HHS Public Access

Author manuscript

Health Serv Outcomes Res Methodol. Author manuscript; available in PMC 2018 December 01.

Published in final edited form as:

Health Serv Outcomes Res Methodol. 2017 December ; 17(3-4): 219–236. doi:10.1007/s10742-017-0170-3.

Implications of family risk pooling for individual health insurance markets

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Abstract

While family purchase of health insurance may benefit insurance markets by pooling individual risk into family groups, the correlation across illness types in families could exacerbate adverse selection. We analyze the impact of family pooling on risk for health insurers to inform policy about family-level insurance plans. Using data on 8,927,918 enrollees in fee-for-service commercial health plans in the 2013 Truven MarketScan database, we compare the distribution of annual individual health spending across four pooling scenarios: (1) “Individual” where there is no pooling into families; (2) “real families” where costs are pooled within families; (3) “random groups” where costs are pooled within randomly generated small groups that mimic families in group size; and (4) “the Sims” where costs are pooled within random small groups which match families in demographics and size. These four simulations allow us to identify the separate contributions of group size, group composition, and family affinity in family risk pooling. Variation in individual spending under family pooling is very similar to that within “simulated families” and to that within random groups, and substantially lower than when there is no family pooling and individuals choose independently (standard deviation \$12,526 vs \$11,919, \$12,521 and \$17,890 respectively). Within-family correlations in health status and utilization do not “undo” the gains from family pooling of risks. Family pooling can mitigate selection and improve the functioning of health insurance markets.

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Compliance with Ethical Standards

Conflict of Interest: All authors declare no conflict of interest.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

¹In anticipation of this behavior, employers have been shown to design their insurance offerings to encourage their employees to select coverage through their spouse’s employer so as to minimize their labor costs.¹⁸ Employers can also use premium and cost sharing choices to dissuade families who have higher expected health spending than individual employees from taking-up an employer-offered plan. These behavioral responses also impose cost externalities on other payers and reduce efficiency.

²While true “families” may differ (e.g., if some employees’ family members get coverage elsewhere), it is the relevant definition for our analysis, as it is the level at which individuals group together to buy insurance in a real-world setting.

Keywords

Risk pooling; Health insurance; Adverse selection

A key design choice made by public and private authorities in health insurance markets is whether beneficiaries may enroll in health plans as family units rather than as individuals. Insurance markets in the U.S. take different approaches. For example, private employers virtually always allow benefits-eligible employees to choose whether to enroll individually or in combination with family members.¹ In contrast, Medicare beneficiaries may not enroll as family groups: if a beneficiary elects to join a private Medicare Advantage (MA) plan she pays an individual premium set by the plan. If that beneficiary's spouse also chooses to join that MA plan he would do so under his own, individual contract.

With the prominence of private health insurance markets, some of which have relatively small numbers of participants, understanding the actual empirical effect of family pooling on the distribution of health risk in a population is increasingly important to determine how to offer, promote and price family-level coverage. Moreover, in most risk adjustment formulas family members are treated as individuals, and a better understanding of the impact of family pooling could inform and improve risk-adjustment systems. Despite its potential importance, however, this question has been largely overlooked in the health insurance literature.

A family is a natural decision-making unit for purchase of health insurance. Selling to families reduces an insurer's administrative cost, as grouping multiple individuals on one contract constitutes a lower administrative burden than maintaining and managing separate contracts for each individual. Likewise, buying as a family reduces the family's cost of choosing and managing health insurance plans.

In many settings, such as the Marketplaces established by the Patient Protection and Affordable Care Act of 2010 (ACA), large families may pay no more than smaller ones, encouraging those large families to purchase as family units.¹ However, for families with fewer than four children, families pay the same premium per person when they enroll as individuals as they do if they enroll as a single family unit. Although some plans offer other incentives to families, such as family-level deductibles, these are only realized when families use a significant amount of medical care. Should these smaller family units have stronger incentives to encourage family purchase of health insurance?

The question of whether families should be encouraged to purchase as family units is relevant because, along with the impact on administrative costs, family purchase of health insurance also affects cost risk in insurance markets. It has long been recognized that pooling of health risks across individuals in small groups can ameliorate adverse selection problems.² While for policy purposes health insurance purchasing groups are usually

¹In ACA Marketplaces premiums for family-level plans increase with each child up until three, with no further increase in family premium with additional children.

thought of as being larger than the 2–6 members of a typical family, the incremental benefits of risk pooling will be largest in the small-number range.

These benefits are achieved in two ways. Compared to when a costly person elects a generous plan on his or her own, when that person instead pulls along lower-risk family members, the effects of this adverse-selection on plan premiums will be partially mitigated.³ Second, as decision-making units become more homogeneous in costs, plan incentives to manipulate benefits, network design or other features in order to attract healthy enrollees and deter sick ones are also mitigated.⁴ For example, with family-level pooling if a plan chooses to offer higher quality care for diabetics, rather than only attracting new, costly diabetic enrollees, the plan will also attract the potentially healthy, profitable family members of diabetic enrollees. This pattern of demand can weaken the distortionary cream-skimming incentives that would prevail if the diabetic enrollee and his family members made independent choices that lead to the diabetic enrolling in a health plan separately from other family members.

However, the extent that pooling family members to purchase health insurance achieves the same gains as pooling across small groups of unaffiliated individuals is unknown. Family pooling may not be the same as pooling 2–6 independent individuals. Health conditions and health status are correlated within families, as we describe in more detail in the next section of the paper. If these correlations extend to health spending, family pooling to purchase health insurance may have limited consequences for adverse selection. For example, if due to genetics or correlated preferences for health care utilization, families are simply groupings of individuals of similar risk-type (i.e., if one family member is a diabetic, other family members are likely to be diabetics all with high health spending), then family pooling does little to offset insurer incentives. Insurers would still be better off from attracting “winner” families (those consisting of low-risk types) and deterring “losers” (the high-risk families).

In this paper we quantify the effect of family pooling on the distribution of health spending across individuals in a health insurance market. Using a large dataset of real families enrolled in commercial health insurance, we compare the individual-level distribution of per-person spending under one “real” and three counterfactual pooling scenarios so as to determine how much within-family affinity in health care spending serves to “undo” the effects of simple group-level pooling (size) and pooling of individuals of varied age and gender (composition). We conclude with a discussion of the implications of our findings for policy towards allowing for family-level purchase and pricing in health insurance markets.

Relevant Literature

Family associations are not completely random, and a large literature examines the correlation of health within families. Although certain risks of high health spending are uncorrelated (e.g., idiosyncratic injuries) or negatively correlated (e.g., pregnancy) within families, positive intra-family correlation in physical health (e.g., body mass index (BMI) and cardiovascular risk factors), mental health, and health behaviors including exercise, alcohol consumption, smoking, and use of preventive care are explained by a number of

factors.⁵ Most obviously, risk of health spending due to contagious diseases that are spread by close contact is higher within families than across independent individuals. Individual health behaviors may also spill over to other family members, as with exposure to second-hand smoke.⁶ Environmental and socio-economic factors (e.g., income, neighborhood) affect health and health spending and will jointly affect family members living together.⁷ In the language of human capital theory, the family “produces” health for its members using joint inputs, introducing positive correlations.⁸ Finally, assortative mating, which is the matching of like-type individuals in health status or preferences for healthy behaviors by marriage, implies a positive correlation of health care utilization.⁹

Supply-side factors could also induce within-family correlations in spending. Provider factors have been shown to be responsible for around 50% of the regional variation in health care spending in Medicare,¹⁰ and providers treat patients within their practices with similar intensity.¹¹ When family members use the same set of providers, a likely very common occurrence particularly among children in a family, provider practice patterns could lead to significant correlations in health care spending within families.

The primary purpose of health insurance is to provide financial protection in cases of large medical expenses. Keeler et al (1977) find that family pooling under a combined deductible reduced the family’s own risk of high health expenditures (e.g., their ex-ante exposure to cost) in comparison to coverage through equivalent individual deductibles.¹² Most significant benefits accrued to families that were larger and when insurance plans included higher coinsurance rates.

To our knowledge, no published research has examined the impact of family pooling on the distribution of health expenditures and risk in health insurance markets. In this paper we disentangle the contribution of three separate aspects of family pooling. The first is group size, which is the effect of pooling expenditures of heterogeneous individuals across individuals in small groups. The second is group composition, and represents the effect on variation in spending of pooling individuals of different ages and genders as are found in families. The third is affinity, and represents the effect of intra-family correlations in health on variation in spending. The relative contributions of each feature, and in particular the extent that family affinity creates selection incentives that work in opposition to group size and group composition, are important for the design of family-level offerings in insurance markets.

Data and Methods

Data

We use the 2013 Truven MarketScan data, a large commercial claims dataset including over 43 million individuals. We selected all individuals who are the primary subscriber on their health plan, age 18–64, and enrolled in a private, fee-for-service insurance plan that includes mental health coverage and prescription drug coverage, and all spouses and children also insured on those contracts into our sample. We refer to groups of individuals who pool together to purchase insurance on one contract as “real families.”ⁱⁱ We exclude families enrolled in a plan with any capitated payments to providers in order to be sure we observe all

spending. We included families with a birth during the study period, but otherwise excluded families that had unexplained changes in their composition during our study year or if any other family member (e.g., other than a newborn infant) was present in the data for less than the calendar year (13% of sample). We also excluded families who switched health plans during a calendar year (7% of sample), or that include seven or more children (0.07%) as they are an uncommon type of family. The final analysis sample includes 8,927,918 unique individuals, 1,704,740 who were enrolled in individual coverage, and 2,260,708 families.

Key Study Variables

The primary measure used in our analysis is individual annual health spending. We define spending to include medical and pharmaceutical expenditures, not administrative costs (which are not included in the MarketScan data). Health plan spending is affected by insurance benefit design.¹³ However, MarketScan does not include measures of health plan generosity or cost-sharing. To focus our analysis on variation in health spending associated with individual factors and not the generosity of insurance coverage, we construct a regression-adjusted measure of individual total spending, which henceforth we call “individual total spending,” from which we have eliminated the impact of benefit design on spending (see Appendix for detailed methods).

Analyses of Within-family correlation in health spending

To document the correlation in health spending among family members we calculated the intra-class correlation coefficient (ICC), a statistic that varies from 0 to 1 and measures the correlation in spending among members of a group (e.g., within family) compared to what we would expect in the full sample. The higher the value of this statistic, then the greater the agreement.

For each person in our sample, we identified where his or her individual total spending fell in the distribution of individual total spending incurred by others of similar age and gender, where age was defined as ten-year categories (age 0–9, 10–19, 20–29, etc). For example, the 30-year old woman with the highest spending among all 30–39 year old women will be assigned the 99th percentile, a 30 year old woman with average individual total spending compared to other 30–39 year old women would be assigned the 50th percentile. We then calculate the ICC of the individual percentile measures of spending within families.

Analyses of Impact of family-pooling on insurer risk

Our main outcome is the standard deviation of the distribution of individual total spending. Reducing this standard deviation can improve the functioning of health insurance markets. We first calculate the standard deviation of “individual” total spending across the whole study sample, which represents the setting where individuals choose plans independently (e.g., single-person coverage) and there is no pooling of individual-level spending across individuals. Next, we calculate the standard deviation of individual-level spending when individuals pool as real families to purchase insurance, where (1) each individual within a given family is assigned the averaged spending among all members of that family, called “Family-averaged individual spending,” and (2) we estimate the standard deviation in the distribution of family-averaged individual spending.

Meet the Sims

We also study the distribution of spending under two alternative scenarios: (1) where individuals pool in “random groups,” and (2) where individuals pool in simulated families we refer to as the “Sims.” Random groups consist of randomly associated individuals and, to identify the contribution of small group pooling on spending, are the same size as real families. To capture the effects of demographic composition within a family (e.g., age and gender) but not the endogenous sorting from assortative mating and childbirth that generates real families, the Sims have both the same number of individuals *and* the same age and gender distributions as the real families.

More specifically, for each real family in our data, we generate a random group through simulation that matches the real family in size. Then for each individual in a random group, we define “random group-averaged individual spending,” following the methods for real families described above. For every real family in our sample we also construct a randomly-generated Sim family that matches the real family not only in the number of people in the family but also in the age and gender distribution of family members, and is drawn through stratified random sampling. We define “simulated family-averaged individual spending,” following the methods for real families described above. We estimate the standard deviation in the distribution of random-group averaged individual spending and simulated family-averaged individual spending. This process is repeated 5000 times through simulation.¹⁴

We compare the standard deviation in individual spending, family-averaged individual spending, random group-averaged individual spending, and simulated family-averaged individual spending to measure how real family pooling affects the distribution of health spending relative to no pooling and to purely random associations. In sensitivity analyses, we assess whether the results vary across family composition by repeating the analysis above only including two-adult families, and then only including two-adult, two-child families (results from sensitivity analyses presented in Appendix).

Relative impact of spending type and spending category

Within-family correlation in health spending may be higher for certain types of care (e.g., inpatient, outpatient, or pharmaceutical) or within clinical categories. If so, reductions in the variance in health spending that occur under family pooling will stem disproportionately from the types or categories of spending where correlations are lower. To assess how spending on each type of medical care, and across 15 mutually exclusive clinical categories, contributes to the variance in total spending for individuals versus real families, we calculate the contribution of the variance of each subcomponent of spending to the total variance, and whether that varies for family pooling versus individuals purchasing insurance on their own (detailed description of these methods provided in the Appendix).

Results

Descriptive statistics for the study sample, including the average expenditure per person in families is presented in Table 1. The intra-class correlation coefficient of individual health

spending within families is 0.26, a level indicative of low correlation in spending within families in comparison to the sample.

Impact of family pooling on insurer risk

Family pooling reduces the variation of individual health spending for a population. We show this illustratively in Figure 1, where Panel A plots individual total spending under no pooling for 200 randomly selected individuals from our study population, ordered from lowest spending to highest. Panel B plots the family-averaged individual spending for the same individuals (e.g., under family pooling), in the same order as they appear in Panel A. In Panel A there is wide variation in spending across the individuals, whereas in Panel B the variation is considerably less and the scale of the highest-spending individual's spending is significantly lower.

This effect can be summarized by the standard deviation of the distribution in spending. Figure 2 shows that the standard deviation of the distribution of family averaged individual spending is much lower than that of individual health spending (e.g., under no pooling), \$5660 smaller (equivalent to 0.3 standard deviations).

Figure 2 also plots the standard deviation of random group-averaged spending and Sim family-averaged spending. Pooling in random groups results in the lowest standard deviation of individual pooled total spending, at \$12,564. Relative to individuals enrolling in plans separately, this level represents a reduction of 0.33 standard deviations in spending, and only an incremental reduction of 0.03 standard deviations from the reduction gained through real family pooling. The standard deviation of real family-averaged individual total spending, which includes the effects of within-family correlations in health spending, is slightly lower than that for the simulated families, which does not. This difference of \$28, though statistically significant due to the large sample size in the simulations, is nearly negligible. Similar results are observed when we restrict the analysis to two-adult families, and two-adult, two child families (see Appendix).

Reductions in variance by spending type and category

The variance of real family-averaged individual spending is 167.4 billion squared-dollars, an amount more than 50% lower than that the variance of individual total spending (375 billion squared-dollars). Approximately 40% of this reduction in variance stems from reduction in the variance in inpatient spending, 30% from reduced variance in outpatient spending and 11% from reduced variance in spending on prescription drugs (Table 2, Panel A). The remaining reduction comes from reductions in the covariances of spending types. Reading across the rows in Table 2 shows that this decrease in variance is not attributable to a particular type of spending, as the contribution of each type to overall variance is consistent. We see similar results when we decompose the reduction in variance by clinical category (Table 2, Panel B).

Discussion

This paper investigates the extent that individuals in families have similar variation in health spending as observed across unaffiliated individuals in a population to answer the question

of whether similar health-risks (e.g., sicker individuals, healthy individuals) “sort” into families together. We find that the within family correlation in health spending is low ($ICC = 0.26$), and relative to a case where health insurance is purchased at the individual level, the standard deviation of family-averaged individual spending, which reflects risk under family pooling, is very similar to that achieved by the Sims, which are randomly associated individuals in family-like groups. This implies that within-family correlations in health status and health care utilization do not “undo” the gains of pooling from group size and group composition.

Thus enrollment of family members as individuals in separate health plans may come at the cost of some losses in the efficiency of market functioning – specifically incentives for adverse selection – and our results suggest that insurance markets may be better off from encouraging family level enrollment. Moreover, family members enrolling in health insurance as a group may have shared interest in coverage and access that serves to mitigate incentives for adverse selection. For example, if a family of five includes one person with diabetes, the entire group may be interested in having generous coverage and access to high quality diabetes care in their family plan, all for the benefit of the one family member who has diabetes. This would be different in case of individual contracts. As such, the family’s pooled preferences for diabetes care, when the family includes several individuals who do not themselves have diabetes, should also serve to dampen insurers’ incentives for service-level distortion. Family-level pooling will not obviate all adverse selection concerns, as, given a particular family size, insurer incentives to attract healthier families and avoid sicker ones will persist.

This finding is likely to be most relevant to insurance markets where concerns of instability due to adverse selection are paramount. There is a history of adverse selection in individual market public exchanges,¹⁵ and adverse selection is a significant concern in the ACA Marketplaces.¹⁶ Moreover, these findings are potentially relevant to a larger population than these marketplaces, as trends suggest that individuals may be increasingly likely to purchase employer-sponsored health insurance through a regulated individual market such as a private exchange.¹⁷

There are several limitations in our study. We cannot observe family members who are enrolled in separate insurance contracts. However, because our data are from a population with employer-sponsored health insurance where family members are not allowed to split across multiple plans offered by an employer, for family members to enroll in their own health plan they must do so with a different employer or in a different market altogether. The health spending by these unobserved family members is unknown. Theory predicts that individuals who expect to use medical care are more likely to purchase health insurance, thus family members who forgo joining a health plan (and who we cannot observe) may be healthier than those who join a plan as a dependent. Alternatively, missing family members may children eligible for public insurance, such as through the S-CHIP program, when parents are not. In either of these cases, health spending of these missing individuals is likely lower than average, so including them in the analysis would result in the gains from family-level risk pooling being the same, or better.

Second, our focus is on non-elderly, commercially-insured families making these findings most relevant for the ACA Marketplaces. However, the findings may not generalize to other populations, in particular the elderly (e.g., Medicare) where prevalence of illness and mortality is higher or the very low-income (e.g., Medicaid) where within-family affinity in health spending due to environmental or socio-economic factors may be greater.

Not only must policymakers determine whether to allow family purchase of health insurance, but family health plans also must be priced for both consumers and insurers. For consumers this refers to family premiums, and for insurers, to the risk adjustment formula used to pay plans for family purchases. Regulation of premiums and risk adjustment are both potential levers through which to encourage family-level purchase of insurance. Before using these levers, the implications of different plan pricing regimes on plan and individual behavior, and for risk-adjustment of plan payments, needs to be better understood. In addition, use of the “family” as a unit raises practical administrative problems because families are very diverse in their basic structure, including, for example, in the number and gender of parents, the numbers and ages of children, and the inclusion of other relatives. Investigating these questions will be important topics for future research so as to capture the potential for family purchase of health insurance to improve efficiency and promote stability in individual, non-elderly health insurance markets.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

We thank Randy Ellis, Joe Newhouse, Bastian Ravensteijn, and Richard van Kleef for helpful comments on an earlier draft. The views in this paper are the authors' alone. Andrew Hicks provided excellent statistical programming assistance.

Funding: We gratefully acknowledge funding for this work from the National Institute for Mental Health (R01 MH094290), and the John and Linda Arnold Foundation.

References

1. Kaiser Family Foundation/Health Research and Educational Trust. 2015 Employer Health Benefits Survey. Menlo Park (CA): KFF; 2015 Sep.
2. Diamond P. Organizing the Health Insurance Market. *Econometrica*. 1992; 60(6):1233–1254.
3. For an example of the elucidation of this effect in Einav L, Finkelstein A. Selection in Insurance Markets: Theory and Empirics in Pictures. *Journal of Economic Perspectives*. 2011; 25(1):115–138. [PubMed: 21595322]
4. Glazer J, McGuire TG. Optimal Risk-Adjustment in Markets with Adverse Selection: An Application to Managed Care. *American Economic Review*. 2000; 90(4):1055–1071.
5. Wilson S. The Health Capital of Families: An Investigation of the Inter-Spousal Correlation in Health Status. *Social Science and Medicine*. 2002; 55:1157–1172. [PubMed: 12365528] Falba TA, Sindelar JS. Spousal Concordance in Health Behavior Change. *Health Services Research*. 2008; 43(1):96–116. [PubMed: 18211520] Christakis NA, Fowler JH. The Spread of obesity in a large social network over 32 years'. *New Engl J Med*. 2007; 357:370–379. [PubMed: 17652652] Christakis NA, Fowler JH. The collective dynamics of smoking in a large social network'. *New Engl J Med*. 2008; 358:2249–2258. [PubMed: 18499567] Jackson SE, Steptoe A, Wardle J. The Influence of Partner's Behavior on Health Behavior Change: The English Longitudinal Study of

- Ageing. JAMA IM. 2015; 175(3):385–392. Clark AE, Etile F. Don't give up on me baby: Spousal correlation in smoking behaviour. Journal of Health Economics. 2006; 25(5):958–978. [PubMed: 16542742] Di Castelnuovo A, Quacquarello G, Donati MB, de Gaetano G, Iacoviello L. Spousal Concordance or Major Coronary Risk Factors: A Systematic Review and Meta-Analysis. Am. J. Epidemiol. 2009; 169(1):1–8. [PubMed: 18845552] Meyler D, Stimpson JP, Peek MK. Health Concordance within couples: A systematic review. Social Science and Medicine. 2007; 64:2297–2310. [PubMed: 17374552]
6. US Surgeon General. US Department of Health and Human Services; 2006. The Health Consequences of Involuntary Exposure to Tobacco Smoke. <http://www.surgeongeneral.gov/library/secondhandsmoke/>
 7. Marmot, M., Wilkinson, RG. Social Determinants of Health. Oxford UK: Oxford University Press; p. 2005
 8. Jacobsen L. The family as producer of health – an extended grossman model. Journal of Health Economics. 2000; 19:611–637. [PubMed: 11184796] Currie J, Moretti E. Mother's education and the intergenerational transmission of human capital: evidence from college openings. Quarterly Journal of Economics. 2003; 118:1495–1532. Burton P, Lethbridge L, Phipps S. Children with disabilities and chronic conditions and longer-term parental health. The Journal of Socio-Economics. 2008; 37:1168–1186.
 9. Mathews C, Reus V. Assortative Mating in the affective disorders: A systematic review and meta-analysis. Comprehensive Psychiatry. 2001; 42(4):257–262. [PubMed: 11458299] Monden C. Partners in Health? Exploring resemblance in health between partners in married and cohabitating couples. Sociology of Health & Illness. 2007; 29(3):391–411. [PubMed: 17470218]
 10. Finkelstein A, Gentzkow M, Williams H. Sources of Geographic Variation in Health Care: Evidence from Patient Migration. The Quarterly Journal of Economics. 2016:1681–1726. [PubMed: 28111482]
 11. Glied S, Graff Zivin J. How do doctors behave when some (but not all) of their patients are in managed care? Journal of Health Economics. 2002; 21:337–353. [PubMed: 11939245]
 12. Keeler EB, Relles DA, Rolph JE. An Empirical Study of the Differences Between Family and Individual Deductibles in Health Insurance. Inquiry. 1977; 14(3):269–277. [PubMed: 143452]
 13. Newhouse, JP., the Insurance Experiment Group. Free for All? Lessons from the RAND Health Insurance Experiment. Cambridge, MA: Harvard University Press; 1993.
 14. Additional detail on these methods provided in Appendix.
 15. Wicks EK, Hall MA. Purchasing cooperatives for small employers: performance and prospects. Milbank Quarterly. 2000; 78:iii, 511–546.
 16. Jost TS. Health Insurance Exchanges and the Affordable Care Act: Key Policy Issues. The Commonwealth Fund. Jul.2010
 17. Buttorff, C., Nowak, SA., Syme, J., Eibner, C. Private Health Insurance Exchanges – Early Evidence and Implications for the Future. RAND Report. 2016. http://www.rand.org/content/dam/rand/pubs/research_reports/RR1100/RR1109/RAND_RR1109.pdf
 18. Dranove D, Spier KE, Baker L. 'Competition' Among employers offering health insurance. Journal of Health Economics. 2000; 19(1):121–140. [PubMed: 10947570]

Appendix

Implications of family risk pooling for individual health insurance markets

This Appendix provides additional detail describing the methods and results of sensitivity analyses conducted in the paper “Implications of family risk pooling for individual health insurance markets.”

Construction of measure of individual annual health spending

To construct our primary measure of annual health spending that is purged of the impact of health plan benefit design we first estimate a linear regression:

$$X_{n,\text{actual}} = \alpha_0 + \delta_p + \varepsilon_n$$

where $X_{n,\text{actual}}$ represents an individual's actual annual spending, and δ_p is a series of indicator variables for each health plan.

Using estimated coefficients from this regression we calculate predicted annual spending for each individual, $\widehat{X}_n$, that accounts for the portion of spending attributed to health plan effects.

We then subtract this component of spending from the individual's actual annual spending:

$$X_{n,\text{actual}} - \widehat{X}_n = X_n$$

to arrive at X_n , purged of plan effects and our measure of individual spending, which we call “individual total spending.”

Analyses of Within-family correlation in health spending

Analyses of variation in spending by types of pooling—We first calculate the standard deviation of individual total spending, X_n , which represents the setting where individuals choose plans independently and there is no pooling of individual-level spending across individuals. Next, we calculate the standard deviation of individual-level spending for the setting where individuals pool as real families to purchase insurance. To capture the effect of pooling we assign each individual within a given family the averaged spending among all members of that family. Thus, for all $n = 1, 2 \dots N$ individuals in a real family f :

$$X_{n,f} = \frac{\sum_{n=1}^N X_n}{N}$$

We assign all individuals $n = 1, 2 \dots N$ within the real family $X_{n,f}$ called “Family-averaged individual spending” and then estimate the standard deviation in the distribution of $X_{n,f}$. Note that summing $X_{n,f}$ across individuals in the family results in the same total health spending for the family, but reflects the fact that the heterogeneous risks across individuals within the family are pooled through their family-level insurance contract.

Meet the Sims: We also study the distribution of spending under two alternative scenarios: (1) where individuals pool in “random groups,” and (2) where individuals pool in simulated families we refer to as the “Sims.” Random groups consist of randomly associated individuals and, to identify the contribution of small group pooling on spending, are the same size as real families. To capture the effects of demographic composition within a family (e.g., age and gender) but not the endogenous sorting from assortative mating and

childbirth that generates real families, the Sims have both the same number of individuals *and* the same age and gender distributions as the real families.

We describe construction of these last two groups more formally. For every real family in the data we construct a corresponding group that matches the real family in number of individuals and is generated through random draw from among all individuals in the study sample with replacement. We call these groups “random groups.” For each individual $n = 1, 2, \dots, N$ in a random group rg , we define “random group-averaged individual spending” as

$$X_{n,rg} = \frac{\sum_{n=1}^N X_n}{N}$$

and assign each individual n this value, $X_{n,rg}$, to replace their actual (e.g., non-averaged) individual total spending. We then estimate the standard deviation in the distribution of $X_{n,rg}$. This process is repeated 5000 times through simulation.

For every real family in our sample we also construct a Sim family that matches the real family not only in the number of people in the family but also in the age and gender distribution of family members. We used stratified random sampling from our study sample with replacement. For example, to construct a Sim family to match a real family that includes a female age 32, male age 30, male age 6 and female age 4, we randomly selected a 32-year old female from among all 32-year old females in our sample, a 30-year old male from among all 30-year old males in our sample, etc. For each individual $n = 1, 2, \dots, N$ in a simulated family Sim , we define “simulated family-averaged individual spending” as:

$$X_{n,Sim} = \frac{\sum_{n=1}^N X_n}{N}$$

and assign each individual in the Sim family $X_{n,Sim}$ to replace their own actual (e.g., non-averaged) individual total spending. We estimate the standard deviation in the distribution of $X_{n,Sim}$ and repeat this process 5000 times through simulation.

Comparing the standard deviation in individual spending, family-averaged individual spending, random group-averaged individual spending, and simulated family-averaged individual spending measures how real family pooling affects the distribution of health spending relative to no pooling and to purely random associations.

Analysis of variation in spending across clinical categories

Health care spending can be decomposed into types of care (inpatient, outpatient or pharmaceuticals) and into Major Diagnostic Categories (MDC) -- clinical categories that divide all possible principal diagnoses into one of 25 mutually exclusive clinical areas. We combine these further to construct fifteen categories (Table A1). We assess how spending on each type of medical care, and across clinical categories, contributes to the variance in total spending for individuals versus real families.

More formally, for each type of medical care, let $X_n = X_{ip} + X_{op} + X_{rx}$ represent individual total spending which is the sum of inpatient (*ip*), outpatient (*op*), and prescription drug (*rx*) spending. The variance of X_n can be decomposed into the sum of variances and covariances. We estimate the following covariance matrix:

$$\begin{bmatrix} \text{Var}(X_{ip}) & \text{Cov}(X_{ip}, X_{op}) & \text{Cov}(X_{ip}, X_{rx}) \\ \text{Cov}(X_{ip}, X_{op}) & \text{Var}(X_{op}) & \text{Cov}(X_{op}, X_{rx}) \\ \text{Cov}(X_{ip}, X_{op}) & \text{Cov}(X_{op}, X_{rx}) & \text{Var}(X_{rx}) \end{bmatrix}$$

We then calculate the contribution of each component of the variance to the total variance. For Var_{ip} this is:

$$(\theta_{ip}) = \frac{\text{Var}(X_{ip})}{\text{Var}(X_n)}$$

The difference in variance in total spending under individual purchase of health insurance and under family pooling is

$$\Delta \text{Var}(X_n) = \text{Var}_{\text{ind}}(X_n) - \text{Var}_{\text{fam}}(X_n).$$

We identify the portion of $\text{Var}(X_n)$ that is due to the difference in the variance of each component under the different pooling regimes. For example, for inpatient spending we calculate the following:

$$\phi_{ip} = \frac{\text{Var}_{\text{ind}}(X_{ip}) - \text{Var}_{\text{fam}}(X_{ip})}{\Delta \text{Var}(X_n)}$$

Similarly, to determine the portion of the difference due to the change in the covariance of inpatient and outpatient spending we would calculate the following:

$$\phi_{ip,op} = \frac{\text{Cov}_{\text{ind}}(X_{ip}, X_{op}) - \text{Cov}_{\text{fam}}(X_{ip}, X_{op})}{\Delta \text{Var}(X_n)}$$

We then compare θ to ϕ for each type of medical spending (inpatient, outpatient, prescription drug) to assess whether the family pooling effect is disproportionately due to reduced variance in any particular type of spending.

We repeat the methods used for type of spending to assess whether the family pooling effect is disproportionately due reduced variance in any of our fifteen clinical category of spending.

Impact of Family Pooling – Results from Sensitivity Analyses

In our main results presented in Figure 2 in the paper, we find that family pooling reduces the variation of individual health spending for a population. In sensitivity analyses, we

assess whether the results vary across family composition by repeating the analysis above only including two-adult families, and then only including two-adult, two-child families.

Figure A2 presents results for two-adult families in the top panel, and two-adult, two-child families on the bottom. While the magnitudes of the standard deviation in health spending for two-adult families are much higher than those observed for the full-sample, a reflection of the fact that adults have significantly higher variance in health care spending than children, the result across pooling scenarios is the same. Spousal pooling results in a standard deviation in real family-averaged individual spending that is \$7328 smaller (equal to 0.29 standard deviations) than when all individuals purchase a health plan on their own, and is very similar to the standard deviation in random group-averaged individual spending and Sim family-averaged individual spending.

Among two-adult families with two children, the findings are again similar as those in the main analysis. The standard deviation of Sim family-averaged individual spending is \$7,144 and of random group-averaged individual spending is \$7,183, which are slightly lower (\$61 and \$22 respectively) than that of real family-averaged individual spending, \$7,205. Although these differences are statistically significant (again, a reflection of our large sample), random group and Sim family pooling represents only a very small incremental reduction in risk from a scenario of no pooling (equal to 0.01 standard deviations) than that achieved through real family pooling.

Table A1

Crosswalk MDC categories to clinical categories analyzed here

Diseases and Disorders of the Nervous System	-->	nervous system
Diseases and Disorders of the Eye	-->	eye, ear, nose, throat
Diseases and Disorders of the Ear, Nose, Mouth and Throat		
Diseases and Disorders of the Respiratory System	-->	respiratory
Diseases and Disorders of the Circulatory System	-->	circulatory system
Diseases and Disorders of the Digestive System	-->	digestive system, hepatobiliary
Diseases and Disorders of the Hepatobiliary System and Pancreas		
Diseases and Disorders of the Skin, Subcutaneous Tissue and Breast	-->	skin, subcutaneous, breast
Diseases and Disorders of the Musculoskeletal System and Connective Tissue	-->	musculoskeletal
Endocrine, Nutritional and Metabolic Diseases and Disorders	-->	endocrine
Diseases and Disorders of the Kidney and Urinary Tract		
Diseases and Disorders of the Male Reproductive System	-->	Kidney, urinary tract, reproductive system
Diseases and Disorders of the Female Reproductive System		
Pregnancy, Childbirth and the Puerperium		
Newborns and Other Neonates with Conditions Originating in Perinatal Period	-->	pregnancy, newborns
Diseases and Disorders of the Blood, Blood Forming Organs, Immunological Disorders		Blood, myeloproliferative diseases etc

Myeloproliferative Diseases and Disorders, Poorly Differentiated Neoplasm		
Mental Diseases and Disorders		
Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders	-->	Mental Health and Substance Abuse
Injuries, Poisonings and Toxic Effects of Drugs		
Burns	-->	injuries, burns, trauma
Multiple Significant Trauma		
Infectious and Parasitic Diseases, Systemic or Unspecified Sites	-->	infectious diseases, HIV
Human Immunodeficiency Virus Infections		
Factors Influencing Health Status and Other Contacts with Health Services	-->	other factors

Enrollees in two-adult insurance contracts **Enrollees in two-adult, two-child insurance contracts** **Figure A2.**

Standard deviation of within group-averaged individual health spending by family type

Source: Truven MarketScan 2013. Authors' analysis of enrollees in two-adult insurance contracts (N= 1,142,718), and enrollees in two-adult, two-child contracts (N= 2,217,163).

Notes: The bar for individual contracts displays the standard deviation in individual health spending treating study sample as enrolling in a separate health plan (e.g., no pooling). The bars for Real families, The Sims, and Random groups display the standard deviation in the distribution of within group-averaged individual health spending. Difference between

random groups and real families is statistically significant $p < 0.01$. Differences between the Sims and real families is statistically significant $p < 0.01$.

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Figure 1.

Individual vs family-averaged individual total spending

Source: Truven MarketScan 2013. Author's analysis of 200 randomly selected members of full study sample.

Figure 2.

Standard deviation of within group-averaged individual health spending

Source: Truven MarketScan 2013. Authors' analysis of full study sample (N= 8,927,918).

Notes: The bar for individual contracts displays the standard deviation in individual health spending treating study sample as enrolling in a separate health plan (e.g., no pooling). The bars for Real families, The Sims, and Random groups display the standard deviation in the distribution of group-averaged individual health spending. Difference between random groups and real families is statistically significant $p < 0.01$. Differences between the Sims and real families is statistically significant $p < 0.01$.

Table 1**Characteristics of Individuals and Families**

<i>Individuals (N=8,927,918)</i>		
Average Age	34	
Age Group		
0–5 yrs	7%	
6–17 yrs	19%	
18–24 yrs	11%	
25–34 yrs	11%	
35–44 yrs	17%	
45–54 yrs	20%	
55–64 yrs	16 %	
Percent Female	51 %	
Region		
Northeast	17%	
North Central	27%	
South	39%	
West	17%	
<i>Families (N=3,965,437)</i>		
Average Family Size	2.3	
Intraclass Correlation		
Coefficient individual percentile of health spending within family	0.26	
Family Type		Average annual spending per person
Single	43%	\$5,851
2 adults	14%	\$8,313
1 adult + children	12%	\$3,611
1 adult + 1 child	6%	\$4,362
1 adult + 2 children	4%	\$3,294
1 adult + 3+ children	2%	\$2,810
2 adults + kids	31%	\$4,027
2 adults + 1 child	9%	\$5,395
2 adults + 2 children	14%	\$3,874
2 adults + 3+ children	8%	\$3,310

Notes: For 0.17% of individuals region is unknown.

Table 2

Decomposition of Variance reduction by Spending Type and Category

	All Individual contracts	Real families	Difference between Individual variance and family pooling variance
Total Variance	\$375,033,536	\$167,421,605	\$207,611,931
Panel A - By Type of Spending			
<i>Percent of total:</i>			
Inpatient	38.7%	37.4%	39.8%
Outpatient	30.6%	31.9%	29.5%
Rx	9.5%	8.2%	10.6%
All covariances	21.2%	22.4%	20.2%
Panel B - By Clinical Category			
<i>Percent of total:</i>			
Blood, Myeloproliferative	10.0%	9.3%	10.6%
Musculoskeletal	8.5%	8.6%	8.3%
Circulatory System	8.5%	8.7%	8.3%
Kidney, Urinary Tract, Reproductive System	8.0%	8.8%	7.4%
Digestive System, Hepatobiliary	5.6%	5.6%	5.6%
Nervous System	5.1%	4.7%	5.4%
Respiratory	4.1%	3.8%	4.4%
Skin, Subcutaneous, Breast	2.4%	2.4%	2.4%
Infectious Diseases, HIV	2.3%	2.3%	2.3%
Pregnancy, Newborns	1.8%	1.8%	1.9%
Injuries, Burns, Trauma	1.8%	1.6%	1.9%
Endocrine	1.5%	1.5%	1.6%
Mental Health/Substance Abuse	1.3%	1.0%	1.5%
Eye, Ear, Nose, Throat	1.0%	1.0%	1.1%
Other Factors	1.0%	1.0%	1.0%
All covariances:	37.1%	37.9%	36.4%

Source: Authors' analysis of Truven MarketScan data, 2013