

## **A dominance approach to analyze the incidence of catastrophic health expenditures in Iran**

Justine Hsu a,\*, Reza Majdzadeh b, Anne Mills c, Kara Hanson d

a World Health Organization, Department of Health Systems Governance and Financing, 20 Avenue Appia, 1211, Geneva, Switzerland

b Director of Knowledge Utilization Research Center and Professor of Epidemiology at the School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

c Deputy Director & Provost and Professor of Health Economics & Policy, London School of Hygiene and Tropical Medicine, London, United Kingdom

d Dean of Faculty of Public Health & Policy and Professor of Health System Economics, London School of Hygiene and Tropical Medicine, London, United Kingdom

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### **Abstract**

Financial protection is a health system goal for all countries. Assessing progress on this relies on measuring the incidence of catastrophic health expenditures (proportion of the population whose out-of-pocket (OOP) payments for health surpass a certain threshold of household resources). Standard approaches rely on selective thresholds, however this masks varying intensities of financial hardship and poses a measurement challenge as incidence is sensitive to the choice of the threshold. We address this problem by applying the dominance approach, which tests differences in catastrophic incidence curves over a continuous range of thresholds.

Iran is an interesting country for empirical application of the dominance approach given its historically high reliance on OOP payments to finance its health system and its commitment to improving financial protection through several national health policies over the last two decades. Using data from annual Household Income and Expenditure Surveys from 2005 to 2017 (sample size: 26,851–39,088 households), incidence was analyzed following this novel approach. Distribution of incidence across socio-economic status was also analyzed by estimating concentration indices and across health services or products by estimating average shares of each item. Results showed that over time catastrophic health expenditures increased for thresholds lower than 25% and decreased for thresholds higher than 35%. Catastrophic health expenditures were more equally distributed across income levels at lower thresholds, becoming concentrated amongst the rich as the threshold rose. Medicines represented the largest share of catastrophic spending for the poorest; medicines, dentistry, inpatient and ancillary services for the richest.

This is the first study to apply dominance methods to analyze catastrophic health expenditures in a country over time. The analysis provides a nuanced picture of who incurs catastrophic health expenditures, to what extent hardship is experienced and what were the drivers of these expenditures – thus providing a better basis for policy responses.

**Key words:** Iran, Dominance, Catastrophic health expenditures, Out-of-pocket payments for health, Financial protection, Equity, Health financing, Health system reforms

## **A dominance approach to analyze the incidence of catastrophic health expenditures in Iran**

### **1. Introduction**

Financial protection is a health system goal for all countries. It means that direct payments made to obtain health services do not expose people to financial hardship and do not threaten their living standards, which could otherwise imply being forced to choose between paying for health and other basic necessities (World Health Organization and World Bank, 2017). Countries need to understand if they are making progress on financial protection; however, this is made challenging by potential inconsistencies in results arising from methodological choices for key indicators. In addition, inconsistent results raise concerns about the ability to develop appropriate policy responses.

A key indicator for assessing progress on financial protection is the incidence of catastrophic health expenditures, which has been widely applied in the empirical literature and adopted in international monitoring frameworks (Berki, 1986; Wagstaff and van Doorslaer, 2003; O'Donnell et al., 2008; Wagstaff et al., 2018b; United Nations, 2017). Health expenditures are identified as catastrophic if those paid out-of-pocket (OOP) surpass a certain threshold of household resources. There are different ways of computing this indicator arising from two main methodological choices – the definition of household resources and the threshold used to identify whether health expenditures are catastrophic. These choices have important conceptual underpinnings and their statistical artefacts have been empirically shown to affect the measurement of incidence and especially the distribution across socio-economic groups (World Health Organization and World Bank, 2017; Cylus et al., 2018).

For the first choice, OOP payments for health can be compared to total household expenditure (or income), following a standard approach known as the budget share; alternatively, OOP payments for health can be compared to total household expenditure (or income) net of spending on basic necessities (e.g. food), following another standard approach known as capacity-to-pay (Wagstaff and van Doorslaer, 2003; O'Donnell et al., 2008). The budget share approach is officially used to monitor progress on financial protection in the Sustainable Development Goals (SDGs) framework (United Nations, 2017). It is easy to understand and calculate, although it is less sensitive to differential opportunity costs of paying for health across socio-economic groups because it does not distinguish between discretionary and non-discretionary spending when determining what resources are available to pay for health and because non-discretionary spending represents a greater share of resources for the poor. As a result, the budget share approach can be considered to overestimate the resources of poor households and likely to underestimate financial hardship experience by them. The main argument for the capacity-to-pay approach is that everyone needs to spend some

minimum amount on basic needs and that spending for health should not undermine one's ability to purchase these essential items. After spending on necessities, the poor will have less resources remaining than their richer counterparts to spend on health and will likely experience greater financial hardship. It has been demonstrated that catastrophic health expenditures are more concentrated amongst the poor when the capacity-to-pay approach is used compared to the budget share (World Health Organization and World Bank, 2017; Cylus et al., 2018). The capacity-to-pay approach, however, requires additional complex decisions regarding estimations of basic needs (e.g. whether to estimate spending just for food items or for a basket of other items, whether to use actual spending or an estimated standard amount of non-discretionary spending, how to estimate such a standard amount). Details of the conceptual underpinnings for these and other choices in the definition of household resources (e.g. expenditure versus income, estimations of basic needs, and/or use of equivalence scales to adjust the size of the household for economies of scale) are discussed elsewhere (Deaton and Zaidi, 2002; Wagstaff and van Doorslaer, 2003; Xu et al., 2003; O'Donnell et al., 2008; World Health Organization and World Bank, 2017; Wagstaff et al., 2018b; Hsu et al., 2018; Cylus et al., 2018; Koch, 2018).

Compared with the choice regarding the measure of household resources, the choice of the threshold has received much less consideration. In empirical studies, thresholds applied vary between 10% and 40%, with 10% and 25% thresholds commonly applied in the budget share approach and 40% commonly applied in the capacity-to-pay approach (Xu et al., 2003; Lu et al., 2012; Bredenkamp and Buisman, 2016; Prakongsai et al., 2009; World Health Organization and World Bank, 2015). Typically a single threshold is uniformly applied across the population; however Ataguba (2012) and Onoka et al., (2011) both examined changing application of a threshold to vary according to income to account for the diminishing marginal utility of income or the increasing opportunity cost of paying for health for poorer households. Neither study, however, addressed the initial choice of threshold, which has been acknowledged as arbitrary (Wagstaff and van Doorslaer, 2003). Anonymous et al., (2018) noted that reliance on a single-point threshold does not allow for gradations of financial hardship experienced and offers only a dichotomous protected or not protected categorization. Further, the choice of threshold could result in inconsistent ranking of catastrophic OOP payment levels across different countries, in a country over time or between sub-population groups (e.g. rich/poor or urban/rural) within a country.

Dominance methods can address the issue of inconsistencies in comparative assessments of catastrophic health expenditures arising from the choice of the threshold. They entail examining the cumulative distribution (versus single-point estimates) of a variable across a range of values to achieve a more robust ranking. Dominance has been applied in the measurement of poverty to

overcome the limitation that comparisons of poverty levels are sensitive to the choice of the poverty line (Ravallion, 1992; Davidson and Duclos, 2000; Chen, 2008). By testing differences between two 'poverty incidence curves' (Ravallion, 1992), constructed by plotting the incidence of poverty across a range of poverty lines, it can be determined whether a distribution of poverty levels was always significantly below another, irrespective of the poverty line. Dominance has only recently been applied in the measurement of financial protection, despite indicators facing similar issues of sensitivity to a threshold. Ataguba (2021) extended the application of dominance from overall poverty to impoverishment due to making OOP payments for health, given sensitivities to the choice of a poverty line. Earlier, Anonymous et al., (2018) applied dominance to analyze catastrophic health expenditures across a group of countries to understand sensitivity of cross-country comparisons to the choice of a threshold. In this study, we apply dominance methods to analyze catastrophic health expenditures over time in Iran. We argue that the application of dominance methods not only helps overcome measurement challenges by making more robust assessment of trends in financial protection for a country over time but also provides additional insight to better inform future policies.

Iran is committed to ensuring financial protection for its population and has implemented several health policies over the 2005–17 period in response to the fact that, in the early 2000s, Iran's health financing system relied heavily on OOP payments which made up 60% of current health expenditure in 2000 (World Health Organization, n.d.). Policies included extending insurance coverage in 2005 and 2014, expanding its benefit package in 2007, introducing subsidies for medicines in 2011 and 2013, and launching a broad reform program known as the Health Transformation Plan in 2014 (Table 1) (Hsu et al., 2020; Harirchi et al., 2020; Doshmangir et al., 2019; Sajadi and Majdzadeh, 2019; Bazayr et al., 2016; Takian et al., 2015, 2011; World Bank, 2008). By 2017, the country had invested significant public financing into its health system, achieved nearly universal levels of insurance coverage, provided a generous benefit package from all public health insurance funds, and was addressing inefficiencies in the purchasing of health services (Hsu et al., 2020). The historically high reliance on OOP payments to finance the health system and policy responses to address this, make Iran an interesting country for empirical application of the dominance approach.

The objective of this study is to undertake a comprehensive analysis of changes in the incidence and distribution of catastrophic health expenditures in Iran from 2005 to 2017, the period during which health reforms were implemented. Incidence provides insight into the frequency of catastrophic spending across the population, while the distribution provides a picture of who is affected and what they purchase. Incidence was analyzed following standard methods employing discrete dichotomous measures at selective thresholds, as well as an innovative method employing

continuous dichotomous measures across a broad range of thresholds and testing for dominance of catastrophic incidence curves. The distribution of catastrophic health expenditures was analyzed across socio-economic groups by estimating concentration indices, as well as across types of health services or products by estimating individual average shares of each component. The analysis addresses the following questions:

- How did the incidence of catastrophic health expenditures evolve during this period of policy reform in Iran and for whom was it increasing or decreasing?
- What type of health services or products were responsible for these changes in catastrophic health expenditures?

This paper helps to fill gaps in the evidence base that were identified in a systematic literature review of studies analyzing financial protection and noted in a study estimating the global incidence of catastrophic spending (Yerramilli et al., 2018; Wagstaff et al., 2018b) – namely the relative lack of studies which analyze recent data, trends over time and distributional aspects. An analysis of trends is important as it can uncover underlying data patterns, which can then help inform hypotheses regarding the relationship between health policies and change in catastrophic health expenditures for testing in future research. Furthermore, our application of dominance methods helps overcome challenges in the measurement of financial protection and provides more granular results for policy-makers seeking to design policies that more effectively protect population groups at risk and address drivers of catastrophic health expenditures.

**Table 1: Overview of major health policy interventions in Iran**

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## **2. Methods**

### **2.1 Data**

Data were drawn from 13 rounds of the Iranian Household Income and Expenditure Survey (HIES) from 2005 to 2017. The HIES is conducted by the Statistical Center of Iran and collects information on household consumption expenditure on all items, including health. The HIES is a nationally

representative survey following a three-staged cluster sampling design with sample size ranging from 26,851 to 39,088 households, depending on the survey round.

All datasets underwent quality assurance tests following those used to determine eligibility for reporting official financial protection estimates on the SDGs to the United Nations and for inclusion in a global database (Wagstaff et al., 2018a; World Health Organization, n.d.). Tests consisted of comparing estimates produced from the HIES to official benchmarks produced by international institutions where deviation of survey estimates from official sources may indicate measurement errors and lead to possible exclusion of the dataset. Three variables were tested as follows: absolute value of the relative difference of total expenditure per capita in log terms not exceeding 10%, absolute difference of the average share of OOP payments for health in total expenditure not exceeding 5 percentage points, and absolute value of the relative difference of total population in log terms not exceeding 10%. Application of these quality assurance tests did not result in any exclusions.

Ethics approval for this study was granted by the Ethics Committee of the London School of Hygiene and Tropical Medicine (Ref: 14626), as well as by the Ethics Committee of Tehran University of Medical Sciences (Ref: IR.TUMS.REC.1396.4276).

## **2.2 Indicators**

We assessed progress in financial protection by relying on the indicator of the incidence of catastrophic health expenditures, i.e. the proportion of the population whose OOP payments surpass a certain threshold of household resources. We estimated population-weighted incidence following the budget share approach defining household resources as total expenditure, given this approach is officially used to monitor financial protection in the SDGs framework. We also replicated the analysis by estimating incidence following the capacity-to-pay approach defining household resources as non-food expenditure. These indicator variants are the two predominantly used for global monitoring of financial protection.

## **2.3 Statistical analysis of the incidence of catastrophic health expenditures**

Population-weighted incidence of catastrophic health expenditures was estimated as:

$$\frac{\sum_h m_h w_h 1(OOP\_share_h > t)}{\sum_h m_h w_h}$$

$h$  denotes a household

$m_h$  denotes the number of members in household  $h$

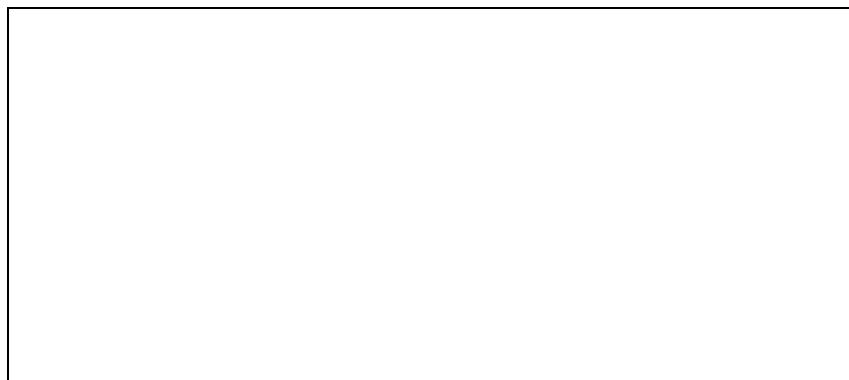
$w_h$  denotes the sampling weight of household  $h$

1() is an indicator function which is equal to 1 if the condition is satisfied and 0 otherwise  
 $OOP\_share_h$  is the share of OOP payments for health in total [non-food] expenditure for household  $h$  when following the budget share [capacity-to-pay] approach  
 $t$  denotes a catastrophic threshold

Estimates were made at the national level and by quintiles, constructed following the SDG framework based on total expenditure per capita to account for household size.

We first estimated incidence of catastrophic health expenditures following the budget share approach and using conventional dichotomous measures with common thresholds of 10%, 25% and 40% of total expenditure. We estimated incidence for each year over the period 2005–17 and estimated the average annual change by regressing the incidence on the year of survey.

We then estimated incidence at each threshold from 0% to 100%, i.e. across the full range of OOP payments as a share of total expenditure. We constructed a catastrophic incidence curve (Fig. 1) for each year by plotting the incidence at each threshold (Hsu et al., 2018; Wagstaff, 2010). The y-axis of the curve thus represents the percentage of the population whose share of OOP payments for health in total expenditure exceeds threshold  $t$  shown on the x-axis. Such a curve corresponds to a descending cumulative distribution function (CDF) and is denoted as  $1 - F_{OOP\_share}(t) \equiv Prob(OOP\_share > t)$ .



**Fig. 1. Catastrophic incidence curve**

Catastrophic incidence curves for each year were then tested for dominance to assess if one distribution always exhibited statistically lower incidence than another, irrespective of the threshold. For dominance testing to be applied to the incidence of catastrophic health expenditures, it is assumed to hold four well-known properties that are similar to axioms for poverty indices: focused, population invariant, anonymous, and Pareto-improving (Zheng, 2000; Chen and Duclos, 2008) 2008). We test for what is referred to as first order dominance (Davidson and Duclos, 2000),



observed when rankings of CDFs of the incidence of catastrophic health expenditures are consistent (i.e. one distribution is always statistically above [below] another). Dominance need not be tested across the full distribution and is said to be ‘restricted’ if it pertains to a part of the distribution. Restricting testing to the middle of the distribution supports hypothesis testing and is justified by the sparse data in the tails of a distribution and which, by definition of a CDF, would also converge (Davidson and Duclos, 2013).

We tested catastrophic incidence curves for restricted dominance across a range of thresholds from 5% to 85% for all possible year combinations in a pairwise fashion. First order restricted dominance of Year A over Year B is observed when the CDF of the population-weighted incidence of catastrophic health expenditures is statistically lower in Year A than in Year B such that  $1 - F_{\text{OOP\_share}}^A(t) < 1 - F_{\text{OOP\_share}}^B(t)$  over  $[t^{\min}, \tau^{\max}]$ . To establish dominance, we used an intersection-union test based on the minimum t-statistic approach (Kaur et al., 1994; Chen and Duclos, 2008) under the null hypothesis of non-dominance between two curves representing the incidence of catastrophic health expenditures for Year A and Year B,  $H_0: \hat{F}_{\text{OOP\_share}}^A - \hat{F}_{\text{OOP\_share}}^B = 0$ . The null hypothesis was rejected at the 10% level to account for fewer observations at the tails of the distribution. Failure to reject the null of non-dominance could be attributed to either: (i) insignificance, differences between curves were not statistically significant or (ii) intersection, differences between curves showed inconsistencies such that incidence in one year was found to be significantly both higher and lower than incidence in another year at different thresholds and reflected by the crossing of curves. In these cases, the alternative hypothesis of dominance was not rejected, indicating that one catastrophic incidence curve was always significantly below another across the range of thresholds tested. Furthermore, if the t-statistic was positive [negative], we inferred Year A [B] dominance meaning the incidence was always statistically lower than the comparator within the range of thresholds tested. Methods for this approach are described in more detail elsewhere (Anonymous et al., 2018).

We conducted dominance tests of catastrophic incidence curves following the budget share approach (i.e. comparing OOP payments for health against total expenditure). Curves for each year were constructed by estimating incidence across the entire population and for the poorest and richest quintiles.

#### **2.4 Statistical analysis of the distribution of catastrophic health expenditures**

The distribution of the incidence of catastrophic health expenditures was also assessed. Firstly, we examined the distribution across socio-economic status (proxied by total expenditure per capita). Concentration indices (CIs) were calculated to estimate the degree to which catastrophic spending

was incurred more frequently by the poor compared with the rich. CIs range from -1 to 1 where a lower [higher] value indicates a disproportionate concentration of catastrophic spending amongst the worse-off [better-off]. A CI of 0 indicates that catastrophic health expenditures were similarly distributed across the population. We estimated CIs following the approach recommended by Wagstaff (2005) for a binary variable of interest. CIs were estimated for each year and the average across all years for catastrophic health expenditures following the budget share approach using thresholds ranging from 10% to 75% in increments of 15%.

Secondly, we assessed the distribution of catastrophic health expenditures across different types of health services or products in order to identify the main drivers for changes in such expenditures over time at different parts of the distribution and as incurred by different population groups. This was done by calculating the share of OOP payments for specific health services or products (i.e. inpatient services, outpatient services, medicines, ancillary services, dentistry services and other services) as a share of total OOP payments at the household-level and averaging this across the population incurring catastrophic health expenditures. We further estimated the average share amongst the poorest and richest quintiles who incurred catastrophic spending, given that expenditure patterns were likely to differ. This was done for catastrophic health expenditures following the budget share approach defined using thresholds ranging from 10% to 75% in increments of 15%.

### **2.5 Sensitivity analysis**

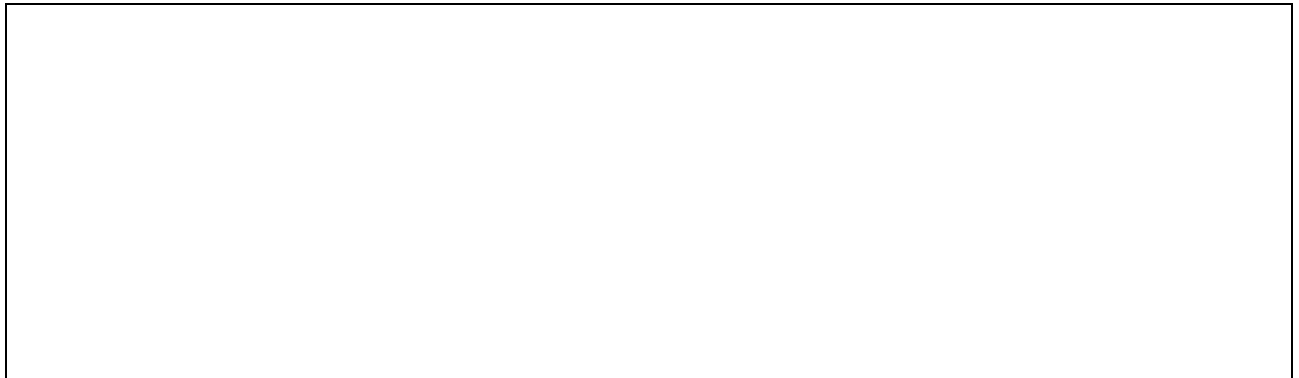
To assess the sensitivity of our findings to the definition of living standards or household resources in the measurement of catastrophic health expenditures, we repeated our analysis following the capacity-to-pay approach (i.e. comparing OOP payments for health against non-food expenditure). We replicated dominance tests of catastrophic incidence curves for all pairwise combination of years at the national level and for the poorest and richest quintiles. We also estimated CIs for the distribution across socio-economic status of catastrophic health expenditures following the capacity-to-pay approach.

## **3. Results**

### **3.1 Incidence of catastrophic health expenditures**

Fig. 2 shows the incidence of catastrophic health expenditures in Iran estimated following the budget share approach using conventional dichotomous measures for each year over the period 2005–17. Catastrophic health expenditures increased over time when estimated using common thresholds of 10% and 25% of total expenditure spent OOP for health. Using the 10% threshold, the

incidence increased from 11.3% in 2005 to 16.9% in 2017, with an average annual percentage point change of 0.5. Using the 25% threshold, the incidence increased from 2.9% in 2005 to 3.7% in 2017, with an average annual percentage point increase of 0.1. However, when catastrophic health expenditures are estimated using a higher threshold of 40% of total expenditure spent OOP for health, the incidence was stable and estimated at 1.1% in 2005 and 1.0% in 2017, with the average annual percentage point change of  $-0.02$ . These results demonstrate that changes in the incidence are sensitive to the choice of the threshold.

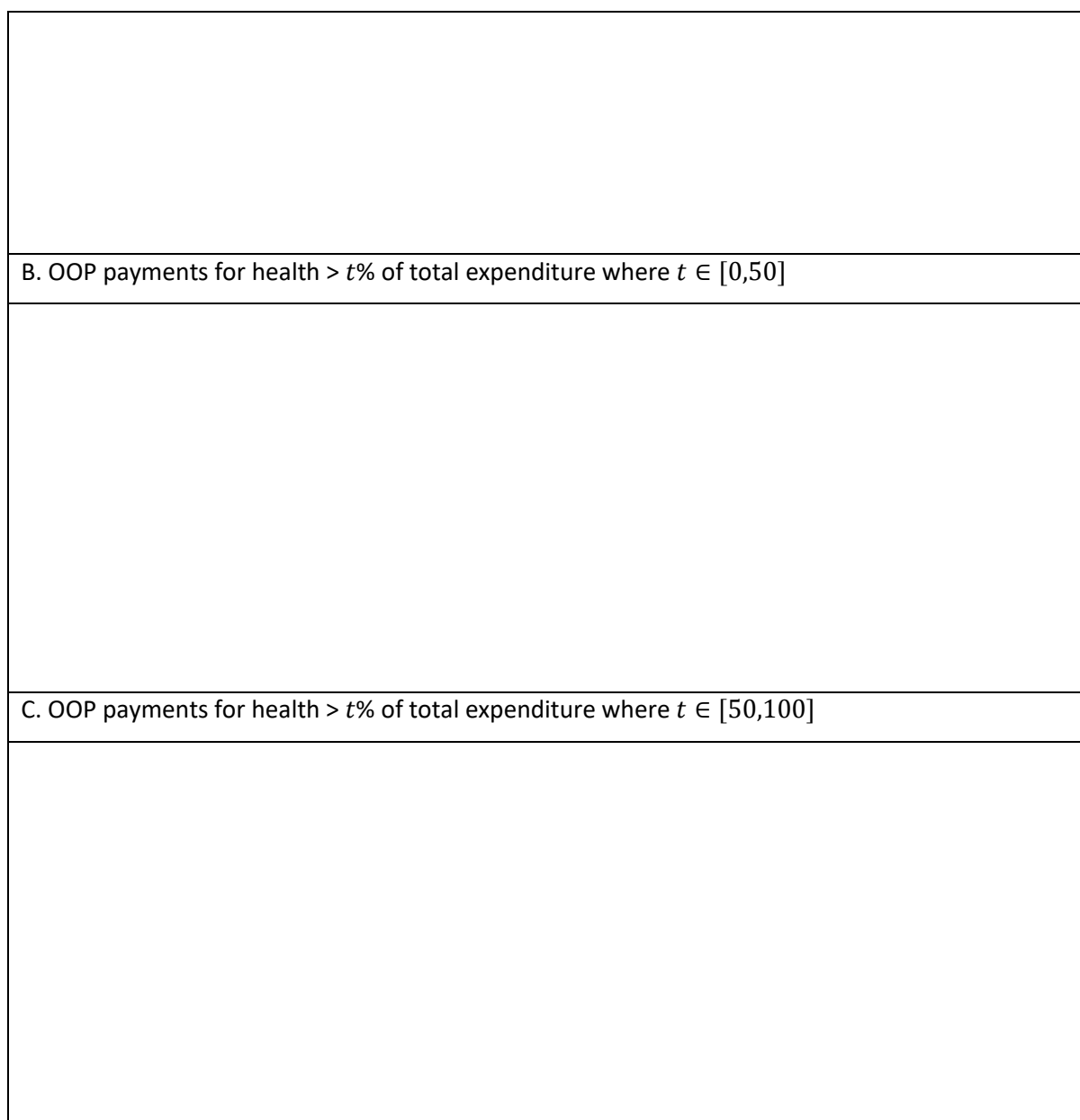


**Fig. 2. Incidence of catastrophic health expenditures estimated using conventional dichotomous measures (OOP payments for health > 10%, 25% and 40% of total expenditure), 2005–17**

Catastrophic incidence curves for the full range of the share of OOP payments for health in total expenditure are shown in Fig. 3. The curves show the percentage of the population incurring catastrophic health expenditures across all thresholds (Fig. 3A). The incidence for 2005 is shown as a solid dark blue line, and all later years are shown as dashed lines in increasingly lighter shades of blue. Incidence curves intersect, indicating that the incidence of catastrophic health expenditures is observed to have both increased and decreased over time depending on the threshold. At the left end of the range where incidence is estimated using lower thresholds (Fig. 3B), the percentage of the population incurring catastrophic spending has increased over time, as illustrated by the outward movement of curves. In contrast, at the right end of the range where incidence is estimated using higher thresholds (Fig. 3C), the percentage of the population incurring catastrophic spending has decreased for certain years as illustrated by the inward movement of some curves.

A. OOP payments for health >  $t\%$  of total expenditure where  $t \in [0,100]$





**Fig. 3. Catastrophic incidence curves, 2005–17**

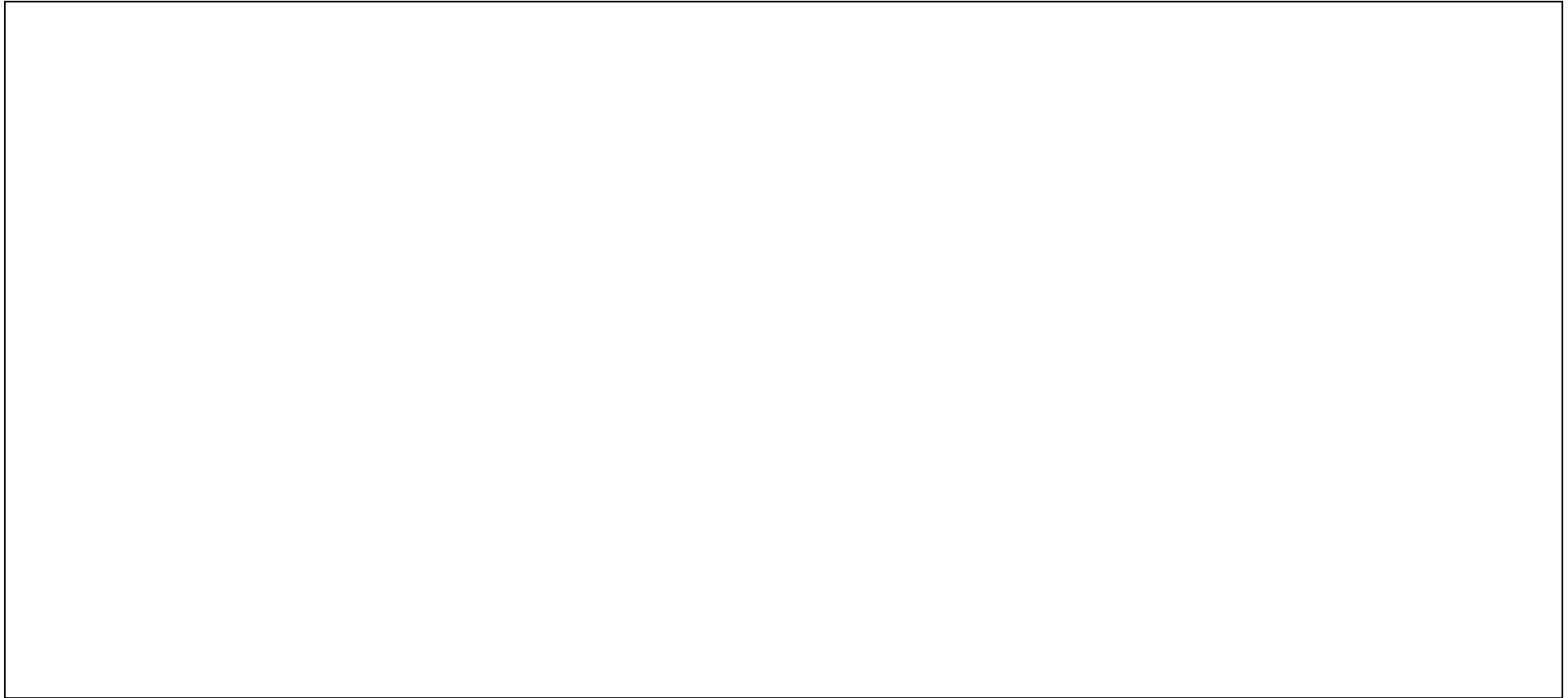
Note: Alternating years are shown in order to render the figure more readable.

To assess where and when changes in the distribution of catastrophic health expenditures occurred and whether these changes were statistically significant, we tested catastrophic incidence curves for restricted dominance. Fig. 4 shows test results for all possible year combinations (vertical axis) across a range of thresholds (horizontal axis). Red [green] bars reflect when the more recent year (Year B) had a statistically higher [lower] incidence of catastrophic health expenditures than the earlier year (Year A) for the threshold range represented by the length of the bar. In other words, red indicates catastrophic incidence is increasing over time and green indicates catastrophic incidence is decreasing over time. White bars indicate the difference in incidence between years was not statistically significant. Results fail to reject the null hypothesis of the non-dominance of

curves as the incidence of catastrophic health expenditures over time increases for thresholds less than ~25% but decreases for thresholds greater than ~35%.

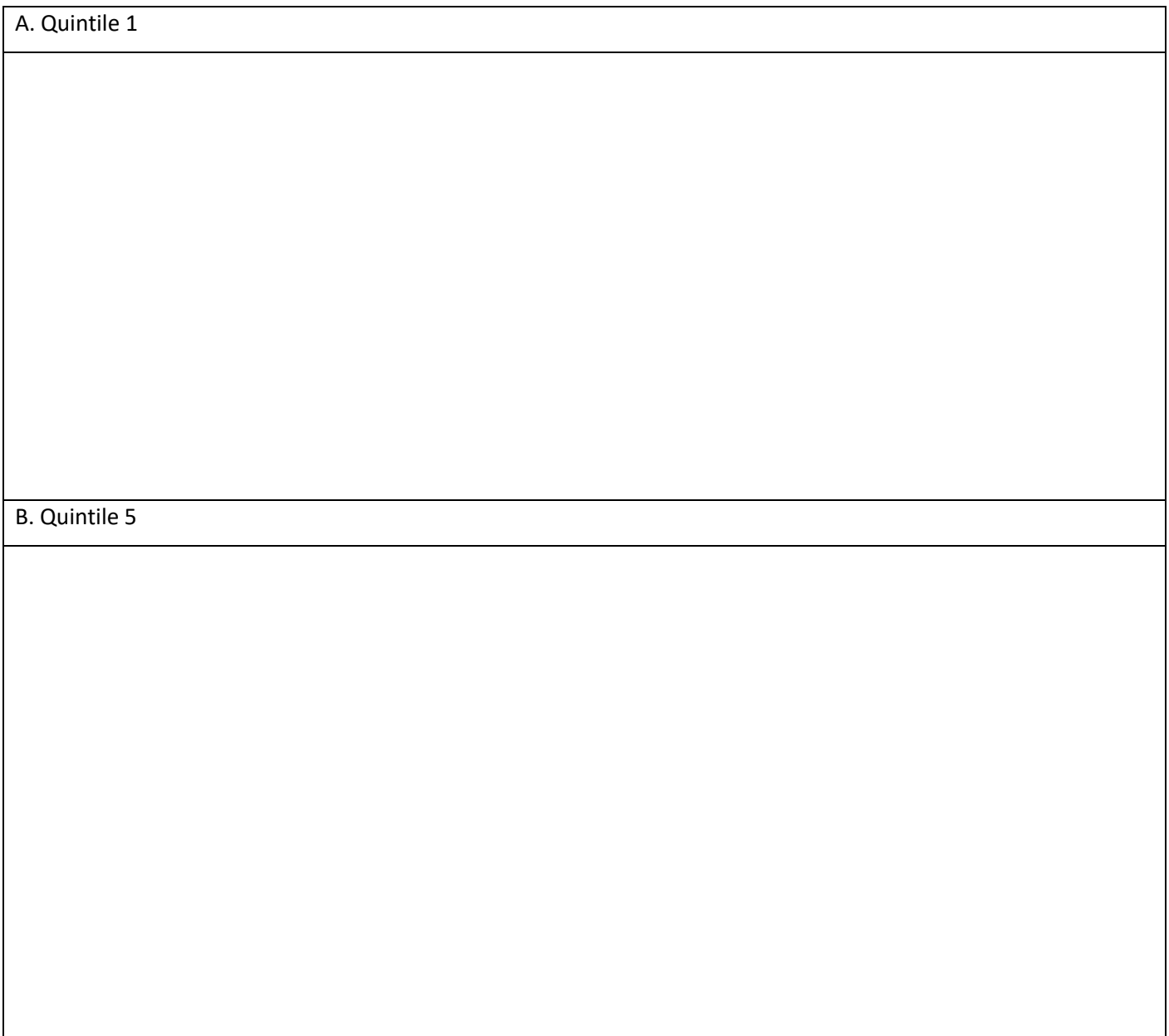
Fig. 4 further reveals distinct patterns of how the incidence of catastrophic health expenditures has evolved over time in Iran. Based on the data, three time periods are identified:

- 2005–10 (grey outline): Catastrophic spending was increasing at the lower end of the distribution (OOP payments for health < ~25% of total expenditure) but was decreasing at the higher end of the distribution (OOP payments for health > ~35% of total expenditure) when comparing to the incidence in 2011 or thereafter
- 2011–12 (orange outline): Catastrophic spending was significantly lower in this two year period such that when compared to the incidence in 2013 or thereafter, there is marked increase or no statistically significant change
- 2013–17 (blue outline): Catastrophic spending was relatively stable with the majority of changes not statistically significant, except for a narrow range of thresholds showing some increases or decreases



*Fig. 4. Results of restricted dominance testing of catastrophic incidence curves, 2005–17*

The analysis was also conducted for different socio-economic groups. Fig. 5A and 5B shows results for restricted dominance tests of catastrophic incidence curves for each year constructed for the poorest and the richest quintiles of the population. The picture is strikingly better for the poorest quintile as changes in incidence over time show either no significant change or significant decreases, with the exception of comparisons made to reference years 2005 and 2011–12. In contrast, the richest quintile displays results very similar to tests at the national level, although decreases in incidence were less frequent for comparisons with reference years 2011–12.



***Fig. 5. Results of restricted dominance testing of catastrophic incidence curves for selected quintiles, 2005–17***

### **3.2 Distribution of catastrophic health expenditures**

Non-dominance of catastrophic incidence curves indicates that different parts of the distribution of catastrophic health expenditures have evolved differently over time with incidence increasing [decreasing] for some population groups because of differences in purchasing patterns on certain health services or products.

Table 2 shows CIs estimating the degree of inequality in the distribution of catastrophic health expenditures following the budget share approach across socio-economic status for each year and the average over the period 2005–17. Catastrophic health expenditures were more equally distributed when defined using lower thresholds than higher thresholds (average CI at the 10% threshold was 0.1218 compared to 0.7871 at the 70% threshold). In other words, catastrophic spending at lower thresholds impacted all socio-economic groups but catastrophic spending at higher thresholds predominantly impacted only a narrow range of the richest socio-economic group and increasingly so as the threshold rises. Over time, the distribution of catastrophic health expenditures has become more concentrated amongst the rich when defined using lower thresholds (CI rose from 0.06 in 2005 to 0.16 in 2017 at the 10% threshold). In comparison, the distribution of catastrophic health expenditures defined using higher thresholds has generally remained the same (CI was 0.77 in 2005 and 0.73 in 2017 at the 70% threshold).

**Table 2. Concentration indices of catastrophic health expenditures (OOP payments for health > t% of total expenditure) across socio-economic status, 2005–17**

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The distribution of catastrophic health expenditures across different types of health services or products is shown in Fig. 6. Distributions are shown for catastrophic spending defined following the budget share approach using different thresholds for 2005, 2011 and 2017, i.e. the start, middle and end of the period 2005–17. When catastrophic spending is defined using lower thresholds, OOP payments are increasingly driven by medicines, with the average share representing approximately 30% of total catastrophic health expenditures at the 10% threshold in 2017. As the threshold



increases, the average share of medicines decreases to approximately 10% while that of inpatient services increases to approximately 45% at the 70% threshold in 2017. Nevertheless, the overall importance of OOP payments for inpatient services has lessened since 2011, with the composition of catastrophic health expenditures shifting from payments for inpatient services to those for medicines (followed by ancillary and dentistry services) across all thresholds.

Fig. 7 shows the distribution of catastrophic health expenditures across different health services or products for the poorest and the richest quintiles. Medicines represent a greater share of catastrophic spending for the poorest quintile, particularly at lower thresholds. For the richest, the distribution is comprised of OOP payments for medicines, dentistry services, inpatient services, and ancillary services. Over time, the composition for the poorest and for the richest quintiles has also changed. In 2005, the composition of expenditures was quite different between the two groups but, by 2017, the composition was quite similar between the two quintiles.

**Fig. 6. Distribution of catastrophic health expenditures across different health services or products, 2005, 2011 and 2017**


**Fig. 7. Distribution of catastrophic health expenditures across different health services or products for selected quintiles, 2005, 2011 and 2017**

### **3.3 Sensitivity analysis**

Similar findings for both the incidence and distribution of catastrophic health expenditures were obtained when following a capacity-to-pay approach in which OOP payments for health were compared to non-food expenditure. Results of dominance tests of catastrophic incidence curves for each year also failed to reject the null hypothesis of non-dominance (Appendix Fig. 1). At the national level, the incidence of catastrophic health expenditures increased for thresholds less than ~30% and decreased for thresholds greater than ~40% over time. Thus, the overall pattern of non-dominance, or where catastrophic incidence curves intersected, was simply shifted upwards as a consequence of the deduction of food expenditure in the measure of available household resources. Restricted dominance tests of catastrophic incidence curves constructed for the poorest and the richest quintiles of the population also displayed results similar to those following the budget share approach.

Analyzing the distribution of catastrophic health expenditures across socio-economic status when following a capacity-to-pay approach also showed that such expenditures were more concentrated in the richest over time, though to a lesser extent than when following the budget share approach. Although point estimates in CIs diverged, results showed similar patterns (Appendix Table 1). CIs for the capacity-to-pay approach also consistently increased as the catastrophic threshold increased and, except for at the 10% threshold, were still positive.

## **4. Discussion**

This paper has comprehensively analyzed the incidence and distribution of catastrophic health expenditures in Iran over the period 2005–17. It assessed whether incidence was increasing or decreasing over time, who was incurring expenditures and what they were purchasing. Estimates of the incidence of catastrophic health expenditures using conventional dichotomous measures defined by the SDG monitoring framework and selective thresholds of 10% and 25%, suggested that Iran has not made much progress on financial protection. However, a novel method which estimated incidence across a continuous range of thresholds and tested catastrophic incidence curves for restricted dominance, together with further analysis of distributional aspects, provided a more nuanced picture – incidence remained generally stable for the poor at thresholds lower than 25% and decreased for the rich at thresholds higher than 35%.

Our analysis adds to the evidence base in four ways: (i) our application of dominance methods overcomes methodological issues related to the choice of a threshold, providing more robust assessments of progress and greater insight into varying degrees of financial hardship; (ii) our sensitivity analysis contributes to methodological debates over the definition of household resources (i.e. budget share versus capacity-to-pay approaches); (iii) our analysis across all possible year combinations highlights data patterns that may help understand the response of financial protection to the timing of policy changes or to broader contextual factors; and (iv) our distributional analyses across socio-economic status and across types of health services or products provide granular detail to better inform policy responses that more effectively protect population groups at risk and address drivers of catastrophic health expenditures.

Firstly, our study's application of dominance methods to analyze catastrophic incidence curves provides a more comprehensive and nuanced picture than standard methods and adds to the measurement literature. Measuring the incidence of catastrophic health expenditures using single-point threshold measures not only pose a methodological challenge as comparative assessments are sensitive to the choice of the threshold, but also mask the financial hardship experienced by those just below a given threshold (Anonymous et al., 2018). Analysis using single-point thresholds results in a significant loss of information as it fails to capture different gradations of financial hardship. The impact of OOP payments for health services or products is not discrete but can vary in intensity. Given the loss of information and the arbitrary and normative nature of the choice, we recommend measuring catastrophic health expenditures using a dominance approach that estimates incidence across a continuous range of thresholds illustrated in incidence curves, which can then be tested for restricted dominance. This approach enables greater understanding of the extent of financial hardship and identifies where in the range (for which thresholds) of catastrophic health expenditures there are changes. The approach also provides a more robust assessment of progress, given there could be inconsistency in ranking incidence of catastrophic OOP payments over time arising from the choice of a threshold.

Secondly, our analysis of the sensitivity of the incidence and distribution of catastrophic spending to the budget share and capacity-to-pay approaches demonstrates that these are not materially different, and thus contributes to methodological debates. Results of dominance tests of catastrophic incidence curves following the capacity-to-pay approach displayed similar patterns as the budget share approach, whether at national level or for the poorest or richest quintile. Catastrophic health expenditures following a capacity-to-pay approach were also found to be more

concentrated amongst richest. A capacity-to-pay approach would be expected to result in greater concentration amongst the poor, and the fact that this was not the case provides additional confidence in the validity of our finding. Such results may be unique to Iran where, in contrast to most other countries, OOP payments have been found to be progressive (Hsu et al., 2020), likely because of high levels of insurance coverage, a generous benefit package and low co-payments.

Thirdly, our analysis of changes in incidence across *all* combinations of years sheds further light on the timing of changes. Significant changes were less likely to be observed year-on-year and more likely between non-consecutive years. Our results showed that from 2005–10 compared to 2011 or thereafter, catastrophic health expenditures following the budget share approach increased when defined using any threshold less than 25% but decreased over time for any threshold greater than 35% of total expenditure. The reference period 2011–12 was marked by lower catastrophic spending, and increases were observed for later years over a wide range of thresholds. Since 2013, the incidence of catastrophic health expenditures has been generally stable except for a narrow range of thresholds showing some increases or decreases. These time periods reflect simple patterns in the data and raise the more complex question of whether changes in financial protection are due to policy changes in the health financing system and/or broader socio-economic changes. For example, the imposition of economic sanctions on Iran intensified in 2011 and would have had a plausible impact on overall household spending, including for health. While medicines were technically exempt from sanctions, their availability was still negatively affected with reported shortages of drugs (44% of which were classified as essential) and increases in prices up to 50% (Setayesh and Mackey, 2016; Gorji, 2013). As a policy response, subsidies for imported essential medicines were introduced in 2011 direct to manufacturers and in 2013 indirectly to public health insurance funds. We cannot infer causal relationships from our analysis, however the overlap between the timing of reforms and pattern of changes in catastrophic health expenditures can inform hypotheses for investigation in future studies using appropriate methods.

Fourthly, this study demonstrates the importance of examining the distributional aspects of catastrophic health expenditures. Evidence regarding which population groups were incurring such expenditures, to what degree (i.e. at what threshold) and what they were spending on provides valuable insight to policymakers seeking to improve financial protection. Our analyses show that, at the start of the period of analysis in 2005, catastrophic health expenditures defined using thresholds less than 25% of total expenditure were more equally distributed across all socio-economic groups but became increasingly concentrated in the rich over time. For lower thresholds, the increase in

overall incidence over time was driven by OOP payments made by the richest quintile for dentistry services, ancillary services and medicines. Meanwhile, the incidence for the poor remained stable at these lower thresholds and with OOP payments predominantly made for medicines. Thus, additional attention is warranted to the design and implementation of pharmaceutical policies and practices. For higher thresholds, catastrophic health expenditures defined using thresholds greater than 35% of total expenditure were rarely incurred by the poor and predominantly impacted the rich. That the rich incurred such expenditures may be less of a policy concern in Iran given their greater ability-to-pay and the more discretionary nature of their spending, which was predominately for dentistry and ancillary services. This raises a key policy question regarding what kind of health services should be publicly or privately covered.

The implications of such findings thus underscore the need to examine the effectiveness of existing policies, such as those around the design of the benefit package in terms of which services or products are provided, for which population groups and under what cost-sharing conditions. Many country policies to improve financial protection are designed to specifically address OOP spending on hospitalization given conventional thinking that acute hospital care is responsible for catastrophic health expenditures; however, our findings show that expenses incurred for medicines were the major driver of catastrophic spending across thresholds and population groups. Medicines in Iran are predominantly paid for OOP in outpatient settings or pharmacies, not least as hospitals previously referred patients to purchase such items in retail settings; however since 2014, such referral practices are prohibited and inpatient medicines have been provided by public hospitals. Although this distinction is specific to Iran, the purchase of medicines has been found to be an important driver of catastrophic spending in other countries (Thomson et al., 2019; Wang et al., 2018). Our study thus adds to the evidence that multiple small payments for medicines can be catastrophic, especially if a person is (near) poor.

The ability to compare our results with previous studies is somewhat limited given the novel methods we adopt and the extended time period of our analysis. Some studies were not comparable with ours as they use different methods, rely on different household surveys as the source of data or examine different time periods (Abdi et al., 2019; Yazdi-Feyzabadi et al., 2019; Kavosi et al., 2012). Of studies identified as comparable, our estimations of catastrophic health expenditures following standard approaches were similar (Hsu et al., 2020; Ahmadnezhad et al., 2019; Wagstaff et al., 2018b). These studies also estimated catastrophic spending following the SDG definition and found the same trends in incidence at various overlapping points in time.

A strength of our study is its reliance on 13 years of data drawn from nationally representative household surveys conducted annually and using consistent methods for estimating catastrophic health expenditures. As such, results are comparable and reflect an extensive and critical time period when key health reforms were being implemented in the country. Our analysis was also comprehensive as we used both the budget share and capacity-to-pay standard approaches and estimated incidence across the full range of thresholds. The fact that results of sensitivity analyses of the budget share and capacity-to-pay approaches were not qualitatively different and resulted in similar trend results lends a degree of confidence in the validity and reliability of our findings. A further strength of our study is the analysis of the distributional aspects of catastrophic spending, which provided more specific insights about which population groups and which types of health services or products were the drivers of catastrophic health expenditures.

Nonetheless, this study has limitations in regard to the survey structure, indicators used and statistical tests employed. The survey structure was modified in 2016 by merging similar categories of medical expenditures, reducing the number of questions, as well as by distinguishing spending by provider setting (i.e. public versus private), increasing the number of questions. Estimations of OOP payments are sensitive to the number of questions (Lu et al., 2009); however, the net effect of survey modifications in Iran would likely balance out, and we believe do not significantly affect interpretation of our results. We also acknowledge, but do not analyze, other indicator variants to measure catastrophic health expenditures (e.g. comparing OOP payments to income, or to expenditure or income net of other estimations of basic needs) as this was not the focus of our study. The indicator variants we adopted in our analysis are those predominantly used globally. Lastly, the minimum t-statistic test that we used for assessing dominance assumes that our samples are mutually independent. Our use of independent cross-sectional surveys using random sampling methods should allow this assumption to be met in the present case. However, some studies (Davidson and Duclos, 2013; Davidson, 2009; Linton et al., 2005; Barrett and Donald, 2003) have examined alternative dominance tests based on an empirical likelihood ratio statistic (with subsampling) that allow for dependence between variables across samples. Although such tests are considered to have improved reliability of inference, results were numerically very similar to those produced from the t-statistic (Davidson, 2009; Linton et al., 2005). In addition, a noted advantage of the minimum t-statistic test is that it is straightforward and easy to implement (Davidson, 2009). Nevertheless, further consideration regarding the independence of samples, assumed by the application of the t-test, may be warranted, and examination of alternative statistical tests for dominance remains an area for future econometric research.



## **5. Conclusion**

This is the first study to innovatively apply the dominance approach to analyze the incidence of catastrophic health expenditures in a single country over multiple time points. We have shown the added value of analyzing catastrophic OOP payments across a continuous range of thresholds and of analyzing the distribution across socio-economic status and types of health services or products. Such an analysis provides more detailed results to better inform the design and implementation of policies that would more effectively protect population groups at risk and address drivers of catastrophic health expenditures. It is a useful addition to the toolbox of methods for analyzing catastrophic health expenditure and its determinants, complementing other methods such as decomposition analysis. Although our analysis pertains to Iran, the methods adopted can be replicated in other settings.

Our analysis found that Iran has made some important progress in financial protection, notably that the incidence for the poor remained stable at lower thresholds and that the incidence for the rich decreased at higher thresholds. Medicines represented the largest share of catastrophic spending for the poorest while a mix of medicines, dentistry, inpatient and ancillary services accounted for catastrophic spending by the richest. Thus, a priority for policymakers should be measures that reduce OOP payments for medicines and especially those made by the poor. Our detailed analysis uncovered underlying data patterns which can be used to generate hypotheses for further research on how changes in catastrophic spending are related to policy changes in the health financing system (e.g. design of insurance pools, benefit packages, cost-sharing arrangements) and/or to broader contextual influences (e.g. the impact of sanctions). By better linking policy outcomes with policy inputs, important system design and contextual attributes can be leveraged to improve financial protection and progress towards universal health coverage.

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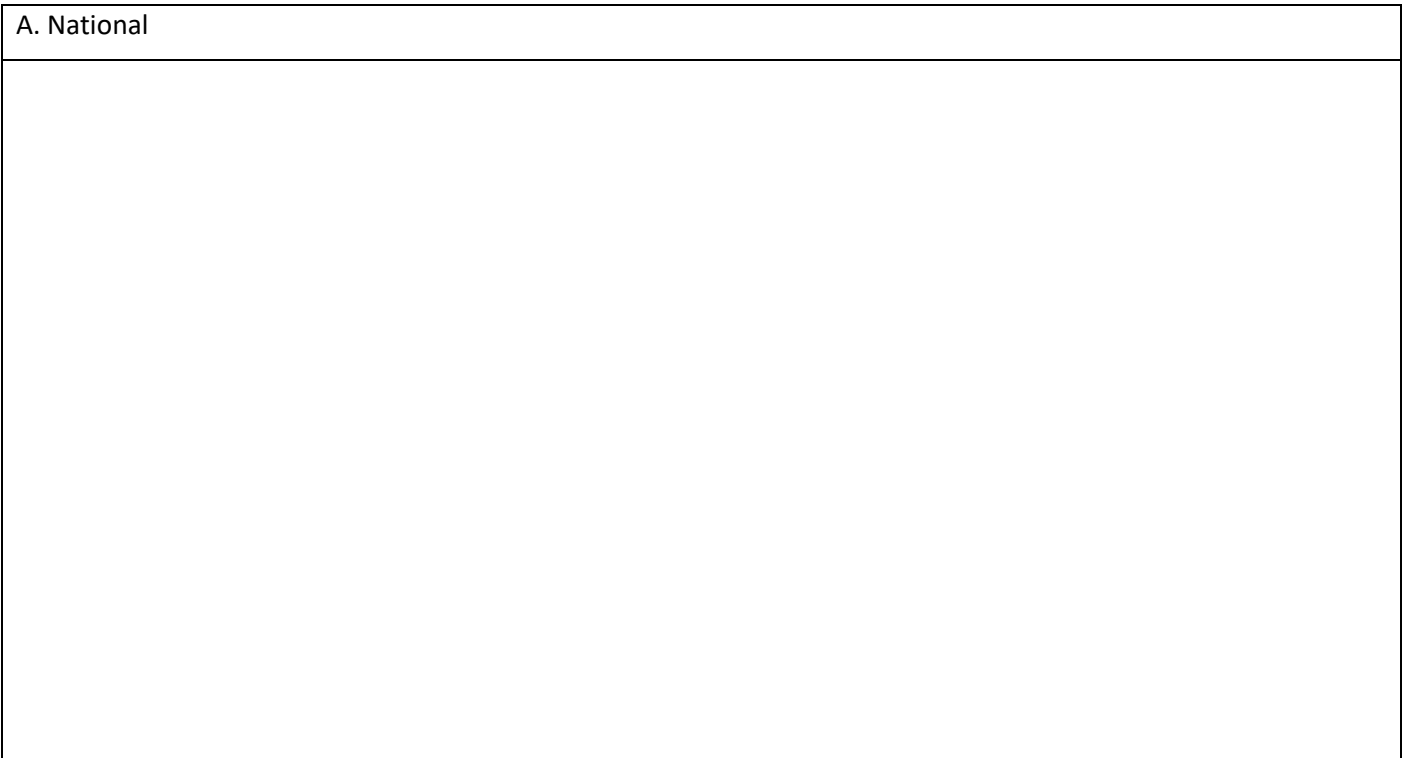
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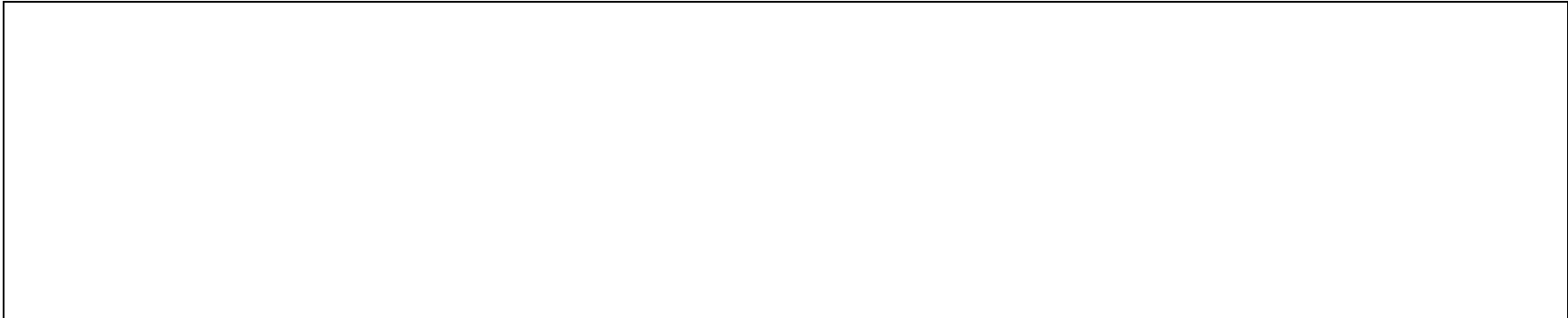
**Appendix Fig. 1. Results of restricted dominance testing of catastrophic incidence curves (OOP payments for health > t% of non-food expenditure), 2005–17**



B. Quintile 1

C. Quintile 5

**Appendix Table 1. Concentration indices of catastrophic health expenditures (OOP payments for health > t% of non-food expenditure) across socio-economic status, 2005–17**



Notes:

\*\*\* significant at 1%      \*\* significant at 5%      \* significant at 10%