

# Supplementary Appendix

## Brazil's unified health system: the first 30 years and prospects for the future

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## **1. Timeline of events**

Table S1 summarizes the most important regulations of the SUS regarding financing and payment, governance and organization, health care model, and resource generation and management. A comprehensive collection of regulations can be found elsewhere.<sup>1</sup>

Here, information is organized by presidential terms, and a summary of achievements and fragilities of the SUS over the last 30 years is presented at the end of the table.

**Table S1 – Detailed timeline of SUS regulations**

Time & Presidency	Context	Financing & Payment	Governance & Organization	Health care model	Resource generation and management	Synthesis
1964 - 1985 Military	Military Dictatorship	Social security budget and Assistance Fund for Rural Workers (FUNRURAL). Fee for service	Healthcare provided to formal workers through the Social Security National Institute of Social Assistance (INAMPS), established in 1977; informal workers relied on philanthropic institutions or private sector by out-of-pocket payment; The Ministry of Health (MoH), created in 1953 (Law 1920), was responsible for national programs targeting specific infectious diseases; State and Municipal Health Secretariats provided healthcare services, free-of-charge, to the most vulnerable groups. Information Systems 1975: Mortality Information System (SIM); 1979: Hospital Inpatient Authorization (AIH)	Hospital centered; public health care to control specific diseases; informal workers relied on philanthropic institutions or private sector by out-of-pocket payment.	<b>1968:</b> Rondon Project; 1978: National Commission for Medical Residency // <b>1971:</b> Centre of Medicines (CEME); <b>1973:</b> National Immunization Program (PNI)	Crisis of the social insurance medical care model for formal workers in the dictatorial period
1985 - 1989 President José Sarney	Redemocratization; 1988: New Constitution	30% of the social security budget (excluding unemployment benefits) should be allocated to health by the federal government until the approval of the Annual Budget Law ( <i>Lei de Diretrizes Orçamentárias</i> - LDO). LDO to establish the annual share of the federal budget that would be applied in health. Fee for service	<b>1986: VIII national health conference report</b> <b>1988: Brazilian Federal Constitution</b> a. Art. 196: Health is a right to everyone, and a duty of the State b. Art. 197: Roles of public power over regulation, supervision, and control of the health system c. Art. 198: guidelines for health system organization d. Art. 199: Health care is open to private initiative. e. Art. 200: Health system competencies			New directions for a universal and unified health system (SUS) built during the redemocratization process
1990 - 1992 President Fernando Collor	Neoliberal economic policies and open market economics; 1992: Collor impeached	Lack of resources for funding SUS: 30% of social security budget predicted was not implemented; MoH was forced get a credit from the Workers Fund. Fee for service	<b>1990</b> <b>Law 8080:</b> Organic Health Law <b>Law 8142:</b> Community participation and intergovernmental transfers <b>Decree 99060:</b> INAMPS incorporated into the MoH <b>1991</b> <b>MD 258:</b> Rules for transferring resources to local levels NOB 91 <b>Decree 100:</b> Fusion of Public Health Services Foundation (Fsesp) and the Superintendence of Public Health Campaigns (Sucam) into FUNASA - National Health Foundation Information Systems – 1990: live births (SINASC); 1991: SUS Inpatient Information System (SIH)	<b>1991:</b> Community Health Agents Program, PACS ( <i>Programa Agente Comunitário de Saúde</i> ) established		Laws and rules for the SUS implementation, MoH coordination and decentralization of responsibilities to local levels with lack of resources for funding SUS
1992 - 1994 President Itamar Franco	Economic instability; 1994: Launch of the Real Plan	<b>1994</b> <b>Constitution Amendment 1:</b> The Social Emergency Fund allowed the government to collect taxes to be used in social and economic programs, including the SUS <b>Decree 1232:</b> Transfer fund-fund for health was established Fee for service predominant; Block grants introduced	<b>1992</b> <b>MD 234:</b> Rules for transferring resources to local levels NOB 92 <b>1993</b> <b>MD 545:</b> Rules for decentralization process: creation of tripartite and bipartite commissions, health councils – NOB 93 <b>Law 8689:</b> INAMPS abolished Information Systems – 1992: SUS outpatient Information System (SIA); 1993: Notifiable Diseases (SINAM)	<b>1994</b> <b>MD 692:</b> PSF/PACS - Family Health Program ( <i>Programa Saúde da Família</i> ) and PACS launched to interiorized the SUS through a minimum staff		Decentralization of federal services to states and municipalities occurred with restrictions of resources (context of economic instability). National policies for changing the model of care began with Family Health Strategy
1995 - 1998 President Fernando Henrique Cardoso (FHC) First term	Macroeconomic stability policies; Privatization of federal institutions; 1995: State Reform Master Plan	<b>1996</b> <b>Law 9311, article 18:</b> CPMF, Provisional Contribution on Financial Transactions, created as a specific tax for health <b>1997</b> <b>MD 1882:</b> Per capita financing for PHC, PAB, established <b>1998</b> <b>Law 9656:</b> Private health insurance firms must reimburse the SUS when beneficiaries receive care in the public system. Project grants by level of care, type of service and programs (majority), and fee for service (minority)	<b>1995</b> <b>Decree 1651:</b> SUS National Audit System, DENASUS, established <b>1996</b> <b>MD 2203:</b> Rules for integrated health planning (PPI), transfer of resources for assistance and surveillance actions, conditions for local management - full, semi-full and basic - NOB 96 Information Systems – 1996: Indicators and Basic Data for Health (IDB); 1997: National Health Card ( <i>Cartão SUS</i> ), and PHC information system (SIAB)	<b>1997</b> <b>Law 9434:</b> National Policy on Organ and Tissue Transplants	<b>1996</b> <b>Law 9313:</b> Free-access to HIV/AIDS medication <b>1998</b> <b>MD 3916:</b> Essential medicines List - RENAME	Decentralization continued with emphasis on municipalities. A new tax (CPMF) for funding created, but revenues used for other areas. Per-capita funding for PHC.

<p><b>1999 - 2002 FHC Second Term</b></p>	<p>Devaluation of the Brazilian Real; Stagnation of domestic economy</p>	<p><b>2000 Constitutional Amendment 29:</b> Minimum health expenditures by government level established: states and municipalities should allocate at least 12% and 15% of their revenues to the SUS, respectively, the minimum amount of federal resources to be defined according to the variation of the GDP. Project grants by level of health care and type of service/programs, including the definition of inter-municipal references (predominant) and Fee for service (minority)</p>	<p><b>1999 Law 9782:</b> National Health Surveillance Agency, ANVISA, established <b>2000 Law 9656:</b> National Health Plan Regulation Agency, ANS, established <b>2001 MD 95:</b> NOAS - Rules for regionalization, strengthening PHC and organization of medium and high complexity (NOAS) <b>2002 MD 373:</b> NOAS 02 - Rules for regionalization, strengthening PHC and organization of medium and high complexity</p>	<p><b>2001 Law 10216:</b> Psychiatric reform Law establishing the rights for mental health patients and guidelines for treatment <b>2002 MD 9:</b> National Program of Assistance for Pain and Palliative Care</p>	<p><b>1999 MD 1262:</b> Program for training of nurse technicians, PROFAE <b>Law 9787:</b> Generic Drugs policy <b>2001 National Education Council resolution 4:</b> New guidelines for health curriculum <b>2002 IMD 610:</b> National Program of Incentive to the Curricular Changes for the Medical Schools</p>	<p>Health regions created. National Agencies for Private Plans and Sanitary Issues created. Minimum health expenditures established. Policies for PHC, HIV/AIDS, generic drugs and changing medical education launched</p>
<p><b>2003 - 2006 President Luiz Inácio "Lula" da Silva First Term</b></p>	<p>1st Left wing Government after redemocratization; Economic stability and social policies (<i>Bolsa-Família</i>); 2005: Political crisis (<i>Mensalão</i>)</p>	<p>Large block grants according to level of health care, type of service, programs and functions (predominant form) and Fee for service (minority)</p>	<p><b>2003 Decree 4726:</b> Human Resources, Science &amp; Technology, and Strategic &amp; Participation Dep. added to MoH structure <b>2006 MD 332:</b> Guidelines for SUS Planning System instruments <b>MD 399:</b> Pact for health (for life, in defense of SUS, and management of SUS)</p>	<p><b>2003 MD 1863:</b> National Policy on Emergency Care <b>2004 Decree 5055:</b> Mobile emergency, SAMU <b>Ministerial guideline:</b> Smiling Brazil Program health policy <b>MD 1169:</b> Specialized policies for Kidney Disease policy <b>MD 1168:</b> Cardiovascular policy <b>MD 2073:</b> Hearing policy <b>2005 MD 221:</b> Orthopedic Trauma policy <b>MD 1161:</b> Neurological Disease policy <b>2006 MD 687:</b> Nacional Policy for PHC - PNAB (<i>Política Nacional de Atenção Básica</i>) <b>MD 648:</b> Nacional Policy for Health Promotion <b>MD 242:</b> Nacional Policy of Medium Complexity Procedures</p>	<p><b>2003 Law 10742:</b> Chamber of Medicines Market Regulation, CMED <b>2004 MD 198:</b> Permanent Education policy <b>Decree 5.090:</b> Program Popular Pharmacy of Brazil (<i>Farmácia Popular do Brasil</i>) <b>2005 IMD 2101:</b> National Program of Reorientation for Professional Training in Health - Pro-Health (PRO-SAÚDE)</p>	<p>MoH reorganized to improve governance capacity. PHC expansion through the FHS; new policies for Emergency care, specialized and hospital sector; health education, pharmaceutical assistance, and health technologies launched</p>
<p><b>2007 - 2010 President Luiz Inácio "Lula" da Silva Second Term</b></p>	<p>2009: Global recession; Counter-cyclical policies: stimulus to the economy: public works (Growth Acceleration Program - PAC), provision of credit for family consumption, rising credits granted by the National Economic and Social Development Bank</p>	<p><b>2007 MD 204:</b> Rules for transfer of federal resources to health actions and services, in the form of blocks of funding, with the respective monitoring Senate repealed the CPMF. Large block grants according to level of health care, type of service, programs and functions</p>	<p><b>2008 MD 3176:</b> Annual SUS Management Report guideline <b>2010 Law 12314:</b> Indigenous Health Department added to the MoH structure <b>Decree 7082:</b> National Program for Restructuring Federal University Hospitals (REHUF)</p>	<p><b>2008 MD 1559:</b> National Policy for the Regulation of SUS <b>MD 154:</b> Multi-professional Family Health Support Teams Family Health Program - NASF (<i>Núcleo de Apoio ao Saúde da Família</i>) <b>MD 2922:</b> Pre-hospital emergency unit - UPA (<i>Unidade de Pronto Atendimento</i>) <b>MD 957:</b> National Policy of Ophthalmology Care <b>2009 MD 1944:</b> National Policy for Men's Health</p>	<p><b>2007 MD 35:</b> Tele-health for distance care and distance education <b>Decree 6108:</b> Compulsory licensing of EFAVIRENZ <b>2008 Inter-ministerial directive 1802:</b> Program for professional training towards the SUS (<i>PET-Saúde</i>) <b>MD 374:</b> National Program to Foment Public Production and Innovation in the Health Industrial Complex <b>2009 MD 1001:</b> Support medical residence programs - Pro-Residency Program <b>2010 Decree 7385:</b> National Open University of SUS – UNASUS</p>	<p>Emphasis on improving access through creation of UPAs and development the health industrial complex. Investment plan in the health sector in response to the global economic crisis. Tax for health (CPMF) not renewed by the Senate.</p>

<p><b>2011 - 2014</b> <b>President Dilma Rousseff</b> <b>First Term</b></p>	<p>2013: Popular protests: bus fares, quality of public services (health, education, public transport, and security), and public spending for the World Cup; 2014: Economic turmoil; investigation on corruption scandals (Car-wash)</p>	<p><b>2012</b> <b>Law 141:</b> Regulation of Constitutional Amendment 29 and definition of actions and health public services Large block grants according to level of health care, type of service, programs and functions. Definition of financial commitments of each federative body in the regions.</p>	<p><b>2011</b> <b>Decree 7508:</b> SUS-Governance rules - Health Region, COAP - Regional contracts, RENAME - National list of medicines, RENASES - National list of Health Services SUS performance index (ID-SUS) Information Systems - 2013: e-SUS/AB (electronic records for PHC)</p>	<p><b>2011</b> <b>MD 1459:</b> Health networks established for Stork-Maternal <b>MD 1600:</b> Health emergency networks <b>MD 3.088:</b> Mental health networks <b>MD 2488:</b> Nacional Policy for PHC (PNAB) was renewed <b>2012</b> <b>MD 793:</b> National Policies on the Health of Persons with Disabilities <b>2013</b> <b>MD 252:</b> National Policy for chronic diseases <b>MD 874:</b> National Policy Oncology <b>MD 3.390:</b> National Policy hospital care (PNHOSP) <b>2014</b> <b>Law 12546:</b> Smoke-free legislation <b>IMD 1:</b> Health in the Prison System (PNAISP)</p>	<p><b>2011</b> <b>IMD 2087:</b> Incentive to medical doctor in PHC with bonus to access in residency (PROV AB) <b>MD 184:</b> Program Popular Pharmacy of Brazil (<i>Saúde não tem preço</i>) <b>Law 12401:</b> National Commission for Technology Incorporation, CONITEC <b>2012</b> <b>Decree 7807:</b> Defined strategic products for SUS and Health Industrial Complex <b>MD 506:</b> Program for the Development of the Industrial Complex of Health (PROCIS) <b>2013:</b> <b>Law 12871:</b> More Doctors Program - Investment in infrastructure, increased vacancies and recruitment (<i>Programa Mais Médicos</i>) <b>2014</b> <b>MD 2531:</b> Redefined guidelines for PDP</p>	<p>Definition of new rules for SUS governance based on health regions and health care networks. Minimum health expenditures defined by law. More Physician Program Launched as a response to Political Crisis.</p>
<p><b>2015 - 2016</b> <b>President Dilma Rousseff</b> <b>Second Term</b></p>	<p>Deep economic recession and political crisis; 2016: President Rousseff impeached</p>	<p><b>2015</b> <b>Constitutional Amendment 86:</b> Changed the definition of the minimum amount of federal resources to health: 13.2% of the Net Current Revenue in 2016, increasing afterwards until reaching 15% of the RCL in 2020 <b>Law 13097:</b> Foreign funds or firms were allowed to participate in Brazilian healthcare</p>	<p>Information Systems - 2015: e-SUS/Hospital (electronic records for Hospital)</p>	<p><b>2015</b> <b>MD 670:</b> National policy for severe obesity <b>MD 1130:</b> National policies child health</p>		<p>Deep recession, short-term austerity policy and political crisis</p>
<p><b>2016 - 2018</b> <b>President Michel Temer</b></p>	<p>Neoliberal reforms and long-term austerity without electoral approval</p>	<p><b>2016</b> <b>Constitutional Amendment 95:</b> Established that federal health spending in 2017 was 15% of the RCL and, from then on limited to 2017 spending levels adjusted for inflation (for 20 years) <b>2017</b> <b>MD for consolidation 6:</b> Merge the strategic financing blocks Large block grants for costing and investment</p>	<p><b>2017:</b> Plan for introducing Electronic Records in PHC within 10 years</p>	<p><b>2016</b> <b>MD 1482:</b> Working group for flexibilization the private health insurance regulation to establish "Popular Plans" <b>2017</b> <b>MD 2436:</b> Change guidelines for PHC <b>MD 3588:</b> Change guidelines for mental health</p>		<p>Long-term austerity and deregulation of policies in the health sector</p>
<b>Summary of Achievements</b>						
<p>Democratization allowed designing a health system based on UHC; in periods of political stability the SUS expansion was favored by social policies</p>	<p>Decentralization to local levels; active inter-governmental commissions and social participation; definition of health regions, national list of medicines and health services; regulatory agencies for private plans. Access to health data by municipal level</p>	<p>Definition of minimum health expenditure by government level. Increased funding for PHC.</p>	<p>Large expansion of APS, emergency care, mental health. High complexity services offered mainly by SUS.</p>	<p>Multi-professional teams in PHC; policies to change health professionals training to focus on PHC after 2000's; improved allocation with MAIS MEDICOS. Access to a broad list of medicines; market regulation and pharmaceuticals; use of government purchasing power to develop national industrial health complex</p>		
<b>Summary of Fragilities</b>						
<p>Political instability, economic and political crises affect the development of the health system</p>	<p>Regionalization was not effective; parallel governance with the private system; suboptimal allocation of human/technological resources. Lack of integration of IT systems; limited use of the data collected</p>	<p>Inadequate funding of SUS. Reduction in federal contributions and increased municipal funding</p>	<p>Regional inequalities in access and quality of health services; lack of policies for hospital and specialized care reform. Parallel private health sector, consuming more resources than SUS</p>	<p>Low regulatory capacity of the MoH for training/allocation of human resources for health; municipalities with budgetary limits for hiring; limited career progression opportunities. Lack of market regulation and price control for medical devices; increase in expenditures (judicial decisions on medicines)</p>		

Notes: Ministerial directive (MD), Inter-ministerial directive (IMD).

## 2. Simulated scenarios

While the first three decades of the SUS brought about increased access to health services accompanied by less inequity in various health indicators, the future is threatened by demographic, epidemiological, economic, political, and social challenges faced by Brazil. To assess how these threats could affect four health indicators until 2030 (the target year for the SDGs), we considered four hypothetical scenarios of federal transfer of funds to municipalities. In the first, federal health transfers were maintained constant at the level of 2015 until 2030. In the remaining three scenarios, transfers were assumed to grow at the same rate as the GDP; specifically, we hypothesized that the GDP would grow at 1% per year in the second scenario, 2% in the third, and 3% in the fourth.

For each of the four scenarios, we simulated the performance of four health indicators (all embedded as targets in SDG-3) until 2030: (i) infant mortality rate (IMR), a commonly used measure of population health;<sup>2</sup> (ii) proportion of births whose mother attended seven or more antenatal care (ANC) visits, a measure of preventive health services; (iii) FHS coverage, a measure of access to PHC; and (iv) since cardiovascular diseases (CVD) are the main cause of death in Brazil, we also included amenable mortality due to CVD among those aged 60 years or more (include ICD codes I05-I09, I15, I20-I25, and I60-I68 of the International Classification of Diseases, 10<sup>th</sup> revision),<sup>3</sup> a measure of quality of care.<sup>4</sup>

### 2.1. Data and analytical methods

Data used in the simulations referred to the years 2004 to 2015, for each of the 5,570 municipalities, and were extracted from varied sources (Table S2). Between 2004 and 2015, 10 new municipalities were created, and thus our data are unbalanced (it has a different number of municipalities per year).

The variable of interest for the different scenarios is the federal health transfer per capita to municipalities. To build simulated scenarios from 2016 to 2030, first we modelled the relationship between federal health transfers and each of the selected indicators using the following specification:

$$Y_{mt} = \alpha + \beta \ln(ft)_{mt} + \gamma X_{mt} + \sigma(Y_{m0} * trend) + \theta_m + \delta_{st} + u_{mt}$$

Here,  $Y_{mt}$  denotes the selected indicator in municipality  $m$  in year  $t$ ,  $\ln(ft)_{mt}$  is the log of federal health transfers per capita,  $X_{mt}$  denotes a set of municipal controls,  $Y_{m0} * trend$  is an interaction term between the municipality indicator computed at the baseline (year 2004) and a linear time trend (allowing for differential trends according to initial health characteristics and convergence across municipalities),  $\theta_m$  are municipality fixed effects,  $\delta_{st}$  are state-specific time dummies,  $\alpha, \beta, \gamma, \sigma$  are parameters to be estimated, and  $u_{mt}$  is a random error. Different model specifications and robustness tests were performed, as detailed below.

**Table S2 – Data description and sources**

Variables	Sources	Description/calculation
<b>SCENARIO VARIABLE</b>		
Federal health transfers to municipalities per capita	Public Health Budget Information System (SIOPS), available at <a href="http://siops.datasus.gov.br/">http://siops.datasus.gov.br/</a>	Total health expenditure (except pensions) per capita transferred from the federal government to the municipality in the year of reference (in current R\$). Estimated using Indicator 1.4, from SIOPS, which includes federal transfers for inpatient and ambulatory care, radiology and laboratory work, and other types of transfers.
<b>SIMULATED INDICATORS</b>		
Infant mortality rate – IMR (per 1,000 live births)	Mortality Information System (SIM), and Information System on Live Births (SINASC), both from the Ministry of Health, and available at <a href="http://datasus.saude.gov.br/informacoes-de-saude/tabnet/estatisticas-vitais">http://datasus.saude.gov.br/informacoes-de-saude/tabnet/estatisticas-vitais</a>	Data for the numerator, total number of deaths of children younger than 1-year-old in the municipality/year, were obtained from SIM. Data for the denominator, total number of live births in the municipality/year, were extracted from SINASC.
Percentage of births whose mother attended seven or more antenatal care (ANC) visits	SINASC	The threshold of seven or more visits reflects the guidelines established by the Brazilian Ministry of Health ( <a href="http://bvsmms.saude.gov.br/bvs/publicacoes/pre-natal_puerperio_atencao_humanizada.pdf">http://bvsmms.saude.gov.br/bvs/publicacoes/pre-natal_puerperio_atencao_humanizada.pdf</a> )
Coverage of the Family Health Strategy (FHS)	Brazilian Health Ministry, available at <a href="http://dab.saude.gov.br/portaldab/historico_cobertura_sf.php">http://dab.saude.gov.br/portaldab/historico_cobertura_sf.php</a>	Since data are available monthly, we extracted the information considering as temporal reference the month of July (mid-year period) for each year/municipality.
Amenable cardiovascular diseases (CVD) mortality rate among people ≥60 years (per 100,000 people)	Mortality Information System (SIM), and Brazilian Institute of Geography and Statistics (IBGE)	Amenable CVD deaths include codes I05-I09, I15, I20-I25, and I60-I68 of the International Classification of Diseases, 10 <sup>th</sup> revision. Rates were standardized by age using the Brazilian population in 2010, and adjusted for ill-defined causes of death.
<b>CONTROLS</b>		
Municipal gross domestic product (GDP) per capita	IBGE	Nominal GDP per capital for each municipality collected at current prices.
Municipal health expenditures financed by the local government (per capita)	SIOPS	SIOPS (Indicator 2.1) includes all municipal health expenditures, including those financed by other levels of the government. Municipal health expenditures financed by the local government were calculated by subtracting the total health transferences received by the municipality from the total health expenditures.
Coverage of <i>Bolsa-Família</i> (conditional cash transfer)	Brazilian Social Development Ministry (MDS), available at <a href="http://www.mds.gov.br">www.mds.gov.br</a>	MDS has information on families receiving <i>Bolsa-Família</i> . The number of beneficiaries was estimated multiplying the number of families by the average number of persons per household, and coverage obtained as beneficiaries divided by the population in each municipality/year.
Private health insurance coverage	Brazilian Regulatory Agency (ANS), available at <a href="http://www.ans.gov.br">www.ans.gov.br</a>	Information on contracts of private insurance by municipality was obtained from ANS for years 2004 to 2015 (no reliable information is available prior to 2004). Private insurance coverage was calculated as the number of contracts (a proxy for number of people with private health insurance) divided by the total population in each municipality/year.
Political alignment between Mayor and Governor	Superior Electoral Tribunal (TSE), <a href="http://www.tse.jus.br">www.tse.jus.br</a> and Survey of Municipal Information, available through IBGE	A dummy variable indicating if the Mayor's political party was the same as the Governor's. No political party coalitions were considered for the match.
Population size	IBGE	Total population by municipality was obtained from IBGE, and municipalities were classified into five categories according to population size: less than 5,000 inhabitants, 5,000-9,999 inhabitants, 10,000-19,999 inhabitants, 20,000-49,999 inhabitants, and 50,000 or more inhabitants.
Municipal institutional quality index (IQIM)	Computed based on 2009 data	The index measures the quality of the public sector management in each municipality. It varies over a scale between 1 (worst quality) to 6 (best quality). <sup>5</sup>

In the case of IMR, the log of the indicator was used in the model. In addition, to mitigate possible under-reporting of vital events, regression models for IMR and ANC visits were weighted by the average number of births in each municipality computed over the sample period. The state-specific time fixed

effects were included to control for the effect of state-specific policies (including state transfers to municipalities) that may vary over time. These effects also control for variations in the cost of living over time across states. The municipal controls included factors that could affect the selected indicators, such as per capita GDP, the share of the population that receive conditional cash transfers (*Bolsa Família*), the share of the population covered by a private health plan, and a political economy variable measuring whether the city mayor and the state governor were from the same political party. An alternative model formulation included a categorical variable indicating the size of the municipality: less than 5,000 inhabitants (MunSize1), 5,000-9,999 inhabitants (MunSize2), 10,000-19,999 inhabitants (MunSize3), 20,000-49,999 inhabitants (MunSize4), and 50,000 or more inhabitants (MunSize5). In the case of CVD mortality, an alternative model considered the IQIM, since the quality of the public sector is likely to affect the management of chronic diseases that require long-term follow-up and treatment.<sup>6</sup>

Results of the models were used to generate the simulated scenarios. The total federal health transfer by municipality in each year after 2015 was calculated for each of the four scenarios. Population projections from IBGE were used to generate the federal transfer per capita. Simulated values for the selected indicators were then obtained applying the modelled effects of federal health transfers, holding constant all other factors. All data preparation and analysis were done in STATA v.14 (Stata Corp., College Station, TX, USA).

## **2.2. Model formulations**

Table S3 shows the results for IMR models. Column 1 shows results of the lighter model specification, which includes only year and municipality fixed-effects. The point estimate slightly dropped (in module) as we added state-specific year fixed-effects (column 2). These dummies (one for each state-year combination) absorbed the confounding influence of public policies that are determined at the state level.

The next model included an interaction between the municipal IMR computed at the baseline (year 2004) and a linear time trend (column 3). These municipal specific-trends should absorb much of the variation in the outcome variable. The point estimate indeed dropped (in module), as expected, but remained statistically significant at the 5% level. Lastly, the most saturated specification further added a series of control variables (column 4), namely, the logarithm of the GDP per capita, *Bolsa-Família* coverage (in % of the total population), private insurance coverage (in % of the total population), a dummy that indicates whether the mayor and the state governor are politically aligned, and the logarithm of the municipality expenditures per capita. The coefficient remained remarkably stable as we moved from column 3 to column 4, suggesting that the variable of interest (federal health transfers to municipalities) is exogenous conditionally upon relevant observable socioeconomic characteristics. Similar findings were observed for ANC visits and FHS coverage.

**Table S3: Relationship between federal health transfers to municipalities and IMR considering different model formulations**

	Model formulations			
	(1)	(2)	(3)	(4)
Ln(ft)	-0.051 (0.018)***	-0.042 (0.014)***	-0.026 (0.013)	-0.027 (0.014)**
Observations	61,187	61,187	61,187	61,187
Number of municipalities	5,101	5,101	5,101	5,101
Year and municipality fixed-effects	Yes	Yes	Yes	Yes
Year*State fixed-effects	No	Yes	Yes	Yes
IMR Trend (baseline IMR * linear trend)	No	No	Yes	Yes
Additional controls	No	No	No	Yes
Weighted	Yes	Yes	Yes	Yes

Notes: Standard errors shown in parenthesis, and clustered at the municipality level. Significance: 1% (\*\*\*) and 5% (\*\*). IMR trend refers to an interaction term between the municipality IMR computed at the baseline (year 2004) and a linear time trend. Additional controls include the logarithm of the GDP per capita, *Bolsa-Família* coverage (in % of the total population), private insurance coverage (in % of the total population), a dummy that indicates whether the mayor and the state governor are politically aligned and the logarithm of the municipality expenditures per capita. All regressions are weighted by the municipality average number of births (municipality average computed over the sample period).

Table S4 shows the different model formulations for CVD amenable mortality among people aged 60 or more. Here, the point estimates are positive, and became non-significant in the most saturated specification (column 4). As risk factors for CVD mortality take a longer time to take its toll (when compared to most short-time outcomes, such as the IMR), it is possible that the small temporal window of the simulation is unable to pick up any larger effects of changes in the federal transfer scheme. As shown below, we tested an additional model formulation for CVD amenable mortality that considered the IQIM, based on previous research.<sup>6</sup>

**Table S4: Relationship between federal health transfers to municipalities and CVD amenable mortality among people aged 60 or more, considering different model formulations**

	Model formulations			
	(1)	(2)	(3)	(4)
Ln(ft)	0.061 (0.017)***	0.042 (0.016)***	0.028 (0.015)	0.019 (0.013)
Observations	60,088	60,088	60,088	60,088
Number of municipalities	5,032	5,032	5,032	5,032
Year and municipality fixed-effects	Yes	Yes	Yes	Yes
Year*State fixed-effects	No	Yes	Yes	Yes
CVD Trend (baseline CVD * linear trend)	No	No	Yes	Yes
Additional controls	No	No	No	Yes
Weighted	Yes	Yes	Yes	Yes

Notes: Standard errors shown in parenthesis, and clustered at the municipality level. Significance: 1% (\*\*\*) and 5% (\*\*). CVD trend refers to an interaction term between the municipality CVD computed at the baseline (year 2004) and a linear time trend. Additional controls include the logarithm of the GDP per capita, *Bolsa-Família* coverage (in % of the total population), private insurance coverage (in % of the total population), a dummy that indicates whether the mayor and the state governor are politically aligned and the logarithm of the municipality expenditures per capita. All regressions are weighted by the municipality average population with 60 years or more (municipality average computed over the sample period).

### 2.3. Robustness checks

Starting from the most saturated model (table 4, column 1), we performed robustness checks and further heterogeneity tests of the IMR results across municipalities. First, we tested whether the point estimate was sensitive to sample selection. IMR might be underreported in less-developed regions, particularly before the mid-2000s, and in smaller municipalities. In column 2 (table S5) we report our most saturated specification excluding the smallest municipalities (those with population below 5,000 inhabitants); in column 3 we run a similar specification but now based on an unweighted regression. While population weights are expected to mitigate the detrimental influence of noisy cells from very small municipalities, it is also true that coefficients would tend to capture the effects from relatively larger municipalities. Results show that when we excluded the smallest municipalities (table S5, column 2) there was a small increase in the coefficient, and it remained statistically significant. Moreover, when we used the unweighted regression (table S5, column 3), the estimated coefficient increased by about 5 times with respect to the saturated model (column 1), which suggests that the effects are relatively larger in smaller places, despite the measurement error due to underreported in less-developed regions. Similar findings were observed for ANC visits, FHS coverage, and CVD amenable mortality among people aged 60 or more.

**Table S5: Robustness checks of IMR models**

	Ln (IMR)		
	(1)	(2)	(3)
Ln(ft)	-0.027 (0.014)**	-0.039 (0.014)***	-0.112 (0.043)***
Observations	61,187	45,715	45,715
Number of municipalities	5,101	3,810	3,810
Year and municipality fixed-effects	Yes	Yes	Yes
Year*State fixed-effects	Yes	Yes	Yes
IMR Trend (baseline IMR * linear trend)	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes
Exclude small municipalities (size 1)	No	Yes	Yes
Weighted	Yes	Yes	No

Notes: Standard errors shown in parenthesis, and clustered at the municipality level. Significance: 1% (\*\*\*) and 5% (\*\*). IMR trend refers to an interaction term between the municipality IMR computed at the baseline (year 2004) and a linear time trend. Additional controls include the logarithm of the GDP per capita, *Bolsa-Familia* coverage (in % of the total population), private insurance coverage (in % of the total population), a dummy that indicates whether the mayor and the state governor are politically aligned and the logarithm of the municipality expenditures per capita. Samples in columns 2 and 3 exclude municipalities with less than 5,000 inhabitants. All regressions are weighted by the municipality average number of births (municipality average computed over the sample period), except in column 3.

With regards to the CVD amenable mortality among people aged 60 or more, robustness tests for the most saturated model did not change the direction and significance of the point estimate (table S6). Excluding smaller municipalities did not change the point estimates (in contrast with the IMR results), and the estimated coefficient doubles (column 3) when we considered an unweighted model.

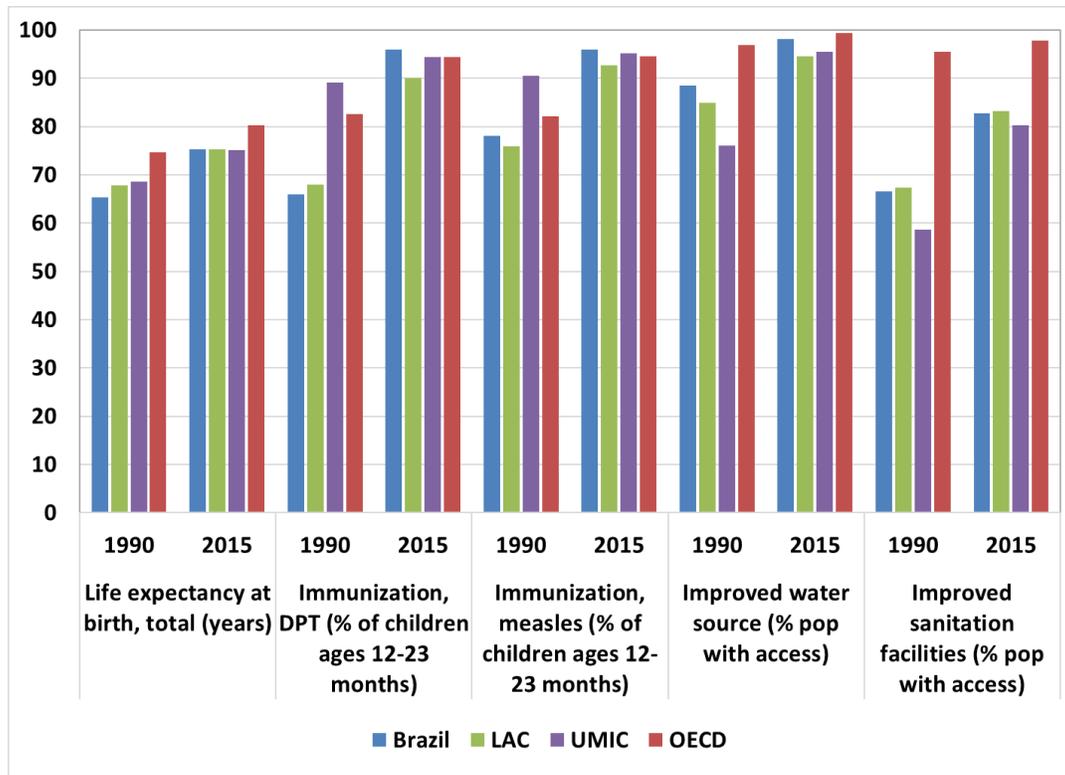
**Table S6: Robustness checks of models for CVD amenable mortality among people aged 60 or more**

	Ln(CVD) of 60+		
	(1)	(2)	(3)
Ln(ft)	0.019 (0.013)	0.016 (0.012)	0.030 (0.025)
Observations	60,088	45,463	45,463
Number of municipalities	5,032	3,792	3,792
Year and municipality fixed-effects	Yes	Yes	Yes
Year*State fixed-effects	Yes	Yes	Yes
CVD Trend (baseline CVD * linear trend)	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes
Exclude small municipalities (size 1)	No	Yes	Yes
Weighted	Yes	Yes	No

Notes: Standard errors shown in parenthesis, and clustered at the municipality level. Significant at 1% (\*\*\*) and 5% (\*\*). CVD trend refers to an interaction term between the municipality CVD computed at the baseline (year 2004) and a linear time trend. Additional controls include the logarithm of the GDP per capita, *Bolsa-Família* coverage (in % of the total population), private insurance coverage (in % of the total population), a dummy that indicates whether the mayor and the state governor are politically aligned and the logarithm of the municipality expenditures per capita. Samples in columns 2 and 3 exclude municipalities with less than 5,000 inhabitants. All regressions are weighted by the municipality average population with 60 years or more (municipality average computed over the sample period), except in column 3.

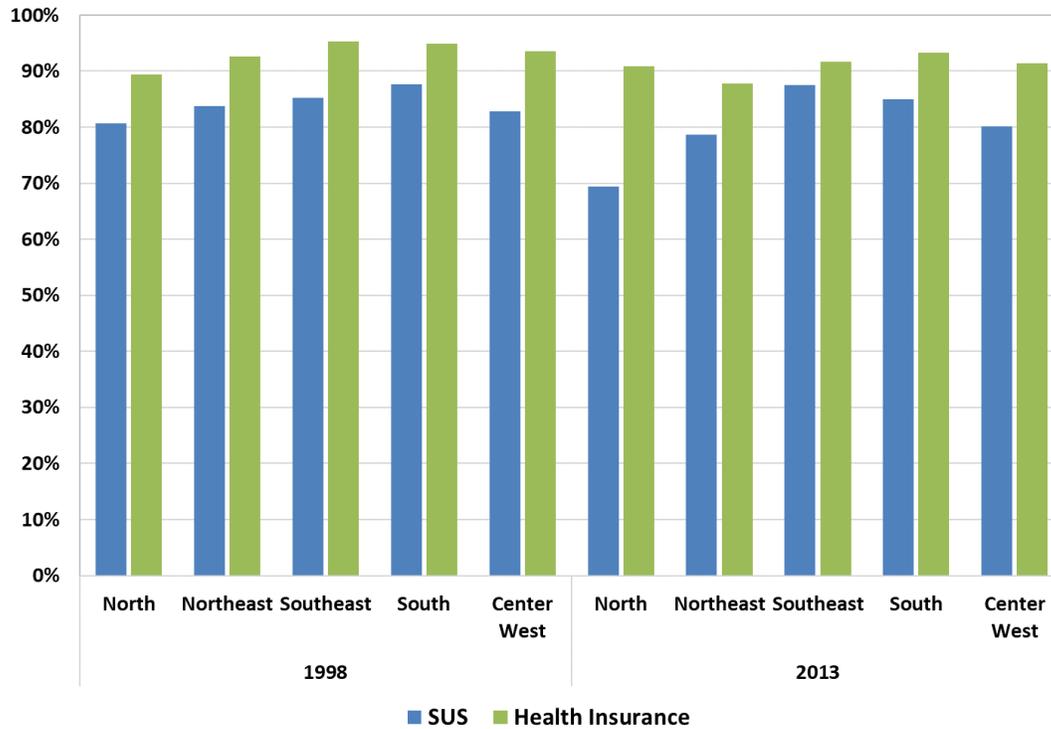
### 3. Figure S1

Life expectancy, immunization and improved water and sanitation in Brazil, Latin America and English Caribbean (LAC), Upper Middle-Income Countries (UMIC), and OECD Countries, 1990 and 2015



#### 4. Figure S2

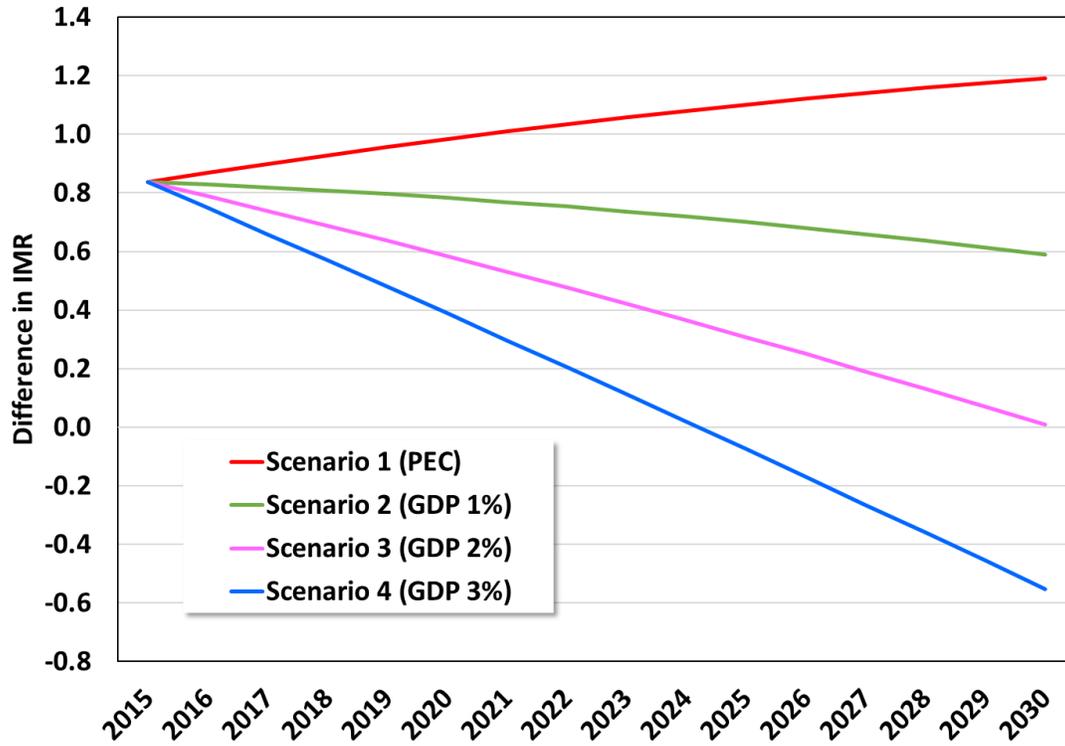
Percentage of self-assessed inpatient services as good or very good, by the SUS and private insurance Users. Brazilian regions, 1998 and 2013



Source: PNAD 1998 and PNS 2013. Results from Poisson regression, controlling for demographics, socioeconomic status, health needs, private health plan coverage, region, survey design and weights.

### 5. Figure S3

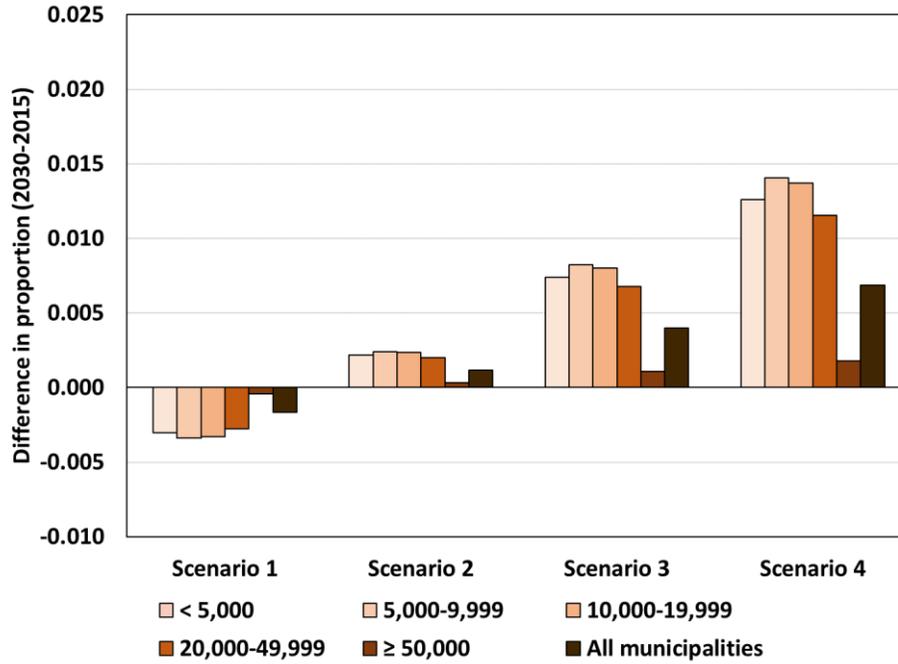
Difference in IMR simulated outcomes between the smallest (< 5,000) and largest municipalities ( $\geq 50,000$ ), by hypothetical scenarios, 2015-2030



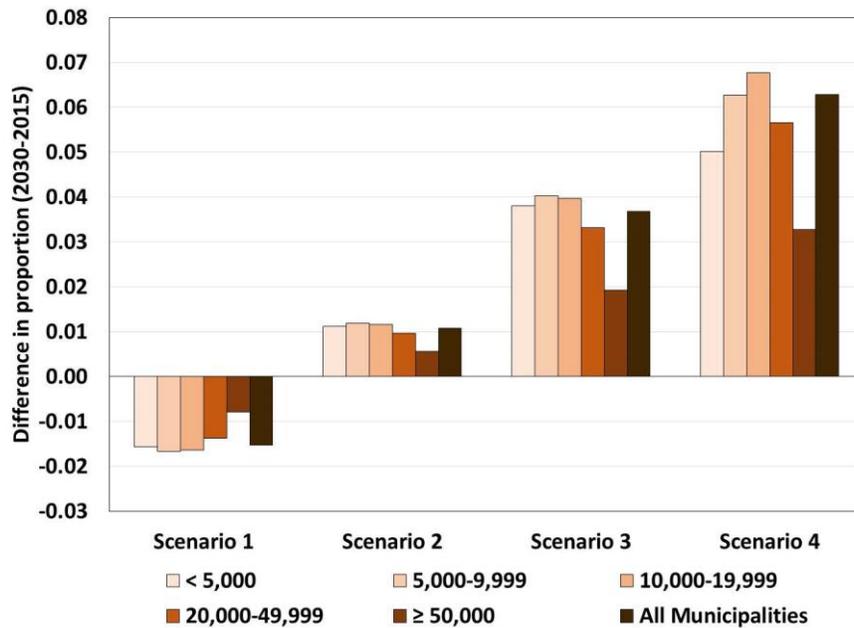
## 6. Figure S4

Difference between the 2030 simulated outcomes and 2015 levels, by municipality size and hypothetical scenarios

(A) Difference in proportion of births whose mother attended seven or more ANC visits



(B) Difference in proportion of FHS coverage



## 7. References

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