A Privacy Calculus Model for Contact Tracing Apps: Analyzing the German Corona-Warn-App

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Agenda

- Introduction / Motivation

- Research Model / Hypotheses

- Methodology

- Results

- Limitations

- Conclusion and Future Work

Introduction

- Contact Tracing App in Germany
  - Covid-19

- Functionality
  - Contact tracing
  - Registration of positive tests

- Long discussion between experts
  - Centralised / **decentralised**
  - PEPP-PT / **DP3T**

- Mixed media echo

- 45 Million downloads (Apr 22)

- Meanwhile new functions
  - Vaccination certificates
 - Statistics
  - Event check-ins

Motivation

- Privacy concerns one major barrier for acceptance of contact tracing apps

  – Previous studies are based on intention not on actual usage

  – some of them even with hypothetical scenarios

- Citizens' decision important

  – CWA voluntary in Germany

- Privacy calculus theory

  – Suitable framework to explain

  – Used with APCO model

- Bonner, M., Naous, D., Legner, C., Wagner, J.: The (lacking) user adoption of covid-19 contact tracing apps–insights from switzerland and germany. In: Proceedings of the 15th Pre-ICIS Workshop on Information Security and Privacy. vol. 1 (2020)
- Horstmann, K.T., Buecker, S., Krasko, J., Kritzler, S., Terwiel, S.: Who does or does not use the 'corona-warn-app'and why? European Journal of Public Health 31(1), 49–51 (2021)
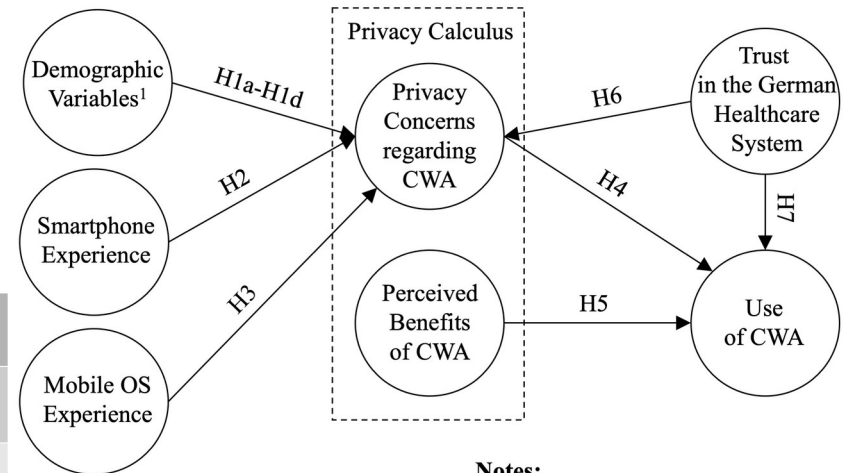
Research Model
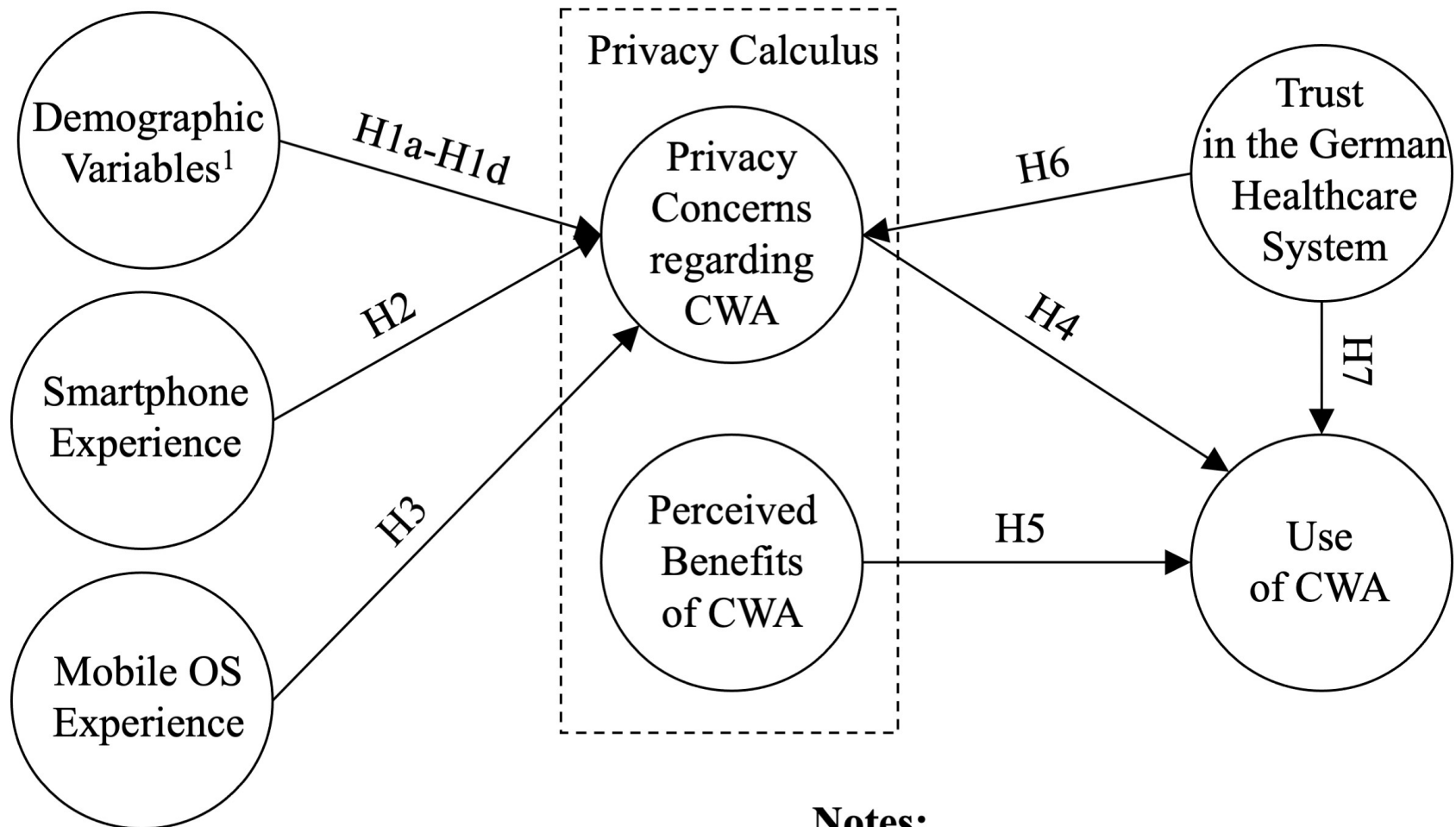
Notes:
1) Age, gender, education, income

Hypotheses

Notes:
1) Age, gender, education, income

|	Relation	Effect
H1a	Age → PC	positive
H1b	Gender → PC	female > male
H1c	Education → PC	negative
H1d	Income → PC	negative
H2	Smartphone Exp → PC	positive
H3	Mobile OS Exp → PC	positive
H4	PC → USE	negative
H5	PB → USE	positive
H6	Trust → PC	negative
H7	Trust → USE	positive

Methodology

- Questionnaire

  - Privacy Concerns (based on Gu et al.)

  - Perceived Benefits (based on Champion)

  - Trust in the German healthcare system

- Data Collection (N=1752), January 2021

  - Sampled for 3 dimensions

    - Age (EUROSTAT 2018)

    - Gender (EUROSTAT 2018)

    - CWA-Users / non-Users

  - Statistically significant but small differences

    - Income   [median =]

    - Education [median ≈]

   - Experience in Smartphones [8.77 vs. 8.35 years]
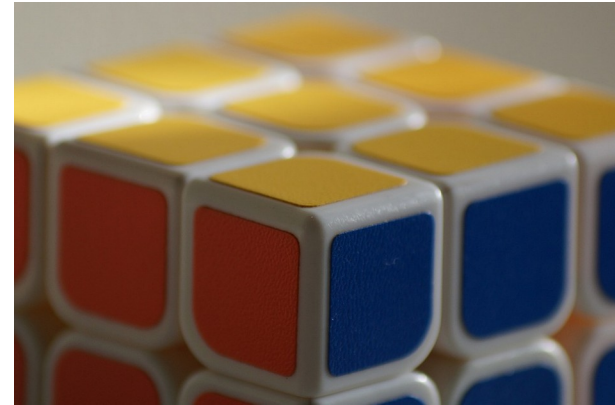
Demographics	N	%
Age		
18-29 years	371	21.17%
30-39 years	316	18.04%
40-49 years	329	18.78%
50-59 years	431	24.60%
60 years and older	305	17.41%
Net income		
500€- 1000€	160	9.13%
1000€- 2000€	402	22.95%
2000€- 3000€	404	23.06%
3000€- 4000€	314	17.92%
More than 4000€	292	16.67%
Prefer not to say	180	10.27%

Demographics	N	%
Gender		
Female	894	51.03%
Males	853	48.69%
Diverse	4	0.23%
Prefer not to say	1	0.06%
Education		
1 No degree	8	0.46%
2 Secondary school	187	10.67%
3 Secondary school+	574	32.76%
4 A levels	430	24.54%
5 Bachelor's degree	240	13.70%
6 Master's degree	285	16.27%
7 Doctorate	28	1.60%

+5 GCSEs at grade C and above

Gu, J., Xu, Y.C., Xu, H., Zhang, C., Ling, H.: Privacy concerns for mobile app download: An elaboration likelihood model perspective. Decision Support Systems 94, 19–28 (2017)

Privacy Concerns, Perceived Benefits & Trust
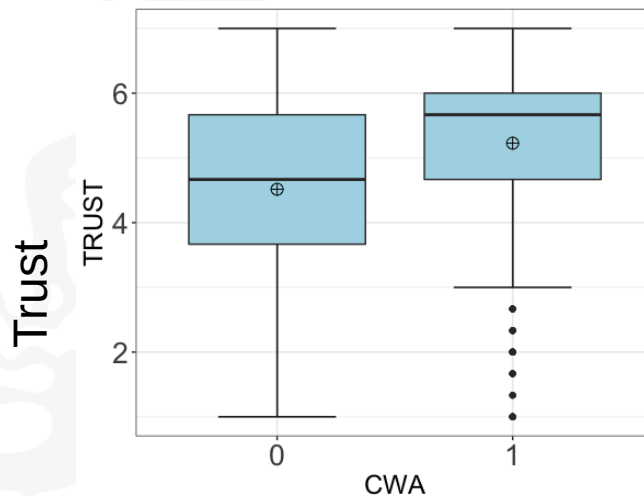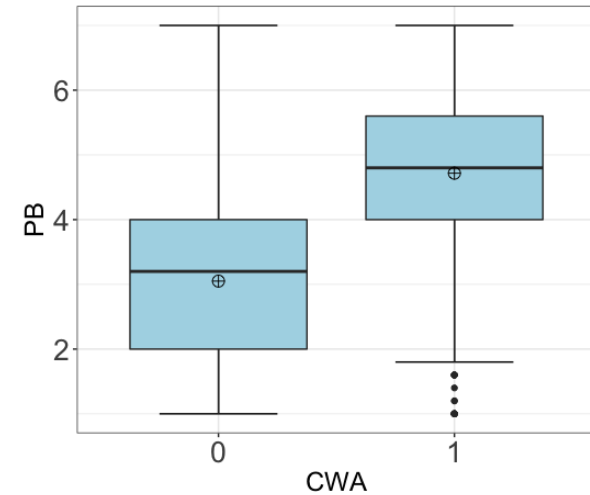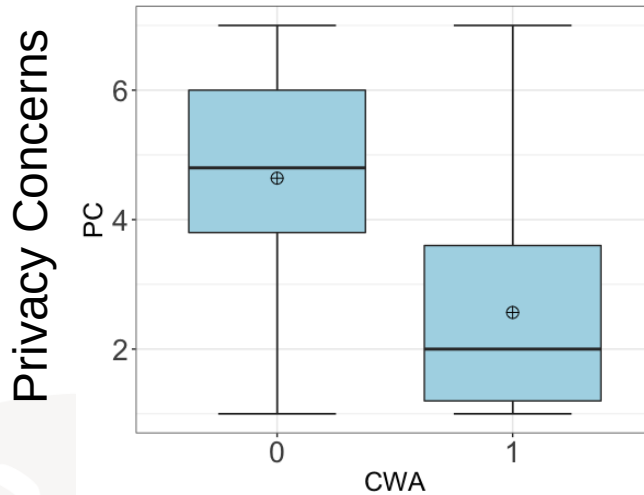
Variables are significantly different between users and non-users
with moderate effect sizes r for

- – Privacy concerns (r=-0.540)
- – Perceived benefits (r= 0.553)
- – Trust (r= 0.258)

Model Assessment

- Measurement Model
  - Internal consistency reliability (ICR)
    - Cronbach's Alpha ✓
    - Composite reliability ✓
  - Convergent Validity
    - Average variance extracted ✓
  - Discriminant Validity
    - Fornell-Larcker criterion ✓
    - Heterotrait-monotrait ratio ✓
  - Common Method Bias
    - Harman's single-factor test ✓
- Structural Model Assessment
  - Collinearity
    - Variance inflation factor ✓
  - Significance and Relevance of Model Relationships
    - adjusted R^2
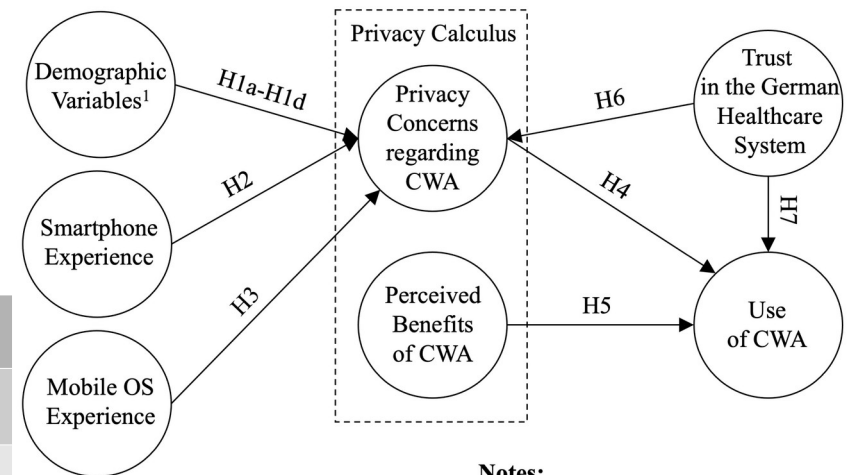   - Privacy concerns: 16.6%
      - USE: 40.7%
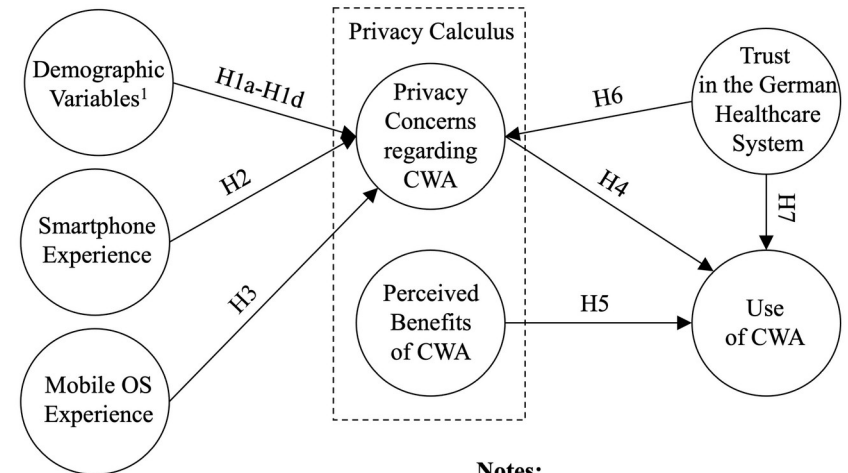
Notes:
1) Age, gender, education, income

Results

	Relation	Path Est.	
H1a	Age → PC	-0.039	
H1b	Gender → PC	-0.017	
H1c	Education → PC	-0.097***	✓
H1d	Income → PC	-0.045*	✓
H2	Smartphone Exp → PC	-0.050	
H3	Mobile OS Exp → PC	0.055	
H4	PC → USE	-0.378***	✓
H5	PB → USE	0.395***	✓
H6	Trust → PC	-0.374***	✓
H7	Trust → USE	-0.054*	✗

Notes:
1) Age, gender, education, income

- Privacy calculus theory / APCO model supported
  - Privacy Concerns + Perceived Benefits influence USE
- Education and Income minor antecedents
- Trust in Healthcare important antecedent
- Trust in Healthcare has negative effect on USE

Limitations

- Results can not easily be generalized for other contact tracing apps

- Based on self-reports
  - But real use instead of intention (+ virtual scenarios)

- Research followed original APCO model
  - Interactions between antecedents not considered
  - Demographic effects on perceived benefits not considered

- Potential biases due to social desirability, mood, translation of the questionnaire's items

Conclusion & Future Work

- One of the first studies investigating use behaviour

- Non surprisingly, non-users have

  - Higher privacy concerns

  - Lower perceived benefits

- Communication strategy important

- Investigate Antecedents of

  - Perceived Benefits

- Investigate other factors

  - Political Opinion

  - Social influence

Contact

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Questions

Demographics

- **AGE** in years

- **EDU** Education (no degree, secondary school, secondary school (>5 GCSE), A levels, bachelor, master, doctorate)

- **GDR** Gender (female, male, divers, prefer not to say)

- **INCOME** of household (in e: 0.5k-1k, 1k-2k, 2k-3k, 3k-4k, >4k, prefer not to say)

- **Smartphone Exp**erience in years

- **Mobile OS Exp**erience in years

- **USE** Corona-Warn-App user (yes/no)

Perceived Benefits

Perceived benefits of the Corona-Warn-App

- **PB1** Using the Corona-Warn-App makes me feel safer.

- **PB2** I have a lot to gain by using the Corona-Warn-App.

- **PB3** The Corona-Warn-App can help me to identify contacts to infected individuals.

- **PB4** If I use the Corona-Warn-App I am able to warn others in case I aminfected with Covid-19.

- **PB5** The spreading of Covid-19 in Germany can be decelerated by using the Corona-Warn-App.

Privacy Concerns

Privacy concerns related to the Corona-Warn-App

- **PC1** I think the Corona-Warn-App over-collects my personal information.

- **PC2** I worry that the Corona-Warn-App leaks my personal information to third-parties.

- **PC3** I am concerned that the Corona-Warn-App violates my privacy.

- **PC4** I am concerned that the Corona-Warn-App misuses my personal information.

- **PC5** I think that the Corona-Warn-App collects my location data.

Trust

Trust in the German healthcare system

- **TRUST1** The German healthcare system is trustworthy.

- **TRUST2** The players acting in the German healthcare system are trustworthy.

- **TRUST3** The German healthcare system can cope with the burden of Covid19 infections.