Heterogeneity, Demand for Insurance and Adverse Selection
WEB APPENDICES

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1 Web Appendix A: Discrete Distributions

The results analyzed in Section 2 extend for general distributions. I illustrate this by introducing two variations that change the perceived values relative to the actual values for any two types in a finite population $\vartheta = \{\zeta_1, \zeta_2, ..., \zeta_N\}$.

The first variation captures a reduction in the correlation between perceived and true values by making a type who has a higher actual value perceive her value as lower than another type.

Definition 1 *$\hat{v}$ is a confound of v if for some pairs of individuals characterized by ζ_x, ζ_y with $v(\zeta_x) < v(\zeta_y) : \hat{v}(\zeta_x) = v(\zeta_x) + \varepsilon$ and $\hat{v}(\zeta_y) = v(\zeta_y) - \varepsilon$ with $v(\zeta_x) + \varepsilon > v(\zeta_y) - \varepsilon$. For all other $\zeta : v(\zeta) = \hat{v}(\zeta)$.*

A natural example of a confound is when each type of a pair perceives to be the other type. This keeps the marginal distribution of the actual and perceived values identical, but reduces the correlation.

The second variation increases the spread of the perceived value relative to the true values.

Definition 2 *$\hat{v}$ is an exaggeration of v if for some pairs of individuals characterized by ζ_x, ζ_y with $v(\zeta_x) \geq v(\zeta_y) : \hat{v}(\zeta_x) = v(\zeta_x) + \varepsilon$ and $\hat{v}(\zeta_y) = v(\zeta_y) - \varepsilon$ for some $\varepsilon > 0$. For all other $\zeta : v(\zeta) = \hat{v}(\zeta)$.*

Notice that an exaggeration coincides with a mean-preserving spread when starting from $v_x = v_y$, in which case it corresponds to the introduction of random noise.

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Both confounds and exaggerations make types who overestimate their valuation to be overrepresented among the insured.

Proposition 1 *If the perceived values are the result of a sequence of exaggerations and confounds of the true values, the demand curve overestimates the value of the insured and underestimates the potential value for the uninsured.*

Proof. *Assume $\hat{v}$ is a confound or exaggeration of v. Consider the set of individuals buying insurance at a price p, $\{\zeta \in \vartheta | \hat{v}(\zeta) \geq p\}$. If there is an individual $\zeta_y \in \vartheta$ buying insurance for whom $\hat{v}(\zeta_y) < v(\zeta_y)$, then there is also a individual $\zeta_x \in \vartheta$ buying insurance for whom $\hat{v}(\zeta_x) > v(\zeta_x)$, with $\hat{v}(\zeta_x) - v(\zeta_x) = v(\zeta_y) - \hat{v}(\zeta_y)$. However, the opposite is not true. That is, for any individual $\zeta_y \in \vartheta$ for whom $\hat{v}(\zeta_y) < v(\zeta_y)$, there is a price $p \in (\hat{v}(\zeta_y), \hat{v}(\zeta_x)]$ at which an individual $\zeta_x \in \vartheta$ for whom $\hat{v}(\zeta_x) > v(\zeta_x)$ buys while individual ζ_y does not. Hence, $E_\zeta (v|\hat{v} \geq p) \geq E_\zeta (\hat{v}|\hat{v} \geq p)$.* ■

We can adjust the notion of confounds and exaggerations for general discrete distributions such that the sign of the wedge between the demand and value curve only depends on the thickness of the market. For this to be the case, it is sufficient that all confounds and exaggerations are centered around some value $\bar{v}$ in the following sense.

Definition 3 *$\hat{v}$ is a $\bar{v}$- centered confound of v if for some pairs of individuals characterized by ζ_x, ζ_y with $v(\zeta_x) \leq v(\zeta_y) : \hat{v}(\zeta_x) = v(\zeta_x) + \varepsilon$ and $\hat{v}(\zeta_y) = v(\zeta_y) - \varepsilon$ with $v(\zeta_x) + \varepsilon \geq \bar{v} \geq v(\zeta_y) - \varepsilon$. For all other $\zeta : v(\zeta) = \hat{v}(\zeta)$.*

Definition 4 *$\hat{v}$ is a $\bar{v}$- centered exaggeration of v if for some pairs of individuals characterized by ζ_x, ζ_y with $v(\zeta_x) \geq \bar{v} \geq v(\zeta_y) : \hat{v}(\zeta_x) = v(\zeta_x) + \varepsilon$ and $\hat{v}(\zeta_y) = v(\zeta_y) - \varepsilon$ for some $\varepsilon > 0$. For all other $\zeta : v(\zeta) = \hat{v}(\zeta)$.*

Proposition 2 *If the perceived value is the result of a sequence of $\bar{v}$- centered exaggerations and confounds of the true value, the demand function underestimates (overestimates) the value of insurance for the marginal buyer if the market is sufficiently thick (thin), i.e. $p < \bar{v}$ ($p > \bar{v}$).*

Proof. *Assume $\hat{v}$ is a $\bar{v}$- centered confound or exaggeration of v. Consider the set of marginal buyers at a price p, $\{\zeta \in \vartheta | \hat{v}(\zeta) = p\}$. If p is above $\bar{v}$, for any marginal buyer $\hat{v}(\zeta) \geq v(\zeta)$. If p is below $\bar{v}$, for any marginal buyer $\hat{v}(\zeta) \leq v(\zeta)$. Hence, $E_\zeta (v|\hat{v} = p) \geq E_\zeta (\hat{v}|\hat{v} \geq p)$ for $p \leq \bar{v}$ and vice versa.* ■

The Proposition implies that the demand and value curve intersect only once, at price $p = \bar{v}$. However, the difference between the two curves is not necessarily monotone in the price as in Proposition 3 in the main text.

Web Appendix B: Calibrations with Normal Heterogeneity

TABLE APP1: THE COST OF ADVERSE SELECTION AS A FUNCTION OF THE NOISE RATIO.

Noise Ratio	Cost of Adverse Selection			
$\frac{cov(\varepsilon, \hat{v})}{cov(\varepsilon + r, \hat{v})}$	Γ (1)	Γ/S^* (2)	Γ/Γ^n (3)	$(\Gamma/\Gamma^n)_{\text{App.}}$ (4)
0	11.7	.04	1	1
.01	12.0	.04	1.02	1.02
.10	14.7	.05	1.24	1.25
.25	19.9	.07	1.69	1.76
.50	35.3	.14	2.49	3.33
1	102.2	.41	8.65	25.67[(1)]

This Table repeats Table 1 in the main text, but assumes normal heterogeneity underlying the demand, value and cost curves. The covariance curve is calibrated under the assumption that all demand components are independent. Column (4) shows the approximated bias in the estimated welfare cost, based on the formula in Proposition 4. [(1)] This large value is due to the fact that the approximating formula in Proposition 4 does not account for the upperbound of 100% of insurance coverage, which is binding in this case when $cov(\varepsilon, \hat{v})/cov(\varepsilon + r, \hat{v}) = 1$.

TABLE APP2: THE WELFARE GAIN OF SUBSIDIES AND MANDATES

Noise Ratio	Government Interventions	
$\frac{cov(\varepsilon, \hat{v})}{cov(\varepsilon + r, \hat{v})}$	Price Subsidy $\Gamma - \Phi^S$ (1)	Universal Mandate $\Gamma - \Phi^M$ (2)
0	-41.2	-50.2
.01	-41.6	-48.9
.10	-48.5	-35.6
.25	-68.2	-12.4
.50	-126.9	26.1
1	-654.0[(1)]	102.0

This Table repeats Table 2 in the main text, but assumes normal heterogeneity underlying the demand, value and cost curves. The covariance curve is calibrated under the assumption that all demand components are independent. I assume that the marginal true value of insurance is greater than zero, which is relevant for the calculation of Φ^M. [(1)]The large negative value is driven by the efficient price p^* being very negative. Because of the normal heterogeneity, the individuals for whom insurance is marginally efficient have a very negative perceived value of insurance.

Table App3: The Welfare Impact of Information Policies.

Noise Reduction	**Scenario 1** *Independence*		**Scenario 2** $var\,(\pi+\varepsilon)=var\,(\pi)$		**Scenario 3** $var\,(r+\varepsilon)=var\,(r)$	
$\Delta\sigma_\varepsilon^2/\sigma_\varepsilon^2$	$\Delta S^c/S^c$ (1a)	Γ (1b)	$\Delta S^c/S^c$ (2a)	Γ (2b)	$\Delta S^c/S^c$ (3a)	Γ (3b)
0	0	19.9	0	19.8	0	20.1
.10	.00	19.9	$-.00$	21.1	.01	19.1
.25	.01	19.1	.00	22.8	.03	17.6
.50	.02	18.6	.01	25.4	.06	15.3
1	.04	17.0	.01	32.5	.11	11.7

This Table repeats Table 3 in the main text, but assumes normal heterogeneity underlying the demand, value and cost curves.

Table App4: The Welfare Impact of Risk-Adjusted Pricing.

Risk Adj.	**No Noise**		**Scenario 1** *Independ.*		**Scenario 2** $var\,(\pi{+}\varepsilon)=var\,(\pi)$		**Scenario 3** $var\,(\pi{+}\varepsilon)=\frac{1}{2}var\,(\pi)$	
β	$\Delta S^c/S^c$ (0a)	Γ (0b)	$\Delta S^c/S^c$ (1a)	Γ (1b)	$\Delta S^c/S^c$ (2a)	Γ (2b)	$\Delta S^c/S^c$ (3a)	Γ (3b)
0	0	11.7	0	19.9	0	19.9	0	19.7
.10	.01	8.2	.01	15.4	.01	15.0	.00	13.0
.25	.03	4.3	.02	10.7	.02	9.5	.00	7.4
.50	.06	.9	.05	5.2	.02	4.9	$-.02$	5.1
.75	.08	.00	.06	2.6	.02	3.9	$-.05$	2.6
1	.09	0	.07	1.8	.01[1]	5.2	$-.09$	1.9

This Table repeats Table 4 in the main text, but assumes normal heterogeneity underlying the demand, value and cost curves. [1]The differences in column (2a) are very small. They should be monotone in theory, but are not due to the simulation of the normal distribution using a finite number of draws.