



Corporate tax microsimulation - The DiRECT model

Workshop “New insights from financial statements”

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The DiRECT model

- **Distributional and Revenue Effects of Corporate Taxes**
- Microsimulation:
 - Firm-level outcomes: taxable income and (current-period) tax liability
 - Static: no behavioural changes
 - Baseline and tax reform scenarios
 - Multi-period (2009-2019, target years 2016-2019)
 - Scope: BE, ES, FR, HR, IT, PL, PT, RO, SK

Corporate tax microsimulation models

- ZEW Mannheim TaxCoMM model (Reister et al., 2008)
- University of Göttingen ASSERT model (Oestreicher et al., 2013)
- Italian Ministry of Economy, Department of Finance CITSIM-DF (Bellucci et al., 2023)

Estimating taxable profits

$$\begin{aligned} & \text{taxable profits}_{it} \\ &= \text{EBITDA}_{it} - \text{tax depreciations}_{ikt} - \text{local business taxes}_{it} \\ &+ \text{financial revenue}_{it} - \text{tax exempt dividend income}_{it} \\ &- \text{financial expenses}_{it} + \text{interest paid}_{it} - \text{interest deduction}_{it} \\ &+ \text{extra pl}_{it} - \text{loss carryforward}_{it} - \text{tax consolidation}_{it} \\ &- \text{ACE deduction}_{it} \end{aligned}$$

Financial accounting data (Orbis)

- Link to real economic activity
 - Entities liable to corporate income tax ([tax residence](#), legal form, year of incorporation)
 - Industry classification
 - Corporate ownership links
 - Balance sheet and P&L statement (unconsolidated): starting point for tax return
- However, Orbis reports mostly aggregate figures (tangible/intangible fixed assets, financial revenue, shareholder funds)
- Taxable items not available or not granular enough

More disaggregated data

- Link to Orbis “national datasets”:
 - Disaggregated data on capital stocks by type of asset (land & buildings, equipment & machinery, patents, trademarks, licenses & concessions, goodwill)
 - Disaggregated data on financial revenue (income from equity participations & debt securities)
 - Disaggregated data on capital & shareholder funds (retained earnings)
- Granular data observed only for a subset of MS and firms
 - AT, BE, DE, GR, IT, FR, PT
 - Roughly 40% of Italian firms report [disaggregated data](#) (AIDA)

Imputation of missing observations

- Predictive approach to estimate the entire distribution of capital stock (by type of asset), financial revenue and net equity (retained earnings)
 - Mix of single imputation (univariate imputation) and multiple imputation methods (regression imputation and chained predictive mean matching)
 - Narrow range of estimated tax revenues
- Extensive [validation](#)

Tax depreciations of Fixed Assets

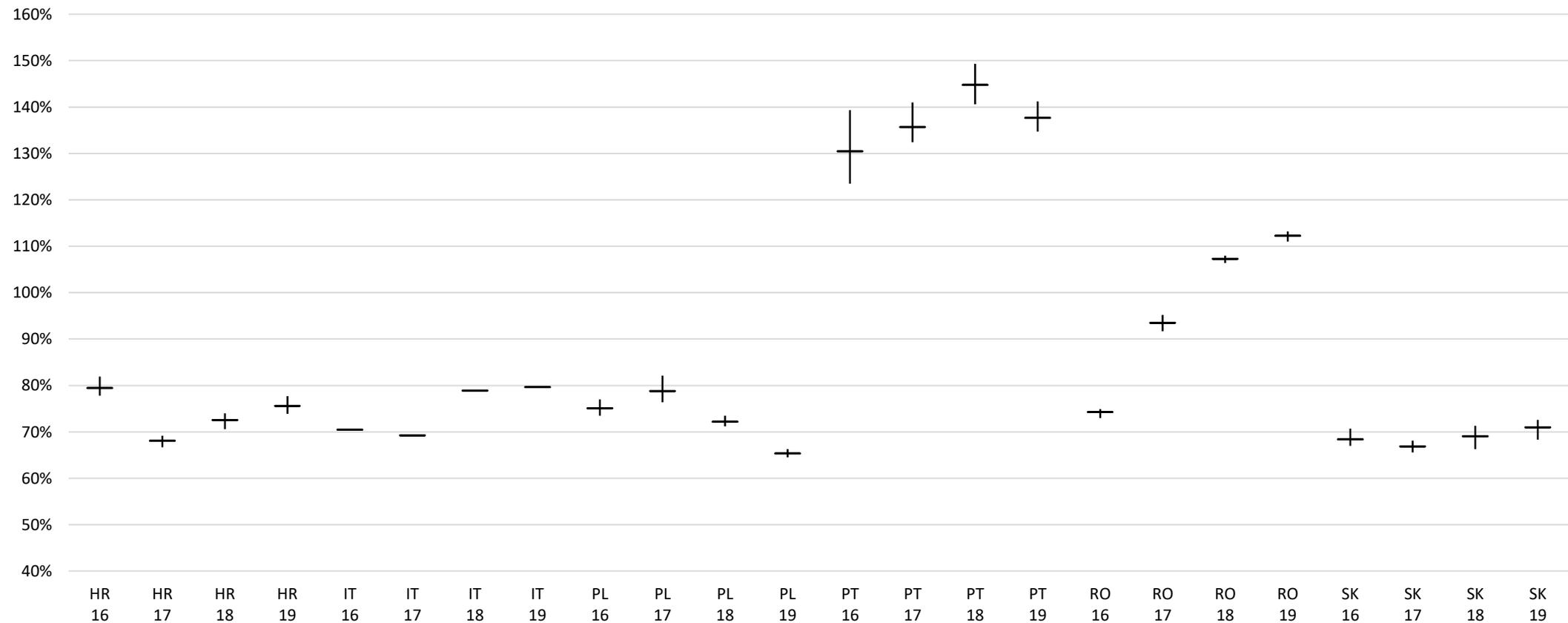
- Case 1: complete time-series of capital stocks
 - Aggregate capital stocks (tangibles & intangibles) and capital stocks shares (observed or imputed)
 - Starting from period 1 (initial investment), simulate accounting depreciation of every investment vintage
 - Residual capital stock (i.e. balance sheet – carrying value of all previous vintages) is the “net” investment in current year
 - Simulate tax depreciation on yearly “net” investments
- Case 2: incomplete time-series of capital stocks
 - Non-parametric estimation of year-to-year changes in the aggregate capital stock
 - Proceed as in Case 1

Tax (group) consolidation

- Tax groups not observable in financial accounting data
- Proxy tax groups based on ownership links
 - Worldwide ownership links (direct and indirect)
 - Different ownership thresholds
 - Vertical tax consolidation over horizontal tax consolidation

Preliminary results

Tax revenue estimates (% total CIT revenues)



Tax base & revenue estimates (% reported base & revenue, industries in-scope)

	Tax base			Tax revenue			Implicit tax rate	
	Reported	Model	%	Reported	Model	%	Reported	Model
2016	104,422.17	88,400.00	84.7%	28,656.13	24,300.00	84.8%	27.4%	27.5%
2017	117,507.05	99,500.00	84.7%	28,129.20	23,900.00	85.0%	23.9%	24.0%
2018	122,078.64	102,000.00	83.6%	29,213.28	24,500.00	83.9%	23.9%	24.0%
2019	122,569.85	109,000.00	88.9%	29,324.72	26,100.00	89.0%	23.9%	23.9%

Benchmark results (firm level)

- Administrative data on profits/losses, taxable income and tax liabilities of +/- 2500 largest firms in Poland
- Reported from 2012 onwards, data revised quarterly (now yearly)
- Separate list on 60-70 tax groups (used to narrow down the scope of tax consolidation in the model)
- Matching via VAT numbers (+/- 2200 firms matched to model)
- Last available year (2019), average estimates from 100 simulations

Tax base estimates (% reported tax base)

	Percentiles	Smallest		
1%	-12.33639	-861.0379		
5%	-.0993894	-123.7352		
10%	.0373659	-100.5977	Obs	1,839
25%	.5757589	-82.82264	Sum of wgt.	1,839
50%	.892737		Mean	41.57967
		Largest	Std. dev.	1043.624
75%	1.099115	2991.793		
90%	2.583771	5422.952	Variance	1089150
95%	8.974715	30101.62	Skewness	29.51827
99%	90.57199	32535.54	Kurtosis	886.7054

Tax liability estimates (% reported tax liability)

	Percentiles	Smallest		
1%	0	0		
5%	0	0		
10%	.0900484	0	Obs	1,867
25%	.5462825	0	Sum of wgt.	1,867
50%	.8908636		Mean	51.3714
		Largest	Std. dev.	1070.934
75%	1.112238	5421.319		
90%	3.477033	11331.19	Variance	1146900
95%	13.41314	30159.42	Skewness	27.66426
99%	228.0001	32597.18	Kurtosis	799.2898

Tax base estimates, weighted (% reported tax base)

	Percentiles	Smallest		
1%	-.4532189	-861.0379		
5%	0	-123.7352		
10%	0	-100.5977	Obs	1,839
25%	.4720782	-82.82264	Sum of wgt.	23,793.204
50%	.8341742		Mean	.7762035
		Largest	Std. dev.	5.510221
75%	.9938223	2991.793		
90%	1.179664	5422.952	Variance	30.36254
95%	1.445	30101.62	Skewness	4405.003
99%	3.278033	32535.54	Kurosis	2.48e+07

Ratio of profits & losses reported in Orbis and administrative data

	Percentiles	Smallest		
1%	-8.954635	-172.9311		
5%	-1.235955	-78.04999		
10%	0.1459127	-44.39701	Obs	2,177
25%	.467081	-38.72554	Sum of wgt.	2,177
50%	.8179375		Mean	.6966525
		Largest	Std. dev.	5.863553
75%	.9977533	48.5104		
90%	1.364105	53.76256	Variance	34.38125
95%	2.083709	62.28426	Skewness	-11.004
99%	9.674471	70.21485	Kurtosis	397.885

Tax base estimates, subsample, weighted (% reported tax base)

	Percentiles	Smallest		
1%	0	-21.51018		
5%	.7760314	-.4532189		
10%	.8493631	0	Obs	501
25%	.9236413	0	Sum of wgt.	5,915.9968
50%	.9673959		Mean	1.074281
		Largest	Std. dev.	7.799187
75%	1.016834	228.0005		
90%	1.078344	234.9156	Variance	60.82732
95%	1.180821	5422.952	Skewness	3505.216
99%	3.91388	32535.54	Kurtosis	1.44e+07

Limitations

- Tax credits?
- Branch/PE income?
- How representative is our sample?
 - Orbis often biased towards larger, more profitable and older firms (OECD, 2020)
 - Mix of reweighting and entropy balancing methods
 - However, **the choice of benchmark is not trivial**
- Aggregate data often not available along all margins (institutional sector, industry & size class, legal form)

Thank you

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Addressing Orbis Data Discrepancies

- Standard method for country assignment based on bvd id's first two letters (Kalemli-Özcan et al. 2022)
- Orbis *all addresses* table: firms reporting multiple addresses => corporate and trading addresses are prioritized
- We solve two discrepancies
 - Country-ISO code different from first two letters of the *bvd id*
 - Country-ISO code identical with first two letter of the *bvd id*, but (city, postcode, region) indicate a different country
 - Based on postcode matching (NUTS3) and within-dataset dictionaries
- Crucial for accurately constructing corporate ownership links and tax consolidation

Capital stock shares (Italy)

Capital Stock Shares by Size Classes

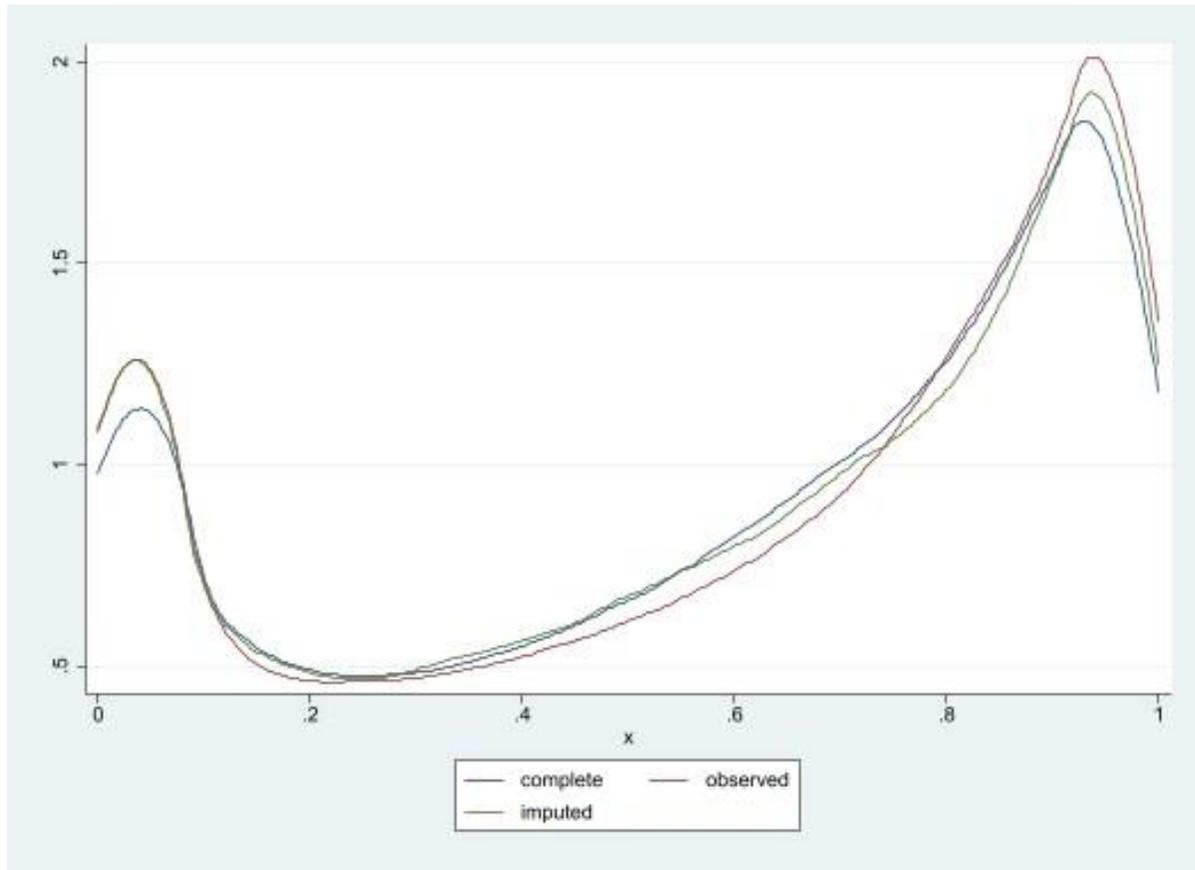
size_class (employees)	0-9	thereof0s	10-19	thereof0s	20-49	thereof0s	50-249	thereof0s	>250	thereof0s
<i>Tangibles</i>										
sh_land_buildings	0.25	62%	0.28	52%	0.32	43%	0.34	35%	0.34	27%
sh_plant_machinery	0.2	32%	0.25	17%	0.26	13%	0.27	11%	0.27	9%
sh_indust_comm equip	0.12	38%	0.12	22%	0.11	16%	0.12	13%	0.13	13%
sh_other_tangibles	0.42	9%	0.34	5%	0.28	4%	0.24	4%	0.22	4%
sh_tang_in_progress	0.02	93%	0.02	90%	0.02	82%	0.03	65%	0.04	41%
<i>Intangibles</i>										
sh_startup_expansion_cost	0.2	61%	0.11	71%	0.08	73%	0.06	74%	0.04	75%
sh_rd_expense	0.04	92%	0.05	89%	0.06	87%	0.06	85%	0.05	83%
sh_patents_ip_rights	0.11	74%	0.13	64%	0.15	56%	0.16	47%	0.15	41%
sh_license_trademark	0.09	79%	0.1	73%	0.11	65%	0.13	54%	0.13	45%
sh_goodwill_consolidation	0.08	88%	0.09	86%	0.1	83%	0.12	78%	0.18	62%
sh_intang_in_progress	0.02	97%	0.02	95%	0.03	92%	0.04	84%	0.06	62%
sh_other_intangibles	0.46	39%	0.5	30%	0.48	27%	0.44	23%	0.39	20%

Capital stock shares (Italy)

Capital Stock Shares by Industries

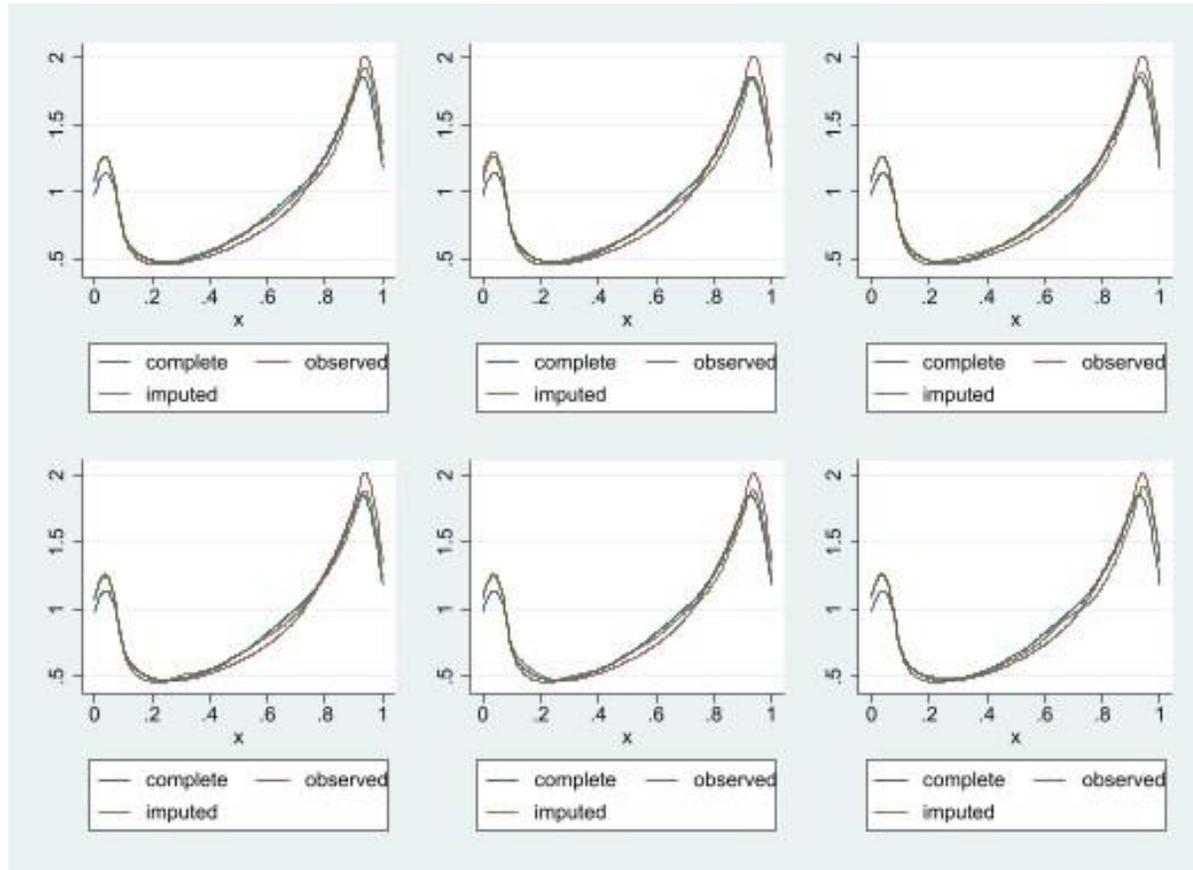
nacerev2_main_section	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
<i>Tangibles</i>																			
sh_land_buildings	0.42	0.45	0.32	0.17	0.29	0.32	0.25	0.19	0.30	0.17	0.20	0.73	0.19	0.19	0.29	0.16	0.33	0.17	0.24
sh_plant_machinery	0.31	0.35	0.37	0.53	0.30	0.16	0.18	0.13	0.20	0.13	0.10	0.07	0.14	0.15	0.20	0.11	0.18	0.20	0.18
sh_indust_comm equip	0.09	0.04	0.10	0.05	0.13	0.12	0.13	0.10	0.15	0.08	0.05	0.03	0.11	0.13	0.04	0.11	0.20	0.25	0.13
sh_other_tangibles	0.16	0.12	0.18	0.20	0.24	0.38	0.42	0.56	0.33	0.60	0.64	0.15	0.55	0.51	0.46	0.59	0.27	0.37	0.43
sh_tang_in_progress	0.03	0.04	0.03	0.04	0.04	0.02	0.01	0.02	0.02	0.01	0.01	0.03	0.02	0.01	0.01	0.02	0.02	0.02	0.01
<i>Intangibles</i>																			
sh_startup_expansion_cost	0.16	0.08	0.09	0.11	0.11	0.20	0.15	0.17	0.13	0.10	0.15	0.16	0.13	0.16	0.15	0.10	0.11	0.12	0.13
sh_rd_expense	0.03	0.03	0.08	0.02	0.03	0.03	0.03	0.02	0.03	0.11	0.02	0.01	0.06	0.04	0.08	0.05	0.02	0.03	0.04
sh_patents_ip_rights	0.10	0.06	0.16	0.11	0.08	0.12	0.11	0.10	0.05	0.20	0.12	0.06	0.18	0.12	0.21	0.12	0.10	0.07	0.10
sh_license_trademark	0.12	0.12	0.12	0.15	0.09	0.09	0.09	0.09	0.05	0.14	0.11	0.08	0.13	0.10	0.00	0.09	0.07	0.09	0.07
sh_goodwill_consolidation	0.03	0.08	0.07	0.13	0.10	0.11	0.10	0.11	0.14	0.10	0.17	0.09	0.07	0.11	0.02	0.07	0.11	0.12	0.11
sh_intang_in_progress	0.03	0.05	0.03	0.04	0.04	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.03
sh_other_intangibles	0.53	0.57	0.44	0.44	0.54	0.44	0.50	0.49	0.58	0.32	0.41	0.58	0.39	0.44	0.51	0.54	0.57	0.55	0.51

PMM capital stocks shares (land & buildings)



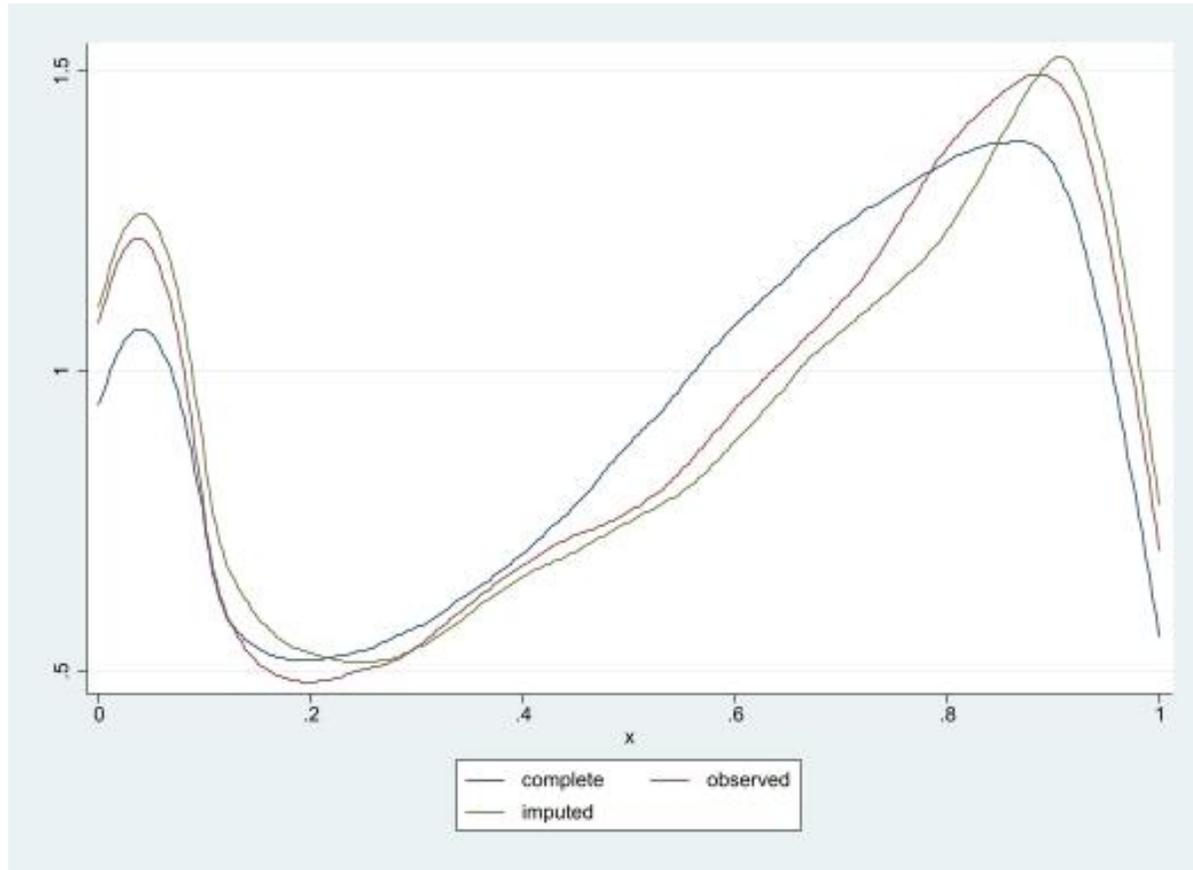
Business economy

PMM capital stocks shares (land & buildings)



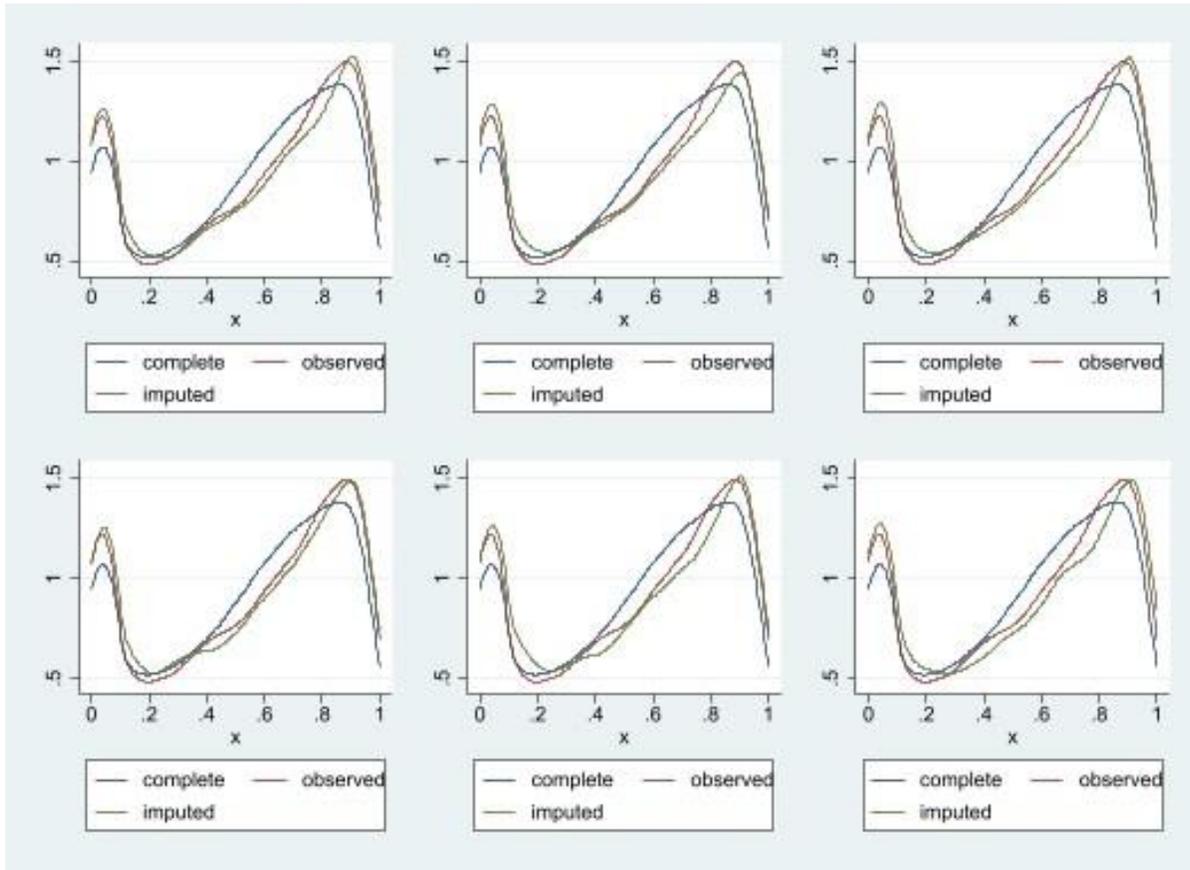
Business economy

PMM capital stocks shares (land & buildings)



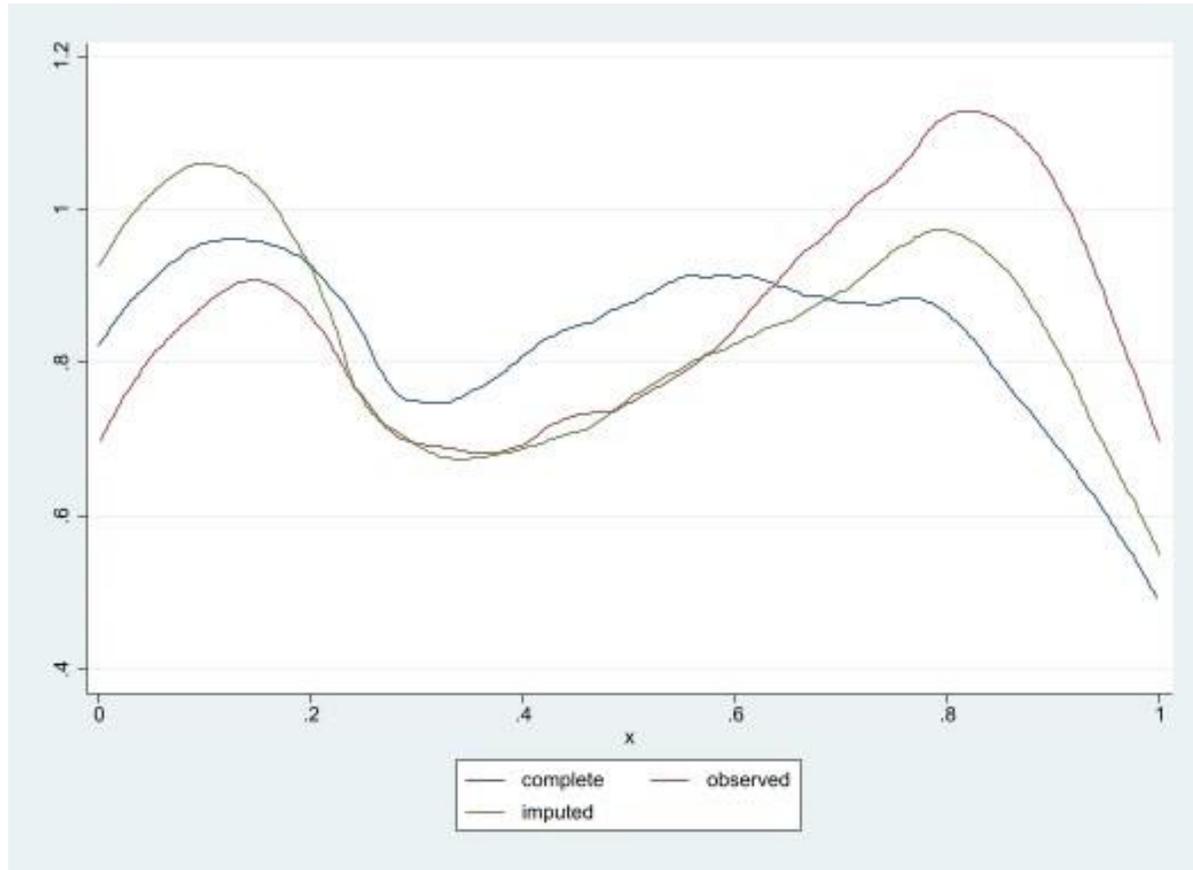
NACE Rev. 2 section C

PMM capital stocks shares (land & buildings)



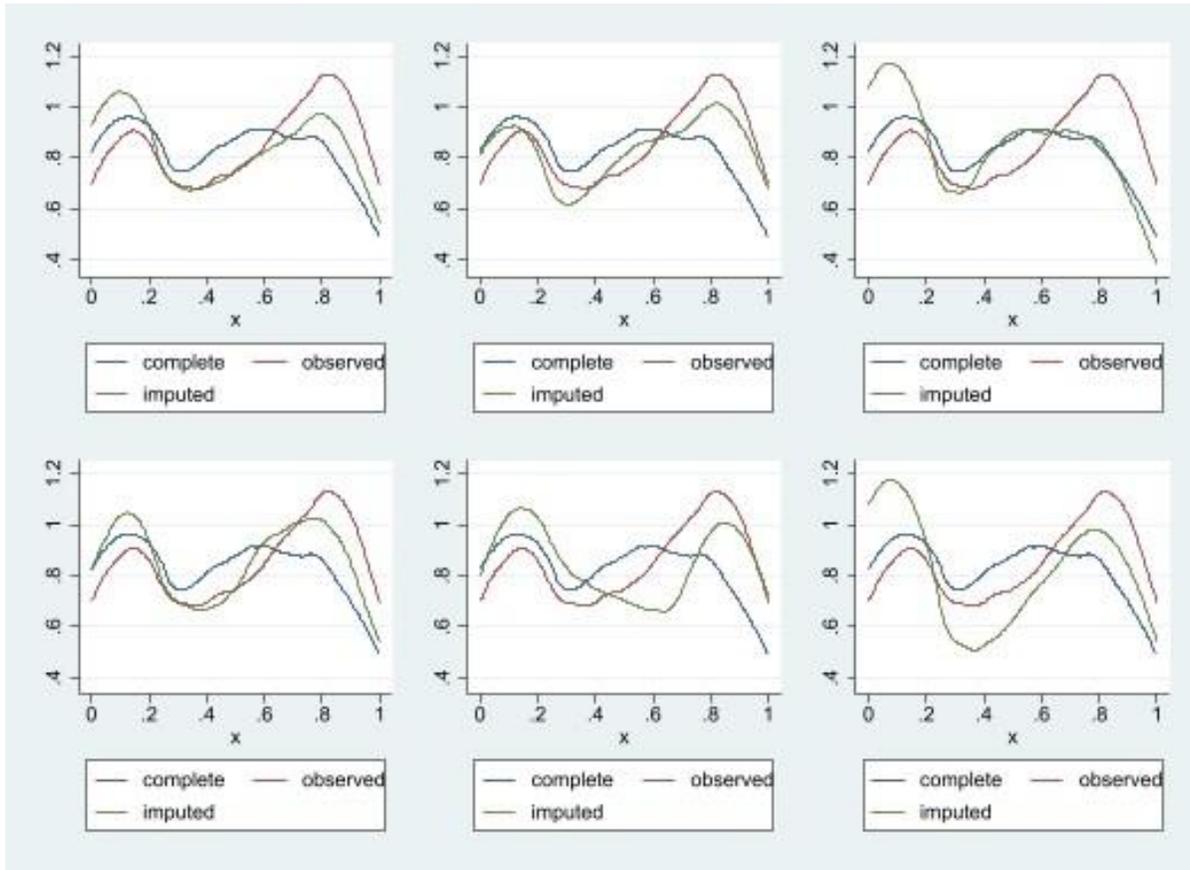
NACE Rev. 2 section C

PMM capital stocks shares (land & buildings)



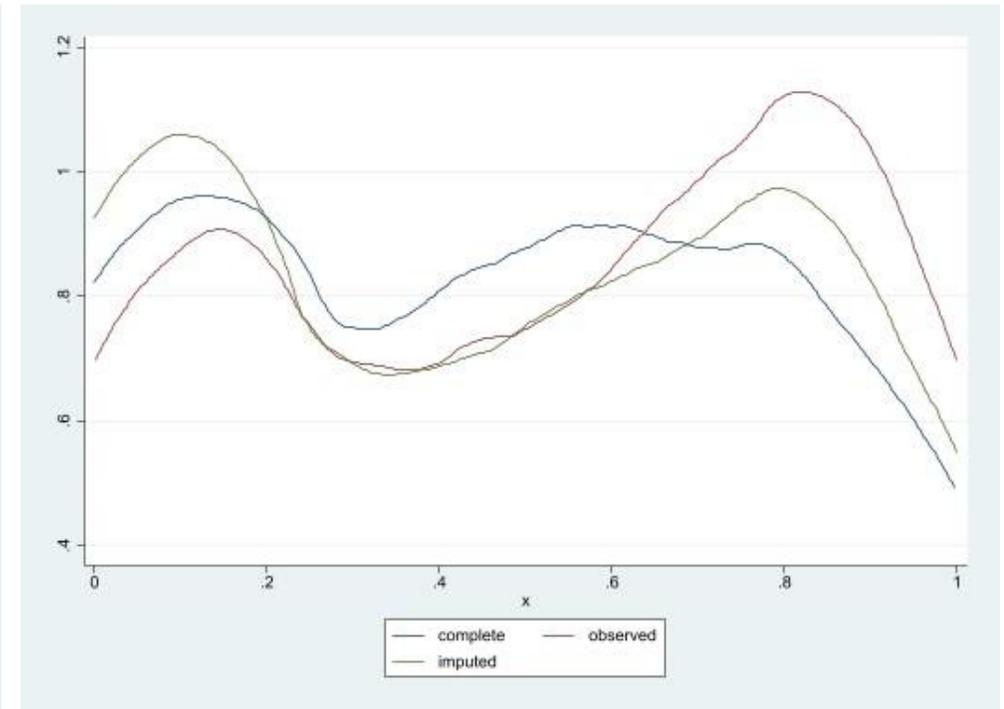
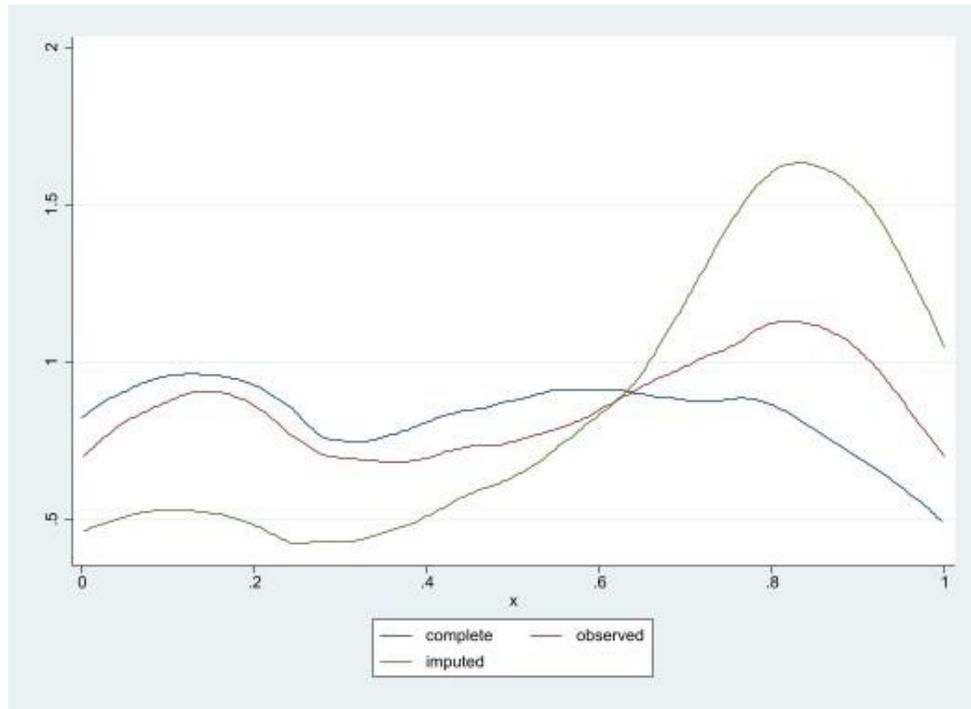
NACE Rev. 2 section B

PMM capital stocks shares (land & buildings)



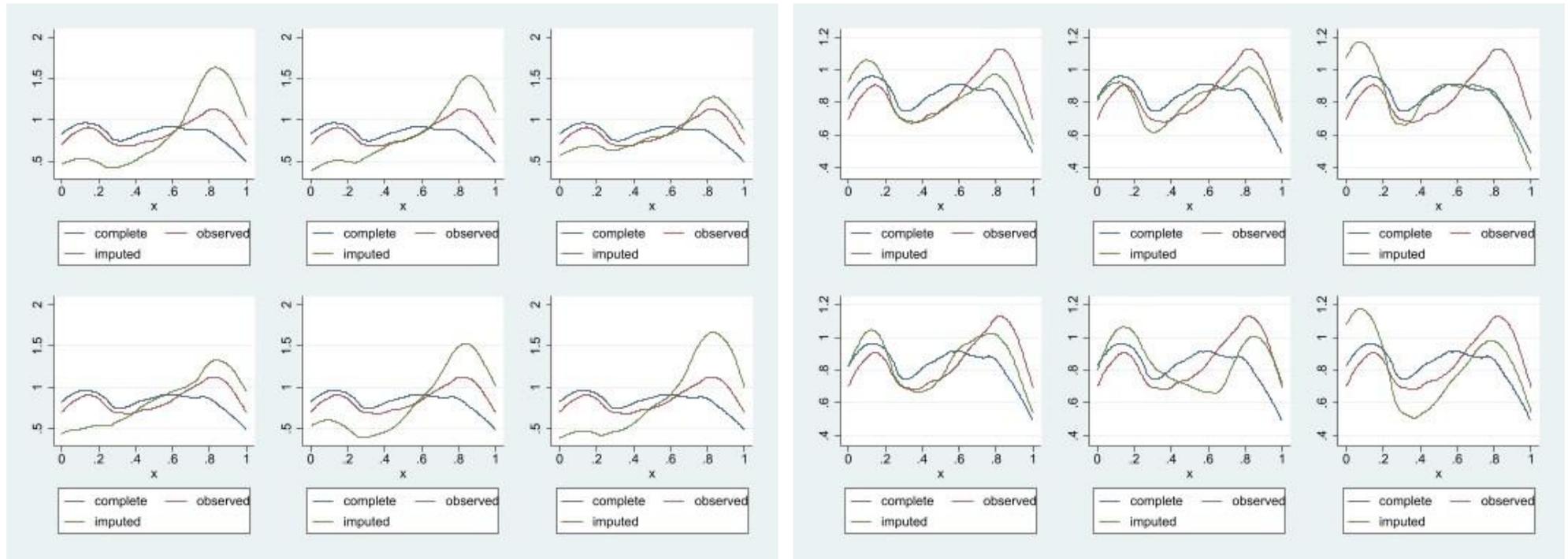
NACE Rev. 2 section B

PMM capital stocks shares (land & buildings)



NACE Rev. 2 section B, simple vs. chained predictions

PMM capital stocks shares (land & buildings)



NACE Rev. 2 section B, simple vs. chained predictions