



Sanitized introduction presentation from IMF technical assistance mission



Advanced Analytics in Revenue Enforcement

Ludvig Wier

Introduction



Purpose: To share our perspective on how state-of-the-art research can improve the use of Artificial Intelligence (AI) in tax and customs



Disclaimer: We are well aware that the your revenue authority have sophisticated risk modelling experience and some of the following concepts will hence be known to the reader



Note: We ask you to pay special attention to how we can contribute in

- Building better predictive models using AI
- Utilize existing data better through transformations
- Implement AI insights better by having targeted tools that



Predictive modelling (explained)

- Say that we had 1000 parallel universes...
- ... and that you chose a 1000 different audit strategies for each universe ...
- ... you could then pick the strategy which yielded the highest return
- *Wouldn't that be amazing*
- **This is what predictive modelling simulates**



Everything can be predicted:

- Expected yield of audit or container examination
- Tax payer satisfaction
- Likelihood of collection (arrear)
- Likelihood of drug smuggling
- Weather tomorrow
- Justin Bieber's next hit



The data-driven approach to audits/examinations/interventions (objective)

- **All** transaction data that is already being recorded is automatically used to predict success of intervention (similar to real-time fraud detection in banks)
- Target is to maximize the predicted return on limited audits/examinations or other interventions
- Audits/interventions will be based on what the model predicts as the highest yield strategy
- Results are fed into the model and the model updates its anomaly finding algorithm (learning)



Benefits of data-driven audit selection

- All data is used – not only what we as humans can grasp
- Variables of interest are chosen by the model (goes beyond our intuition)
- Risk assessments continuously updated to face reality
- Ensures that firms/citizens know they are always “watched” not only when audited



Big data is already here

- Transaction data from annual reports, customs, wealth indicators etc. is already available
- We want to process all the data *automatically*
- Focus on the data that is already available before you collect new data



Getting data the right format ASAP will determine the success of this mission

- You can predict anything, but the data must:
 - Have the outcome of all investigations/audits (also non results)
 - Be in a standardized finite format
 - Data that can be used (Yes/No; 1,2,3; Apple, Banana)
 - Data that is hard to use: “The gentleman looks suspicious because he wears a hat..”
 - Be matched – e.g. by TIN
 - Be in a computer readable format (e.g. xls)
- *Getting data should be the focus of the first set of meetings and meetings should therefore include it/ data analysts (might not be interesting for senior management)*

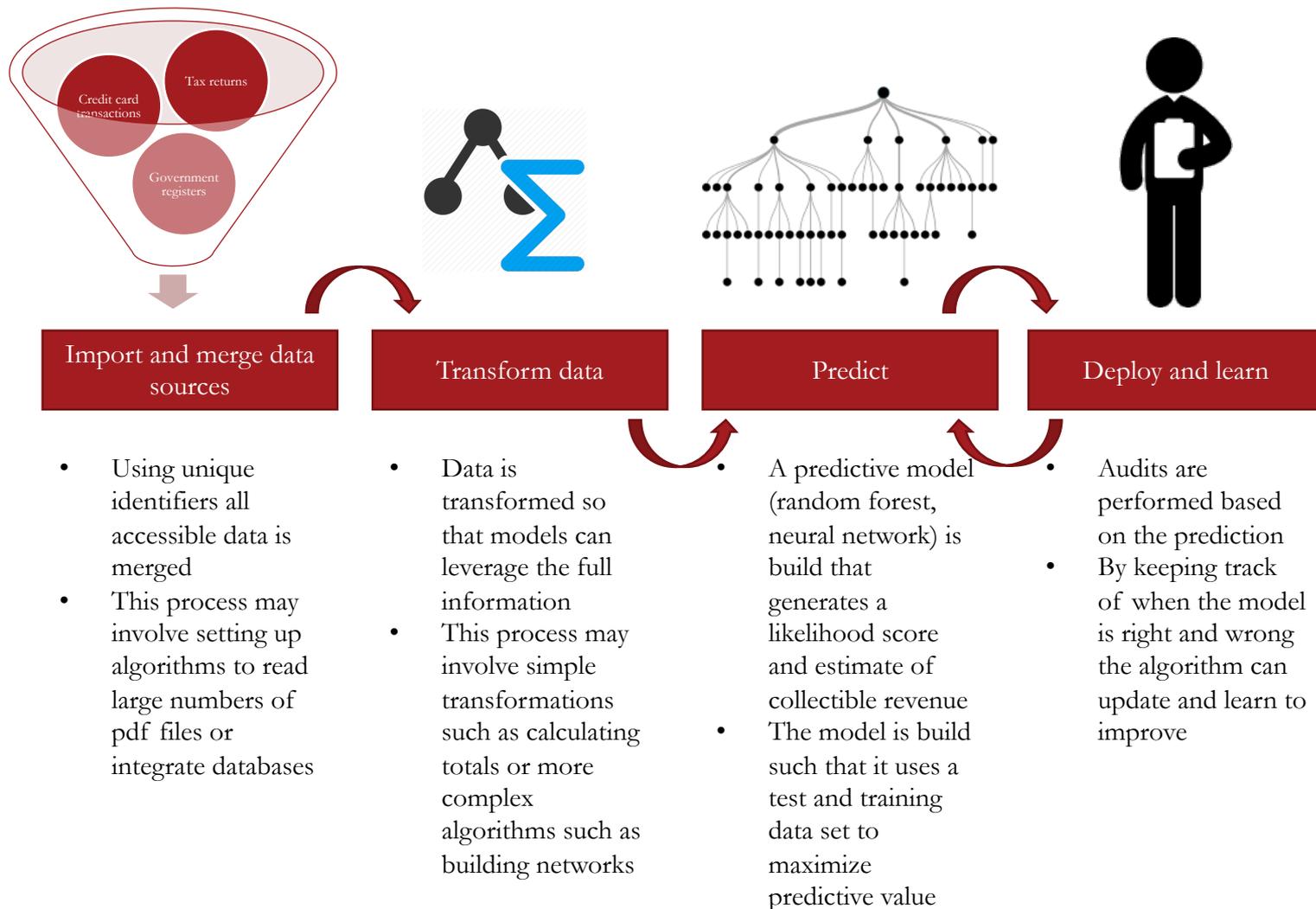


Example of data sources required for the success of the mission

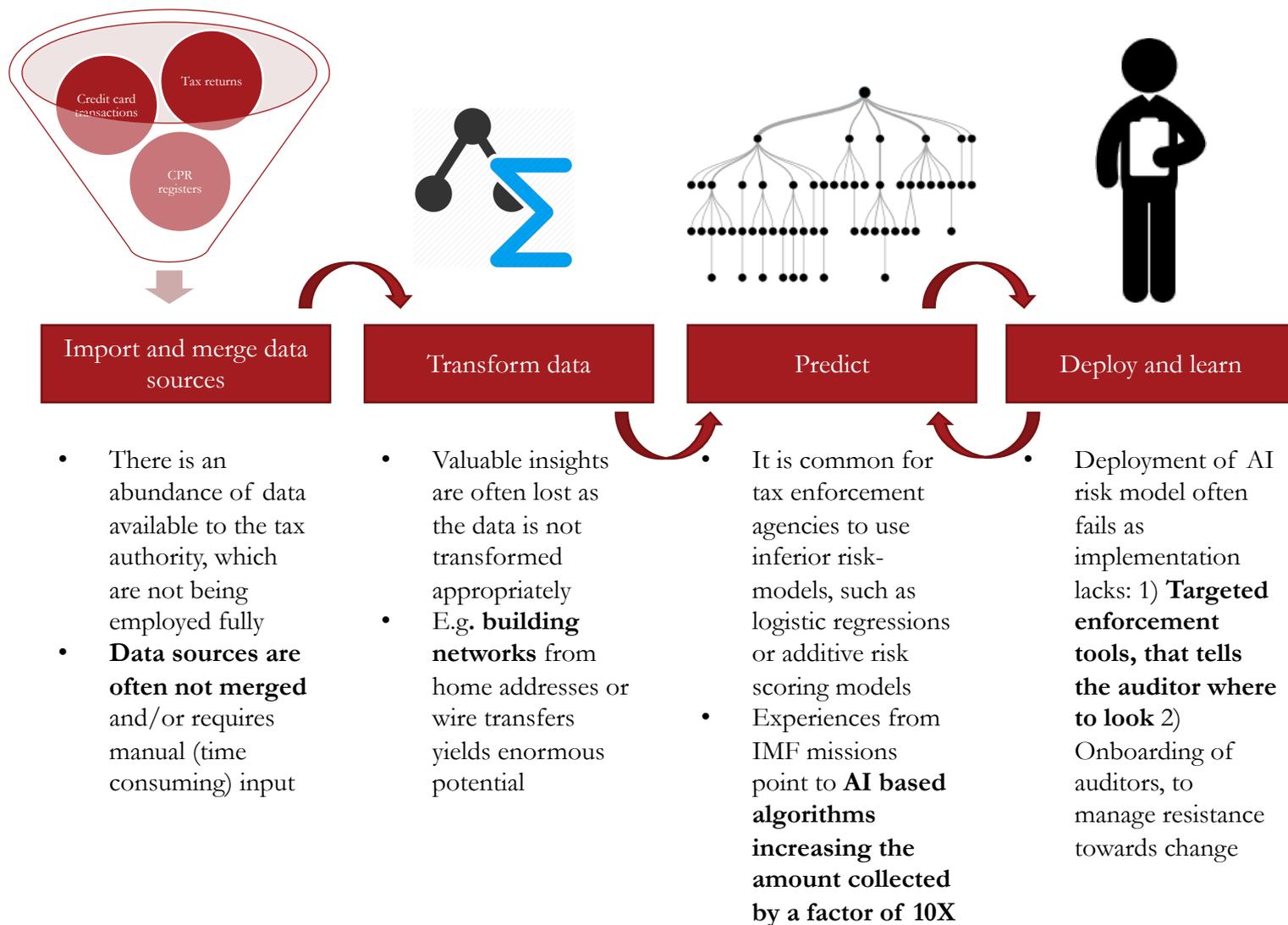
- Outcome (both positive and negative) of tax audits of individuals merged with tax returns and other information (last 3 years - xls format)
- Outcome (both positive and negative) of container examinations merged with bill of label information (last 3 years - xls format)



The data driven approach to audit selection



Our experience: 4 common areas of improvement



The premortum of a data analytics unit (1)

- Prospective hindsight – imagining an event has already occurred – increases the ability to correctly identify reasons for future outcomes by 30%.
- A premortem is the hypothetical opposite of a postmortem.
- A postmortem aim to learn what caused a patient’s death. Everyone benefits except, of course, the patient.
- A premortem comes at the beginning of a project rather than the end, so that the project can be improved rather than autopsied.
- The premortem operates on the assumption that the “patient” has died, and so asks what *did* go wrong.



The premortum of a data analytics unit (2)

- **Step 1:** Begin with the premise that your plan has failed spectacularly.
- **Step 2:** Write down every reason you can think of for the failure.
- **Step 3:** Ask members of the group to read one of their reasons
- **Step 4:** Continue until all reasons have been recorded.
- **Step 5:** Review the reasons and look for ways to strengthen your plan



Pre Mortem

WHAT WENT WRONG?

RIP



Cause of death: Satellite unit ignored by rest of organization

- Likely reasons:
 - Failure of senior management to endorse/prioritize /commit
 - Failure of unit to gain popular support in the organization
 - Failure of unit to collaborate with rest of organization
 - Failure to *convince* that old habits are inferior to new ones
 - Failure to present positive incentives for change



Cause of success: A skill and leadership empowered unit with a clear value to the entire organization

- Reasons:
 - The right (few) people hired
 - All you need are 3 really good data wizards
 - Valuable tools delivered and directly implemented
 - Feedback loop from practice to analytics (piloting)
 - Constant input from tax enforcers
 - Prioritization of high-return-low-cost interventions
 - Endorsement/prioritization by senior management
 - Progress incentivized
 - Lack of progress disincentivized
 - Sense of importance widespread in organization
 - Clear vision
 - Burning platform



Failed implementation is the #1 reason for AI not to be utilized in revenue authorities

Common areas of implementation failure is:

- **Lack of trust in algorithms producing correct results**
Solution: Rigorous impact measurement
- **Lack of actionable intel produced from algorithm to successfully proceed with audits**
Solution: Transparent and targeted predictions
- **Resistance to change from employees who feel their skills become redundant**
Solution: Change management



Rigorous impact measurement has two stages

Stage 1: Statistical testing

- The model is tested out-of-sample on subset not used for estimation. If model is more successful than old, move to stage 2

Stage 2: In field (real life) policy evaluation

- To demonstrate value of new risk model it must be compared with the old after implementation
- Randomized Control Trials (RCTs) provide an honest test of whether the new approach is better at managing
 - Details: randomly assign firms to new and old risk model and assess which one does best at select firms. Must be implemented with double blind so auditors do not whether old or new model is used.
 - Note: Can also be used to evaluate profitability on how much to audit.



Making algorithms transparent by translating predictive output into actionable intel

- Existing literature has emphasized tradeoff between simplicity/interpretability vs. predictive performance
- Recent research provides new tools for inspecting the inner workings of any predictive model. Examples:
 - Make an auxiliary model which is simple, e.g. linear or decision tree, as a proxy for the underlying model (*surrogate models*)
 - For each variable compute its marginal effect on output given all other data matches population (*individual conditional expectation*)
- **The target is a model that not only predicts an outcome but tells you *why* it predicted that outcome and *what* to investigate further**



Change management: Largest obstruction to implementing AI is reluctance towards change

- An OECD survey of 16 tax authorities experiences with AI found the largest obstruction to digital tax enforcement was reluctance towards change:
 - “... cited by respondents were the natural **scepticism of operational staff toward a new and unfamiliar approach**, and the wide gaps in mind-set, expertise, and even terminology between analytical and operational specialists” Page 32, OECD (2016)
- Successful change management requires:
 - A clear mandate from senior management
 - Integrating the operational staff in the process of moving towards AI
 - The predictions provided are transparent, trusted and actionable



How to prioritize assignments

- The key is to choose the area where the reward is the largest
- Ways to determine
 - Size of closable tax gap (based on actual analysis or intuition)
 - Bidding round (how large resources will each division devote)
 - Political decision (importance beyond revenue)
 - Data available (fit for data analytics?)
 - Next best alternative



Keeping in mind the next-best option

“... a key part of the decision to build a model is an assessment of the next best alternative. Where this alternative is under-developed, advanced analytics can add significant value without difficulty; where this alternative is mature, and particularly where it uses information that cannot be made available to a model (for instance, in the form of “local knowledge”)” Page 21, OECD (2016





Costa Rica (Sales tax)

~Ludvig Wier



Raising taxes can be very easy...

- Economists from the World Bank and the “Nudge Unit” went to Costa Rica with the aim of getting firms to file sales taxes
- Non-filing is widespread across developing countries, despite the fact that the tax authority often know who is not filling
- Costa Ricas Ministry of Finance estimate that 30% of sales taxes are evaded and 70% of corporate taxes
- The issue is that the audit costs >> taxes collected when intervening



Raising taxes can be very easy...

- Firm-to-firm transactions have to be reported by both parties if they are sufficiently large
- State institutions report all purchases from private firms
- Credit or debit card companies report all card sales by affiliated businesses

=> The information is there, but what do you do with it?



SUBJECT: Urgent: Please submit your tax return now

Attention: NAME,

PLEASE FILE YOUR INCOME TAX RETURN IN THE NEXT 10 DAYS

Declare now by visiting:

<https://www.haciendadigital.go.cr/tribunet/loginDeclaraciones.jsp>

According to our records, you have not filed your tax return (Form D101). 8 out of 10 Costa Ricans have already filed their 2014 income tax return. You are part of a small minority of citizens who have not.

It is a serious offense to not file your taxes.

T1:

We have third-party information confirming that you or your client performed activities in 2014 which require you to pay taxes.

T2:

We have third-party information confirming that you or your client performed activities in 2014 which require you to pay taxes. From third-party returns (D150, D151 and D153), we know about your operations, for example:

- **Revenues of at least XXX reported by COMPANY,**
- **Revenues from credit/debit cards of at least ZZZ reported by BANK,**
- **Sales or contracts with state entities of at least WWW.**

If you do not file, you could be audited and your business may be closed. Furthermore, [your name may be published on our website](#) as someone who did not contribute.

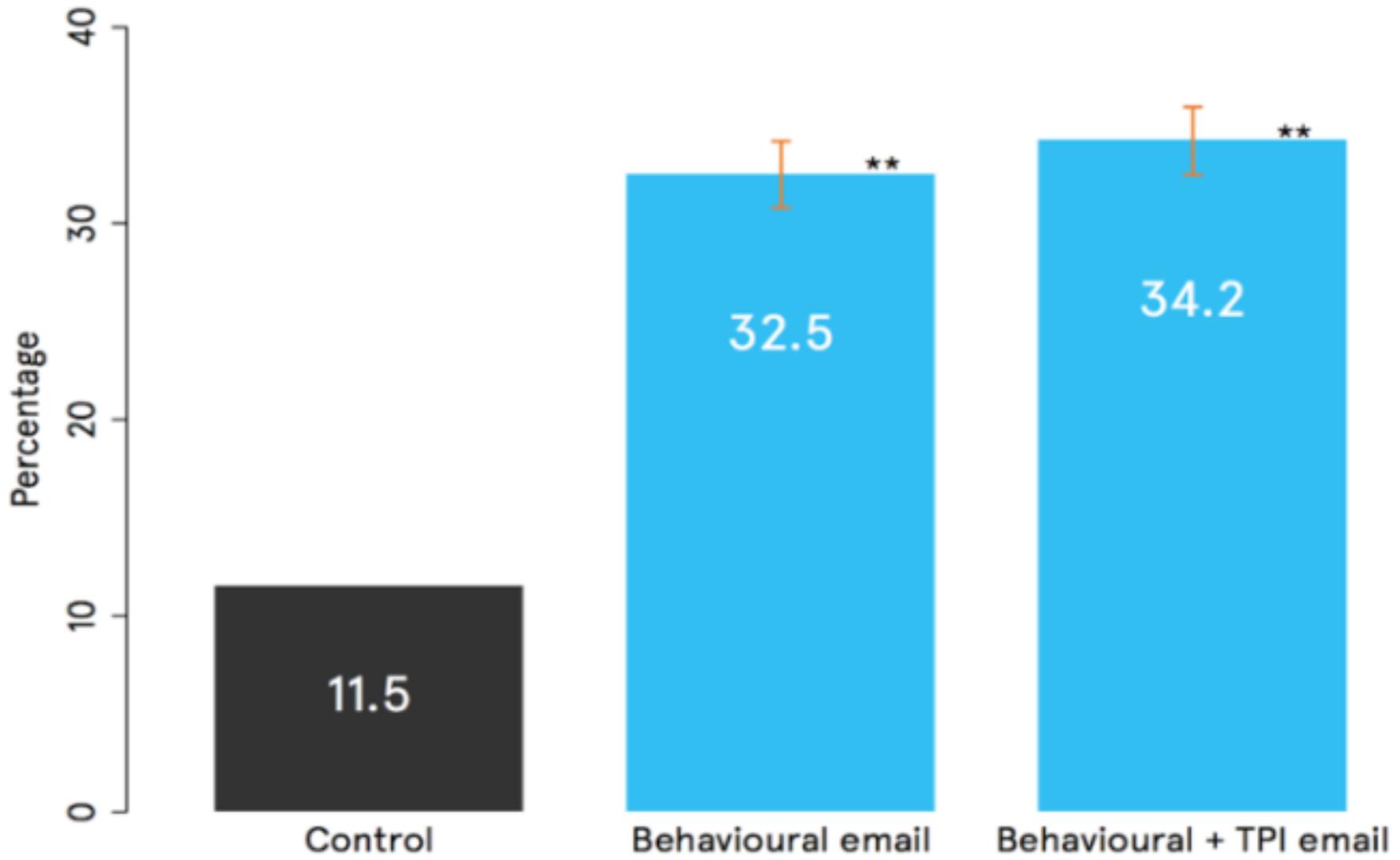
If you have any questions, you can contact me by PHONE or E-MAIL. I'll be checking whether you respond to this message.

Sincerely,

NAME OF OFFICIAL
POSITION



Rates of tax declaration under different email conditions



N=12,515

** p<0.01, * p<0.05, + p<0.1



... Next step was withholding

- When you see credit card sales, you can withhold taxes on these sales...
- ...this comes with a margin of error, but the idea is that you flip the table:
 - The firm has to come to the tax authority and tell them they made an error
- The finding: Withholding sales taxes increases tax payments by at least 16%





UK nudging

Personal income

~*Ludvig Wier*



The world famous nudge unit

- UK set up a team of behavioral economists to fight tax losses
- They used randomized control trials to test seemingly harmless message variations to tax payers
- In randomized controlled trials you
- Here is what they found:



£210 million extra collected by messaging:

