Online Appendixes B and C of "A Theory of Structural Change That Can Fit the Data"

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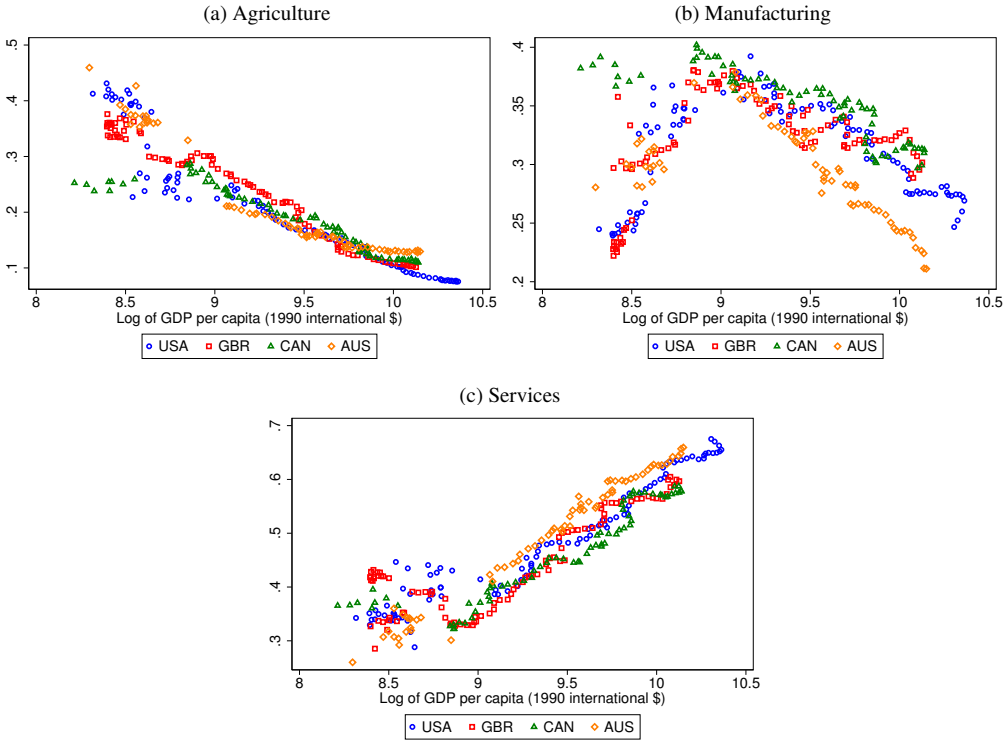
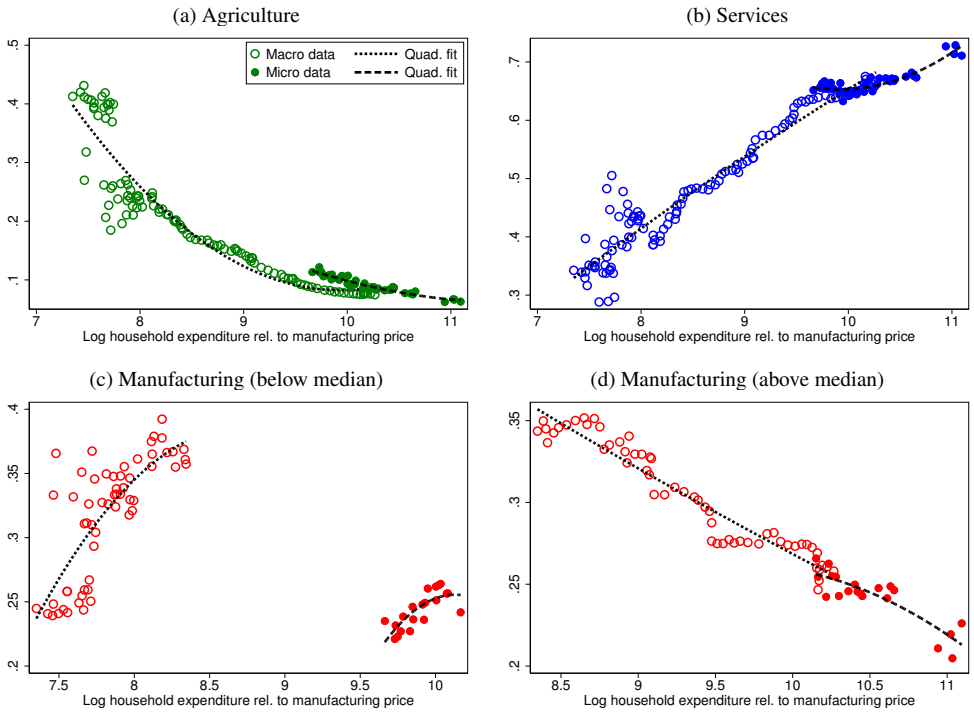
APPENDIX B: ADDITIONAL FIGURES AND TABLES



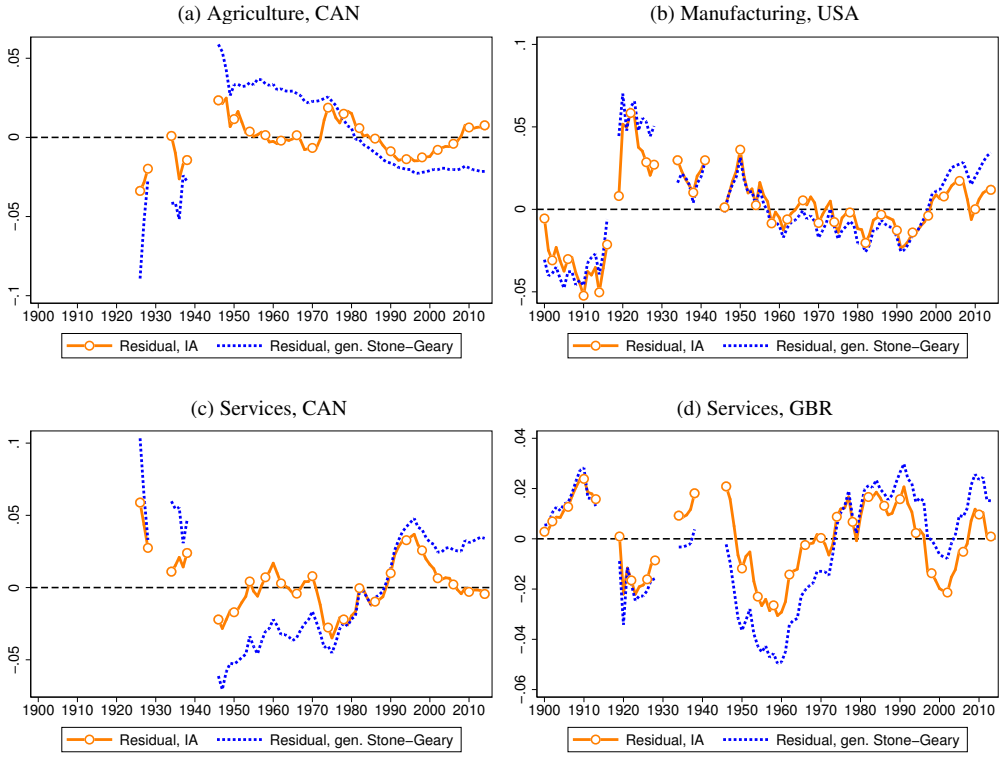
Notes: The figure plots the final private consumption expenditure shares over log GDP per capita (1990 international $) for all countries by sector. The years affected by WWI, WWII, and the Great Depression are excluded. Source: Expenditure shares (see Online Appendix C), GDP per capita (Bolt and van Zanden, 2014).

Figure B1. Final private consumption expenditure shares



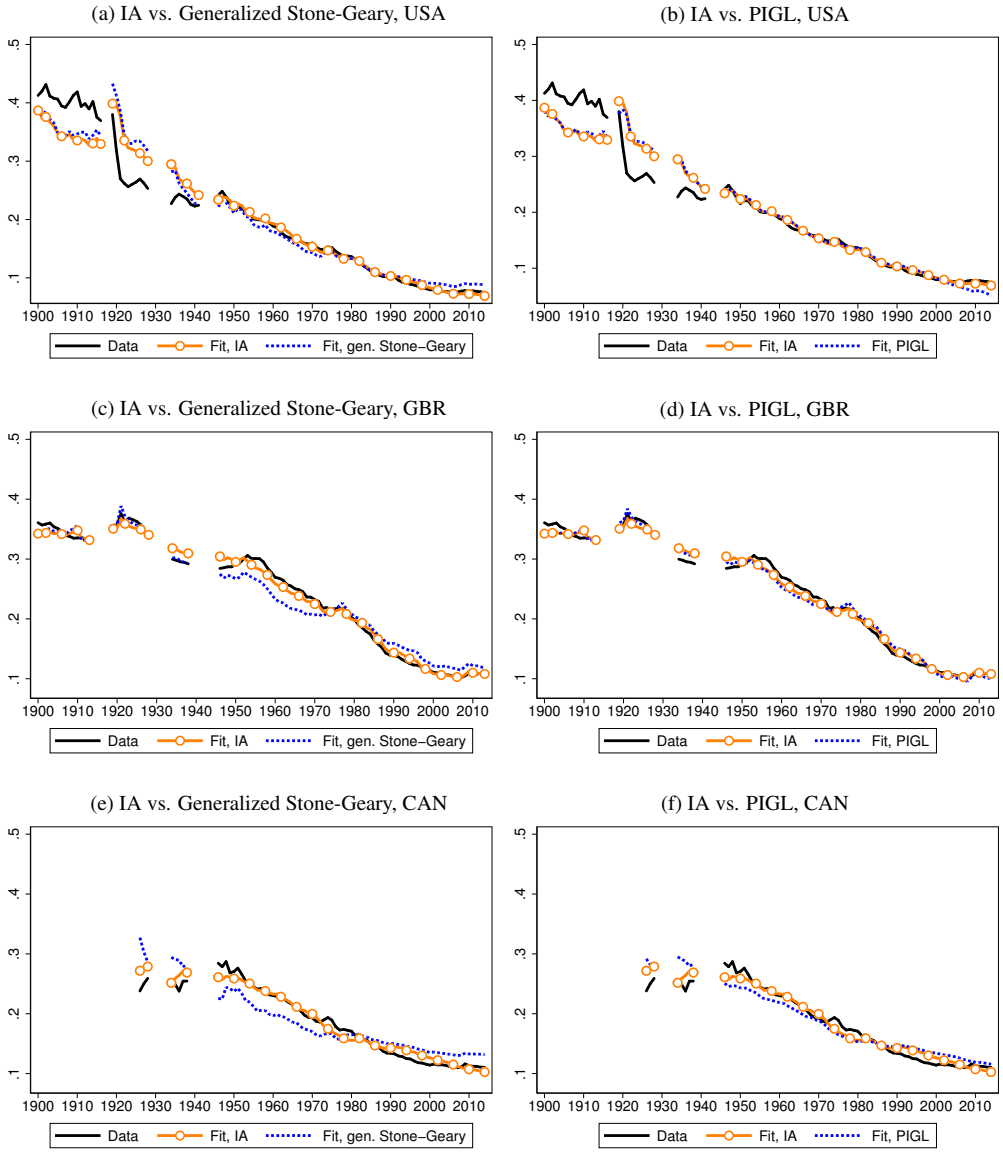
Notes: The figure plots the consumption expenditure shares for agriculture, manufacturing, and services against total household expenditure in the macroeconomic data (hollow circles) and microeconomic data (filled circles). In the microeconomic data, households are grouped by income deciles and each dot in the figure represents the average household expenditure of the income group in each year 2014-2017. We adjust microeconomic expenditure for differences in household size using the OECD-modified equivalence scale, and differences in the average expenditure levels across the four years are removed by controlling for year fixed effects. The manufacturing sector in both data sets is split at the median household expenditure level. The dashed lines are quadratic fits.

Figure B2. Consumption expenditure shares in the USA across households and time



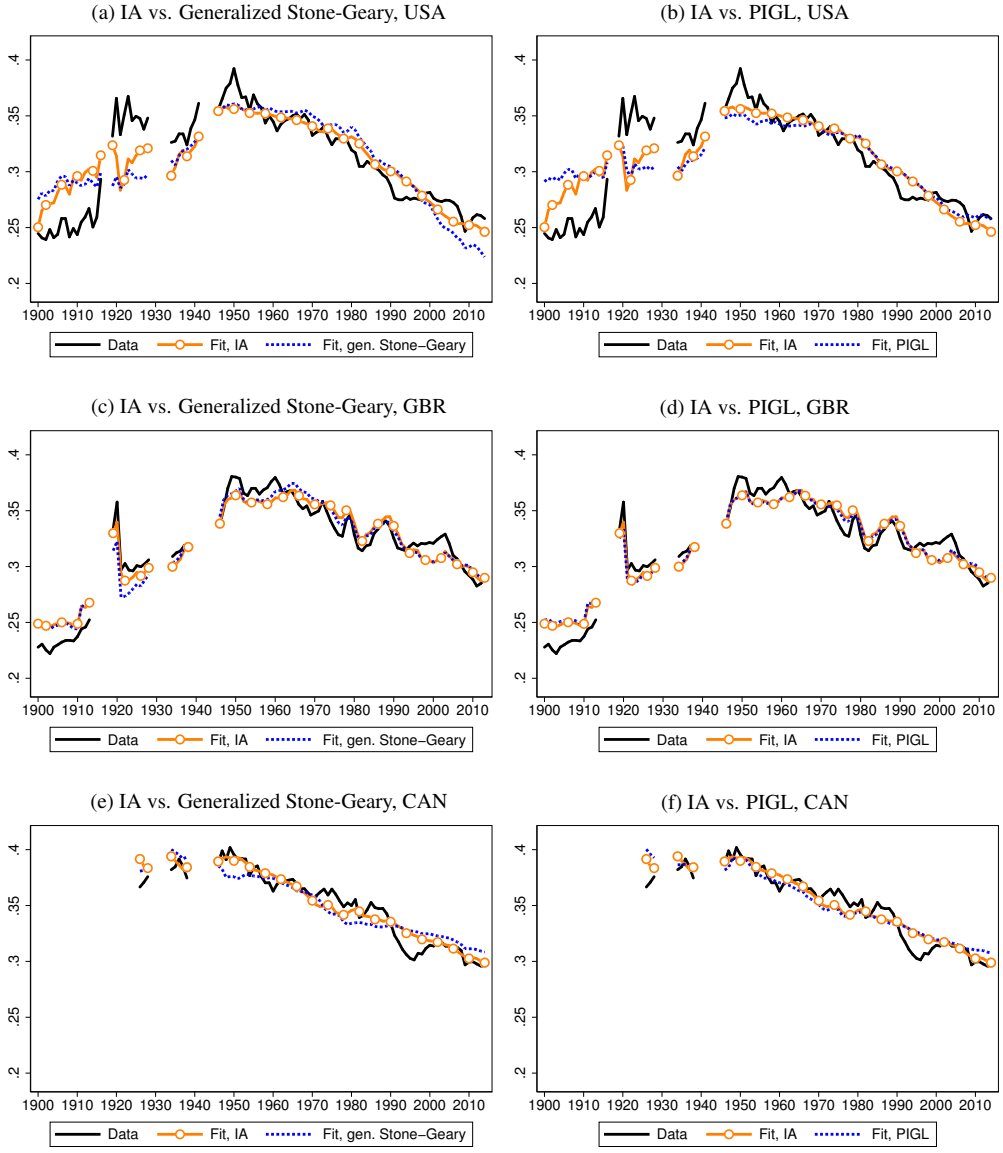
Notes: The figure plots the residuals of final private nominal consumption expenditure shares based on the country-specific estimates in Tables 1 and 2. In each panel the orange line with circles indicates the residuals of the IA preferences and the dashed blue line the residuals of the generalized Stone-Geary.

Figure B3. Residuals final private nominal consumption expenditure shares



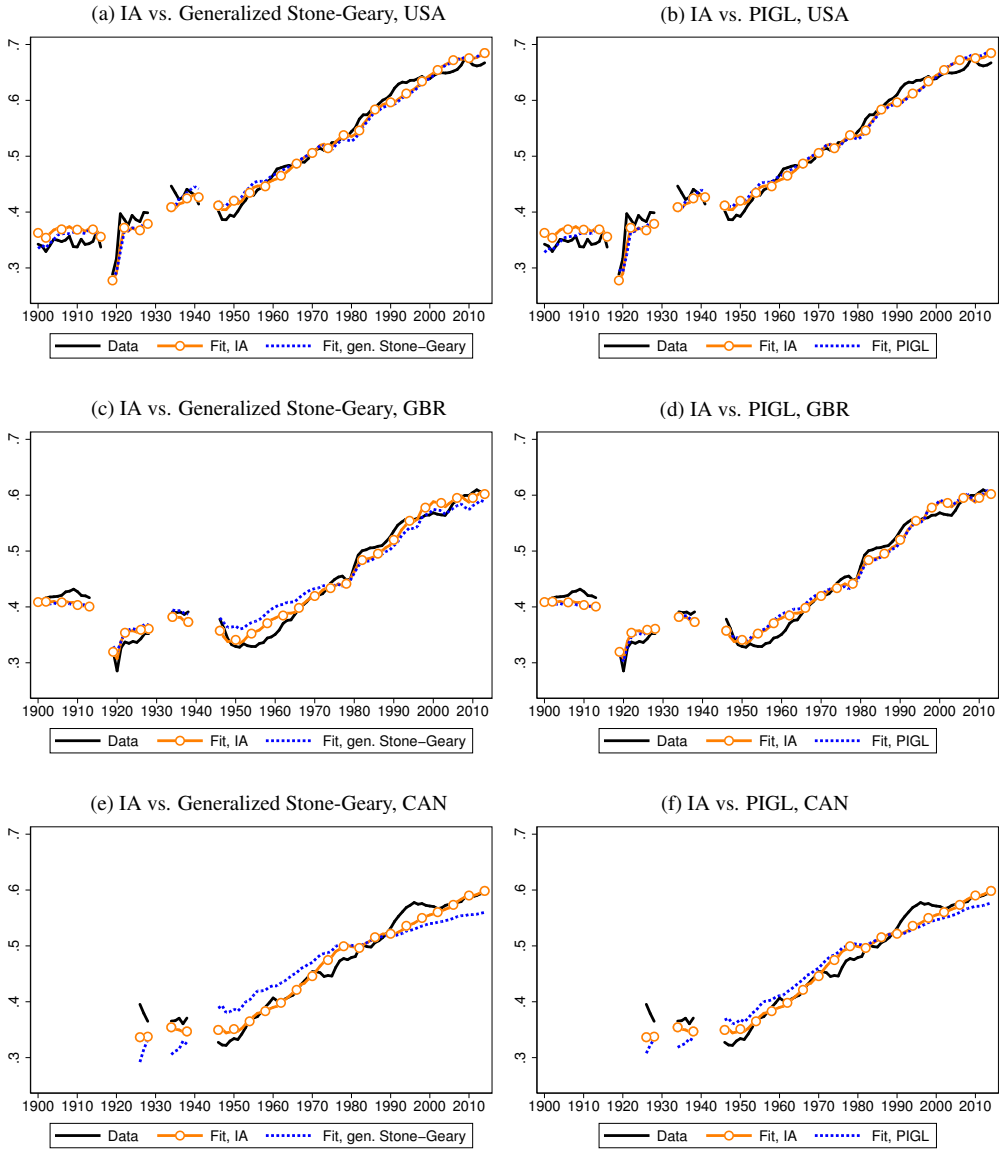
Notes: The figure plots the predicted final private nominal consumption expenditure shares in agriculture based on the estimates in Tables 1 and 2. In each panel the solid black line shows the data, the orange line with circles indicates the fit of the IA preferences and the dashed blue line the prediction of the generalized Stone-Geary (left panels) or the PIGL (right panels).

Figure B4. Predicted final private nominal consumption expenditure shares, Agriculture



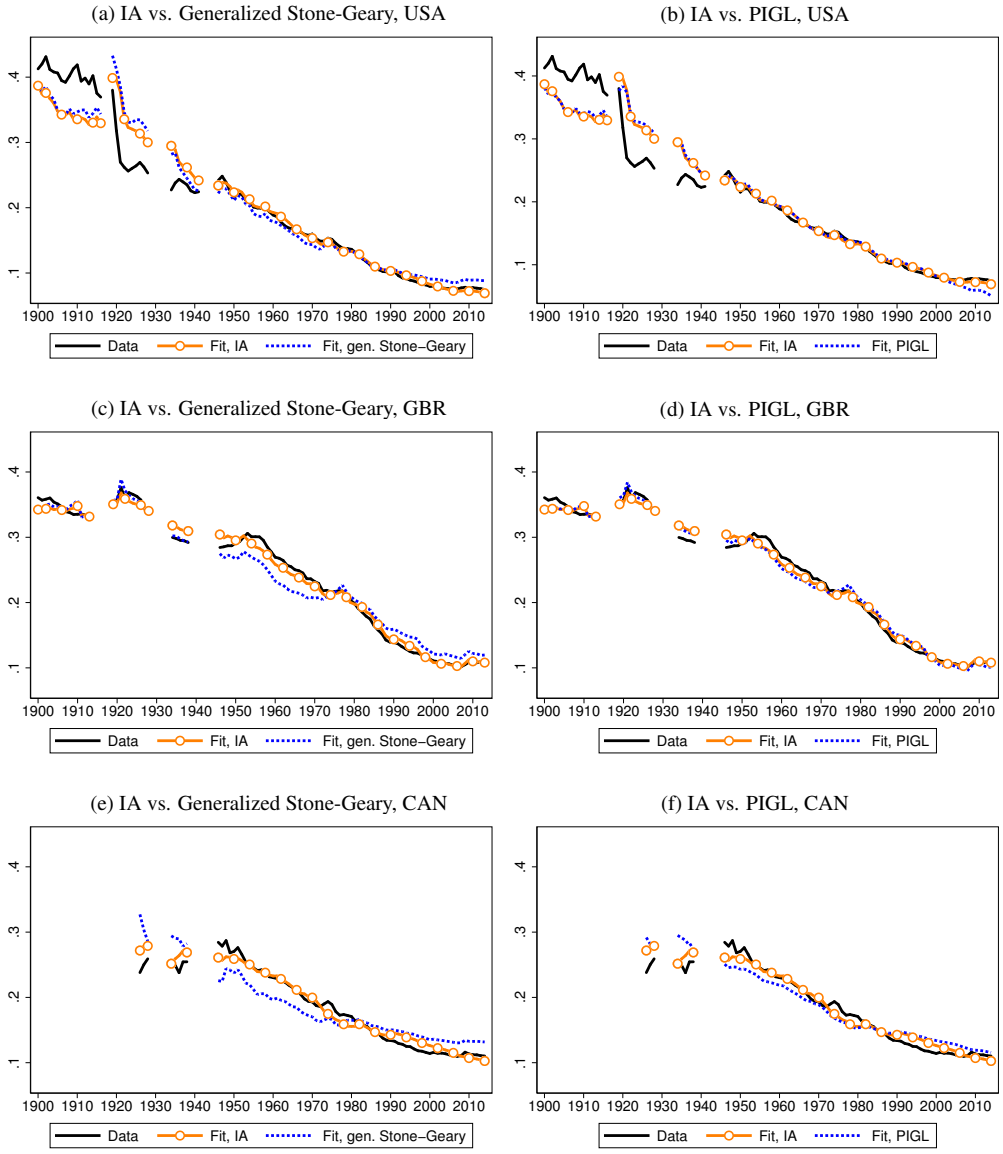
Notes: The figure plots the predicted final private nominal consumption expenditure shares in manufacturing based on the estimates in Tables 1 and 2. In each panel the solid black line shows the data, the orange line with circles indicates the fit of the IA preferences and the dashed blue line the prediction of the generalized Stone-Geary (left panels) or the PIGL (right panels).

Figure B5. Predicted final private nominal consumption expenditure shares, Manufacturing



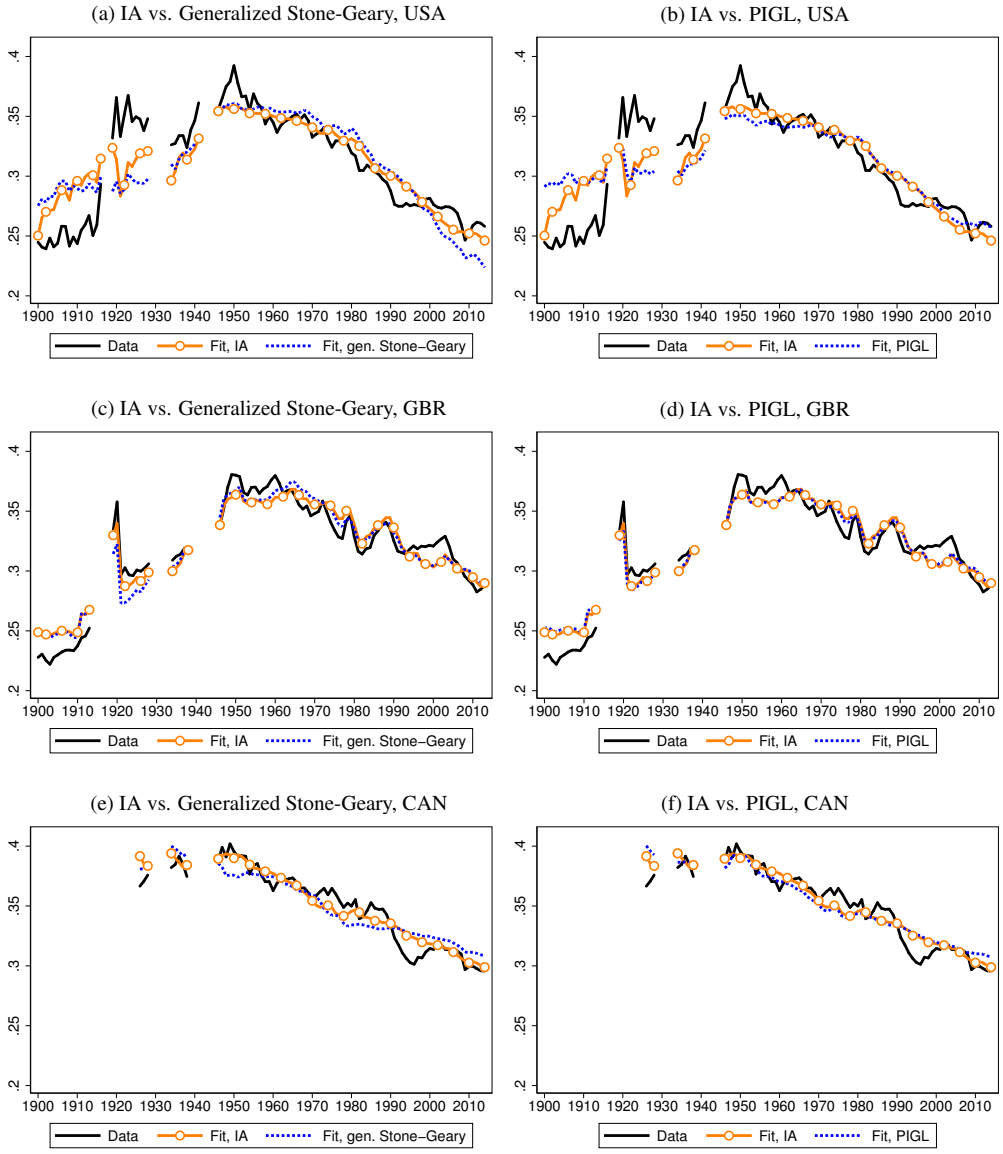
Notes: The figure plots the predicted final private nominal consumption expenditure shares in services based on the estimates in Table 1 and 2. In each panel the solid black line shows the data, the orange line with circles indicates the fit of the IA preferences and the dashed blue line the prediction of the generalized Stone-Geary (left panels) or the PIGL (right panels).

Figure B6. Predicted final private nominal consumption expenditure shares, Services



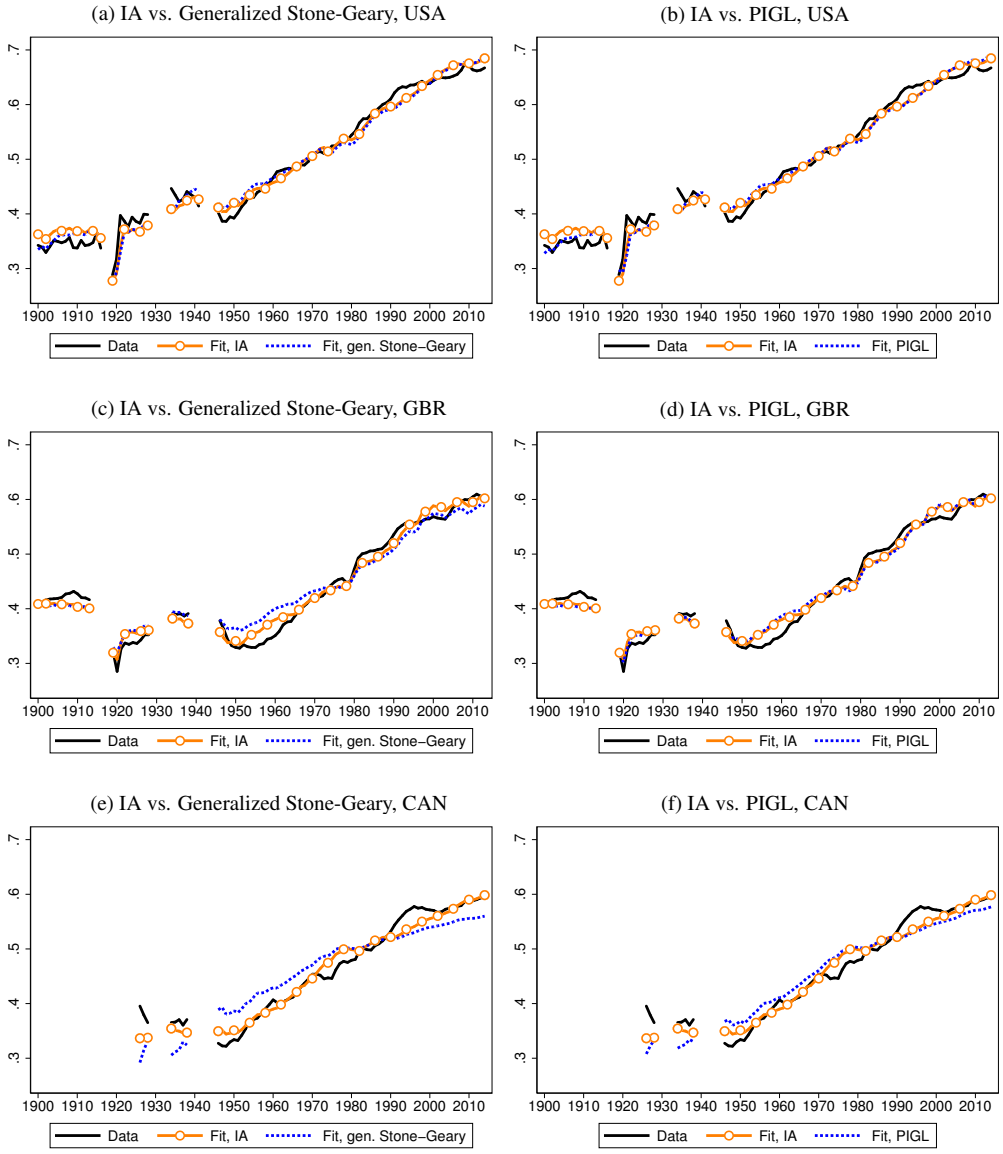
Notes: The figure plots the predicted final private real consumption expenditure shares in agriculture based on the estimates in Tables 1 and 2. In each panel the solid black line shows the data, the orange line with circles indicates the fit of the IA preferences and the dashed blue line the prediction of the generalized Stone-Geary (left panels) or the PIGL (right panels).

Figure B7. Predicted final private real consumption expenditure shares, Agriculture



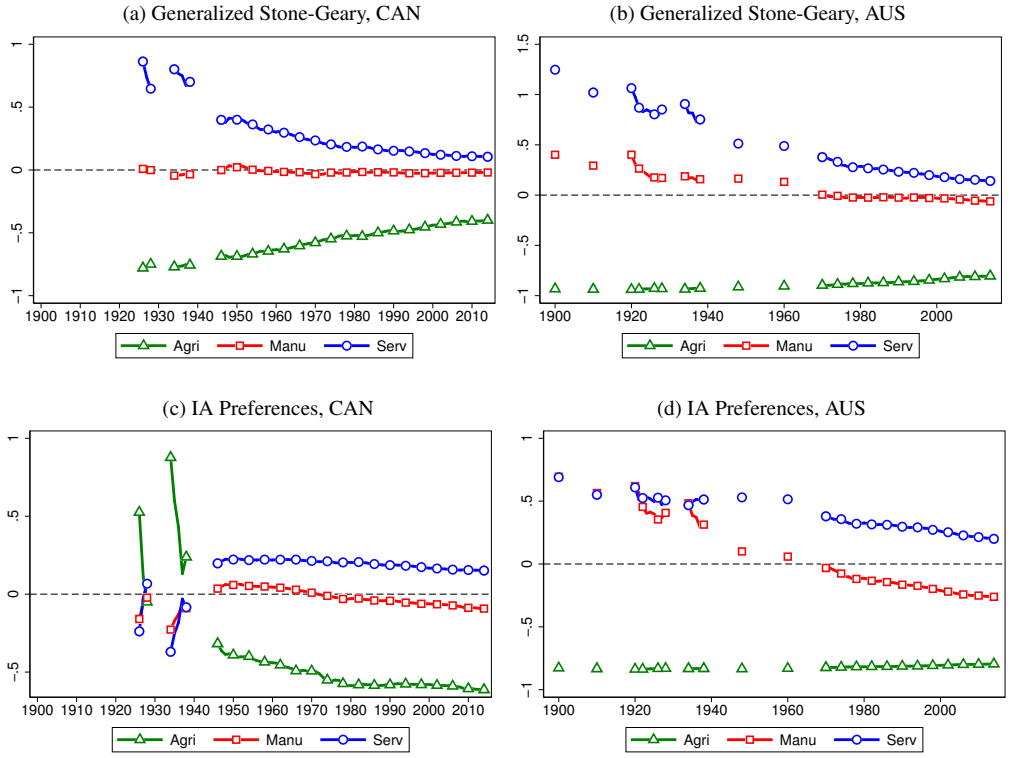
Notes: The figure plots the predicted final private real consumption expenditure shares in manufacturing based on the estimates in Tables 1 and 2. In each panel the solid black line shows the data, the orange line with circles indicates the fit of the IA preferences and the dashed blue line the prediction of the generalized Stone-Geary (left panels) or the PIGL (right panels).

Figure B8. Predicted final private real consumption expenditure shares, Manufacturing



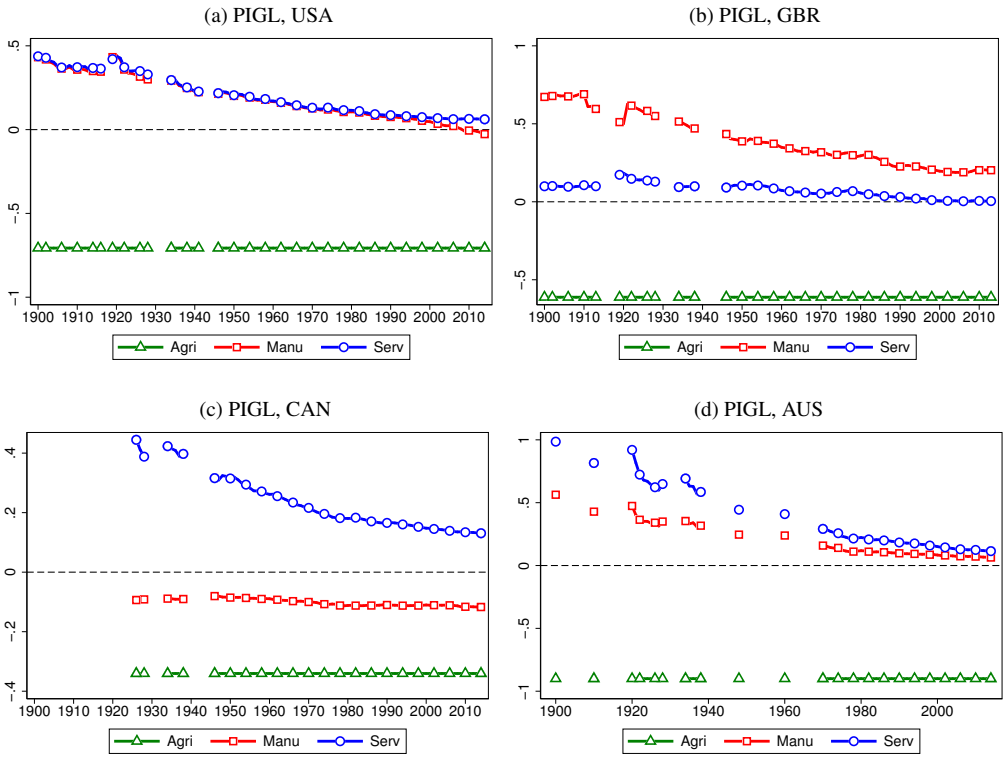
Notes: The figure plots the predicted final private real consumption expenditure shares in services based on the estimates in Tables 1 and 2. In each panel the solid black line shows the data, the orange line with circles indicates the fit of the IA preferences and the dashed blue line the prediction of the generalized Stone-Geary (left panels) or the PIGL (right panels).

Figure B9. Predicted final private real consumption expenditure shares, Services



Notes: The figure plots the predicted income elasticities of the sectoral expenditure shares for the CAN and AUS based on the estimates in Table 2. Panels (a) and (b) show the elasticities predicted by the generalized Stone-Geary specification, and panels (c) and (d) the elasticities predicted by the IA preferences.

Figure B10. Predicted income elasticities of the expenditure shares in CAN and AUS



Notes: The figure plots the PIGL preferences' predicted income elasticities of the sectoral expenditure shares for each country based on the estimates in Tables 1 and 2.

Figure B11. Predicted income elasticities of the expenditure shares with PIGL

	USA			GBR			CAN		
	IA	PIGL	SG	IA	PIGL	SG	IA	PIGL	SG
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
σ	-1.99	0.22	0.13	0.51	0.45	0.47	-0.25	0.29	0.65
	(0.58)	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)	(0.18)	(0.1)	(0.03)
$\bar{c}_A$	714		714	897		897	721		721
	(·)		(·)	(·)		(·)	(·)		(·)
$\bar{c}_M$	-567		-1474	446		248	556		-145
	(307)		(347)	(·)		(34)	(·)		(118)
$\bar{c}_S$	1289		-3001	1292		953	1089		-1229
	(·)		(705)	(·)		(68)	(·)		(420)
ϵ	0.43	0.71		0.30	0.65		0.30	0.34	
	(0.03)	(0.03)		(0.04)	(0.02)		(0.03)	(0.06)	
γ	0.17	0.66		-4.95	-0.40		1.19	0.82	
	(0.11)	(0.16)		(10.67)	(0.44)		(0.45)	(0.24)	
ω_A	0.000	0.000	0.047	0.000	0.000	0.086	0.000	0.000	0.077
	(·)	(·)	(0.003)	(·)	(·)	(0.004)	(·)	(·)	(0.005)
ω_M	0.040	0.335	0.322	0.451	0.461	0.390	0.251	0.276	0.325
	(0.025)	(0.003)	(0.003)	(0.013)	(0.008)	(0.003)	(0.035)	(0.012)	(0.006)
ω_S	0.960	0.665	0.632	0.549	0.539	0.525	0.749	0.724	0.598
	(0.025)	(0.003)	(0.004)	(0.013)	(0.008)	(0.005)	(0.035)	(0.012)	(0.011)
θ_A	0.151	0.967		0.320	0.120		0.263	0.507	
	(0.015)	(0.04)		(0.703)	(0.06)		(0.031)	(0.022)	
θ_M	0.849	0.033		0.237	0.359		0.555	0.493	
	(0.015)	(0.04)		(0.426)	(0.05)		(0.027)	(0.022)	
θ_S	0.000	0.000		0.443	0.521		0.181	0.000	
	(·)	(·)		(0.277)	(0.01)		(0.024)	(·)	
φ	1.68	7.84		0.09	0.34		2.20	1.67	
	(0.36)	(3.39)		(1.12)	(0.07)		(0.15)	(0.17)	
ν	25.4	105.9		3.3	497.8		5.6	6.7	
	(7.3)	(32.1)		(7.1)	(299.4)		(1.7)	(3.6)	
Obs	104	104	104	97	97	97	77	77	77
AIC	-1104	-1001	-1000	-1245	-1203	-1058	-1012	-910	-801
RMSE_A	0.032	0.032	0.033	0.008	0.011	0.019	0.011	0.016	0.029
RMSE_M	0.020	0.026	0.027	0.011	0.011	0.013	0.009	0.010	0.013
RMSE_S	0.016	0.017	0.017	0.015	0.016	0.022	0.017	0.021	0.038

Table B1—Estimation, Unconstrained σ, φ, and γ: USA, GBR, and CAN

Note: All variables are based on final private consumption expenditure. Years affected by WWI, WWII, and the Great Depression are excluded. AIC is the Akaike information criterion and RMSE_j is the root mean squared error for sector j. Robust standard errors are reported in parenthesis.

	AUS			Pooled Sample (AUS, CAN, GBR, and USA)					
	IA	PIGL	SG	IA		PIGL		SG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
σ	0.02	-0.02	0.15	0.40	-1.77	0.25	-0.04	0.17	0.00
	(0.86)	(0.15)	(0.1)	(0.1)	(1.24)	(0.05)	(0.2)	(0.03)	(·)
$\bar{c}_A$	947		947	714	714			714	714
	(·)		(·)	(·)	(·)			(·)	(·)
$\bar{c}_M$	-367		-2180	-90	-621			-1213	-2012
	(1557)		(681)	(166)	(378)			(152)	(2183)
$\bar{c}_S$	1353		-6891	1089	1089			-2199	-6622
	(·)		(1637)	(·)	(·)			(297)	(8306)
ϵ	0.53	0.85		0.51	0.44	0.74	0.79		
	(0.27)	(0.12)		(0.05)	(0.11)	(0.02)	(0.06)		
γ	1.06	1.73		0.49	0.46	1.13	0.73		
	(6.39)	(0.51)		(0.11)	(0.17)	(0.18)	(1.05)		
ω_A	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.057	0.020
	(·)	(·)	(0.003)	(·)	(·)	(·)	(·)	(0.002)	(0.023)
ω_M	0.081	0.284	0.276	0.265	0.026	0.361	0.233	0.341	0.206
	(0.286)	(0.028)	(0.027)	(0.033)	(0.039)	(0.004)	(0.061)	(0.004)	(0.011)
ω_S	0.919	0.716	0.704	0.735	0.974	0.639	0.767	0.602	0.774
	(0.286)	(0.028)	(0.027)	(0.033)	(0.039)	(0.004)	(0.061)	(0.005)	(0.026)
θ_A	0.011	0.318		0.312	0.165	0.846	0.155		
	(0.078)	(0.422)		(0.058)	(0.104)	(0.141)	(0.329)		
θ_M	0.149	0.285		0.688	0.604	0.064	0.176		
	(0.569)	(0.027)		(0.058)	(0.145)	(0.06)	(0.17)		
θ_S	0.840	0.397		0.000	0.230	0.090	0.669		
	(0.644)	(0.398)		(·)	(0.166)	(0.084)	(0.163)		
φ	0.26	0.56		0.37	0.49	1.84	0.07		
	(0.74)	(0.76)		(0.16)	(0.19)	(0.92)	(0.18)		
ν	514.0	1015.0		29.5	23.4	149.5	1149.0		
	(3453.5)	(2308.1)		(9.3)	(19.4)	(28.5)	(2594.1)		
Obs	63	63	63	341	341	341	341	341	341
AIC	-693	-672	-670	-3015	-3208	-2970	-3143	-2929	-3093
RMSE_A	0.018	0.018	0.017	0.026	0.026	0.026	0.026	0.028	0.027
RMSE_M	0.015	0.017	0.017	0.027	0.023	0.029	0.025	0.029	0.024
RMSE_S	0.018	0.019	0.018	0.032	0.025	0.035	0.028	0.036	0.029
Fixed Effects	No	No	No	No	Yes	No	Yes	No	Yes

Table B2—Estimation, Unconstrained σ, φ, and γ: AUS and Pooled Sample

Note: All variables are based on final private consumption expenditure. Years affected by WWI, WWII, and the Great Depression are excluded. AIC is the Akaike information criterion and RMSE_j is the root mean squared error for sector j. Columns (5), (7), and (9) include country-sector fixed effects. Robust standard errors are reported in parenthesis.

	USA			GBR			CAN		
	IA	PIGL	SG	IA	PIGL	SG	IA	PIGL	SG
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
σ	0.00	0.58	0.47	0.67	0.74	0.69	0.38	0.66	0.79
	(·)	(0.03)	(0.04)	(0.14)	(0.04)	(0.03)	(0.09)	(0.03)	(0.03)
$\bar{c}_A$	787		787	74		897	450		721
	(·)		(·)	(571)		(·)	(268)		(·)
$\bar{c}_M$	487		-326	332		237	507		171
	(·)		(389)	(482)		(33)	(42)		(59)
$\bar{c}_S$	1613		-2317	36		1098	2018		-1082
	(·)		(1512)	(4048)		(144)	(·)		(619)
ϵ	0.27	0.73		0.73	0.68		0.49	0.64	
	(0.02)	(0.08)		(0.13)	(0.01)		(0.13)	(0.04)	
γ	0.00	0.73		0.00	0.00		0.49	0.64	
	(·)	(0.08)		(·)	(·)		(0.13)	(0.04)	
ω_A	0.000	0.000	0.040	0.000	0.000	0.058	0.000	0.000	0.064
	(·)	(·)	(0.005)	(·)	(·)	(0.003)	(·)	(·)	(0.005)
ω_M	0.087	0.240	0.234	0.332	0.316	0.272	0.203	0.267	0.227
	(0.009)	(0.012)	(0.003)	(0.067)	(0.007)	(0.003)	(0.045)	(0.015)	(0.007)
ω_S	0.913	0.760	0.726	0.668	0.684	0.670	0.797	0.733	0.709
	(0.009)	(0.012)	(0.007)	(0.067)	(0.007)	(0.005)	(0.045)	(0.015)	(0.011)
θ_A	0.223	0.752		0.205	0.300		0.493	0.370	
	(0.009)	(0.09)		(0.28)	(0.024)		(0.178)	(0.109)	
θ_M	0.777	0.248		0.132	0.122		0.507	0.172	
	(0.009)	(0.09)		(0.046)	(0.006)		(0.178)	(0.009)	
θ_S	0.000	0.000		0.663	0.578		0.000	0.458	
	(·)	(·)		(0.237)	(0.018)		(·)	(0.117)	
φ	2.62	0.52		0.37	0.00		2.18	0.00	
	(0.16)	(0.84)		(0.27)	(·)		(0.27)	(·)	
ν	3.2	143.2		495.1	237.8		18.0	135.4	
	(0.6)	(89.6)		(205.2)	(26)		(20.1)	(53.2)	
Obs	81	81	81	97	97	97	77	77	77
AIC	-950	-938	-926	-1248	-1212	-1108	-1074	-902	-875
RMSE_A	0.017	0.016	0.016	0.008	0.009	0.013	0.008	0.019	0.023
RMSE_M	0.012	0.013	0.014	0.012	0.013	0.014	0.008	0.008	0.012
RMSE_S	0.013	0.013	0.014	0.016	0.016	0.019	0.013	0.022	0.033

Table B3—Estimation, Total consumption: USA, GBR, and CAN

Note: All variables are based on final total consumption expenditure. Years affected by WWI, WWII, and the Great Depression are excluded. AIC is the Akaike information criterion and RMSE_j is the root mean squared error for sector j. Robust standard errors are reported in parenthesis.

	AUS			Pooled Sample (AUS, CAN, GBR, and USA)					
	IA	PIGL	SG	IA		PIGL		SG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
σ	0.00	0.07	0.16	0.47	0.04	0.56	0.54	0.35	0.00
	(·)	(0.15)	(0.1)	(0.08)	(0.61)	(0.05)	(0.13)	(0.03)	(·)
$\bar{c}_A$	947		947	721	-3			721	721
	(·)		(·)	(·)	(1376)			(·)	(·)
$\bar{c}_M$	-672		-2587	73	446			-810	-95
	(1083)		(1032)	(121)	(·)			(115)	(53)
$\bar{c}_S$	1738		-14965	-661	1613			-3804	-1220
	(·)		(3720)	(855)	(·)			(529)	(480)
ϵ	0.67	0.92		0.27	0.74	0.74	0.73		
	(0.12)	(0.02)		(0.12)	(0.16)	(0.02)	(0.05)		
γ	0.67	0.92		0.27	0.74	0.74	0.73		
	(0.12)	(0.02)		(0.12)	(0.16)	(0.02)	(0.05)		
ω_A	0.000	0.000	0.012	0.000	0.000	0.000	0.000	0.043	0.087
	(·)	(·)	(0.003)	(·)	(·)	(·)	(·)	(0.002)	(0.017)
ω_M	0.064	0.221	0.181	0.308	0.131	0.258	0.195	0.229	0.073
	(0.119)	(0.012)	(0.02)	(0.072)	(0.069)	(0.007)	(0.064)	(0.004)	(0.007)
ω_S	0.936	0.779	0.808	0.692	0.869	0.742	0.805	0.728	0.840
	(0.119)	(0.012)	(0.02)	(0.072)	(0.069)	(0.007)	(0.064)	(0.005)	(0.018)
θ_A	0.030	0.798		0.216	0.096	0.587	0.869		
	(0.081)	(0.053)		(0.219)	(0.194)	(0.2)	(0.058)		
θ_M	0.278	0.202		0.006	0.117	0.134	0.131		
	(0.526)	(0.053)		(0.06)	(0.108)	(0.02)	(0.058)		
θ_S	0.692	0.000		0.779	0.787	0.279	0.000		
	(0.608)	(·)		(0.188)	(0.091)	(0.188)	(·)		
φ	0.38	0.00		0.00	0.22	0.00	0.00		
	(0.25)	(·)		(·)	(0.11)	(·)	(·)		
ν	562.9	783.6		3.4	1616.4	210.0	134.0		
	(957.4)	(117.1)		(1.8)	(6661.8)	(48)	(51.8)		
Obs	63	63	63	318	318	318	318	318	318
AIC	-705	-679	-697	-3084	-3184	-3085	-3127	-3036	-3154
RMSE_A	0.015	0.015	0.015	0.019	0.018	0.019	0.019	0.020	0.018
RMSE_M	0.013	0.017	0.015	0.024	0.022	0.024	0.022	0.024	0.022
RMSE_S	0.019	0.020	0.019	0.032	0.029	0.032	0.031	0.031	0.031
Fixed Effects	No	No	No	No	Yes	No	Yes	No	Yes

Table B4—Estimation, Total consumption: AUS and Pooled Sample

Note: All variables are based on final total consumption expenditure. Years affected by WWI, WWII, and the Great Depression are excluded. AIC is the Akaike information criterion and RMSE_j is the root mean squared error for sector j. Columns (5), (7), and (9) include country-sector fixed effects. Robust standard errors are reported in parenthesis.

For the ease of comparison, we use the same categorization of the broad sectors as in Herrendorf, Rogerson and Valentinyi (2013). Roughly speaking, agriculture consists of food and beverages purchased for off-premise consumption. Manufacturing captures durable goods, clothing and footwear, gasoline and other energy goods, and other nondurable goods. Services consist of private services when we consider private consumption expenditures. In the analysis with total consumption the service sector also contains government consumption. The latter categorization is challenging for the period before 1929 where government consumption is not always observed at an annual frequency. Our baseline analysis therefore focuses on private consumption.

We aggregate up prices and quantities (which we obtain for finer subcategories from the raw data) to the three broad sectors agriculture, manufacturing, and services using Fisher indexes (see Section C2 below). Finally, the resulting sectoral price indexes are then adjusted for the local currency and purchasing power parity (PPP) according to the PPP conversion factors (see Section C3 below) in the World Development Indicators (WDI) provided by the World Bank (2016*c*).

C1. Data Sources

We selected USA, CAN, GBR, and AUS because they allow to compile a consistent historical data set that includes the pre-war period. The expenditure and price data need to be available for a sufficiently fine categorization, such that we can aggregate to the sector level in a consistent way across countries and time. The data sources are the national accounts and established sources, as listed below. The sample of countries could be extended if one focused solely on the post-war period. We next discuss the data sources for each country in detail one by one.

United States

HOUSEHOLD AND GOVERNMENT CONSUMPTION EXPENDITURES, 1929–2014. — We construct the broad consumption expenditure categories from the historical National Income and Product Account (NIPA) tables provided by the U.S. Bureau of Economic Analysis (2015). The series on annual real and nominal private consumption expenditures are taken from:

- Table 2.4.3. Real Personal Consumption Expenditures by Type of Product, Quantity Indexes
- Table 2.4.5. Personal Consumption Expenditures by Type of Product

The corresponding government consumption expenditures are taken from:

- Table 3.10.3. Real Government Consumption Expenditures and General Government Gross Output, Quantity Indexes

- Table 3.10.5. Government Consumption Expenditures and General Government Gross Output

We use the same categorization of the broad sectors as in Herrendorf, Rogerson and Valentinyi (2013) by aggregating the following subcategories of the NIPA tables (which are themselves classified in even finer categories):

- Agriculture: Food and beverages purchased for off-premise consumption.
- Manufacturing: Durable goods, Clothing and footwear, Gasoline and other energy goods, other nondurable goods.
- Services: Services, Government consumption expenditures.

HOUSEHOLD AND GOVERNMENT CONSUMPTION EXPENDITURES 1900–1929. — For periods earlier than 1929, we use various chapters from Carter et al. (2006). The historical consumption expenditure data are from Craig (2006*a*,*b*), which are based on Tables A1 and A2 in Lebergott (1996). The series on annual real and nominal private consumption expenditures are taken from:

- Tables Cd78-152. Consumption expenditures, by type: 1900–1929 [1987 constant $].
- Tables Cd1-77. Consumption expenditures, by type: 1900–1929.

Since the subcategories available for earlier periods from Craig (2006*a*,*b*) are not as detailed as the more recent NIPA tables, we list the exact categorization of the broad categories as shown below (column codes from Craig (2006*a*,*b*) in brackets):

- Agriculture: Purchased food and meals without alcohol (Cd3), Food to employees (Cd4), Food consumed on farms (Cd5), Alcohol (Cd6).
- Manufacturing: Tobacco (Cd7), Shoes (Cd9), Civilian clothing (Cd10), Military clothing (Cd13), Jewelry (Cd14), Toilet articles (Cd17), Furniture and mattresses (Cd25), Kitchen appliances (Cd26), China (Cd27), Furnishings, other durables (Cd28), Furnishings, semidurables (Cd29), Cleaners and polishes (Cd30), Stationery (Cd31), Wood, gas, and coal (Cd35), Drugs (Cd40), Motor vehicles and wagons (Cd53), Tires and accessories (Cd54), Gasoline and oil (Cd56), Books and maps (Cd61), Magazines and newspapers (Cd62), Nondurable toys (Cd63, Durable toys and wheel goods (Cd64), Music, radio, and television (Cd65), Flowers and plants (Cd66).
- Services: Clothing services (Cd15), Barber and beauty (Cd18), Owner occupied housing (Cd20), Tenant occupied housing (Cd21), Rent of farmhouse (Cd22), Other housing (Cd23), Electricity (Cd32), Gas (Cd33), Water (Cd34), Telephone and telegraph (Cd36)[56], Domestic services (Cd37), Other household operations

[56]We classify this as services but this category could be ambiguous. However, it is a small share of total expenditures (less than 1% in both 1900 and 1929).

(Cd38), Ophthalmology (Cd41), Medical, dental, and other professional services (Cd42), Hospitals (Cd43), Health insurance (Cd44), Brokerage (Cd46), Banking and financial services (Cd47), Life insurance (Cd48), Legal services (Cd49), Funeral (Cd50), Other personal business (Cd51), Automobile repair (Cd55), Auto insurance and tolls (Cd57), Local purchased transportation (Cd58), Intercity purchased transportation (Cd59), Recreational services (Cd67), Higher education (Cd69), Elementary education (Cd70), Other education and research (Cd71), Religion (Cd73), Welfare (Cd74), Net foreign travel (Cd75).

The composition of the broad categories is chosen such that in the overlapping year 1929 the sectoral expenditure shares derived from the historical data from Craig (2006*a*,*b*) and the NIPA tables are consistent. For private consumption expenditures, we obtain a complete price and nominal expenditure series for agriculture, manufacturing, and services with yearly observations from 1900 to 1929.[57] For total consumption (including government consumption), we obtain four additional observations (1902, 1913, 1922, 1927) before 1929.

The corresponding nominal government consumption expenditures are based on Wallis (2006*a*,*b*) and taken from:

- Tables Ea24-51. Total government revenue, by source: 1902–1995.
- Tables Ea52-60. Total government expenditure, by character and object: 1902–1995.

To construct government consumption expenditure, we subtract from the current operation series (obtained from the table by character and object) the unemployment benefits and social security expenditures (obtained from the table by source) in order to make it consistent with the definition of government consumption reported in the NIPA tables of the U.S. Bureau of Economic Analysis (2015). Nominal government consumption expenditure is only available at roughly ten-year intervals (1902, 1913, 1922, 1927) before 1929 and price data is missing over the entire historical period. Thus, we are using the same deflator for government expenditure as for private services to approximate the historical price index for the total service sector including government services.[58]

POPULATION. — The population size from 1929 onward is taken from the NIPA Table 7.1: "Selected Per Capita Product and Income Series in Current and Chained Dollars." For earlier years, we obtain the population size from table Aa6-8. "Population: 1790–2000 [Annual estimates]" in Haines and Sutch (2006).

[57] Whenever possible, we take the finest categories reported in the tables. We then calculate the Fisher aggregates based on these categories. For civilian clothing, the data in constant prices is only available for the total clothing, while the nominal data is reported separately for women and men civilian clothing. We therefore rely on total civilian clothing to calculate prices and Fisher aggregates.

[58] When we consider the same approximation of the price for total services at later points in time where actual price data is available, we find that the difference between the approximation and the correct Fisher price index are very small. This suggests that the approximation works well.

HOUSEHOLD CONSUMPTION EXPENDITURE CROSS-SECTIONAL DATA. — We obtain nominal household consumption expenditure from the U.S. Consumer Expenditure Survey:

- Table 1101. Quintiles of income before taxes: Annual expenditure means, shares, standard errors, and coefficients of variation, Consumer Expenditure Survey, 1984–2016.
- Table 1110. Deciles of income before taxes: Annual expenditure means, shares, standard errors, and coefficients of variation, Consumer Expenditure Survey, 2014–2017.
- Table R-1. All consumer units: Annual detailed expenditure means, standard errors, coefficients of variation, and weekly (D) or quarterly (I) percentst reporting, Consumer Expenditure Survey, 2013–2017.

We use table 1101 from U.S. Bureau of Labor Statistics (2018) to obtain the total household expenditure at each quintile of the income distribution for the years since 1984. U.S. Bureau of Labor Statistics (2019*b*) provides tables 1110 with household expenditures at each decile of the income distribution for the years since 2014. We classify the expenditures as follows:

- Agriculture: Food at home; Alcoholic beverages.
- Manufacturing: Clothing; Drugs; Household furnishings and equipment; Housekeeping supplies; Medical supplies; Pets, toys, hobbies, and playground equipment; Reading; Tobacco; Vehicle purchases; Gas and oil; Television, radios, sound equipment.
- Services: Education; Fees and admission; Food away from home; Health insurance; Medical services; Personal Insurance and pension; Other vehicle expenses; Other household expenses; Public transportation; Shelter; Personal services; Utilities, fuels, and public services; Miscellaneous.
- Detailed classification based on sub-categories: Several categories cannot unambiguously be allocated to either manufacturing or services and we therefore assign them in proportion to their sub-categories (see below). These categories include: Other apparel products and services; Maintenance and repairs; Other entertainment supplies, equipment, and services; Personal care products and services; Audio and visual equipment and services.

For the detailed classification of the ambiguous categories, we use additional information on detailed household expenditures (the finest categories of expenditures) to assign ambiguous categories. For example, we use the detailed data in table R-1 from U.S. Bureau of Labor Statistics (2019*a*) to identify the subcategories of "Personal care products and services" (which are "Personal care products" and "Personal care services" and can thus be clearly assigned to the broad sectors manufacturing and services) and then assign the category "Personal care products and services" to the broad sectors in proportion to

the subcategories. We apply the same procedure to the other ambiguous categories in the data by decile and we can do this for every year for which we have detailed expenditure data (2014–2017). The detailed data also show that some of the categories clearly belong to one sector, such as Miscellaneous that consists of subcategories that all belong to services. The detailed tables report the expenditures for the average household and we thus use the same proportions to assign ambiguous categories in all deciles. We adjust for household size using the modified OECD equivalence scale.

United Kingdom

HOUSEHOLD AND GOVERNMENT CONSUMPTION EXPENDITURES. — We obtain the annual nominal and real household consumption expenditure data from three sources:

1995–2013. — We obtain the consumption expenditure series from EuroStat (2015), Series nama_co3_c (Final consumption expenditure of households by consumption purpose (COICOP 3 digit) – aggregates at current prices), Series nama_co3_k (Final consumption expenditure of households by consumption purpose – COICOP 3 digit – volumes). For the GBP/EUR exchange rate, we use OECD (2015).

We classify consumption expenditures as follows:

- Agriculture: Food, Non-alcoholic beverages, Alcoholic beverages
- Manufacturing: Tobacco, Clothing, Footwear, Furniture & carpets, Household textiles, Household appliances, Glass & table utensils, Tools & equipment, Goods and services for maintenance,[59] Medical products & appliances, Vehicle purchases, Telecommunication equipment, Audio and visual equipment, Durable recreational goods, Newspapers and books, Personal care, Personal effects.
- Services: Actual rent, imputed rent, house maintenance & repair, Water & miscellaneous services, Electricity & gas & fuel, Outpatient services, Hospital services, Transport operation, Transport services, Postal services, Telecommunication services, Recreational services, Holidays, Primary education, Secondary Education, Post secondary education, Tertiary education, Undefined education, Catering services, Accommodation services, Prostitution, Social protection, Insurance, Financial services, Other services.

1963–2011. — For this earlier period, we obtain the consumption expenditure series from Office for National Statistics (2015*c*).[60]

For the period from 1966 to 1995 the Office for National Statistics (2015*b*) only provides a real consumption index for the broad categories goods, services, and aggregate

[59] This category is ambiguous and we classify it as manufacturing.

[60] The Office for National Statistics published this data as "ad hoc data and analysis" on August 21, 2015.

private household consumption.[61] There is no separate price index for agriculture and manufacturing. However, using a historical food price index from the retail price index for food (series CCYY) in Office for National Statistics (2015*a*) as the price for agriculture, we can solve for the real quantity sequence of manufacturing that—after aggregating up the three sectoral quantities (agriculture, manufacturing, and services) according to the Fisher procedure stated in Equation (C1) in Online Appendix C—is consistent with the real quantity index of aggregate private consumption in the Office for National Statistics (2015*b*) data.

1900–1965. — For the period going back to 1900, we obtain the consumption expenditure series from Feinstein (1972), Table 24 (current prices, 1900–65) and Table 25 (constant prices, 1900–65).

We classify the broad sectors agriculture (with and without alcohol), manufacturing, and services as follows:[62]

- Agriculture: food and alcohol.
- Manufacturing: tobacco, clothing, motor cars & motor cycles, furniture & floor coverings & electrical, household textiles & hardware, matches & cleaning material, books & miscellaneous recreational goods, chemists' & other goods.
- Services: housing, fuel & light, public travel & communication, vehicle running costs, domestic services, catering (meals & accommodation), other services, and government consumption.

GOVERNMENT CONSUMPTION. — Annual real and nominal government consumption for the period 1830 to 2009 is available from Hills, Thomas and Dimsdale (2014) and for the more recent period 1948 to 2014 from the Office for National Statistics (2015*d*).[63]

POPULATION. — The population size is obtained from Office for National Statistics (2014) where data is provided from 1851 onwards.

Canada

[61] The Office for National Statistics published this data as "ad hoc data and analysis" on September 15, 2015.

[62] For some of the periods, the categories are further aggregated. In particular for the period 1957–1962, the following manufacturing goods are only available as a total for the nominal expenditures: furniture, floor coverings, electrical, household textiles, hardware, matches, cleaning materials, books, miscellaneous recreational goods, chemists' and other goods. For the same period, the following services are only available as a total: domestic service, catering, other services. There are a few further instances that involve fewer categories, but in all cases the classification into the three broad sectors is unambiguous. The real consumption expenditures have a similar feature and in some cases slightly different subcategories than the nominal expenditures, in which case we aggregated the nominal expenditures to match the categories in the real expenditures.

[63] The relevant ONS Series are NMRP (nominal values) and NMRY (real quantities).

HOUSEHOLD NOMINAL CONSUMPTION EXPENDITURES, 1926–1986. — We obtain the detailed subcategories of nominal household consumption expenditures for the years 1926 to 1986 from Table 380-0565. "Personal expenditure on consumer goods and services, 1968 System of National Accounts (SNA), annual (dollars)" provided by Statistics Canada (1988). The categorization is as follows:

- Agriculture: Food & non-alcoholic beverages, Alcoholic beverages.
- Manufacturing: Tobacco, Mens & boys clothing, Women & children clothing, Footwear, Furniture & carpets, Household appliances, Semi-durable household furnishings, Non-durable household furnishings, Drugs, Other health goods, Vehicle purchases, Motor vehicle repair parts, Motor vehicle fuel, Other fuels, Reading & entertainment supplies, Jewelry & watch, Toilet articles & cosmetics, Personal care.
- Services: Rent by tenant, Rent imputed, Other occupant charges, Electricity, Gas, Laundry & dry cleaning, Domestic child care, Other health services, Physician services, Hospital care, Other automobile services, Purchase of transportation, Communication, Recreational equipment & services[64], Education & cultural services, Restaurants & hotels, Financial & legal services.

HOUSEHOLD REAL CONSUMPTION EXPENDITURES, 1926–1986. — We obtain the nominal and real consumption expenditures of durable goods, semi-durable goods, non-durable goods, and services for the period 1926–1986 from Statistics Canada (2016*c*). We can calculate the prices of services directly from this series for the entire period. Agricultural goods are not separately listed and are part of non-durable goods. Similar to the case of the United Kingdom, we compute real quantities based on the nominal expenditures and the consumer price index (CPI) for food that we obtain from Statistics Canada (2015, 2014). We then separate real quantities of manufacturing goods from the non-durable goods with a root finding procedure to find the missing sectoral quantities and prices that make the aggregate real consumption consistent with the index implied by the Fisher aggregation.

HOUSEHOLD CONSUMPTION EXPENDITURES, 1981–2014. — We obtain the series for annual nominal and real household consumption expenditures for the years 1981–2014 from Statistics Canada (2016*a*). The classification in the three broad categories is as follows:

- Agriculture: Food & non-alcoholic beverages, Alcohol.
- Manufacturing: Tobacco, Clothing, Garment, Footwear, Maintenance & repair goods, Furniture, Carpets, Textiles, Major household appliances, Small household appliances, Major tools & equipment, Small tools & miscellaneous accessories,

[64]This category is ambiguous and we classify it as services.

Other semi-durable household goods, Other non-durable household goods, Pharmaceutical & medical products, Medical products & equipment, Car purchases, Truck & van purchases, Fuel, Telecommunication equipment, Audio and visual equipment, Information processing equipment, Recording & media, Major recreational goods, Indoor recreational goods, Games & toys, Sport and camping equipment, Garden products, Pet & pet food products, Books, Newspaper, Miscellaneous print, Personal goods, Other personal goods, Jewelry & clocks & watches, Other personal effects.

- Services: Clothing services, Actual house rental, imputed house rental, Household maintenance & repair services, Water, Electricity, Gas, Repair of personal and household goods, Rent of household goods, Other property services, Outpatient services, Hospital services, Vehicle maintenance & repair, Parking, Passenger vehicle rent, Transport operation, Bus transport, Taxi & limo transport, Air transport, Rail & water transport, Other transport services, Postal services, Telephone & fax services, Veterinary services, Recreational & sport services, Cable & satellite services, Cinema, Photo services, Other cultural services, Chance & games, University education, Other education, Food & beverages services, Liquor services, Accommodation services, Insurance & financial services, Life insurance, Property insurance, Health insurance, Transport insurance, Personal services, Childcare outside services, Childcare inside services, Other social & funeral services, Legal & other services.

GOVERNMENT CONSUMPTION. — We obtain annual nominal and real government consumption for the years 1926–1986 from Statistics Canada (2016*c*) and for the years 1981–2015 from Statistics Canada (2016*d*).

POPULATION DATA. — We get the population data until 1977 from Statistics Canada (2016*e*) and the more recent series are obtained from Statistics Canada (2016*b*).

Australia

HOUSEHOLD CONSUMPTION EXPENDITURES, 1900–1948. — The nominal household consumption expenditures for the period 1900–1948 (with some gaps) are obtained from Haig and Anderssen (2006). For some subcategories we have missing observations in 1900 and 1910 that we need to approximate based on more aggregated series. In particular, we assume that car purchases in 1900 and 1910 were the same proportion of total expenditures on travel as in 1920. We apply the same strategy for private transport services. Furthermore, we calculate public transport services prior to 1920 by subtracting private transport services and vehicle purchases from total transport expenditures. The real household consumption expenditures are available from the same source.[65]

[65]We corrected some obvious typos in the real data. For example, the columns for health and education were incorrectly labeled and some decimal places were shifted.

We calculate prices for each category that is available in the real and nominal series. For some categories such as private transport services we needed to calculate the nominal expenditures by subtracting subcategories from aggregates. In order to find the real quantities and prices for these subcategories, we apply a root finding procedure that inverses the Fisher aggregation as described on earlier occasions for GBR and CAN.

We then construct aggregate quantities and prices for the three broad sectors using Fisher aggregation with the following classification:

- Agriculture: Food and non-alcoholic beverages, Alcoholic beverages.
- Manufacturing: tobacco, clothing & footwear, durable goods, toys & sports goods, newspapers & books, electricity & gas & fuel,[66] other goods.
- Services: Rent, communication, entertainment, education, health, other services.

Since some of the subcategories like private transport had to be constructed for the early years, we need to make some assumptions in order to link the series for prices and quantities over time. In particular, we use the growth rates in prices and quantities in manufacturing and services without transport in order to link the series before and after 1920.

In order to link the series prior to 1948 to the new series starting in 1970 (discussed below), we exploit that Haig and Anderssen (2006) report nominal and real data for several subcategories every ten years between 1950 and 2000. Since this overlaps with the more recent data that starts in 1970, we are able to link the two series.[67]

HOUSEHOLD CONSUMPTION EXPENDITURES, 1970–2015. — We obtain household final consumption expenditure for the period 1970 to 2015 from Table 42 of the Australian System of National Accounts (Australian Bureau of Statistics, 2015).[68] The table includes expenditures in current and constant prices for 27 expenditure categories and we calculate prices for each category. The quantities for recreational goods, recreational services, and books are missing for the years prior to 1986, but we have the total expenditures for recreation. We therefore assume that price growth in each of the missing subcategories is the same as in total recreation.[69]

[66] This category is ambiguous because it is partly manufacturing (fuel) and partly services (electricity and gas). We allocate it to manufacturing because data from other countries suggest that fuel is the larger part. For example, in the USA in 1929, expenditures on gasoline and oil were $1,814 and expenditures on electricity and gas were $1,158 (in million USD), see Carter et al. (2006).

[67] The subcategories for which we observe both nominal and real data in both periods include Food, Clothing, Rent, Tobacco, Alcohol, Durable Goods, Fuel & Light, Household Operation, Public Transport, Private Transport, and Communication. The base year of the constant price data changes in 1948, but in that year the data is provided for both base years, such that we can express the series in a common base year. We then construct the broad aggregates from the appropriate subcategories in order to obtain series for quantities and prices that link the pre-1948 and post-1970 data.

[68] The table goes back to 1960, but a number of sub-categories are missing.

[69] This appears the best available approximation, but it should be noted that some sub categories combine services and other goods.

We then use Fisher aggregation in order to compute quantity and price growth for the broad sectors agriculture (with and without alcohol), manufacturing, and services. The subcategories are classified as follows:

- Agriculture: food and alcohol.
- Manufacturing: tobacco, clothing, furnishings and household equipment, vehicle purchases, goods for recreation and culture, books, papers, stationery and artists goods, electricity & gas & fuel.[70]
- Services: rent, health, vehicle operation, transport services, communication, recreational services, education services, hotel & restaurant services, insurance & financial services, and government consumption.

Quantities for insurance and financial services are not available for the years prior to 1980 and we therefore approximate their growth for the early years based on the remaining services. The series from 1900–1948 and 1970–2015 are linked together as described above.

GOVERNMENT CONSUMPTION. — The nominal and real series for government consumption for the years 1960–2014 are obtained from the WDI (World Bank, 2016*a*,*b*). The nominal and real series for government consumption for the years 1900–1970 are obtained from Tables 22 and 23 from Butlin, N.G. and Australian National University (1985) in the Source Papers in Economic History Series (No. 6). We use Fisher aggregation in order to combine government consumption with private household consumption.

POPULATION. — The population statistics from 1900 to 2010 are obtained from the Australian Historical Population Statistics (Australian Bureau of Statistics, 2014). The population statistics for the years 1981 to 2015 are available from the Australian Demographic Statistics (Australian Bureau of Statistics, 2016). We use these population series to obtain our per capita measures.

C2. Price Aggregation

We collect data on prices (or, real quantities) and nominal expenditure for the finest subcategories available in each country and time period. By dividing the the nominal expenditure for each subcategory by the price (quantity) index we obtain the associated quantity (price) index. The real quantities are aggregated from the subcategories to the sectoral level according to a chained Fisher index. Fisher aggregation is also the standard procedure for the most recent NIPA tables provided by the Bureau of Economic Analysis (BEA) in the USA (see Whelan (2002)). More formally, let the total real consumption

[70] This category is ambiguous and is assigned to manufacturing. See footnote 66 for details.

index at the sectoral level (for example, manufacturing) be denoted by $c_{j,t}$. The real growth rate of the index satisfies the equation

$$\frac{c_{j,t}}{c_{j,t-1}} = \sqrt{\frac{\sum_{s=1}^{S} p_{s,t} c_{s,t}}{\sum_{s=1}^{S} p_{s,t} c_{s,t-1}} \times \frac{\sum_{s=1}^{S} p_{s,t-1} c_{s,t}}{\sum_{s=1}^{S} p_{s,t-1} c_{s,t-1}}}, \tag{C1}$$

where $p_{s,t}$ is the price of subcategory $s = 1, \ldots, S$ (for example, clothing and footwear) and $c_{s,t}$ denotes the associated quantity index such that nominal expenditure on subcategory s corresponds to the product, $p_{s,t} c_{s,t}$. After choosing a base year for the sectoral quantity index $c_{j,t}$ we use the the growth rate implied by Equation (C1) to chain the index backward and forward. The sectoral Fisher price index is then simply given by the $p_{j,t}$ such that the product $p_{j,t} c_{j,t}$ corresponds to the total nominal expenditure for sector j in period t.

The aggregation procedure in Equation (C1) can also be applied to a more aggregate level. In particular, subcategories s can be substituted by sectors i and the left-hand side by aggregate real consumption growth. This is useful whenever we cannot directly aggregate the price indexes of subcategories to the sectoral level because of missing data. In these cases, however, when we have available an aggregate consumption price index and the other two sectoral price indexes, we are using a root-finding procedure in combination with a more aggregate version of Equation (C1) to solve for the unknown sectoral price index. Or, in other words, we are solving for the unknown sectoral price index which makes the aggregate consumption price index consistent with the Fisher index that results from aggregating up the sectoral prices. This is the case for GBR in the period from 1966 to 1995, and for CAN between 1926 and 1986. The data availability of nominal expenditures for the subcategories on the other hand is always complete for the considered time periods and countries.

C3. Purchasing Power Parity Adjustment

We adjust the sectoral price and quantity indexes measured in local currency units for the power purchasing parity (PPP) relative to the USA for each of the other countries. We follow Bolt and van Zanden (2014) and choose 1990 as the base year. Formally, we set the PPP-adjusted price index in 1990 for the USA to unity and for the remaining countries the price in the same period corresponds to the PPP-adjusted exchange rate reported in World Bank (2016*c*) for 1990. Then, we chain the PPP-adjusted prices in the base year forward and backward with the inflation rate of the non-adjusted sectoral prices. Thus, all prices can be interpreted in terms of 1990 international \$. The same procedure is applied to the sectoral real consumption indexes, except that in the base year real consumption corresponds to nominal consumption expressed in 1990 international \$. The PPP-adjusted nominal sectoral expenditure is then derived by simply multiplying the PPP-adjusted price and quantity indexes for each sector.

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