 percent were between the ages of 50 and 64.
- For insurance coverage, approximately 45 percent of inpatients had Original Medicare, 33 percent had commercial coverage (which will include some Health Connector Authority plans), eight percent had MassHealth managed care plans, two percent had MassHealth non-managed care coverage, seven percent had Medicare health plans, and six percent had other coverage (*e.g.*, self-pay patients, other government insurance, workers’ compensation, auto insurance, free care, etc.).¹⁰³
- The case mix index (or “CMI”)— which is calculated as the average of the Medicare Severity-DRG relative weights¹⁰⁴ across inpatients at the hospital—for MGH’s inpatients was 2.12.

77. The second column of the figure summarizes the characteristics of those MGH patients who resided in the hospital’s 75 percent service area. This service area is created by identifying

¹⁰³ The share of patients with MassHealth non-managed care coverage may differ substantially for the inpatient and outpatient services. This is largely due to the Hospital Inpatient Discharge Database (used for inpatient services) and APCD (used for outpatient services) classifying primary payors differently: The Hospital Inpatient Discharge Database nearly always assigns MassHealth non-managed care coverage as the secondary payor if there are two or more payors for a discharge.

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>.)

the smallest set of ZIP Codes that comprised at least 75 percent of MGH's discharges for the relevant inpatient services. MGH's 75 percent service area is shown in Figure MGH2.¹⁰⁵

78. The third column of Figure MGH1 provides a summary of the characteristics of all inpatients admitted to Massachusetts hospitals who resided in MGH's 75 percent service area. Broadly speaking, the profiles of MGH'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 below.

- Relative to MGH's patients in its 75 percent service area, patients in MGH's service area (regardless of which hospital they chose) were more likely to be female (52 percent compared to 47 percent), more likely to be Black (12 percent compared to seven percent), and slightly less likely to be Hispanic (eight percent compared to nine percent).
- Relative to MGH's patients in its 75 percent service area, patients in MGH's service area were less likely to have commercial insurance (23 percent compared to 31 percent), slightly more likely to be covered by MassHealth (11 percent compared to ten percent), and more likely to be covered by Medicare (59 percent compared to 52 percent).
- The age distribution of MGH's patients in its 75 percent service area was similar to the age distribution of patients who resided in the hospital's service area, although the latter group of patients were more likely to be age 75 or older (35 percent compared to 29 percent).
- Lastly, consistent with MGH's status as an academic medical center, acuity levels (as measured by the case mix index) for patients who received care at MGH in its service area

¹⁰⁵ Figure MGH2 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, BWFH = Brigham and Women's Faulkner Hospital, MEE = Mass Eye and Ear, NWH = Newton-Wellesley Hospital, and SH = Salem Hospital (formerly North Shore Medical Center).

were substantially higher than overall acuity levels for all patients in its service area (a case mix index of 2.04 compared to 1.68).

2. Changes in Utilization

79. Figure MGH3 shows MGH's inpatient discharges and patients days associated for each year from 2015 through 2019.¹⁰⁶ The figure also shows discharges and patient days separately for cancer services, heart and vascular services, and all other inpatient services.¹⁰⁷

80. While overall discharges at MGH remained approximately the same from 2015 through 2019, the total number of patient days grew by approximately five percent from 207,047 to 217,164. The lack of growth in discharges but an increase in patient days is attributable to an increase in patients' average length of stay over this period.

81. Inpatient cancer and heart and vascular services, which MGB proposes consolidating in a new tower on the MGH campus,¹⁰⁸ accounted for 39 percent of admissions and 41 percent of patient days in 2019. While MGH experienced a small decline in both the number of discharges related to cancer services (four percent decline) and patient days related to cancer services (two percent decline), the hospital experienced substantial growth in discharges related to heart and vascular services (nine percent) and patient days related to heart and vascular services (17 percent). Across these two service lines, between 2015 and 2019 total discharges at MGH grew by two percent and total patient days grew by eight percent.

82. In a supplemental response provided to the DoN program, MGB noted that MGH operated at or above its capacity in fiscal year 2019 (the last full fiscal year in which utilization was not affected by the COVID-19 pandemic).¹⁰⁹ Specifically, MGB noted that MGH's medical/surgical and ICU beds operated at an average utilization of 83 percent in fiscal year 2019 when considering

¹⁰⁶ This figure uses the 2019 Hospital Inpatient Discharge Database.

¹⁰⁷ The 2019 discharges reported in Figure MGH3 are slightly lower than those reported in Figure MGH1 because the latter includes discharges with unknown MDCs and unknown patient gender. We retain these discharges in Figure MGH1 so that the patient panels capture MGH's patient characteristics more completely

¹⁰⁸ MGH DoN, Appendix 2, Section 2.1, p. 10.

¹⁰⁹ MGH Bed Summary Response, p. 3.

only inpatient stays, and that this utilization increases to 88 percent in cases when not all beds in semi-private rooms can be used because of infection control, a need to provide patients with privacy at the end of their lives, or differences in patient gender.¹¹⁰ MGB also noted that inpatient beds often are used for observation patients and post-procedure recovery patients who may need to stay overnight.¹¹¹ According to MGB, accounting for the effect of these considerations on inpatient bed capacity increases average utilization at MGH to 92 percent in 2019.¹¹²

83. Because MGH operated at a high level of average utilization in 2019, the hospital may not have had the capacity to provide care for all patients who wanted to receive care at MGH. As such, to assess overall changes in demand for MGH's inpatient services, we examine changes in utilization of inpatient hospital services (separately for cancer services, heart and vascular services, and other services) in MGH's 75 percent service area for all patients (*i.e.*, regardless of where the patient was admitted). This is shown in Figure MGH4.¹¹³ In MGH's 75 percent service area, total discharges and patient days increased by four percent and eight percent from 2015 through 2019, respectively. In comparison, over the same timeframe, MGH inpatient discharges were flat and patient days grew by five percent. Patient days for heart and vascular inpatient services at MGH grew at the same rate as in the hospital's 75 percent service area (17 percent); while patient days for inpatient cancer services declined by two percent at MGH between 2015 and 2019, patient days for inpatient cancer services increased by two percent in the hospital's 75 percent service area.

B. Outpatient Services

84. 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, Plymouth, and Worcester Counties. These limitations and exclusions apply to all analyses we

¹¹⁰ MGH Bed Summary Response, p. 2.

¹¹¹ MGH Bed Summary Response, p. 2.

¹¹² MGH Bed Summary Response, p. 2.

¹¹³ The 2019 discharges reported in Figure MGH4 are slightly lower than those reported in Figure MGH1 because the latter includes discharges with unknown MDCs and unknown patient gender. We retain these discharges in Figure MGH1 so that the patient panels capture the characteristics of patients residing in MGH's 75 percent service area more completely.

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.

85. In what follows, we describe the characteristics of patients who received care at MGH in 2018 for outpatient cardiovascular services, outpatient oncology services, and outpatient diagnostic imaging services (*i.e.*, MR, CT, and PET/CT scans) and compare the characteristics of these patients to the broader population of patients who resided in the hospital's service area.

1. Outpatient Cardiovascular Services

86. Among patients who received outpatient cardiovascular services in 2018, Figure MGH5 summarizes the characteristics of MGH patients, of MGH patients who resided in the hospital's 75 percent service area,¹¹⁴ and 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 MGH patients who received outpatient cardiovascular services.

- Approximately 53 percent of these patients were female.
- Information on patients' race and ethnicity is not available in the APCD, so the figure reflects this information only for patients covered by Original Medicare. These data indicate that White patients accounted for 86 percent of MGH's outpatient cardiovascular patients. Among the remaining 14 percent of outpatient cardiovascular patients, approximately five percent of patients were Black, two percent were Asian/Pacific Islander/American Indian/Alaska Native, two percent were Hispanic, and six percent were of other or unknown race.
- The figure also shows the distribution of ages for MGH outpatient cardiovascular patients. Approximately 59 percent of MGH's patients were 65 and older and approximately 21 percent were between the ages of 50 and 64.

¹¹⁴ We determine MGH's service area for outpatient cardiovascular services specifically. As such, this area differs from the hospital's 75 percent service area for inpatient services, which we discussed previously. In subsequent analyses we calculate separate service areas for outpatient oncology services and for outpatient diagnostic imaging services at the hospital.

- For insurance coverage, approximately 55 percent of patients were covered by Original Medicare, 27 percent had commercial insurance (which will include some Health Connector Authority plans), two percent had MassHealth non-managed care coverage, six percent had MassHealth managed care plans, seven percent had Medicare health plans, and three percent had other coverage (*e.g.*, self-pay patients, other government insurance, disability, etc.).

87. The second column of the figure summarizes patient characteristics for those MGH outpatient cardiovascular patients 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 MGH's outpatient cardiovascular procedure volume. MGH's 75 percent service area for these procedures is shown in Figure MGH6.¹¹⁵

88. The third column of Figure MGH5 provides a summary of the characteristics of all patients who received outpatient cardiovascular services and who resided in MGH's 75 percent service area (regardless of which health care provider those patients chose). Broadly speaking, the profiles of MGH'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 MGH's patients in its 75 percent service area, patients in MGH's service area (regardless of which provider they chose) were somewhat more likely to be female (57 percent compared to 54 percent) and were somewhat more likely to be Black (eight percent compared to six percent).
- The age distribution of MGH's patients in its service area was similar to the age distribution of all patients who resided in the hospital's service area, although the latter group of patients were less likely to be age 65 and older (51 percent compared to 57 percent).

¹¹⁵ Figure MGH6 shows MGH's 75 percent service area for outpatient cardiovascular services. The map is limited to facilities that provided at least 300 outpatient cardiovascular visits in the 2018 APCD and Medicare Claims data after applying the aforementioned exclusions.

- The broader population was less likely to be covered by Original Medicare (44 percent compared to 53 percent) and was more likely to be covered by MassHealth managed care plans (11 percent compared to six percent).

2. Outpatient Oncology Visits

89. Among patients who received outpatient oncology services in 2018, Figure MGH7 summarizes the characteristics of MGH patients, of MGH patients who resided in the hospital's 75 percent service area, and 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 MGH patients who received outpatient oncology services.

- Approximately 58 percent of MGH 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 89 percent of MGH's outpatient oncology patients. Among the remaining 11 percent of patients, approximately three percent of patients were Black, one percent were Asian/Pacific Islander/American Indian/Alaska Native, one percent were Hispanic, and five percent were of other or unknown race.
- The figure also shows the distribution of ages for MGH outpatient oncology patients. Approximately 54 percent of MGH's patients were 65 and older and approximately 27 percent were between the ages of 50 and 64.
- For insurance coverage, approximately 45 percent of patients were covered by Original Medicare, 36 percent had commercial insurance (which will include some Health Connector Authority plans), one percent had MassHealth non-managed care coverage, seven percent had MassHealth managed care plan, eight percent had Medicare health plans, and three percent had other coverage (*e.g.*, self-pay patients, other government insurance, disability, etc.).

90. The second column of the figure summarizes patient characteristics for those MGH outpatient oncology patients who resided in the hospital's 75 percent service area. This area is

created by identifying the smallest set of ZIP Codes that comprised at least 75 percent of MGH's outpatient oncology visits. MGH's 75 percent service area is shown in Figure MGH8.¹¹⁶

91. The third column of Figure MGH7 provides a summary of the characteristics of all patients who received outpatient oncology care and who resided in MGH's 75 percent service area (regardless of which health care provider those patients chose). Broadly speaking, the profiles of MGH'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 below.

- Relative to MGH's patients in its 75 percent service area, patients in MGH's service area (regardless of which provider they chose) were more likely to be female (62 percent compared to 58 percent) and were slightly more likely to be Black (four percent compared to three percent).
- The age distribution of MGH's patients was similar to the age distribution of patients who resided in the hospital's service area, although the latter group of patients were less likely to be age 65 and older (48 percent compared to 52 percent).
- The broader population was less likely to be covered by Original Medicare (36 percent compared to 43 percent) and was somewhat more likely to be covered by MassHealth managed care plans (11 percent compared to eight percent).

3. Outpatient Diagnostic Imaging Services

92. Among patients who received outpatient CT, MR, or PET/CT scans in 2018, Figure MGH9 summarizes the characteristics of MGH patients, of MGH patients who resided in the hospital's 75 percent service area, and of all patients who resided in the hospital's 75 percent service area regardless of where the patient received care.¹¹⁷ The first column of the figure summarizes patient characteristics for all MGH patients who received outpatient diagnostic imaging services.

- Approximately 56 percent of these patients were female.

¹¹⁶ Figure MGH8 shows MGH's 75 percent service area for outpatient oncology services. The map is limited to facilities that provided at least 300 outpatient oncology visits in the 2018 APCD and Medicare Claims data after applying the aforementioned exclusions.

¹¹⁷ We understand that in 2018 there were no operational PET/MR units in Massachusetts.

- Information on patients' race and ethnicity is only available for Original Medicare patients, but the available data indicate that White patients accounted for 86 percent of MGH's outpatient diagnostic imaging patients. Among the remaining 14 percent of outpatient imaging patients, five percent of patients were Black, two percent were Asian/Pacific Islander/American Indian/Alaska Native, two percent were Hispanic, and five percent were of other or unknown race.
- The figure also shows the distribution of ages for MGH outpatient diagnostic imaging patients. Approximately 41 percent of MGH's patients were 65 and older and approximately 29 percent were between the ages of 50 and 64.
- For insurance coverage, approximately 34 percent of patients were covered by Original Medicare, 38 percent had commercial insurance (which will include some Health Connector Authority plans), 13 percent had MassHealth managed care plans, four percent had MassHealth non-managed care plans, seven percent had Medicare health plans, and four percent had other coverage (*e.g.*, self-pay patients, other government insurance, disability, etc.).

93. The second column of the figure summarizes patient characteristics for those MGH outpatient diagnostic imaging patients 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 MGH's outpatient CT, MR, and PET/CT scans. MGH's 75 percent service area is shown in Figure MGH10.¹¹⁸

94. The third column of Figure MGH9 provides a summary of the characteristics of all patients who received outpatient diagnostic imaging services and who resided in MGH's 75 percent service area (regardless of which health care provider those patients chose). As with the other services, the profiles of MGH's patients who resided in the hospital's 75 percent service area and profiles of all patients who resided in that area are broadly similar, with the primary difference being in insurance coverage. Relative to MGH's patients in its 75 percent service area, the broader population was

¹¹⁸ Figure MGH10 shows MGH's 75 percent service area for outpatient advanced diagnostic imaging visits (CT, MRI, PET/CT). The map is limited to facilities that provided at least 300 diagnostic imaging scans in the 018 APCD and Medicare Claims data after applying the aforementioned exclusions.

somewhat less likely to have commercial insurance (32 percent compared to 37 percent) and somewhat more likely to be covered by Original Medicare (34 percent compared to 32 percent).

V. Five- and Ten-Year Estimates of Demand for MGH's Services

95. 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 MGH's service area. In addition, the DoN program requested that we project changes in demand at MGH for inpatient services (including heart and vascular and cancer inpatient services), outpatient diagnostic imaging services (*i.e.*, outpatient CT, MR, and PET/CT scans), outpatient cardiovascular services, and outpatient oncology visits. We discuss each of these considerations in what follows.

A. Inpatient Services

1. Changes in Demographics in Five and Ten Years

96. Figure MGH11 summarizes 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 MGH'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 MGH's 75 percent inpatient service area, the total population is projected to grow from 3.3 million in 2020 to 3.5 million by 2030, an increase of six 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 550 thousand in 2020 to 712 thousand in 2030.

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

97. 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 MGH. 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.¹¹⁹ Figure MGH12 summarizes the resulting estimates of demand in 2025 and 2030 separately for cancer services, heart and vascular services, and other inpatient services. This method does not account for changes in patients' demand for inpatient hospital care 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 MGH. Importantly, our method also does not account for changes in inpatient demand or capacity at MGH associated with the proposed project.

98. We project that total discharges and patient days at MGH will increase by nine percent between 2019 and 2025 and by 17 percent between 2019 and 2030. The estimated growth rate in demand for inpatient cancer services is similar to the overall projected increases in demand for inpatient services at MGH, with cancer discharges projected to increase by 14 percent by 2030, with an accompanying 15 percent increase in patient days. Demand for heart and vascular services is projected to grow at a higher rate, with discharges and patient days predicted to increase by more than 20 percent by 2030. These projections are consistent with increased short- and long-term demand for inpatient services at MGH.¹²⁰

99. In the DoN application for MGH, MGB provides its own projections of future inpatient demand at MGH. MGB explains that its projections account for population changes, “shifting care from the inpatient to outpatient setting,” “improved care coordination and improved health outcomes resulting in fewer inpatient medical/surgical admissions,” “shift[ing] appropriate cases to community hospitals,” and taking on “higher acuity patients from community hospitals.”¹²¹ MGB’s projections for inpatient cancer services and inpatient heart and vascular services at MGH

¹¹⁹ For example, MGH discharged 22 female patients from ZIP Code 02155 in the 45-49 age group. According to the UMDI projections, this demographic group will grow by 20 percent between 2020 and 2025 and by 45 percent between 2020 and 2030. Therefore, we predict that MGH will discharge 26 female patients from ZIP Code 02155 in the 45-49 age group in 2025 and 32 in 2030.

¹²⁰ We perform the same analysis for patients living within MGH’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 MGH’s service area. These growth rates are similar to the growth rates we project for MGH itself. For patients residing within MGH’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. For cancer and heart and vascular services patient days, we project growth rates of 19 percent and 23 percent, respectively.

¹²¹ MGH DoN, Appendix 2, pp. 16, 18, 21, and 23.

also assume expanded inpatient beds and the construction of a new tower focused on cancer and heart and vascular services. 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.

100. MGB projects a six percent increase in total patient days at MGH between 2019 and 2029, which is lower than our projected 17 percent increase over a similar period.¹²² However, our estimates of changes in demand for inpatient cancer services and inpatient heart and vascular services are similar to MGB's projections for these services. MGB estimates that patient days at MGH will increase by 19 percent by 2029 for both service lines¹²³, which is similar to our projected increases in patient days for cancer services (15 percent by 2030) and heart and vascular services (21 percent by 2030).

101. In summary, we predict substantial increases in demand for inpatient services at MGH 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 cancer inpatient services and heart and vascular inpatient services, our projections are consistent with the projections that MGB included in its DoN application, although we rely on a different method to arrive at our projections.

B. Outpatient Services

1. Changes in Demographics in Five and Ten Years

102. Figure MGH13 summarizes short- and long-term estimates of expected changes in total population and projected demographic shifts in MGH's 75 percent service area for outpatient services, including diagnostic imaging services, cardiovascular services, and oncology services. As with our projections for inpatient services in MGH'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 MGH's 75 percent outpatient service area, the total population is projected to grow from 3.1 million in 2020 to 3.3 million in 2030, an increase of six percent. During this period,

¹²² Attachment C - Revised MGH Bed Allocation FY29.docx [hereinafter, Updated MGH Bed Summary Response].

¹²³ Updated MGH Bed Summary Response.

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 529 thousand in 2020 to 682 thousand in 2030.

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

103. To estimate future demand for outpatient services at MGH, we combine the UMDI population projections with data from the APCD and Medicare Claims data on current demand for outpatient health care services. Specifically, we tabulate the current volume for each outpatient service line by patient age, gender, and ZIP Code for MGH. 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 outpatient service volume.¹²⁴ Figure MGH14 summarizes the resulting estimates of demand in 2025 and 2030 separately for outpatient CT scans, MR scans, PET/CT scans, cardiovascular services, and oncology visits.¹²⁵ This method does not account for changes in patients' demand for outpatient hospital services 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 MGH. Importantly, our method also does not account for changes in outpatient demand or capacity at MGH associated with the proposed project.

104. We project that outpatient CT, MR and PET/CT scans at MGH will increase by nine percent, six percent, and ten percent, respectively, between 2018 and 2025. The projected growth rates for the same outpatient diagnostic imaging services are 16 percent, ten percent, and 17 percent, respectively, between 2018 to 2030. We project that cardiovascular services and outpatient oncology visits will increase by 12 percent and ten percent between 2018 and 2025 and by 21 percent and 18 percent between 2018 and 2030, respectively. These results are consistent

¹²⁴ 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 procedures currently provided by MGH is likely understated.

¹²⁵ For example, MGH performed 24 outpatient MR scans on men aged 55-59 from ZIP Code 02446 in 2018. According to the UMass Donahue Population Projection, this demographic group is predicted to grow two percent through 2025 and 11 percent through 2030. Therefore, we predict that MGH will perform 24.5 outpatient MR scans on this group in 2025 and 26.6 outpatient MR scans on this group in 2030.

with increased short- and long-term demand for outpatient diagnostic imaging services, cardiovascular services, and oncology visits at MGH.¹²⁶

105. In the DoN application for MGH, MGB provides its own projections of future demand for outpatient imaging, oncology, and cardiovascular services. MGB explains its projections account for expected population changes, increases in incidence of cancer and cardiovascular disease, expectations of patient volume shifting from inpatient to outpatient treatment and services, and current capacity constraints and wait times.¹²⁷ MGB's projections for these outpatient services also assume the construction of a new tower focused on oncology and cardiovascular services, including the expansion of its imaging capacity and additional oncology exam rooms, infusion bays, and cardiovascular operating rooms.¹²⁸ 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 health care services constant.

106. Because of these differences, our projections for outpatient diagnostic imaging volumes are substantially lower than MGB's projections from 2018 to 2029. While we estimate outpatient CT scan volume to grow 16 percent from 2018 to 2030, MGB projects an increase of 77 percent.¹²⁹ Similarly, while we estimate outpatient MR scan volume to grow ten percent from 2018 to 2030, MGB projects an increase of 24 percent.¹³⁰ Lastly, we estimate outpatient PET/CT scan volume to grow 17 percent from 2018 to 2030, which is much lower than MGB's projection of a 112 percent increase.¹³¹

¹²⁶ We perform the same analysis for patients living within MGH's 75 percent service area who sought outpatient services from any provider in Massachusetts to measure total projected demand for outpatient services for patients residing in MGH's service area. For each of the outpatient services, the growth rates are similar to the growth rates we project for MGH itself. For patients residing within MGH's 75 percent service area, we project growth rates from 2018 to 2030 of 17 percent (CT scans), 13 percent (MR scans), and 23 percent (PET/CT scans). For cardiovascular and oncology services, we project growth rates of 21 percent and 18 percent, respectively.

¹²⁷ MGH DoN, Appendix 2, pp. 18-26.

¹²⁸ MGH DoN, Appendix 2, pp. 1-2.

¹²⁹ MGH DoN, Appendix 2, Section 2.1, p. 24.

¹³⁰ MGH DoN, Appendix 2, Section 2.1, p. 25.

¹³¹ MGH DoN, Appendix 2, Section 2.1, pp. 25-26.

107. Our projections for outpatient cardiovascular services are higher than MGB’s estimates: We project growth of 21 percent from 2018 to 2030, while MGH projects growth of seven percent.¹³² In contrast, our projections for outpatient oncology visits are lower than MGB’s estimates: We project growth of 18 percent from 2018 to 2030, while MGB projects growth of 38 percent.¹³³

108. In summary, we predict substantial increases in demand for outpatient diagnostic imaging, oncology, and cardiovascular services at MGH in the next five to ten years. These increases are driven by the projected population growth in the service area of the hospital and the aging of that population. While we predict substantial increases in demand for these services, our projections are lower than the projections that MGB included in its DoN application (except for outpatient cardiovascular procedures). However, we rely on a different method to arrive at our projections that does not account for the same factors that MGB considered, including an expansion of MGH’s outpatient capacity.

VI. Models of Patients’ Demand for Health Care Services

A. Inpatient Services

109. 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-reviewed¹³⁴ and is flexible enough to estimate projections of consumer demand for inpatient hospital services that allow us to address the elements of the ICA.

¹³² MGH DoN, Appendix 2, Section 2.1, p. 22.

¹³³ MGH DoN, Appendix 2, Section 2.1, pp. 20-21.

¹³⁴ Devesh Raval, Ted Rosenbaum, and Steven A Tenn. “A Semiparametric Discrete Choice Model: An Application to Hospital Mergers.” *Economic Inquiry* (2017).

110. 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 ASCs operated by another health care provider.

111. 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).¹³⁵ 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).¹³⁶

112. 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.¹³⁷ In the second step, we estimate hospital preferences within

¹³⁵ 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).

¹³⁶ 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.

¹³⁷ 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

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.

113. We use the results of this model to calculate “diversion ratios” between MGB hospitals and hospitals affiliated with other health systems.¹³⁸ In the context of our model, diversion ratios answer the question: If a patient wanted to receive inpatient hospital care at MGH 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 MGH 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 MGH, 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 MGH 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.

114. Conversely, the diversion ratios can be used to predict which competing hospitals MGH would attract patients from if the proposed project to expand the number of inpatient beds at the hospital were approved. Using the previous example, if the proposed project increased the number

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).

¹³⁸ 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.

of inpatient admissions at MGH 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.

115. The estimated model can also be used to calculate diversion ratios for specific groups of patients, for example, cancer patients or patients from ZIP Code 02116. In the previous example, overall diversion from MGH to Boston Medical Center is 30 percent. This overall measure is a summation of patient-specific diversions that will vary across patients. Perhaps, for example, diversion from MGH to Boston Medical Center is 35 percent for patients receiving cancer care and less than 30 percent for all other patients.

116. 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 MGH would increase the number of inpatient patient days at the hospital from 270,488 in fiscal year 2019 to 287,991 in fiscal year 2029, which is comprised of an increase in the number of cancer and heart and vascular patient days from 66,901 and 48,971 to 79,550 and 58,519, respectively, and a decrease in patient days for other inpatient services from 154,616 to 149,922.¹³⁹ 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 cancer and heart and vascular patients would switch to MGH following the proposed project. We adjust the parameters in the demand model so that the predicted increase in inpatient volume at MGH for cancer, heart and

¹³⁹ Updated MGH Bed Summary Response.

vascular, and all other inpatient services exactly matches MGB's inpatient volume projections in the MGH DoN.^{140,141,142}

B. Outpatient Services

117. 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.

118. Because the DoN application for MGH proposes expanding the hospital's diagnostic imaging equipment (with the proposed addition of two CT units, two MRI units, two PET/CT units, and one PET/MR unit),¹⁴³ cardiac operating and procedure rooms (with a proposed net

¹⁴⁰ We assume that when MGH increases its capacity and admits more inpatients, the characteristics of the incremental patients that MGH admits will be like those of patients previously admitted to MGH. Within the context of the patient demand model, this means the proposed project increases every patient's probability of choosing MGH by the same relative amount.

For example, consider two groups of patients. The first group includes patients from a ZIP Code close to MGH for a service that MGH is renowned for, and the second group includes patients from a ZIP Code more distant from MGH for a service that is commonly provided by community hospitals. Assume that 50 percent of the first group chooses MGH but only one percent of the second group chooses MGH. Our calculations assume that if MGH expands, its shares within the two groups increase by the same relative amounts. For example, if MGH's share in the first group increases from 50 percent to 55 percent (*i.e.*, by ten percent), then MGH'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.*, MGH 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 MGH, then when MGH's shares in the first two groups are expanded by ten percent to 55 percent and 1.1 percent, respectively, MGH'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 MGH will admit more of the types of patients that currently value MGH the most, according to the estimated patient demand model, where "value" is reflected in the MGH group shares.

¹⁴¹ We perform this exercise separately for inpatient heart and vascular services, cancer services, and all other inpatient service lines. Because MGB projects it will admit fewer patients from other inpatient service lines (*i.e.*, not heart and vascular or cancer services) in the future, our simulations decrease MGH's share for those other inpatient service lines.

¹⁴² When we perform this exercise, we increase MGH inpatient patient days for cancer-related discharges by 7,958 instead of by 12,649, as indicated in the text (= 79,550 – 66,901). We scale down the MGH 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. We make the same adjustments to the changes in inpatient patient days for heart and vascular services and other types of discharges.

¹⁴³ The APCD and Medicare Claims data that we use to estimate our model of demand for outpatient diagnostic imaging services reflect claims for 2018. We understand that in 2018 there were no operational PET/MR units in

increase of 18 cardiac operating rooms and three cardiology procedure rooms), and oncology infusion bays (with a proposed net increase of 21 infusion bays),¹⁴⁴ we estimate separate models of patient demand for outpatient diagnostic imaging, outpatient cardiovascular procedures, and outpatient oncology visits. For each of these services, we restrict the APCD and Medicare Claims data to those patients whose demand for outpatient health care services may be affected by the proposed project.¹⁴⁵ We describe our model of patient demand for outpatient diagnostic imaging services first, followed by the models for outpatient cardiovascular services and outpatient oncology visits. Our models of patient demand for outpatient services (*i.e.*, diagnostic imaging, cardiovascular, and oncology) all share several features, so descriptions of the latter models often reference the first.

119. 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.¹⁴⁶ 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

120. 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

Massachusetts, and so we have no data from which we can infer patients' demand for this new technology. As such, we exclude PET/MR scans from our model of demand for outpatient diagnostic imaging services.

¹⁴⁴ MGH Applicant Response – Excel Submission, Tab 3.b.

¹⁴⁵ The proposed additional diagnostic imaging units or cardiovascular operating rooms may also be used by inpatients who receive care at MGH, but this demand would be reflected in our inpatient hospital model, and we do not address it separately here.

¹⁴⁶ 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.¹⁴⁷

121. 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).¹⁴⁸ 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).¹⁴⁹ Based on these preferences, patients choose at which facility they receive their diagnostic imaging scans.^{150,151}

¹⁴⁷ We restrict the data to these seven counties because it is unlikely that patients who might receive care at MGH for outpatient diagnostic imaging services would travel outside of this region for these services, except under unusual or exceptional circumstances.

¹⁴⁸ 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).

¹⁴⁹ 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.

¹⁵⁰ 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.

¹⁵¹ 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.

122. 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.¹⁵² 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.

123. 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 MGH would attract patients from if the proposed project to expand the number of imaging units at the hospital were approved.¹⁵³

124. 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 increasing the number of CT units at MGH from 14 to 16 (a 14 percent increase), the number of MRI units from ten to 12 (a 20 percent increase), and the number of PET/CT units from three to five (a 67 percent

¹⁵² 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.

¹⁵³ We use the same methodology to perform these simulations as when simulating the effects of MGH's additional inpatient capacity on utilization of inpatient GAC services. As with the inpatient demand model, we assume that when MGH completes the proposed project and is able to perform more CT, MR, and PET/CT scans, the incremental patients MGH performs these scans on will resemble the patients to whom MGH already provides diagnostic imaging services.

increase).¹⁵⁴ To address the ICA questions related to shifts in the utilization of diagnostic imaging facilities if the proposed project were approved, we use the outpatient demand model to predict which patients would switch to MGH for their CT, MR, and PET/CT scans after the expansion. We calibrate the demand model so that the predicted increase (in percentage terms) in CT, MR, and PET/CT scan volume at MGH exactly matches the percentage increase in CT, MR, and PET/CT scans MGB proposes to add in the DoN application for MGH.

2. Cardiovascular Services

125. To estimate patients' demand for outpatient cardiovascular services, we use a method that is similar to the one used to estimate demand for diagnostic imaging services. In estimating this model, we restrict the APCD and Medicare Claims data to those patients who might potentially use the additional cardiovascular services that will be available at MGH if the proposed project to expand the hospital's cardiovascular operating and procedure rooms is approved. We restrict the APCD and Medicare Claims data to patients who received outpatient care for the cardiovascular services we previously described in Section III.B.2. We exclude claims associated with patients who reside outside of Massachusetts, and we limit to claims with service locations in Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, and Worcester Counties in Massachusetts.¹⁵⁵

126. We assume that patients' preferences over facilities that offer outpatient cardiovascular services vary based on the same factors as in our model of demand for outpatient diagnostic imaging, including where the patients live (*e.g.*, the ZIP Code of their residence), the type of cardiovascular procedure they seek (*e.g.*, the patients' CPT code), their health insurance coverage (*e.g.*, Original Medicare), and their demographics (*e.g.*, age and gender).¹⁵⁶ In our model, patients'

¹⁵⁴ MGH Applicant Response – Excel Submission, Tab 3.b.

¹⁵⁵ We restrict the data to these seven counties because it is unlikely that patients who might receive care at MGH for outpatient cardiovascular services would travel outside of this region for these services, except under unusual or exceptional circumstances.

¹⁵⁶ More specifically, patient preferences in our model of demand for outpatient cardiovascular services depend on (i) the patient's county and ZIP Code of residence; (ii) the CPT code associated with the cardiovascular procedure the patient received; (iii) the cardiovascular service line (*e.g.*, Echocardiography Procedures or Surgical Procedures on the Pericardium); (iv) the service type (*i.e.*, Surgical Procedures on the Heart and Pericardium, Surgical Procedures on Arteries and Veins, and Cardiovascular Procedures); (v) the patient's health insurance coverage (commercial,

preferences over outpatient cardiovascular facilities may also depend on the characteristics of the facilities from which the patients are choosing. Based on these preferences, patients choose a facility for their outpatient cardiovascular care.¹⁵⁷ We estimate the model using approximately 2.5 million cardiovascular procedures performed at Massachusetts outpatient facilities and the same two-step estimation process as in our model of demand for outpatient diagnostic imaging services; as before, we use the model to calculate diversion ratios between facilities offering outpatient cardiovascular services.

127. Our forecasts of the effect of the proposed expansion at MGH on demand for cardiovascular services are derived from diversion ratios that predict which patients will shift their demand for outpatient cardiovascular procedures to MGH after the proposed project is completed. MGH performed 42,092 cardiovascular procedures in fiscal year 2019, and in fiscal year 2025 it projects a volume of 43,195 cardiovascular procedures, representing a 2.6 percent increase in procedure volume.¹⁵⁸ For the purpose of modeling the effect of MGH's proposed expansion, we assume that outpatient cardiovascular procedure volume will increase by this amount and conservatively assume that the entirety of this projected increase is due to the proposed expansion in MGH's capacity (rather than, for example, changes in the incidence of heart disease or changes in patient demographics).

3. Oncology Services

128. We estimate patients' demand for outpatient oncology care somewhat differently than we do for outpatient diagnostic imaging services and outpatient cardiovascular procedures. Whereas diagnostic imaging and cardiovascular services can be identified using specific CPT or HCPCS procedure codes, outpatient oncology services may include an array of procedural services that are not limited to patients receiving oncology services (*e.g.*, a patient receiving oncology care at MGH may receive evaluation and management services from an oncologist in addition to chemotherapy

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).

¹⁵⁷ In our model, patients make separate choices for each outpatient cardiovascular service (*i.e.*, CPT procedure code) that they receive.

¹⁵⁸ MGH DoN, Appendix 2, Tables 8 and 9.

infusion services, radiation oncology services, or surgical oncology services). Accordingly, we define “oncology services” using the diagnosis codes recorded for each patient in the APCD and Medicare Claims data,¹⁵⁹ rather than using the procedure codes for each claim. As such, our model of demand for outpatient oncology services models this demand at the patient-visit level—which may encompass more than one procedure code—rather than at the procedure-code level as in our models of demand for other types of outpatient health care services.

129. In estimating our model, we restrict the APCD and Medicare Claims data to those patients potentially affected by the expanded oncology services that will be available at MGH if the proposed project is approved. To do this, we restrict the APCD and Medicare Claims data to outpatient visits where the claim for the visit was associated with an oncology diagnosis code. We exclude claims associated with patients who reside outside of Massachusetts, and we limit to claims with service locations in Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, and Worcester Counties in Massachusetts.¹⁶⁰

130. We assume that patients’ preferences over facilities that offer outpatient oncology care vary based on the same factors as in our models of demand for outpatient diagnostic imaging and cardiovascular services (*e.g.*, the ZIP Code of the patients’ residence, the patients’ health insurance coverage, the patients’ demographics, and so on) with one exception. Because we estimate our model at the patient-visit level rather than at the procedure-code level, there is not necessarily a single procedure code associated with each outpatient visit. As such, rather than allowing patients’ preferences over health care facilities to vary based on procedure, we allow patients’ preferences to depend on their type of cancer.¹⁶¹ In our model, patients’ preferences over outpatient oncology providers may also depend on the characteristics of the facilities from which the patients are choosing. Based on these preferences, patients choose a facility for their outpatient oncology care.

¹⁵⁹ See Section III.B.2.

¹⁶⁰ We restrict the data to these seven counties because it is unlikely that patients who might receive care at MGH for outpatient oncology services would travel outside of this region for these services, except under unusual or exceptional circumstances.

¹⁶¹ More specifically, patient preferences in our model of demand for outpatient oncology visits depend on (i) the patient’s county and ZIP Code of residence; (ii) the type of cancer with which the patient has been diagnosed (*e.g.*, breast, sarcoma, melanoma, head and neck, and so on); (iii) 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); (iv) gender; and (v) age category (18-45, 46-62, and 63 and older).

We estimate the model using approximately 1.7 million patient-visits and the same two-step estimation process as in our models of demand for outpatient diagnostic imaging and cardiovascular services; as before, we use the model to calculate diversion ratios between facilities offering outpatient oncology services.

131. To forecast the effect of the proposed project on demand for outpatient oncology patient-visits, we rely on the same methodology applied to demand for outpatient diagnostic imaging and cardiovascular services. MGH provided 159,365 outpatient oncology visits in fiscal year 2019, and in fiscal year 2025 it projects a volume of 188,063 outpatient oncology visits, representing an 18 percent increase.¹⁶² For the purpose of modeling the effect of MGH's proposed expansion, we assume that outpatient oncology visits will increase by this amount and conservatively assume that the entirety of this projected increase is due to the proposed expansion in MGH's capacity (rather than, for example, changes in the incidence of cancer or changes in patient demographics).

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

132. 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.

133. 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

¹⁶² MGH DoN, Appendix 2, Tables 5 and 7.

providers as occurring in two stages.¹⁶³ 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.

134. 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

135. 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

¹⁶³ 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).

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.¹⁶⁴ Although government-sponsored health plans like Medicare Advantage plans negotiate prices with hospitals, research has found that the prices negotiated by these plans are typically comparable to the corresponding Medicare fee schedule amounts.¹⁶⁵

136. 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.¹⁶⁶ 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.¹⁶⁷ 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.¹⁶⁸

¹⁶⁴ 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, 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.

¹⁶⁵ Robert A. Berenson, Jonathan H. Sunshine, David Helms, and Emily Lawton. "Why Medicare Advantage Plans Pay Hospitals Traditional Medicare Prices." *Health Affairs* (2015).

¹⁶⁶ 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 $10,000 \div n$.

¹⁶⁷ U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010).

¹⁶⁸ 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

137. 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 above 2,500.¹⁶⁹ Because mergers typically increase concentration,¹⁷⁰ 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.¹⁷¹ (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.¹⁷²

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.

¹⁶⁹ U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010), § 5.3.

¹⁷⁰ 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 $100 = 2 \times 5 \times 10$.

¹⁷¹ U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010), § 5.3.

¹⁷² 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>.)

138. 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.¹⁷³ We review this literature in the next subsection 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 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

139. 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.¹⁷⁴ 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).

¹⁷³ 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.)

¹⁷⁴ 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).

140. 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.¹⁷⁵ 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 (*i.e.*, where the HHI would be 10,000) are 12 percent higher than in markets where there are four or more competitors.

141. 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.¹⁷⁶ 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.¹⁷⁷ 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

¹⁷⁵ 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).

¹⁷⁶ 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.

¹⁷⁷ 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.

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.)

142. 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 prices for inpatient services.¹⁷⁸ The authors regress the logarithm of inpatient prices on concentration in the hospital market (measured using the HHI for inpatient 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.

143. 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.¹⁷⁹ 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.

¹⁷⁸ 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).

¹⁷⁹ 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).

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.

144. 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.¹⁸⁰ The authors’ primary research question concerns whether being part of a multi-hospital system was associated with 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.

145. Antwi *et al.* (2009) assess changes in hospital prices in California between 1992 and 2006.¹⁸¹ 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. 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

¹⁸⁰ Glenn Melnick and Emmett Keeler. “The effects of multi-hospital systems on hospital prices.” *Journal of Health Economics* (2007).

¹⁸¹ 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).

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.

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

146. 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.

147. 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.¹⁸² 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

¹⁸² Martin Gaynor and Robert Town. “The impact of hospital consolidation—Update.” Robert Wood Johnson Foundation: The Synthesis Project (2012).

effect of hospital competition on prices.¹⁸³ 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.”

148. 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-constrained.^{184,185} 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.

149. 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

¹⁸³ Martin Gaynor, Kate Ho, and Robert J. Town. “The Industrial Organization of Health-Care Markets.” *Journal of Economic Literature* (2015).

¹⁸⁴ Kate Ho. “Insurer-Provider Networks in the Medical Care Market.” *The American Economic Review* (2009).

¹⁸⁵ 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 her 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.”

for their services.”¹⁸⁶ 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.)

150. 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 present a risk of anticompetitive outcomes that may outweigh the benefits of these programs.¹⁸⁷ 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.¹⁸⁸ 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,”¹⁸⁹ 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.

151. 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.¹⁹⁰ In addition, the

¹⁸⁶ Federal Trade Commission and Department of Justice, “Improving Health Care: A Dose of Competition.” (July 2004), Chapter 8, p. 1.

¹⁸⁷ 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).

¹⁸⁸ Matthew D. Mitchell. “Do Certificate-of-Need Laws Limit Spending?” *Mercatus Working Paper*, Mercatus Center, George Mason University (2016).

¹⁸⁹ Matthew D. Mitchell. “Do Certificate-of-Need Laws Limit Spending?” *Mercatus Working Paper*, Mercatus Center, George Mason University (2016), p. 29.

¹⁹⁰ Christopher J. Conover and James Bailey. “Certificate of need laws: a systematic review and cost-effectiveness review.” *BMC Health Services Research* (2020).

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.

152. In summary, while there is little economic literature that is directly relevant to the effects of expansion by MGH 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

153. For inpatient services, we calculate the shares of MGB and its competitors in the service area of MGH in two steps.¹⁹¹ 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 MGH'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).¹⁹² 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.¹⁹³ 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 MGH's discharges.

¹⁹¹ All calculations in this section adopt the inpatient service line definitions we described in Section III.B.1.

¹⁹² *See*, for example, Christopher Garmon. "The accuracy of hospital screening methods." *RAND Journal of Economics* (2017).

¹⁹³ U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010), Section 4.

154. Using this approach, Figure MGH15 reports inpatient shares in MGH's service area. We calculate shares separately for all inpatient services, inpatient cancer services, inpatient heart and vascular services, and other inpatient services (*i.e.*, inpatient services not in the cancer or heart and vascular service lines).

- MGB has the highest share in MGH's own service area for each of these four groups of inpatient services, with shares ranging from 32 percent (other inpatient services) to 45 percent (inpatient cancer services).
- Beth Israel Lahey Health has the second-to-highest share in MGH's service area for all four groups of inpatient services, with shares ranging from 23 percent (inpatient cancer services) to 26 percent (other inpatient services).
- Other health systems with a share in MGH's service area exceeding five percent in at least one inpatient service line include Boston Medical Center (shares of five percent), Steward Health Care (shares of four to seven percent), and Wellforce (shares of seven to nine percent).

155. 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 MGH 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.

156. Figure MGH16 reports each hospital's share of inpatient admissions in MGH's service area and the implied concentration levels before and after the proposed project. If the proposed project were approved, across all inpatient service lines, we predict that MGH's share of discharges in its service area would increase by 1.3 percentage points from 18.9 percent to 20.2 percent. MGB's overall share increases by less than this amount because some of the additional MGH discharges

are patients who otherwise would have received care at other MGB hospitals, including Brigham and Women's Hospital (whose share in MGH's service area declines by 0.13 percentage points) and Salem Hospital (whose share in MGH's service area declines by 0.05 percentage points). Given the small increase in MGH's share in its own service area, the predicted effects of the proposed project on other hospitals' discharge volume are also very small. In particular, the hospital whose share in MGH's service area declines by the largest amount is Beth Israel Deaconess Medical Center, and its share declines by only 0.21 percentage points.

157. Using the predicted change in shares, the bottom panel of Figure MGH16 shows that the HHI in MGH's service area is projected to increase by 59 points from 4,212 to 4,271. 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.¹⁹⁴ As such, we believe that the proposed project is unlikely to affect MGB's negotiating leverage with third-party payors.

C. Outpatient Services

158. In this section we assess MGH's current shares for outpatient diagnostic imaging services (separately for CT, MR, and PET/CT scans), outpatient cardiovascular services, and outpatient oncology services in the hospital's service area and how those shares might change if MGB's DoN were approved. For each of these outpatient service lines, we also assess how changes in MGB's shares might affect its negotiating leverage with third-party payors.

1. Diagnostic Imaging Services

159. For outpatient diagnostic imaging services, we use the same general approach that we used in analyzing MGH'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 MGH's service area for outpatient diagnostic imaging services in two steps. First, we calculate health care providers' share of outpatient diagnostic imaging procedures (separately for CT, MR, and PET/CT scans) and the resulting HHIs in each ZIP Code in Massachusetts. Second, we calculate the weighted averages of these shares and HHIs across ZIP

¹⁹⁴ U.S. Department of Justice and the Federal Trade Commission. *Horizontal Merger Guidelines* (2010), § 5.3.

Codes, where each ZIP Code is weighted by the number of outpatient diagnostic imaging procedures (separately for CT, MR, and PET/CT scans) that MGH provided in that ZIP Code.

160. 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.1. 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 separately for outpatient CT, MR, and PET/CT scans in MGH'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.

161. Using this approach, Figure MGH17 reports shares for outpatient CT scans in MGH's service area. If the proposed project were approved, we predict that MGH's share of outpatient CT scans in its service area would increase by 2.2 percentage points from 15.7 percent to 17.9 percent. MGB's overall share increases by less than this amount because some of the additional MGH volume comes from patients who otherwise would have received services at other MGB facilities (*i.e.*, the share of other MGB facilities in MGH's service area decreases by 0.6 percentage points from 19.5 percent to 18.9 percent). Given the small increase in MGH's share in its own service area, the predicted effects of the proposed project on other providers' outpatient CT scan volumes are modest. The providers whose shares in MGH's service area decline by the largest amounts are Beth Israel Lahey Health (a decline of 0.5 percentage points) and Wellforce (a decline of 0.3 percentage points).

162. Figure MGH18 reports shares for outpatient MR scans in MGH's service area. If the proposed project were approved, we predict that MGH's share of outpatient MR scans in its service area would increase by 2.8 percentage points from 14.0 percent to 16.8 percent. MGB's overall share increases by less than this amount because some of the additional MGH volume comes from patients who otherwise would have received services at other MGB facilities (*i.e.*, the share of

other MGB facilities in MGH's service area decreases by 0.7 percentage points from 19.2 percent to 18.5 percent). Given the small increase in MGH's share in its own service area, the predicted effects of the proposed project on other providers' outpatient MR scan volumes are modest. The provider whose shares in MGH's service area declines by the largest amount is Beth Israel Lahey Health (a decline of 0.6 percentage points).

163. Figure MGH19 reports shares for outpatient PET/CT scans in MGH's service area. If the proposed project were approved, we predict that MGH's share of outpatient PET/CT scans in its service area would increase by 8.1 percentage points from 16.4 percent to 24.6 percent. Our predicted increase in MGH's share for outpatient PET/CT scans is larger than our predicted increases in MGH's shares for outpatient CT and MR scans because the proposed *relative* increase in MGH's capacity for PET/CT scans is higher: from three to five, whereas the number of CT units would increase from 14 to 16 and the number of MRI units would increase from ten to 12.¹⁹⁵ MGB's overall share increases by somewhat less than this amount because some of the additional MGH volume comes from patients who otherwise would have received services at other MGB facilities (*i.e.*, the share of other MGB facilities in MGH's service area decreases by 2.0 percentage points from 16.3 percent to 14.3 percent). The providers whose shares in MGH's service area decline by the largest amounts are Beth Israel Lahey Health (a decline of 2.7 percentage points), Dana-Farber Cancer Institute (a decline of 1.2 percentage points), and Shields Heath Care Group (a decline of 0.9 percentage points).

164. Using the predicted change in shares, the bottom panels of Figures MGH17-MGH19 show the associated changes in concentration for outpatient CT, MR, and PET/CT scans in MGH's service areas. Across the three imaging modalities, concentration in MGH's service area is projected to increase by 100 points (outpatient CT), 131 points (outpatient MRI), or 260 points (outpatient PET/CT). While these changes are somewhat higher than the safe-harbor threshold in *Horizontal Merger Guidelines*, the overall changes in MGB's shares for each modality are modest and it is unlikely that the proposed project would meaningfully increase MGB's bargaining leverage with third-party payors.

¹⁹⁵ MGH Application Response – Excel Submission, Tab 3.b.

2. Cardiovascular Services

165. Figure MGH20 reports providers' shares of outpatient cardiovascular procedures in MGH's service area. The method we use to calculate is similar to the method we used for outpatient diagnostic imaging services, except that ZIP Codes in MGH's service area are weighted by the number of outpatient cardiovascular procedures MGH provided to patients in that ZIP Code. Using our model of patient demand for outpatient cardiovascular procedures, if the proposed project were approved, we predict that MGH's share of outpatient cardiovascular procedures in its service area would increase by only 0.4 percentage points from 13.8 percent to 14.2 percent. MGB's overall share increases by less than this amount because some of the additional MGH volume comes from patients who otherwise would have received services at other MGB facilities (*i.e.*, the share of other MGB facilities in MGH's service area decreases by 0.1 percentage points from 18.3 percent to 18.2 percent). Given the small increase in MGH's share in its own service area, the predicted effects of the proposed project on other providers' outpatient cardiovascular procedure volumes are modest. The providers whose shares in MGH's service area decline by the largest amounts are Beth Israel Lahey Health (a decline of 0.1 percentage points) and Wellforce (a decline of 0.1 percentage points). Using the predicted change in shares, the bottom panel of Figure MGH20 shows that the HHI in MGH's service area is projected to increase by only ten points from 3,782 to 3,792, which is competitively insignificant.

3. Oncology Services

166. Figure MGH21 reports providers' shares of outpatient oncology visits in MGH's service area; for these calculations ZIP Codes in MGH's service area are weighted by the number of outpatient oncology visits that MGH provided to patients in that ZIP Code. Using our model of patient demand for outpatient oncology visits, if the proposed project were approved, we predict that MGH's share of outpatient oncology visits in its service area would increase by only 3.2 percentage points from 18.2 percent to 21.4 percent. MGB's overall share increases by less than this amount because some of the additional MGH volume comes from patients who otherwise would have received services at other MGB facilities (*i.e.*, the share of other MGB facilities in MGH's service area decreases by 0.9 percentage points from 16.4 percent to 15.6 percent). The predicted effects of the proposed project on other providers' outpatient oncology visit volumes are modest. The providers whose shares in MGH's service area decline by the largest amounts are Beth Israel Lahey

Health (a decline of 0.9 percentage points) and Dana-Farber Cancer Institute (a decline of 0.5 percentage points). Using the predicted change in shares, the bottom panel of Figure MGH21 shows that the HHI in MGH's service area is projected to increase by only 113 points from 3,126 to 3,239. This change is slightly higher than the *Horizontal Merger Guidelines* safe harbor, but the overall changes in MGB's shares are small and it is unlikely that the proposed project would meaningfully increase MGB's bargaining leverage with third-party payors.

VIII. Rates for Private and Semi-Private Room Rates at MGH

167. As part the ICA, the DoN program asked us to evaluate any impact on health care costs resulting from MGB's proposal to increase the number of private beds at MGH. As part of the proposed project, 482 private inpatient beds (418 medical/surgical and 64 ICU beds) would be constructed in a new tower on MGH's main campus; combined with the planned closure of 388 existing semi-private beds, the net impact would be to increase the number of licensed inpatient beds on MGH's main campus by 94.¹⁹⁶ The result of this proposal would increase the percentage of single-bed medical/surgical rooms on MGH's main campus from 38 percent to 88 percent.¹⁹⁷ MGB argues that single-bed rooms would improve patient satisfaction, contribute to enhanced patient outcomes, and alleviate capacity constraints caused by bed blocks resulting from gender or age mismatches, patients requiring end-of-life care, disruptive patient behavior, or a need for infection control.¹⁹⁸

168. Putting aside the benefits of private rooms, we have determined that a greater utilization of private rooms at MGH would not directly impact health care costs.

¹⁹⁶ MGH DoN, Appendix 2, Section 2.1, pp. 1-2 and MGH Bed Summary Response, p. 2.

¹⁹⁷ MGH DoN, Appendix 2, p. 2.

¹⁹⁸ MGH DoN, Appendix 2, p. 11.

- First, Original Medicare pays MGH for inpatient stays using the Inpatient Prospective Payment System. Under this system, hospital reimbursement does not depend on the type of room in which the patient was boarded.¹⁹⁹
- Second, for patients covered by commercial insurance, MassHealth managed care plans, or Medicare health plans, our review of MGH’s chargemaster and price transparency data indicates that hospital reimbursement does not depend on the type of room in which the patient was boarded.²⁰⁰ Instead, payments associated with room charges are included in a larger overall payment that does not differentiate based on room type (*i.e.*, similar to the Medicare Inpatient Prospective Payment System).
- Finally, MassHealth non-managed care pays for inpatient care utilizing an Adjudicated Payment Amount per Discharge payment rate that does not vary based on room type.²⁰¹

We did not assess any indirect effects of a shift to private rooms on health care costs, such as a reduction in overall expenditures on health care services that may result, for example, from improved infection control associated with a greater number of single-bed rooms at MGH.

IX. Predicted Changes in Health Care Expenditures

169. 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

¹⁹⁹ 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.

²⁰⁰ Mass General Brigham, CMS-Required Hospital Charge Data, available at https://healthcare.partners.org/pricetransparency/042697983_Massachusetts-General-Hospital_StandardCharges.zip.

²⁰¹ 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>.

estimate the cost impact of changes in where patients choose to receive care if the proposed project were approved.

A. Inpatient Services

170. 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 we described in Section III.A.4. Specifically, the simulations summarized in Figure MGH16 predict which patients would switch to MGH to receive care after the proposed project. For each patient who would switch to MGH, 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 MGH. If the price for the service is higher at MGH than at the hospital the patient previously utilized, health care expenditures will increase. If the price for the service at MGH 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 MGH or one of its competitors after the completion of the proposed project), there is no impact on health care expenditures.

171. 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 Figure MGH16 show that MGH's share of inpatient discharges in its service area is predicted to increase by 1.3 percentage points as a result of the proposed project, partially at the expense of Beth Israel Deaconess Medical Center, whose share in MGH's service area decreases by 0.2 percentage points. The Beth Israel Deaconess Medical Center patients who are predicted to switch to MGH are covered by many different payors. Approximately half of these patients are covered by Original Medicare, ten percent are covered by a BCBS-MA commercial health plan, ten percent are covered by a Tufts Health Plan Medicare Advantage plan, and so on.

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

- The CHIA Inpatient Relative Price Data report that BCBS-MA pays MGH commercial rates that are 36 percent higher than BCBS-MA's average commercial rates across its hospital network. CHIA also reports that BCBS-MA pays Beth Israel Deaconess Medical Center commercial rates that are 20 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 13 percent increase ($= 1.36 \div 1.20 - 1$) in expenditures on average for each patient enrolled in a commercial plan who switches to MGH from Beth Israel Deaconess Medical Center.
- The CHIA Inpatient Relative Price Data report that Medicare Advantage plans offered by Tufts Health Plan pay MGH rates that are 65 percent higher than Tufts' average Medicare Advantage rates across its hospital network. CHIA also reports that Tufts pays Beth Israel Deaconess Medical Center Medicare Advantage rates that are 43 percent higher than Tufts' average Medicare Advantage rates across its hospital network. This implies that Tufts will incur a 15 percent increase ($= 1.65 \div 1.43 - 1$) in expenditures on average for each patient enrolled in a Medicare Advantage plan who switches to MGH from Beth Israel Deaconess Medical Center.

In this example, the overall effect on a payor's inpatient hospital expenditures then depends on how many patients of each type would switch to MGH 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 Beth Israel Deaconess Medical Center to MGH following the project, BCBS-MA's overall expenditures on inpatient hospital services would increase by 1.3 percent ($= 13 \text{ percent} \times 10 \div 100$). If only one of these patients switch, BCBS-MA's overall expenditures on inpatient hospital services would increase by 0.13 percent ($= 13 \text{ percent} \times 1 \div 100$).

173. The previous example calculated inpatient hospital expenditure changes separately by payor, but we do not report payor-specific results below 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 MGH 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 13.7 percent ($= 0.13 \times 10 \div 15 + 0.15 \times 5 \div 15$) for each patient who switches.

174. We first summarize the results of these calculations across all inpatient service lines at MGH, and then briefly review the results of similar analyses that are limited to inpatient cancer services or inpatient heart and vascular services provided at MGH.

1. Inpatient Services

175. The first panel of Figure MGH22 summarizes the results of our calculations using our model's full predictions of which patients would switch to MGH and the relative prices for those patients' care at MGH and at the hospital they are switching from.²⁰² We predict that commercial payors' average expenditure on inpatient services will increase percent, respectively, for each patient who switches to MGH. 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 expenditures on inpatient services will increase by 7.1 percent and 1.7 percent, respectively, for each patient who switches to MGH. Overall, across all coverage types, we predict that the average expenditure on inpatient services will increase by an average of 14.4 percent for each patient who switches to MGH.

176. These increases in expenditures on inpatient hospital services are limited to patients who we predict would switch to MGH following the proposed project. However, the choices of most 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 also reported in Figure MGH22 and represent total expenditure effects across patients residing in Massachusetts and who received relevant inpatient

²⁰² 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).

services within the state. Across all coverage types, we predict that the average inpatient hospital services expenditure per person (*i.e.*, including both patients who switch to MGH and patients whose choices are unchanged) would increase by 0.06 percent.

2. Cancer Services

177. The second panel of Figure MGH22 summarizes similar calculations for inpatient cancer services. We predict that commercial payors' average expenditure on inpatient cancer services will increase by 72.7 percent for each patient who switches to MGH. Similarly, we predict that Medicare health plans' and MassHealth managed care plans' average expenditure on inpatient cancer services will increase by 121.2 percent and 82.7 percent, respectively, for each patient who switches to MGH. Changes in expenditures for patients covered by MassHealth non-managed care and Original Medicare are smaller: On average, we predict that Original Medicare and MassHealth non-managed care expenditures on inpatient cancer services will increase by 21.4 percent and 5.0 percent, respectively, for each patient who switches to MGH. Overall, across all coverage types, we predict that expenditures on inpatient cancer services will increase by an average of 37.8 percent for each patient who switches to MGH. Including patients who switch to MGH and patients whose choices are unchanged, average per-person expenditure on inpatient cancer services across all coverage types would increase by 1.01 percent.

3. Heart and Vascular Services

178. The third panel of Figure MGH22 summarizes similar calculations for inpatient heart and vascular services. We predict that commercial payors' average expenditure on inpatient heart and vascular services will increase by 62.5 percent for each patient who switches to MGH. Similarly, we predict that Medicare health plans' and MassHealth managed care plans' average expenditure on inpatient heart and vascular services will increase by 52.5 percent and 58.5 percent, respectively, for each patient who switches to MGH. Changes in expenditures for patients covered by MassHealth non-managed care and Original Medicare are smaller: On average, we predict that Original Medicare and MassHealth non-managed care expenditures on inpatient services will increase by 9.5 percent and 2.2 percent, respectively, for each patient who switches to MGH. Overall, across all coverage types, we predict that average expenditure on inpatient heart and vascular services will increase by 19.4 percent for each patient who switches to MGH. Including

patients who do switch to MGH and patients whose choices are unchanged, average per-person expenditure on inpatient heart and vascular services would increase by 0.35 percent.

B. Outpatient Services

179. 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 described in Section VI.B 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 MGH18 predict which patients would switch to receiving outpatient MR scans at MGH after the proposed project. For each patient who would switch to MGH, 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 MGH. If the price for the service is higher at MGH than at the facility the patient is switching from, health care expenditures will increase. If the price for the service at MGH 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 MGH or one of its competitors), there is no impact on health care expenditures.

180. For example, the simulations summarized in Figure MGH18 show that MGH’s share of outpatient MR scans in its service area is predicted to increase by 2.8 percentage points as a result of the proposed project, partially at the expense of Beth Israel Lahey Health, whose share in MGH’s service area decreases by 0.6 percentage points. While not reported in Figure MGH18, 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 MGH. Among patients switching from Beth Israel Lahey to MGH, 31 percent have Original Medicare or MassHealth non-managed care coverage. As we explained in Sections III.C.2 and III.C.3, 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 MGH 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.²⁰³ The remainder of patients switching from Beth Israel Lahey to MGH are covered by commercial health plans, Medicare health plans, or MassHealth managed care plans. BCBS-MA commercial plans, for example, cover 15 percent of the patients predicted to switch from Beth Israel Lahey Health to MGB. Because we can directly observe in the APCD data the amount that BCBS-MA reimburses MGH and Beth Israel Health for the same outpatient MR scans, we can predict the change in BCBS-MA expenditures when its members switch to receiving an outpatient MR scans at MGH instead of Beth Israel Lahey Health. We perform this exercise separately for each outpatient facility that MGH is predicted to draw patients from and for each third-party payor that covers the patients predicted to switch to MGH from these facilities.²⁰⁴ Aggregating these calculations across facilities and payors for each patient predicted to switch to MGH yields an estimate of how health care expenditures will change following the proposed project.²⁰⁵

181. In addition to calculating the effect of the proposed project on changes in expenditures associated with outpatient MR scans, in the following sections we use a similar approach to calculate the effect of the proposed project on expenditure for outpatient CT scans, outpatient PET/CT scans, outpatient cardiovascular services, and outpatient oncology services. We provide

²⁰³ 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).

²⁰⁴ 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 MGH, there was an insufficient amount of pricing data in the APCD to reliably calculate relative price of MGH 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.

²⁰⁵ 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 MGH 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 MGH.

If, hypothetically, MGH'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 MGH'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 MGH as $(0.50 \times 0.10 + 0.30 \times 0.05) \div (0.50 + 0.30) = 0.081$, or 8.1 percent.

both the predicted expenditure effect for patients who switch providers and the predicted total percentage effect on expenditures for patients—regardless of whether they switch to MGH—who reside in Massachusetts and receive these outpatient services from facilities in Suffolk, Essex, Middlesex, Norfolk, Bristol, Plymouth, and Worcester Counties.

1. Diagnostic Imaging Services

182. Figure MGH23 summarizes the changes in health care expenditures associated with the expansion of outpatient CT imaging capacity at MGH.

- We predict that commercial payors' expenditures on these services will increase by 24.4 percent for each patient who switches to MGH. Commercial patients comprise 25.4 percent of the patients predicted to switch to MGH.
- We predict that expenditures for each patient covered by Original Medicare who switches to MGH will increase by 5.5 percent and expenditures for each patient covered by a Medicare health plan who switches will decrease by 5.2 percent. Among patients who are predicted to switch to MGH, 41.2 percent are covered by Original Medicare and 8.7 percent are covered by a Medicare health plan.
- We predict that expenditures for each patient covered by MassHealth non-managed care who switches to MGH will increase by a very small amount and expenditures for each patient covered by a MassHealth managed care plan who switches will increase by 0.3 percent. Among patients who are predicted to switch to MGH, 5.4 percent are covered by MassHealth non-managed care and 13.5 percent are covered by a MassHealth managed care plan.
- Overall, across all coverage types, we predict that expenditures on outpatient CT scans will increase by an average of 7.2 percent for each patient who switches to MGH. Across all coverage types, we predict that total expenditures on outpatient CT scans (*i.e.*, including both patients who switch to MGH and patients whose choices are unchanged) will increase by 0.1 percent.

183. Figure MGH24 summarizes the changes in health care expenditures associated with the expansion of outpatient MRI capacity at MGH.

- We predict that commercial payors' expenditures on these services will increase by 23.7 percent for each patient who switches to MGH. Commercial patients comprise 41.0 percent of the patients predicted to switch to MGH.
- We predict that expenditures for each patient covered by Original Medicare who switches to MGH will increase by 18.6 percent and expenditures for each patient covered by a Medicare health plan who switches will increase by 0.5 percent. Among patients who are predicted to switch to MGH, 28.0 percent are covered by Original Medicare and 7.4 percent are covered by a Medicare health plan.
- We predict that expenditures for each patient covered by MassHealth non-managed care who switches to MGH will increase by 0.7 percent and expenditures for each patient covered by a MassHealth managed care plan who switches will increase by 2.1 percent. Among patients who are predicted to switch to MGH, 3.5 percent are covered by MassHealth non-managed care and 15.9 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 15.1 percent for each patient who switches to MGH. Across all coverage types, we predict that total expenditures on outpatient MR scans (*i.e.*, including both patients who switch to MGH and patients whose choices are unchanged) will increase by 0.2 percent.

184. Figure MGH25 summarizes the changes in health care expenditures associated with the expansion of outpatient PET/CT imaging capacity at MGH.

- We predict that commercial payors' expenditures on these services will increase by 16.7 percent for each patient who switches to MGH. Commercial patients comprise 23.1 percent of the patients predicted to switch to MGH.
- We predict that expenditures for each patient covered by Original Medicare who switches to MGH will increase by 21.1 percent and expenditures for each patient covered by a Medicare health plan who switches will increase by 25.9 percent. Among patients who are predicted to switch to MGH, 47.2 percent are covered by Original Medicare and 15.8 percent are covered by a Medicare health plan.

- We predict that expenditures for each patient covered by MassHealth non-managed care who switches to MGH will increase by 2.0 percent and expenditures for each patient covered by a MassHealth managed care plan who switches will increase by 3.0 percent. Among patients who are predicted to switch to MGH, 1.8 percent are covered by MassHealth non-managed care and 8.3 percent are covered by a MassHealth managed care plan.
- Overall, across all coverage types, we predict that expenditures on outpatient PET/CT scans will increase by an average of 18.4 percent for each patient who switches to MGH. Across all coverage types, we predict that total expenditures on outpatient PET/CT scans (*i.e.*, including both patients who switch to MGH and patients whose choices are unchanged) will increase by 1.1 percent.

2. Cardiovascular Services

185. Figure MGH26 summarizes the changes in health care expenditures associated with the expansion of outpatient cardiovascular services at MGH.

- We predict that commercial payors' expenditures on these services will increase by 34.9 percent for each patient who switches to MGH. Commercial patients comprise 20.3 percent of the patients predicted to switch to MGH.
- We predict that expenditures for each patient covered by a Medicare health plan who switches to MGH will increase by 1.8 percent. Among patients who are predicted to switch to MGH, 6.9 percent are covered by a Medicare health plan. For patients covered by Original Medicare who switch to MGH, we predict that nearly all of these patients shift to MGH from another HOPD. Therefore, the change in health care expenditures associated with patients covered by Original Medicare who switch to MGH is minimal. Among patients who are predicted to switch to MGH, 62.5 percent are covered by Original Medicare.
- We predict that expenditures for each patient covered by a MassHealth managed care plan who switches to MGH will increase by 2.9 percent. Among patients who are predicted to switch to MGH, 5.1 percent are covered by a MassHealth managed care plan. Similar to patients covered by Original Medicare, we predict minimal change in expenditures for

patients covered by MassHealth non-managed care who switch to MGH. Among patients who are predicted to switch to MGH, 2.0 percent are covered by MassHealth non-managed care.

- Overall, across all coverage types, we predict that expenditures on outpatient cardiovascular procedures will increase by an average of 7.7 percent for each patient who switches to MGH. Across all coverage types, we predict that total expenditures on outpatient cardiovascular procedures (*i.e.*, including both patients who switch to MGH and patients whose choices are unchanged) would increase by only a minimal amount. (Because the shift in utilization is small relative to total utilization, the overall effect on payors' expenditures is close to zero.)

3. Oncology Services

186. Figure MGH27 summarizes the changes in health care expenditures associated with the expansion of outpatient oncology visits at MGH.

- We predict that commercial payors' expenditures on these services will increase by 69.3 percent for each patient who switches to MGH. Commercial patients comprise 27.2 percent of the patients predicted to switch to MGH.
- We predict that expenditures for each patient covered by Original Medicare who switches to MGH will increase by 2.9 percent and expenditures for each patient covered by a Medicare health plan who switches will increase by 3.2 percent. Among patients who are predicted to switch to MGH, 48.2 percent are covered by Original Medicare and 9.9 percent are covered by a Medicare health plan.
- We predict that expenditures for each patient covered by MassHealth non-managed care who switches to MGH will increase by 0.1 percent and expenditures for each patient covered by a MassHealth managed care plan who switches will increase by 24.5 percent. Among patients who are predicted to switch to MGH, 2.7 percent are covered by MassHealth non-managed care and 8.6 percent are covered by a MassHealth managed care plan.
- Overall, across all coverage types, we predict that expenditures on outpatient oncology will increase by an average of 22.3 percent for each patient who switches to MGH. Across

all coverage types, we predict that total expenditures on outpatient oncology visits (*i.e.*, including both patients who switch to MGH and patients whose choices are unchanged) will increase by 0.5 percent. (Because the shift in utilization is small relative to total utilization, the overall effect on payors' expenditures is much smaller than the effect on expenditures for those who switch.)

X. Other Considerations

A. Effect on Demand for Health Care Services

1. The Potential for Supply-Induced Demand

187. 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 [themselves].”²⁰⁶ 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.

188. 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 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.

189. 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

²⁰⁶ 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.

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—or physicians reimbursed under alternative payment models or as part of accountable care organizations.

190. 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.²⁰⁷

- 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).
- 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.

²⁰⁷ HANDBOOK: Chapter 2: Jonathan Skinner. "Causes and Consequences of Regional Variation in Health Care.", pp. 54-56.

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.²⁰⁸

191. 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.

192. 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 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?²⁰⁹ Some recent studies have used a more robust empirical approach to address the issue of causation. We describe findings from a few such studies below.

²⁰⁸ Mark V. Pauly, Thomas G. McGuire, and Pedro Pita Barros (eds). *Handbook of Health Economics*, Volume 2. North Holland, Elsevier (2012), Chapter 6: Amitabh Chandra, David Cutler, and Zirui Song. “Who Ordered That? The Economics of Treatment Choices in Medical Care.” pp. 402-403.

²⁰⁹ 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.

193. 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.²¹⁰ 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.

194. 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 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.²¹¹ 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.

²¹⁰ 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).

²¹¹ 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.

195. 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.²¹² 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.

196. Clemens and Gottlieb (2014) investigate the extent to which physicians' compensation arrangements affect their treatment recommendations.²¹³ 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.²¹⁴ The 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).²¹⁵ The authors also assess the effect of the reimbursement change on the provision of particular

²¹² 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.

²¹³ Jeffrey Clemens and Joshua Gottlieb. “Do Physicians’ Financial Incentives Affect Medical Treatment and Patient Health?” *American Economic Review* (2014).

²¹⁴ 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 Adjustment Factors were calculated. As a result, some physicians experienced increases in Medicare reimbursements while others experienced decreases.

²¹⁵ 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.

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.”

197. 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.

198. Ikegami *et al.* (2021) assess how physicians at one hospital change their use of MRIs when a neighboring hospital purchases a new MRI.²¹⁶ 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 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.

²¹⁶ Kei Ikegami, Ken Onishi, and Naoki Wakamori. “Competition-driven physician-induced demand.” *Journal of Health Economics* (2021).

199. Finkelstein *et al.* (2016) use another type of natural experiment to assess regional variation in health care utilization.²¹⁷ 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.

200. Finally, Young *et al.* (2021) examine whether physicians who become hospital employees change their usage of MRIs following employment.²¹⁸ 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. They classify MRIs used to diagnose causes of lower back pain, knee pain, and shoulder pain as appropriate or inappropriate

²¹⁷ Amy Finkelstein, Matthew Gentzkow, and Heidi Williams. "Sources of Geographic Variation in Health Care: Evidence from Patient Migration." *Quarterly Journal of Economics* (2016).

²¹⁸ 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).

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.

201. 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.

2. Literature on the Effect of Additional Imaging Capacity on Demand for Surgery and Inpatient Care

202. In connection with MGB's application to add additional diagnostic imaging capacity to MGH, the DoN program asked CRA to assess the downstream impact of the proposed project's new imaging capacity on inpatient and surgical volume at MGH. The literature that directly addresses the question of the downstream impact of increased capacity in advanced imaging (*e.g.*, CT, MRI, PET/CT, or PET/MR) on surgical and inpatient volumes is sparse. A larger body of research analyzes the costs and benefits of providing advanced imaging to various categories of patients and provides evidence of improved quality of life or lengthened life, although we were unable to identify studies that estimated the effects of *each* type of imaging equipment requested by MGB in its DoN application on both cancer and cardiac care outcomes.

203. However, as van Beek *et al.* (2019) notes, it is difficult to evaluate the effectiveness of any diagnostic modality because diagnosis generally begins a therapeutic episode whose outcomes are typically evaluated at the end or at least at a point in time substantially after the initial diagnostic

test.²¹⁹ As a result, a variety of confounding influences can affect the measure of the relevant outcome. Notwithstanding this difficulty, in this section we briefly summarize examples of recent studies of each imaging modality. There has also been substantial analysis of the trends in utilization of specific imaging modalities as well as imaging in general for both commercially insured and government-insured patients. We summarize this literature at the end of this section.

i. Positron Emission Tomography/Computed Tomography

204. PET scanning is often used to assess brain function and disorders, diagnose cancer as well as its spread and response to treatment, and evaluate heart problems.²²⁰ Based on our reviews of the health literature, its use in the diagnosis and treatment of various types of cancer has been most studied. Strong evidence exists for the use of PET/CT in the diagnosis and staging of non-small cell lung cancer, the most common form of lung cancer with more than 200 thousand new cases in the U.S. annually.²²¹ Zeng *et al.* (2019) found that the diagnostic accuracy and sensitivity of combined PET/CT imaging is superior to that of CT alone, and that the combined approach met cost-effectiveness thresholds in the Chinese health system.²²² The authors also found that the use of PET/CT imaging was positively correlated with survival rates.

205. Buck *et al.* (2010) note that the “combination of a dedicated PET scanner and multislice helical CT enables integrated functional and high-resolution morphologic imaging” and has many advantages in “differential diagnosis of undefined lesions, initial tumor staging, detection of relapse, and response monitoring,” leading to higher sensitivity and specificity in cancer imaging

²¹⁹ Edwin J.R. van Beek, Christiane Kuhl, Yoshimi Anzai, Patricia Desmond, Richard L. Ehman, Qiyong Gong, Garry Gold, Vikas Gulani, Margaret Hall-Craggs, Tim Leiner, C.C. Tschoyoson Lim, James G. Pipe, Scott Reeder, Caroline Reinhold, Marion Smits, Daniel K. Sodickson, Clare Tempany, H. Alberto Vargas, and Meiyun Wang. “Value of MRI in Medicine: More Than Just Another Test?” *Journal of Magnetic Resonance Imaging* (2019).

²²⁰ C.H. Weaver. “The Role of PET Scans in the Diagnosis and Treatment of Cancer.” *CancerConnect* (2021), available at <https://news.cancerconnect.com/treatment-care/the-role-of-pet-scans-in-the-diagnosis-and-treatment-of-cancer>.

²²¹ Cancer.Net. “Lung Cancer – Non-Small Cell: Statistics,” available at <https://www.cancer.net/cancer-types/lung-cancer-non-small-cell/statistics>.

²²² Xiaohui Zeng, Liubao Peng, Chongqing Tan, and Yunhua Wang. “Cost-effectiveness analysis of positron-emission tomography-computed tomography in preoperative staging for nonsmall-cell lung cancer with resected monometastatic disease.” *Medicine* (2019).

than previously available.²²³ The authors note that, in response, third-party payors in the United States and Europe have approved reimbursement of combined PET/CT for various oncologic indications. In addition to demonstrated cost-effectiveness for non-small cell lung cancer, they note the cost effectiveness of PET/CT in the restaging of Hodgkin's disease, non-Hodgkin lymphoma, and colorectal carcinoma.

206. Langer (2010) assessed a variety of studies on the use of PET/CT in oncology, finding the strongest evidence of cost-effectiveness for non-small cell lung cancer.²²⁴ More generally, they concluded that PET/CT led to improved care and reduced exposure to ineffective treatments and may, therefore, be more generally cost-effective. The author noted, however, that further research is needed for many types of cancer to determine the most cost-effective use of PET/CT imaging in cancer care. However, like the previously cited study, this review of existing literature was issued in 2010, so more recent research, not yet summarized in the form of a meta-analysis, may provide more evidence on the cost-effectiveness of PET/CT in cancer care. Indeed, a 2016 editorial notes the significant promise of combined PET/CT for reducing the cost of cancer management by improving the accuracy of both diagnosis and staging.²²⁵ This improved accuracy may help to avoid expensive but ineffective treatment and the associated side effects.

ii. Computed Tomography

207. Regular CT imaging has been widely recommended as a screening technique for current and former regular smokers. Specifically, the U.S. Preventive Services Task Force guideline, most recently updated in March 2021, recommends that adults aged 50-80 with a 20 pack-year smoking history (*i.e.*, 20 years of smoking one pack of cigarettes per day or equivalent) who are current smokers or who have quit during the last 15 years should undergo annual low-dose CT

²²³ Andreas K. Buck, Ken Herrmann, Tom Stargardt, Tobias Dechow, Bernd Joachim Krause, and Jonas Schreyögg. "Economic Evaluation of PET and PET/CT in Oncology: Evidence and Methodologic Approaches." *Journal of Nuclear Medicine Technology* (2010).

²²⁴ Astrid Langer. "A systematic review of PET and PET/CT in oncology: A way to personalize cancer treatment in a cost-effective manner?" *BMC Health Services Research* (2010).

²²⁵ Barbara Malene Fischer, Barry A. Siegel, Wolfgang A. Weber, Konrade von Bremen, Thomas Beyer, and Antonis Kalemis. "Editorial: PET/CT is a cost-effective tool against cancer: synergy supersedes singularity." *European Journal of Nuclear Medicine and Molecular Imaging* (2016).

screening.²²⁶ This guideline continues recommendations that have been in effect since a 2010 National Cancer Institute-sponsored study of more than 53,000 individuals found that annual CT scanning of current and former smokers reduced the risk of death by 20 percent.²²⁷

208. Recently, a multidisciplinary international panel evaluated the efficacy of CT scanning for management of patients with COVID-19.²²⁸ The panel agreed that imaging with CT is indicated for patients with COVID-19 and worsening respiratory status, as well as patients who are mildly ill but at risk for disease progression. They also recommend CT imaging as a method to triage patients in a resource-constrained environment.

iii. *Magnetic Resonance Imaging*

209. Redd *et al.* (2015) assessed the effect of MRI utilization on subsequent hospitalization and length of stay.²²⁹ The authors measured the effect of locating an always-accessible MRI in the emergency department of a hospital on changes in emergency MRI utilization and its effect on resource utilization for two classes of patients presenting in the emergency department. The authors found that locating an MRI in the emergency department of a trauma center increased MRI utilization by 38 percent for rule-out stroke cases and by 51 percent for neurology consults.

²²⁶ U.S. Preventive Services Task Force. “Final Recommendation Statement – Lung Cancer: Screening,” *available at* <https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/lung-cancer-screening>. Exceptions are made for individuals who have health problems that limit their life expectancy or the ability to undergo lung surgery; *See also*, Harry J. de Koning, Carlijn M. van der Aalst, Pim A. de Jong, Ernst T. Scholten, Kristiaan Nackaerts, Marjolein A. Heuvelmans, Jan-Willem J. Lammers, Carla Weenink, Uraujh Yousaf-Khan, Nanda Horeweg, Susan van’t Westeinde, Mathias Prokop, Willem P. Mali, Firdaus A.A. Mohamed Hosein, Peter M. A. van Ooijen, Joachim G. J. V. Aerts, Michael A. den Bakker, Erik Thunnissen, Johny Verschakelen, Rozemarijn Vliegenthart, Joan E. Walter, Kevin Ten Haaf, Harry J. M. Groen, and Matthijs Oudkerk. “Reduced Lung-Cancer Mortality with Volume CT Screening in a Randomized Trial.” *New England Journal of Medicine* (2020).

²²⁷ Gardiner Harris. “CT Scans Cut Lung Cancer Deaths, Study Finds,” *New York Times* (November 4, 2010), *available at* <https://www.nytimes.com/2010/11/05/health/research/05cancer.html>.

²²⁸ Geoffrey D. Rubin, Christopher J. Ryerson, Linda B. Haramati, Nicola Sverzellati, Jeffrey P. Kanne, Suhail Raoof, Neil W. Schluger, Annalisa Volpi, Jae-Joon Yim, Ian B. K. Martin, Deverick J. Anderson, Christina Kong, Talissa Altes, Andrew Bush, Sujal R. Desai, Jonathan Goldin, Jin Mo Goo, Marc Humbert, Yoshikazu Inoue, Hans-Ulrich Kauczor, Fengming Luo, Peter J. Mazzone, Mathias Prokop, Martine Remy-Jardin, Luca Richeldi, Cornelia M. Schaefer-Prokop, Noriyuki Tomiyama, Athol U. Wells, and Ann N. Leung. “The Role of Chest Imaging in Patient Management during the COVID-19 Pandemic: A Multinational Consensus Statement from the Fleischner Society.” *Radiology* (2020).

²²⁹ Vanessa Redd, Scott Levin, Matthew Toerper, Amanda Creel, and Susan Peterson. “Effects of Fully Accessible Magnetic Resonance Imaging in the Emergency Department.” *Academic Emergency Medicine* (2015).

Subsequent hospital admission of these patients declined by 17 percent for rule-out stroke cases, while remaining unchanged for neurology consults. Patients spent more time in the emergency department, but patients who were hospitalized had shorter lengths of stay. Moreover, utilization of MRI imaging during any subsequent inpatient stay declined significantly for both cohorts.

210. Kraus *et al.* (2021) note that some patients initially diagnosed with soft tissue sarcomas of the extremity or trunk experience a recurrence that generally predicts substantially worse outcomes unless detected early.²³⁰ A comparison of MRIs with clinical examinations to detect recurrence found that MRI diagnostics were superior, but the study recommends using both techniques as complementary approaches.

iv. Trends in Utilization of and Spending on Imaging

211. As we noted above, a large volume of literature has documented trends in the utilization of and expenditures on diagnostic imaging. This literature has generally concluded that expenditures on imaging services have grown more slowly (or even declined) relative to spending on other types of health care services.

212. Lee *et al.* (2013) compared trends in Medicare spending on imaging and non-imaging services.²³¹ The authors found that between 2000 and 2006, spending on diagnostic imaging grew at nearly double the rate of non-imaging services (a 12 percent increase for imaging compared to a 6.8 percent increase for other services). However, between 2007 and 2011, Medicare spending on diagnostic imaging spending fell by 3.5 percent, while Medicare spending on other services increased by 3.6 percent. Similarly, Kassavin *et al.* (2021) found that the annual growth rate of Medicare Part B spending between 2009 and 2019 for all imaging services was negative 3.0 percent.²³² The reduction in Medicare spending for imaging services was contrasted with increases

²³⁰ Daniel Kraus, Felix Oettinger, Jurij Kiefer, Holger Bannasch, G. Björn Stark, and Filip Simunovic. “Efficacy and Cost-Benefit Analysis of Magnetic Resonance Imaging in the Follow-Up of Soft Tissue Sarcomas of the Extremities and Trunk.” *Journal of Oncology* (2021).

²³¹ David W. Lee, Richard Duszak Jr., and Danny R. Hughes. “Comparative analysis of Medicare spending for medical imaging: sustained dramatic slowdown compared with other services.” *American Journal of Roentgenology* (2013).

²³² Monica H. Kassavin, Keval D. Parikh, Sree Harsha Tirumani, and Nikhil Ramaiya. “Trends in Medicare Part B Payments and Utilization for Imaging Services between 2009 and 2019.” *Current Problems in Diagnostic Radiology* (2021).

in Medicare spending on other services, including prescription drugs (5.9 percent) and physicians' services (0.9 percent). The findings of Rosenkrantz *et al.* (2015) are consistent with these two studies.²³³ Using data on Medicare expenditures on imaging between 2004 and 2012, the authors find that average per beneficiary Medicare Part B imaging spending peaked in 2006 and then decreased by 4.4 percent annually between 2006 and 2012. The authors also found that this decline was experienced in nearly all states.

213. Hong *et al.* (2020) assessed trends in imaging utilization between 2003 and 2016 for both Original Medicare beneficiaries and commercially insured patients.²³⁴ The authors found that utilization for both populations increased through 2010 but began to decline after that.²³⁵ They also document consistent trends in the Medicare and commercially insured populations, though utilization levels were always higher among Medicare beneficiaries than the commercially insured.

214. Flaherty *et al.* (2018) focused specifically on utilization of health care services for commercially insured residents of Massachusetts between 2009 and 2013.²³⁶ Using data from the Massachusetts APCD, the authors measured trends in imaging and non-imaging utilization and expenditures. Utilization per member for imaging services grew by less than one percent per year over the period of the study, while expenditures declined by more than seven percent per year, on average, over the period of study. In contrast, utilization per member for non-imaging services grew by seven percent per year over the study period, corresponding to an increase in expenditures for non-imaging services of four percent per year. The authors found substantial variation in utilization trends across imaging modalities, with CT and nuclear medicine showing declines in utilization, while X-ray, MRI, PET, and ultrasound showed increases in utilization.

²³³ Andrew B. Rosenkrantz, Danny R. Hughes, and Richard Duszak Jr. "State Variation in Medical Imaging: Despite Great Variation, the Medicare Spending Decline Continues." *American Journal of Roentgenology* (2015).

²³⁴ Arthur S. Hong, David Levin, Laurence Parker, Vijay M. Rao, Dennis Ross-Degnan, and J. Frank Wharam. "Trends in Diagnostic Imaging Utilization among Medicare and Commercially Insured Adults from 2003 through 2016." *Radiology* (2020).

²³⁵ The one exception to this general pattern was that utilization of CT continued to grow between 2012 and 2016 for the under-45 commercially insured population.

²³⁶ Stephen Flaherty, Koenraad J. Mortelet, and Gary J. Young. "Utilization Trends in Diagnostic Imaging for a Commercially Insured Population: A Study of Massachusetts Residents 2009 to 2013." *Journal of the American College of Radiology* (2018).

215. Lastly, Rosenkrantz and Duszak (2017) assessed whether utilization of advanced imaging techniques had any effect on Medicare Shared Savings Program-participating Accountable Care Organizations' ability to achieve savings and meet the minimum savings rate necessary to qualify for savings sharing.²³⁷ Using data on per member utilization of MRI and CT, the authors found that MRI utilization had a small, significant positive effect on Accountable Care Organizations' achieved savings as well as the probability of achieving the minimum savings rate threshold. These findings indicate that the cost of higher MRI utilization was more than offset by savings in other types of care. However, the authors found no significant effect of CT utilization on reducing expenditures on other types of care.

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

216. 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 MGH'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.²³⁸ 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.

217. In its DoN application for MGH, MGB noted that in fiscal year 2019, 78 percent of MGH's admissions through its emergency department boarded in the emergency department for more than two hours following a bed request before transferring to an inpatient bed.²³⁹ 82 percent of cardiology patients admitted by the MGH emergency department were boarded in the emergency

²³⁷ Andrew B. Rosenkrantz and Richard Duszak Jr. "Advanced Imaging Utilization and Cost Savings Among Medicare Shared Savings Program Accountable Care Organizations: An Initial Exploratory Analysis." *Journal of the American College of Radiology* (2017).

²³⁸ 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/>.

²³⁹ MGH DoN, Appendix 2, p. 12.

department, with an average length of stay in the emergency department of 10.5 hours.²⁴⁰ Similarly, 87 percent of oncology patients admitted by the MGH emergency department were boarded in the emergency department.²⁴¹ Based on information that MGB provided CRA, the average length of stay in the emergency department for these patients was 10.9 hours. 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 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.

218. 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 who boarded in the emergency department of a large, urban academic medical center.²⁴² 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.

219. 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.²⁴³ 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

²⁴⁰ MGH DoN, Appendix 2, p. 12.

²⁴¹ MGH DoN, Appendix 2, p. 12.

²⁴² 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).

²⁴³ 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).

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.

220. 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.²⁴⁴ 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 of their emergency department boarding time in a hospital hallway and boarded in the emergency department longer before being admitted.

221. 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.²⁴⁵ 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

²⁴⁴ 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).

²⁴⁵ Lindsey Woodworth and James F. Holmes. "Just a Minute: The Effect of Emergency Department Wait Time on the Cost of Care." *Economic Inquiry* (2020).

department within four hours.²⁴⁶ 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.

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

222. 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.

223. 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.

²⁴⁶ 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).

224. 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.²⁴⁷ 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.²⁴⁸

225. 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.²⁴⁹ 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

²⁴⁷ Centers for Medicare and Medicaid Services, National Health Expenditure Accounts, Table 20, *available at* <https://www.cms.gov/files/zip/nhe-tables.zip>.

²⁴⁸ 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.”

²⁴⁹ 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>.

incurred by plan participants in the previous year can affect premiums for the plan in subsequent years.²⁵⁰

226. 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 MGH28.²⁵¹ Two features of these data are noteworthy. First, as we noted 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.

227. 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

²⁵⁰ See Peter R. Kongstvedt (ed.). *The Managed Health Care Handbook*, Fourth Edition. Gaithersburg, Aspen Publishers (2001), Chapter 49.

²⁵¹ Centers for Medicare and Medicaid Services. National Health Expenditure Accounts, Table 20, *available at* <https://www.cms.gov/files/zip/nhe-tables.zip>.

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.

228. Kolstad and Kowalski (2016) analyzed Massachusetts' adoption of individual and employer mandates in 2006.²⁵² 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 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).

229. 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.²⁵³ 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.

230. 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.²⁵⁴ 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

²⁵² 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).

²⁵³ Priyanka Anand. "Health Insurance Costs and Employee Compensation: Evidence from the National Compensation Survey." *Health Economics* (2017).

²⁵⁴ Katherine Baicker and Amitabh Chandra. "The Labor Market Effects of Rising Health Insurance Premiums." *Journal of Labor Economics* (2006).

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.

231. 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 associated with benefit mandates.²⁵⁵ The author finds that the costs of the mandates are shifted completely to workers, with little effect on net labor input.

232. 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.²⁵⁶ 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.²⁵⁷

233. 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

²⁵⁵ Jonathan Gruber. “The Incidence of Mandated Maternity Benefits.” *American Economic Review* (1994).

²⁵⁶ 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>.

²⁵⁷ 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>.

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.

XI. Conclusions

234. 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 MGH for inpatient services (including cancer and heart and vascular inpatient services), outpatient diagnostic imaging services (*i.e.*, outpatient CT, MR, and PET/CT scans), outpatient cardiovascular services, and outpatient oncology visits. 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 MGH29 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 MGH will increase by 17 percent over the next ten years (with somewhat lower projected increases for inpatient cancer services and higher projected increases for inpatient heart and vascular services), while demand for outpatient diagnostic imaging, cardiovascular services, and oncology visits at MGH will increase by between ten and 21 percent.

Figure MGH29

Service Line (Units)	Projected Increase in Demand at MGH
Adult Inpatient (Patient Days)	17%
Cancer (Patient Days)	15%
Heart & Vascular (Patient Days)	21%
Outpatient CT (Scans)	16%
Outpatient MR (Scans)	10%
Outpatient PET/CT (Scans)	17%
Outpatient Cardiovascular (Procedures)	21%
Outpatient Oncology (Visits)	18%

235. In all 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. Without expansion, these projected increases in demand for care at MGH likely exceed the hospital’s existing ability to provide care because the hospital operated at or above its capacity in fiscal year 2019 (the last full fiscal year in which utilization was not affected by the COVID-19 pandemic).

236. 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. Our calculations are summarized in Figure MGH30 below. As shown in the figure, in each of the service lines addressed in the DoN application, MGB’s current share in MGH’s service area is between 32 and 35 percent. The proposed project would increase MGB’s share in these service areas by 2.3 percentage points or less with the exception of outpatient PET/CT scans, where we predict that MGB’s share would increase by 6.1 percentage points as a result of the proposed project.

Figure MGH30

Service Line	MGB’s Share Before Proposed Project	Change in MGB’s Share After Proposed Project
Adult Inpatient Discharges	34%	1.1%
Outpatient CT Scans	35%	1.6%
Outpatient MR Scans	33%	2.1%
Outpatient PET/CT Scans	33%	6.1%
Outpatient Cardiovascular Procs.	32%	0.3%
Outpatient Oncology Visits	35%	2.3%

237. 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.

238. 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 MGH 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 MGH 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 MGH's expansion. We provide these estimates separately for each service line addressed in the DoN application and also combined across all service lines.²⁵⁸ In all cases, 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.

239. Our estimates of the cost impact of the proposed project are summarized in Figure MGH31 below. Estimates using our first approach that measures the increase in expenditures for patients who would switch to MGH is shown in the left column; estimates using our second approach that measures the increase in expenditures across all patients is shown in the right column. As shown in the figure, for each patient who switches to MGH, the change in expenditures ranges between seven percent (outpatient CT scans) and 38 percent (inpatient cancer services), with the weighted average change across all service lines being 18 percent. Across all patients, the changes in expenditures range between 0.0 percent (outpatient cardiovascular services) and 1.1 percent (outpatient PET/CT scans), with the weighted average change across all service lines being 0.2 percent.

²⁵⁸ To calculate the changes in expenditures across all service lines reported in Figure MGH31, 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. These 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.

Figure MGH31

Service Line	Change in Spending Per Switch to MGH	Change in Spending Across All Patients
Adult Inpatient Services	14%	0.1%
Cancer	38%	1.0%
Heart & Vascular	19%	0.4%
Outpatient CT Scans	7%	0.1%
Outpatient MR Scans	15%	0.2%
Outpatient PET/CT Scans	18%	1.1%
Outpatient Cardiovascular Procs.	8%	0.0%
Outpatient Oncology Visits	22%	0.5%
<i>Across All Service Lines</i>	<i>18%</i>	<i>0.2%</i>

240. In summary, we predict substantial increases in demand for inpatient and outpatient services at MGH over the next decade. Health care services at MGH are more costly than those at many competing health care providers in Massachusetts, but the overall **increase** in health care expenditures across the service lines associated with the proposed expansion of MGH is only 0.2 percent. Moreover, the economics literature predicts that allowing capacity-constrained providers such as MGH 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.