































the age coefficients. Even conditional on health, older people exhibit lower levels of consistency with economic rationality in the experiment.

## 6 Conclusion

Social science has documented that older people have lower levels of several cognitive skills. Some of these skills are likely important for making sound spending, saving, insurance, or health choices. Indeed, our prior work (Choi et al, 2014) showed that older people exhibit lower levels of economic rationality in a simple, incentivized choice experiment. In this way, we found evidence that older people are less able (or willing) to make choices consistent with any stable objective.

In this paper, we used a new dataset to investigate the sources of the correlation between age and economic rationality. In the new data, we replicate the qualitative relationship observed in the previous work. Older people have lower levels of economic rationality and these differences are both statistically and economically significant.

The findings suggest that the decline in economic rationality with age is a true age effect, not a cohort effect. We find no evidence that the lower levels of decisionmaking quality among older people are due to their disproportionate difficulties with the computer interface used in the experiment. In this way, the findings indicate that the relatively lower levels of decisionmaking quality among older people should be expected to persist.

Similarly, we find no evidence that the decline in economic rationality in the experiment is explained by more general forms of cognitive decline. Thus, the findings indicate that the lower decisionmaking quality among older people is not a simple consequence of declines in general forms of cognitive ability. Finally, we find no evidence that the lower average levels of cognitive ability in older people is concentrated among those who have experienced important declines in physical health. Certainly older people are in worse health, but we find no evidence that this explains why they exhibit lower levels of rationality in the experiment.

Taken together the results indicate that economic decisionmaking quality declines with normal aging and this is distinct phenomenon from other forms of cognitive decline with age. The evidence thus suggests that there is something distinct about financial decision making ability that declines in older ages. If older people make different choices from younger ones or from what a normative theory would suggest, it follows that additional scrutiny is justified. The evidence presented here suggests it is less likely to be ex-

clusively a matter of special tastes among the elderly. Instead, the results presented here suggest analysts should give more credence to the possibility that diminished capacities to understand and make effective economic tradeoffs are influencing choices in older population. It follows that policymakers and market participants that are concerned with the welfare of older people should focus more attention on assuring that products and markets are designed to that the elderly have same effective opportunities as younger populations.

## References

- [1] Abaluck, J. and Jonathan Gruber (2011) “Choice Inconsistencies among the Elderly: Evidence from Plan Choice in the Medicare Part D Program.” *American Economic Review*, 101(4), 1180-1210.
- [2] Afriat, S. (1967) “The Construction of a Utility Function from Expenditure Data.” *Econometrica*, 6, pp. 67-77.
- [3] Afriat, S. (1972) “Efficiency Estimates of Production Functions.” *International Economic Review*, 8, pp. 568-598.
- [4] Afriat, S. (2012) “Afriat’s Theorem and the Index Number Problem.” *The Economic Journal*, 122, pp. 295-304.
- [5] Agarwal, S., J. Driscoll, X. Gabaix and D. Laibson (2009) “The Age of Reason: Financial Decisions over the Life-Cycle with Implications for Regulation.” *Brookings Papers on Economic Activity*, 2, pp. 51-117.
- [6] Ameriks, J., A. Caplin and J. Leahy (2003) “Wealth Accumulation and the Propensity to Plan.” *Quarterly Journal of Economics*, 118, pp. 1007-1047.
- [7] Banks, J. (2010) “Cognitive Function, Financial Literacy and Financial Outcomes at Older Ages: Introduction.” *Economic Journal*, 120, pp. 357-362.
- [8] Bernheim, D. and D. Garrett (2003) “The Effects of Financial Education in the Workplace: Evidence from a Survey of Households.” *Journal of Public Economics*, 87, pp. 1487-1519.
- [9] Bernheim, D. and A. Rangel (2008) “Choice-Theoretic Foundations for Behavioral Welfare Economics.” In *The Foundations of Positive and*



*Normative Economics*, ed. A. Caplin and A. Schotter. Oxford University Press.

- [10] Bernheim, D. and A. Rangel (2009) “Beyond Revealed Preference: Theoretic Foundations for Behavioral Economics.” *Quarterly Journal of Economics*, 124, pp. 51-104.
- [11] Camerer, C., S. Issacharoff, G. Loewenstein, T. O’Donoghue and M. Rabin (2003) “Regulation for Conservatives: Behavioral Economics and the Case for Asymmetric Paternalism.” *University of Pennsylvania Law Review*, 151, pp. 1211-1254.
- [12] Choi, J., D. Laibson and B. Madrian (2004) “Plan Design and 401(k) Savings Outcomes.” *National Tax Journal*, 57, pp. 275-298.
- [13] Choi S., R. Fisman, D. Gale and S. Kariv (2007a) “Revealing Preferences Graphically: An Old Method Gets a New Tool Kit,” *American Economic Review Papers & Proceedings*, 97, pp. 153-158.
- [14] Choi S., R. Fisman, D. Gale and S. Kariv (2007b) “Consistency and Heterogeneity of Individual Behavior under Uncertainty.” *American Economic Review*, 97, pp. 1921-1938.
- [15] Choi S., S. Kariv, W. Müller and D. Silverman (2014) “Who Is (More) Rational?” *American Economic Review*, 104(6), 1518-50.
- [16] Cole, S. and G. Shastry (2009) “Smart Money: The Effect of Education, Cognitive Ability, and Financial Literacy on Financial Market Participation.” Harvard Business School Finance Working Paper No. 09-071.
- [17] Diewert, W (2012) “Afriat’s Theorem and some Extensions to Choice under Uncertainty.” *The Economic Journal*, 122, pp. 305-331.
- [18] Dohmen, T., A. Falk, D. Huffman and U. Sunde (2010) “Are Risk Aversion and Impatience Related to Cognitive Ability?” *American Economic Review*, 100, pp. 1238-1260.
- [19] Duflo, E. and E. Saez (2003) “The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence From a Randomized Experiment.” *Quarterly Journal of Economics*, 118, pp. 815-842.
- [20] Echenique, F., S. Lee and M. Shum (2011) “The Money Pump as a Measure of Revealed Preference Violations.” *Journal of Political Economy* 119, pp. 1201-1223.

- [21] Fang, H., M. Keane and D. Silverman (2008) "Sources of Advantageous Selection: Evidence from the Medigap Insurance Market." *Journal of Political Economy*, 116(2), pp. 303-350.
- [22] Fisman R., S. Kariv and D. Markovits, (2007) "Individual Preferences for Giving." *American Economic Review*, 97, pp. 1858-1876.
- [23] Hadar, J. and W. Russell (1969) "Rules for Ordering Uncertain Prospects." *American Economic Review*, 59, pp. 25-34.
- [24] Heiss, F., D. McFadden and J. Winter (2010) "Mind the Gap! Consumer Perceptions and Choices of Medicare Part D Prescription Drug Plans," in David A. Wise (ed.) *Research Findings in the Economics of Aging*, NBER, University of Chicago Press, pages 413 - 481.
- [25] Houtman, M. and J. Maks (1985) "Determining all Maximial Data Subsets Consistent with Revealed Preference." *Kwantitatieve Methoden*, 19, pp. 89-104.
- [26] Levitt, S. and J. List (2007) "What do Laboratory Experiments Tell Us About the Real World?" *Journal of Economic Perspectives*, 21, pp. 153-174.
- [27] Loewenstein, G. and E. Haisley (2008) "The Economist as Therapist: Methodological Ramifications of "Light" Paternalism." In *The Foundations of Positive and Normative Economics*, ed. A. Caplin and A. Schotter. Oxford University Press.
- [28] Lusardi, A. and O. Mitchell (2007) "Baby Boomer Retirement Security: The Roles of Planning, Financial Literacy, and Housing Wealth." *Journal of Monetary Economics*, 54, pp. 205-224.
- [29] Madrian, B. and D. Shea (2001) "The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior." *Quarterly Journal of Economics*, 116, pp. 1149-1525.
- [30] Manski, C. (1995) "Identification Problems in the Social Sciences." Cambridge: Harvard University Press.
- [31] McArdle, John J.; Ferrer-Caja, Emilio; Hamagami, Fumiaki; Woodcock, Richard W. (2002). *Developmental Psychology*, Vol 38(1), Jan, 115-142.

- [32] McFadden, D., J. Winter and F. Heiss (2008) "Consumer-Directed Health Care: Can Consumers Look After Themselves?" *Swiss Journal of Economics and Statistics*, 144(III), pp. 285-307.
- [33] Rohwedder, Susann, and Robert J. Willis (2010). "Mental Retirement" *Journal of Economic Perspectives*, 24(1): 119-38.
- [34] Samuelson, P. (1947) *Foundations of Economic Analysis*. Cambridge: Harvard University Press.
- [35] Smith, J., J. McArdle and R. Willis (2010) "Financial Decision Making and Cognition in a Family Context." *Economic Journal*, 120, pp. 363-380.
- [36] Thaler, R. and S. Benartzi (2004) "Save More Tomorrow: Using Behavioral Economics to Increase Employee Savings." *Journal of Political Economy*, 112, pp. 164-187.
- [37] Thaler, R. and C. Sunstein (2003) "Libertarian Paternalism." *American Economic Review*, Papers & Proceedings, 93, pp. 175-179.
- [38] Varian, H. (1982) "The Nonparametric Approach to Demand Analysis." *Econometrica*, 50, pp. 945-972.
- [39] Varian, H. (1983) "Non-Parametric Tests of Consumer Behaviour." *Review of Economic Studies*, 50, pp. 99-110.
- [40] Varian, H. (1990) "Goodness-of-Fit in Optimizing Models." *Journal of Econometrics*, 46, pp. 125-140.
- [41] Varian, H. (1991) "Goodness-of-Fit for Revealed Preference Tests." Mimeo.
- [42] Varian, H. (2012) "Revealed Preference and its Applications." *The Economic Journal*, 122, pp. 332-338.
- [43] Vermeulen, F. (2012) "Foundations of Revealed Preference: Introduction." *The Economic Journal*, 122, pp. 287-294.
- [44] Willis, R. J. (2007) "Cognitive Economics and Human Capital." Presidential Address to the Society of Labor Economists. Chicago, IL.

## 7 Figures and Tables

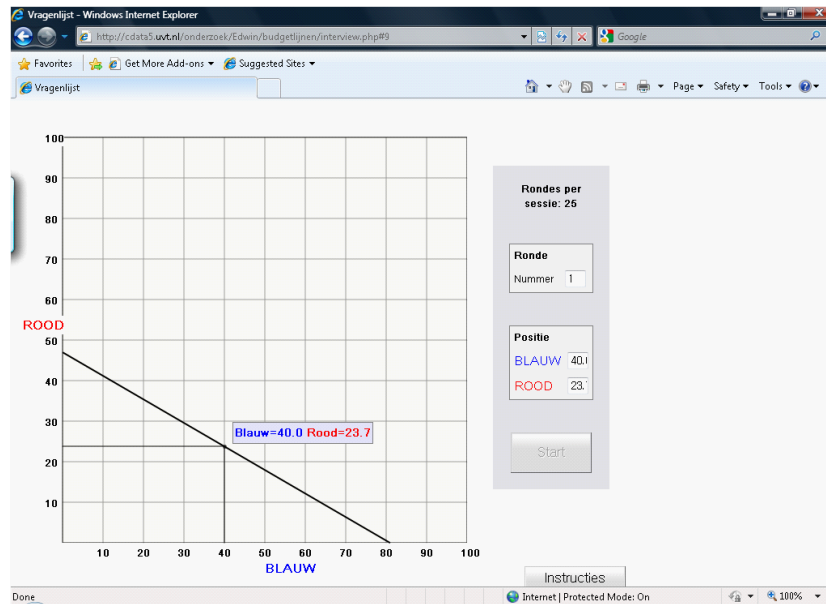


Figure 1: Example of the Experimental Interface

Table 1. Socio-demographic information

|                                 | Percent |
|---------------------------------|---------|
| Female                          | 53.20   |
| Age                             |         |
| 16-23                           | 11.71   |
| 24-35                           | 17.09   |
| 36-50                           | 25.53   |
| 51-63                           | 23.37   |
| 64-71                           | 13.37   |
| 72+                             | 8.94    |
| Education                       |         |
| Primary school                  | 8.82    |
| Intermediate vocational ed.     | 23.77   |
| Intermediate secondary ed.      | 22.36   |
| Higher vocational ed.           | 22.48   |
| Higher secondary ed.            | 12.45   |
| University degree               | 10.12   |
| Individual gross monthly income |         |
| €0-900                          | 25.35   |
| €901-1805                       | 24.60   |
| €1806-2835                      | 25.12   |
| €2835+                          | 24.94   |
| Occupation                      |         |
| Paid work                       | 51.54   |
| House work                      | 7.04    |
| Disabled                        | 4.04    |
| Retired                         | 18.03   |
| Others                          | 19.35   |
| Household composition           |         |
| Partner                         | 70.50   |
| # of kids                       | 0.84    |
| # of obs.                       | 4160    |

Table 2A. CCEI scores

|                                 | Mean  | Sd    | Percentiles |       |       |       |       | # of obs. |
|---------------------------------|-------|-------|-------------|-------|-------|-------|-------|-----------|
|                                 |       |       | 10          | 25    | 50    | 75    | 90    |           |
| All                             | 0.870 | 0.142 | 0.668       | 0.792 | 0.913 | 0.992 | 1.000 | 4,160     |
| Female                          | 0.867 | 0.144 | 0.664       | 0.790 | 0.912 | 0.992 | 1.000 | 2,213     |
| Age                             |       |       |             |       |       |       |       |           |
| 16-23                           | 0.869 | 0.139 | 0.656       | 0.802 | 0.912 | 0.988 | 1.000 | 487       |
| 24-35                           | 0.874 | 0.132 | 0.679       | 0.787 | 0.914 | 0.992 | 1.000 | 711       |
| 36-50                           | 0.874 | 0.141 | 0.670       | 0.798 | 0.921 | 0.995 | 1.000 | 1,062     |
| 51-63                           | 0.871 | 0.145 | 0.673       | 0.794 | 0.918 | 0.994 | 1.000 | 972       |
| 64-71                           | 0.854 | 0.148 | 0.652       | 0.770 | 0.890 | 0.985 | 1.000 | 556       |
| 72+                             | 0.867 | 0.144 | 0.663       | 0.793 | 0.911 | 0.990 | 1.000 | 372       |
| Education                       |       |       |             |       |       |       |       |           |
| Primary school                  | 0.866 | 0.150 | 0.663       | 0.789 | 0.909 | 0.995 | 1.000 | 367       |
| Intermediate vocational ed      | 0.870 | 0.138 | 0.669       | 0.794 | 0.910 | 0.991 | 1.000 | 989       |
| Intermediate secondary ed       | 0.867 | 0.142 | 0.673       | 0.792 | 0.908 | 0.990 | 1.000 | 930       |
| Higher vocational ed.           | 0.874 | 0.137 | 0.684       | 0.794 | 0.914 | 0.991 | 1.000 | 935       |
| Higher secondary ed.            | 0.866 | 0.154 | 0.637       | 0.787 | 0.919 | 0.995 | 1.000 | 518       |
| University degree               | 0.873 | 0.135 | 0.677       | 0.780 | 0.918 | 0.996 | 1.000 | 421       |
| Individual gross monthly income |       |       |             |       |       |       |       |           |
| €0-900                          | 0.873 | 0.140 | 0.673       | 0.805 | 0.916 | 0.993 | 1.000 | 631       |
| €901-1805                       | 0.860 | 0.147 | 0.647       | 0.781 | 0.911 | 0.990 | 1.000 | 458       |
| €1 806-2835                     | 0.874 | 0.136 | 0.661       | 0.794 | 0.919 | 0.992 | 1.000 | 579       |
| €2835+                          | 0.869 | 0.145 | 0.664       | 0.787 | 0.910 | 0.995 | 1.000 | 768       |
| Occupation                      |       |       |             |       |       |       |       |           |
| Paid work                       | 0.872 | 0.139 | 0.674       | 0.794 | 0.915 | 0.993 | 1.000 | 2,144     |
| House work                      | 0.870 | 0.144 | 0.674       | 0.798 | 0.918 | 0.994 | 1.000 | 293       |
| Disabled                        | 0.845 | 0.160 | 0.621       | 0.764 | 0.883 | 0.987 | 1.000 | 168       |
| Retired                         | 0.867 | 0.145 | 0.657       | 0.791 | 0.910 | 0.989 | 1.000 | 750       |
| Others                          | 0.870 | 0.140 | 0.667       | 0.788 | 0.916 | 0.993 | 1.000 | 805       |

Table 2B. MPI scores

|                                 | Mean  | Sd    | Percentiles |       |       |       |       | # of obs. |
|---------------------------------|-------|-------|-------------|-------|-------|-------|-------|-----------|
|                                 |       |       | 10          | 25    | 50    | 75    | 90    |           |
| All                             | 0.880 | 0.160 | 0.638       | 0.809 | 0.957 | 0.998 | 1.000 | 4,160     |
| Female                          | 0.877 | 0.163 | 0.636       | 0.807 | 0.955 | 0.998 | 1.000 | 2,213     |
| Age                             |       |       |             |       |       |       |       |           |
| 16-23                           | 0.884 | 0.155 | 0.640       | 0.818 | 0.957 | 0.997 | 1.000 | 487       |
| 24-35                           | 0.881 | 0.154 | 0.643       | 0.796 | 0.958 | 0.998 | 1.000 | 711       |
| 36-50                           | 0.887 | 0.155 | 0.647       | 0.821 | 0.963 | 0.999 | 1.000 | 1,062     |
| 51-63                           | 0.881 | 0.162 | 0.641       | 0.815 | 0.959 | 0.999 | 1.000 | 972       |
| 64-71                           | 0.862 | 0.173 | 0.612       | 0.789 | 0.933 | 0.995 | 1.000 | 556       |
| 72+                             | 0.876 | 0.169 | 0.633       | 0.804 | 0.953 | 0.997 | 1.000 | 372       |
| Education                       |       |       |             |       |       |       |       |           |
| Primary school                  | 0.872 | 0.176 | 0.607       | 0.804 | 0.948 | 0.999 | 1.000 | 367       |
| Intermediate vocation           | 0.881 | 0.154 | 0.637       | 0.809 | 0.953 | 0.997 | 1.000 | 989       |
| Intermediate seconda            | 0.878 | 0.161 | 0.650       | 0.807 | 0.950 | 0.998 | 1.000 | 930       |
| Higher vocational ed.           | 0.883 | 0.159 | 0.639       | 0.813 | 0.961 | 0.998 | 1.000 | 935       |
| Higher secondary ed.            | 0.879 | 0.168 | 0.609       | 0.814 | 0.958 | 0.999 | 1.000 | 518       |
| University degree               | 0.885 | 0.155 | 0.648       | 0.802 | 0.962 | 0.999 | 1.000 | 421       |
| Individual gross monthly income |       |       |             |       |       |       |       |           |
| €0-900                          | 0.888 | 0.152 | 0.653       | 0.818 | 0.964 | 0.998 | 1.000 | 631       |
| €901-1805                       | 0.872 | 0.165 | 0.607       | 0.790 | 0.952 | 0.997 | 1.000 | 458       |
| €1806-2835                      | 0.884 | 0.152 | 0.647       | 0.816 | 0.955 | 0.998 | 1.000 | 579       |
| €2835+                          | 0.881 | 0.160 | 0.632       | 0.803 | 0.959 | 0.999 | 1.000 | 768       |
| Occupation                      |       |       |             |       |       |       |       |           |
| Paid work                       | 0.884 | 0.155 | 0.647       | 0.815 | 0.959 | 0.998 | 1.000 | 2,144     |
| House work                      | 0.874 | 0.164 | 0.634       | 0.798 | 0.951 | 0.998 | 1.000 | 293       |
| Disabled                        | 0.839 | 0.191 | 0.562       | 0.717 | 0.922 | 0.996 | 1.000 | 168       |
| Retired                         | 0.877 | 0.166 | 0.636       | 0.814 | 0.955 | 0.997 | 1.000 | 750       |
| Others                          | 0.882 | 0.161 | 0.638       | 0.817 | 0.959 | 0.998 | 1.000 | 805       |

Table 3. The correlation between rationality scores and age

|                        | (1)                | (2)                  | (3)                 | (4)                  |
|------------------------|--------------------|----------------------|---------------------|----------------------|
|                        | CCEI               | CCEI                 | MPI                 | MPI                  |
| Constant               | .868***<br>(.007)  | .861***<br>(.011)    | 0.885***<br>(0.007) | .870***<br>(.013)    |
| Age                    |                    |                      |                     |                      |
| 24-35                  | 0.004<br>(.008)    | 0.005<br>(0.010)     | -0.005<br>(0.009)   | -0.003<br>(0.011)    |
| 36-50                  | 0.006<br>(.011)    | 0.008<br>(0.010)     | 0.001<br>(0.009)    | 0.003<br>(0.011)     |
| 51-63                  | 0.002<br>(.011)    | 0.004<br>(0.010)     | -0.005<br>(0.009)   | -0.001<br>(0.011)    |
| 64-71                  | -0.015*<br>(0.009) | -0.038***<br>(0.014) | -0.026**<br>(0.010) | -0.050***<br>(0.017) |
| 72+                    | -0.001<br>(0.010)  | -0.025*<br>(0.015)   | -0.008<br>(0.011)   | -0.034*<br>(0.018)   |
| Socioeconomic controls | no                 | yes                  | no                  | yes                  |
| $R^2$                  | 0.0021             | 0.0079               | 0.0027              | 0.0111               |
| # of obs.              | 3,910              | 3,910                | 3,910               | 3,910                |

OLS estimates with the omitted age category being those from 16-23. Socioeconomic controls include indicators for gender, employment statuses, and completed education levels, as well as levels of individual income and the number of children in the household. Standard errors, robust to heteroskedasticity, are in parentheses. \*, \*\*, \*\*\* indicate 10, 5, 1 percent significance levels, respectively.



Table 4. Evaluation a Cohort Effect:  
the correlation between rationality scores, age, and performance on a target task

|                            | (1)                  | (2)                  | (3)                 | (4)                | (5)                 | (6)                |
|----------------------------|----------------------|----------------------|---------------------|--------------------|---------------------|--------------------|
|                            | CCEI                 | MPI                  | CCEI                | MPI                | CCEI                | MPI                |
| Constant                   | .861***<br>(.011)    | .870***<br>(.013)    | 0.865***<br>(0.014) | .870***<br>(.017)  | 0.868***<br>(0.015) | .874***<br>(.017)  |
| Age                        |                      |                      |                     |                    |                     |                    |
| 24-35                      | 0.005<br>(0.010)     | -0.003<br>(0.011)    | 0.011<br>(0.014)    | 0.020<br>(0.015)   | 0.010<br>(0.014)    | 0.019<br>(0.015)   |
| 36-50                      | 0.008<br>(0.010)     | 0.003<br>(0.011)     | 0.006<br>(0.013)    | 0.016<br>(0.014)   | 0.006<br>(0.013)    | 0.016<br>(0.014)   |
| 51-63                      | 0.004<br>(0.010)     | -0.001<br>(0.011)    | 0.003<br>(0.013)    | 0.009<br>(0.014)   | 0.004<br>(0.013)    | 0.010<br>(0.014)   |
| 64-71                      | -0.038***<br>(0.014) | -0.050***<br>(0.017) | -0.033*<br>(0.019)  | -0.037*<br>(0.022) | -0.032*<br>(0.019)  | -0.036*<br>(0.022) |
| 72+                        | -0.025*<br>(0.015)   | -0.034*<br>(0.018)   | -0.029<br>(0.020)   | -0.030<br>(0.023)  | -0.027<br>(0.020)   | -0.027<br>(0.024)  |
| I(Missed the target)       |                      |                      |                     |                    | 0.002<br>(0.012)    | 0.009<br>(0.013)   |
| Size of miss (# of points) |                      |                      |                     |                    | -0.001<br>(0.001)   | -0.001*<br>(0.001) |
| Socioeconomic controls     | yes                  | yes                  | yes                 | yes                | yes                 | yes                |
| $R^2$                      | 0.0079               | 0.0111               | 0.0125              | 0.0143             | 0.0134              | 0.0163             |
| # of obs.                  | 3,910                | 3,910                | 2,374               | 2,374              | 2,374               | 2,374              |

OLS estimates with the omitted age category being those from 16-23. Soc ioeconomic controls include indicators for gender, employment statuses, and completed education levels, as well as levels of individual income and the number of children in the household. Columns 5 and 6 include controls for whether, in a separate round, the participant failed to choose a specific target bundle and, if so, by how many points did she miss the target. Standard errors, robust to heteroskedasticity, are in parentheses. \*, \*\*, \*\*\* indicate 10, 5, 1 percent significance levels, respectively.

Table 5. The Role of General Cognitive Decline:  
the correlation between rationality scores, age, and performance on Raven's Matrices

|                              | (1)                  | (2)                  | (3)                 | (4)               | (5)                 | (6)                |
|------------------------------|----------------------|----------------------|---------------------|-------------------|---------------------|--------------------|
|                              | CCEI                 | MPI                  | CCEI                | MPI               | CCEI                | MPI                |
| Constant                     | .861***<br>(.011)    | .870***<br>(.013)    | 0.851***<br>(0.018) | .861***<br>(.021) | 0.848***<br>(0.020) | .854***<br>(.024)  |
| Age                          |                      |                      |                     |                   |                     |                    |
| 24-35                        | 0.005<br>(0.010)     | -0.003<br>(0.011)    | 0.013<br>(0.016)    | 0.019<br>(0.018)  | 0.014<br>(0.016)    | 0.019<br>(0.018)   |
| 36-50                        | 0.008<br>(0.010)     | 0.003<br>(0.011)     | 0.014<br>(0.015)    | 0.024<br>(0.016)  | 0.014<br>(0.016)    | 0.025<br>(0.017)   |
| 51-63                        | 0.004<br>(0.010)     | -0.001<br>(0.011)    | 0.020<br>(0.016)    | 0.025<br>(0.017)  | 0.021<br>(0.016)    | 0.027<br>(0.017)   |
| 64-71                        | -0.038***<br>(0.014) | -0.050***<br>(0.017) | -0.027<br>(0.023)   | -0.031<br>(0.027) | -0.026<br>(0.024)   | -0.029<br>(0.027)  |
| 72+                          | -0.025*<br>(0.015)   | -0.034*<br>(0.018)   | -0.016<br>(0.025)   | -0.022<br>(0.029) | -0.014<br>(0.025)   | -0.019<br>(0.029)  |
| Score on Raven's Test (0-20) |                      |                      |                     |                   | 0.0004<br>(0.0010)  | 0.0007<br>(0.0012) |
| Socioeconomic controls       | yes                  | yes                  | yes                 | yes               | yes                 | yes                |
| $R^2$                        | 0.0079               | 0.0111               | 0.0118              | 0.0136            | 0.0118              | 0.0138             |
| # of obs.                    | 3,910                | 3,910                | 1,698               | 1,698             | 1,698               | 1,698              |

OLS estimates with the omitted age category being those from 16-23. Socioeconomic controls include indicators for gender, employment statuses, and completed education levels, as well as levels of individual income and the number of children in the household. Standard errors, robust to heteroskedasticity, are in parentheses. \*, \*\*, \*\*\* indicate 10, 5, 1 percent significance levels, respectively.

Table 6. The Role of Declining Health:  
the correlation between rationality scores, age, and health

|                        | (1)                  | (2)                  | (3)                 | (4)                 | (5)                 | (6)                 |
|------------------------|----------------------|----------------------|---------------------|---------------------|---------------------|---------------------|
|                        | CCEI                 | MPI                  | CCEI                | MPI                 | CCEI                | MPI                 |
| Constant               | .861***<br>(.011)    | .870***<br>(.013)    | 0.849***<br>(0.014) | .862***<br>(.016)   | 0.893***<br>(0.021) | .926***<br>(.024)   |
| Age                    |                      |                      |                     |                     |                     |                     |
| 24-35                  | 0.005<br>(0.010)     | -0.003<br>(0.011)    | 0.014<br>(0.013)    | 0.004<br>(0.014)    | 0.015<br>(0.013)    | 0.005<br>(0.014)    |
| 36-50                  | 0.008<br>(0.010)     | 0.003<br>(0.011)     | 0.014<br>(0.012)    | 0.007<br>(0.014)    | 0.015<br>(0.012)    | 0.008<br>(0.014)    |
| 51-63                  | 0.004<br>(0.010)     | -0.001<br>(0.011)    | 0.014<br>(0.012)    | 0.008<br>(0.013)    | 0.014<br>(0.012)    | 0.009<br>(0.013)    |
| 64-71                  | -0.038***<br>(0.014) | -0.050***<br>(0.017) | -0.034**<br>(0.016) | -0.049**<br>(0.020) | -0.033**<br>(0.016) | -0.047**<br>(0.020) |
| 72+                    | -0.025*<br>(0.015)   | -0.034*<br>(0.018)   | -0.020<br>(0.018)   | -0.035*<br>(0.021)  | -0.019<br>(0.018)   | -0.033<br>(0.021)   |
| Health controls        | no                   | no                   | no                  | no                  | yes                 | yes                 |
| Socioeconomic controls | yes                  | yes                  | yes                 | yes                 | yes                 | yes                 |
| $R^2$                  | 0.0079               | 0.0111               | 0.0107              | 0.0125              | 0.0164              | 0.0198              |
| # of obs.              | 3,910                | 3,910                | 2,762               | 2,762               | 2,762               | 2,762               |

OLS estimates with the omitted age category being those from 16-23. Health controls include indicators for poor and good self-reported health (very good or excellent health category omitted), and for having a chronic ailment. Health controls also include the number of (i)adls with which the respondent has difficulty and a measure of body mass index. Socioeconomic controls include indicators for gender, employment statuses, and completed education levels, as well as levels of individual income and the number of children in the household. Standard errors, robust to heteroskedasticity, are in parentheses. \*, \*\*, \*\*\* indicate 10, 5, 1 percent significance levels, respectively.

## 8 Appendix: Testing for Consistency with GARP

### I. Afriat's (1967) Theorem

Let  $\{(p^i, x^i)\}_{i=1}^{25}$  be the data generated by a participant's choices, where  $p^i$  is the  $i$ -th observation of prices and  $x^i$  is the associated choice. An allocation  $x^i$  is *directly revealed preferred* to an allocation  $x^j$ , denoted  $x^i R^D x^j$ , if  $p^i \cdot x^i \geq p^i \cdot x^j$ . An allocation  $x^i$  is *revealed preferred* to  $x^j$ , denoted  $x^i R x^j$ , if there exists a sequence of allocations  $\{x^k\}_{k=1}^K$  with  $x^1 = x^i$  and  $x^K = x^j$ , such that  $x^k R^D x^{k+1}$  for every  $k = 1, \dots, K - 1$ .

The Generalized Axiom of Revealed Preference (GARP) requires that if  $x^i R x^j$  then  $p^j \cdot x^j \leq p^j \cdot x^i$ ; that is, if  $x^i$  is revealed preferred to  $x^j$ , then  $x^i$  must cost at least as much as  $x^j$  given the prices when  $x^j$  is chosen. If the data are generated by a non-satiated utility function, then they satisfy GARP. Conversely, Afriat (1967) shows us that if a finite data set of choices satisfies GARP, then the data can be rationalized by a utility function.

**Afriat's (1967) Theorem** If the data set  $\{(p^i, x^i)\}$  satisfies GARP, then there exists a piecewise linear, continuous, increasing, concave utility function  $u(x)$  such that for each observation  $(p^i, x^i)$   $u(x) \leq u(x^i)$  for any  $x$  such that  $p^i \cdot x \leq p^i \cdot x^i$ .

This statement of the theorem is due to Varian (1982, 1983), who replaced the condition Afriat called *cyclical consistency* with GARP. Note that satisfying GARP entails only that choices are consistent with utility maximization. The implication that choices may be rationalized by a well-behaved utility function is a consequence of linear budget lines. When the budget constraints are linear, if any utility function can represent the choices, then a well-behaved one can too.

### II. Goodness-of-fit

GARP offers an exact test. Choice data either satisfy the axiom, or they do not. It is therefore useful to measure the *extent* of GARP violations. This paper reports measures of GARP violations based on two indices: Afriat's (1972) critical cost efficiency index (CCEI), and Echinique et al.'s (2011) money pump index.

**Afriat (1972)** The CCEI measures the amount by which each budget constraint must be adjusted in order to remove all violations of GARP. For any number  $0 \leq e \leq 1$ , define the direct revealed preference relation  $R^D(e)$  as

$$x^i R^D(e) x^j \iff e p^i \cdot x^i \geq p^i \cdot x^j,$$











