Arrested Development? Puerto Rico in an American Century

Appendix two – Online Data Appendix

The first section of this appendix describes the GDP index along with various GNI indices and the terms of trade adjustment to GDP. The second section provides the 1950 Puerto Rico US comparison. I close with a discussion of the COLA price level comparisons.

Much of the data used in the calculations comes from four sources, the *Annual report of the Governor of Puerto Rico* for the fiscal year ending June 30 henceforth the Report of the Governor, *Historical Statistics (1959)* and the statistical annuals - *the Statistics of Puerto Rico* and its successor volume the *Annual book on statistics of Puerto Rico*.[1]

1. The GDP Index

The GDP index is a quantity index where the weights are the base year shares in value added. Table One from the text provides the weights. A missing sector is housing where, so far, I have not found sufficient information to construct an index. The implicit assumption is that housing grows at the same rate as the rest of the economy.

I form the sectoral output indices as follows:

[1] The Puerto Rican data cover the fiscal year.

(i) Agriculture

The agricultural sub-weights are in Table 1a. The weights give the share of each product in 1940 gross agricultural output. I calculate the 1940 weights from Perloff (1950) Table 19 page 81. I also provide 1909 weights calculated from the 1909 census.

Table 1a
Agricultural Weights

	1909 Prices	1940 prices
Sugar Cane	0.491	0.517
Tobacco	0.073	0.051
Coffee	0.199	0.050
Milk	0.038	0.133
Eggs	0.015	0.016
Beef	0.059	0.062
Pork	0.013	0.035
Poultry	0.018	0.036
Pineapples	0.008	0.009
Coconuts	0.008	0.009
Oranges	0.008	0.009
Grapefruit	0.008	0.009
Plantains	0.030	0.032
Bananas	0.030	0.032
	1.000	1.000
Annual Growth Rate agriculture 1900-1940	0.036	0.028

The weights show a dramatic decline in the importance of coffee from 1909 to 1940 while milk share increases. The share of sugar is unchanged.

Table 2a provides the sub- indices for agriculture. The main source is the census, which contains data for all items, save meat. Production outside of the census years is available for sugar, tobacco and coffee using the Report of the Governor. Starting in the 1930's, there are annual data for most other items. Where annual data is not available, I interpolate between census benchmarks.

Meat (beef, pork and poultry) poses the most difficulties. Statistics for meat production date from the 1930's but they are unsatisfactory before the 1940's. To form the meat index for earlier years, I use post-1940 data and allow for an increase in meat produced per animal over time. For beef and pork, I assume a one percent increase per year. For poultry, I assume two percent.

The weights cover 1909 and 1940. This allows me to calculate annual growth rates for agriculture in 1909 and 1940 prices. The results are in the bottom panel of Table 1a. As expected, growth is faster using early period weights, 3.6 percent as compared to 2.8 percent. Using 1940 prices, agricultural output increases threefold while it increases by more than four times with 1909 prices.

Table 2a
Agricultural Indices
1940 = 100

	Sugar	Tab	Coff	Milk	Eggs	Beef	Pork	Poultry	Pin	Coc	Oran	Grape	Plan	Ban
1900	8	36	153	24	38	82	45	38	137	71	119	2	45	100
1901	10	36	153	24	40	82	45	40	137	71	119	2	45	100
1902	10	36	153	24	42	83	46	42	137	71	119	2	45	100
1903	13	36	153	24	43	83	47	43	137	71	119	2	45	100
1904	15	36	153	24	45	84	48	45	137	71	119	2	45	100
1905	21	36	153	24	47	84	49	47	137	71	119	2	45	100
1906	20	36	153	24	49	84	50	49	137	71	119	2	45	100
1907	23	36	153	24	51	85	51	51	137	71	119	2	45	100
1908	27	36	153	24	53	85	52	53	137	71	119	2	45	100
1909	34	36	153	24	56	86	53	56	137	71	119	2	45	100
1910	34	39	161	24	58	86	55	58	137	71	119	2	45	100
1911	36	39	153	25	60	87	56	60	125	75	127	3	44	101
1912	39	46	153	25	62	87	57	62	114	78	135	3	43	102
1913	35	53	153	25	65	87	58	65	105	82	144	4	43	104
1914	34	46	153	25	67	88	59	67	96	86	154	5	42	105
1915	34	43	153	25	69	88	60	69	87	89	165	6	41	106
1916	47	67	153	26	72	89	62	72	80	94	176	7	41	107
1917	49	90	153	26	74	89	63	74	73	98	187	8	40	108
1918	45	92	153	26	77	90	64	77	67	102	200	10	39	110
1919	40	69	153	26	80	90	65	80	61	107	214	12	39	111
1920	48	90	163	27	83	91	67	83	58	113	233	17	38	112
1921	48	89	135	28	85	91	68	85	63	105	223	18	37	116
1922	40	80	118	30	86	91	70	86	68	97	213	19	37	119
1923	37	93	78	32	88	92	71	88	74	90	203	20	36	123
1924	44	89	89	34	90	92	72	90	81	84	195	21	35	127
1925	65	82	105	37	91	93	74	91	87	78	186	22	35	130
1926	60	128	111	39	93	93	75	93	95	72	178	23	34	134
1927	62	178	120	41	95	94	77	95	103	67	170	24	33	138
1928	73	96	99	44	96	94	78	96	112	62	162	26	33	143
1929	58	100	56	47	98	95	80	98	122	58	155	27	32	147
1930	86	116	16	51	100	95	82	100	137	55	150	29	32	152
1931	77	97	18	55	100	96	83	100	133	64	154	33	33	144
1932	97	21	31	58	100	96	85	100	129	75	158	37	35	137
1933	82	60	35	62	100	97	87	100	126	88	163	41	37	130
1934	109	89	28	66	100	97	89	100	122	103	168	46	40	123
1935	77	80	25	71	100	98	90	100	119	128	172	52	42	117
1936	91	93	79	76	100	98	92	100	115	122	154	59	49	114
1937	98	124	63	81	100	99	94	100	111	116	137	66	58	110
1938	106	157	51	86	100	99	96	100	107	110	122	74	68	106
1939	84	49	58	92	100	100	98	100	103	105	108	83	80	103
1940	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Notes: The estimates cover sugar, tobacco (Tob), coffee (Coff), milk, eggs, beef, pork, poultry, pineapples (Pin), coconuts (Coc), oranges (Oran), grapefruits (Grap), plantains (Plan) and bananas (Ban)

(ii) Manufacturing

Table 3a gives weights for the manufacturing index. The weights are value added shares taken from Creamer (1947) for 1940. I derive the 1909 weights from census of manufacturing. For both years, manufacturing has as simple structure. The activities covered in the Table account for ninety percent of value added in 1909 and eighty percent of manufacturing value added for 1940.

Table 3a
Manufacturing Weights

	1909 prices	1940 Prices
Sugar mills and refining	0.600	0.456
Distilling and bottling of liquors	0.070	0.078
Bakery Products	0.040	0.060
Tobacco products	0.290	0.120
Needle work and other textiles		0.290
	1.000	1.000
Growth rate of Manufacturing 1900-1940	0.054	0.052

By 1940, the relative importance of Tobacco and to a lesser extent sugar has declined. Needlework and textiles did not exist in 1909. By 1940, they account for thirty percent of value added.

The manufacturing indices are in Table 4a. The sources are as follows:

Sugar Manufacturing*:* Sugar output is from sources outlined in the agricultural index.

Distilling and bottling of liquors. Before prohibition, I estimate domestic production from excise receipts in the Report of the Governor. After prohibition, output is from Historical Statistics.

Bakery Products: I project the 1940 benchmark backwards using flour imports from the food import index described later.

Tobacco products: The tobacco index consists of three sub-indices – cigars, cigarettes and activities associated with stemming and re-drying of tobacco. The sub-weights are from the census of manufacturing (1949) which I assume also hold for 1940 while the data used to construct the sub-indices are from the Report of the Governor.

Needlework and other Textiles: I assume that all output is exported. Perloff (1950) and the Report of the Governor provide nominal exports of textiles. I deflate exports using the BLS wholesale textile price from US Historical Statistics – E45 transformed to a fiscal year.

The final panel gives growth rates for manufacturing in early and late period prices. In contrast to agriculture, the late period weights do not have a large impact on growth rates. Using early prices, the growth rate is 5.4 percent while late prices give growth as 5.2. The results may reflect the extraordinary volatility of the sub components of manufacturing which are driven by changes in world prices and by dramatic changes government policy towards sugar.

To sum up, the available evidence for agriculture and to a lesser extent manufacturing shows that late period weights reduce measured growth rates. Outside of agriculture and manufacturing, it is not possible to construct indices using early period weights.

Table 4a
Manufacturing Indices
1940 = 100

Year	Sugar	Distilling	Bakery	Tobacco	Needlework
1900	8	38	52	44	
1901	10	38	52	44	
1902	10	38	58	50	
1903	13	40	64	55	
1904	15	42	54	52	
1905	21	61	48	60	
1906	20	46	60	67	
1907	23	46	67	70	
1908	27	43	65	66	
1909	34	44	72	73	
1910	34	44	79	76	
1911	36	53	85	85	
1912	39	46	81	81	
1913	35	42	87	99	
1914	34	25	82	87	
1915	34	24	74	85	
1916	47	23	83	104	
1917	49	24	76	132	
1918	45	53	72	129	
1919	40		95	106	
1920	48		94	141	
1921	48		94	121	
1922	40		97	113	18
1923	37		106	129	27
1924	44		108	122	30
1925	65		103	120	24
1926	60		99	167	36
1927	62		118	198	42
1928	73		100	124	43
1929	58		125	126	74
1930	86		112	136	71
1931	77		81	122	87
1932	97		102	46	90
1933	82		111	70	92
1934	109	70	106	94	98
1935	77	73	99	85	92
1936	91	77	102	94	112
1937	98	83	110	125	129
1938	106	89	121	151	74
1939	84	92	94	54	99
1940	100	100	100	100	100

(iii) Other Sectors

Construction: Outside of labor, almost all inputs to construction were imported. To project the 1940 benchmark backwards, I form an index of building material imports in 1940 prices. The index covers cement and boards/planks etc where I weight quantities with 1940 prices. These data come from Historical Statistics and the Statistical Annuals. The index reaches to 1926. For earlier years, I construct a quantity index for building material imports by deflating the nominal imports of construction materials taken from Smith (1936) by the BLS construction material price index from the US Historical Statistics (E47). I change the BLS index to a fiscal year.

Transportation: The index has three components, rail, motor vehicles and shipping. After 1935, statistics for railways are available from the Statistical Annuals. To create an initial benchmark, I take passengers for 1903 from page 32 United Sates Department of Commerce (1907) while I take 1903 ton-miles from page 87 of Monthly Consular and Trade Reports, No. 329 (1908). To interpolate, I assume that rail freight moves with sugar production. Mitchell (1993) provides data on commercial vehicles. I assume that output of road transporation is proportional to vehicles and that productivity increases by five percent per year – similar to the US. Finally, shipping output is set equal to the volume of exports plus imports described later. The weights for the sub-indices are from Appendix A-2 Perloff (1950).

Power and Gas: Electricity generation. These data begin at 1937 from Mitchell (1993). I use US electricity generation to extrapolate to earlier years.

Communications. Telephones in use. Mitchell (1993) gives estimates starting from 1923. Rippy (1946) gives data for 1900 and 1913. I interpolate to obtain annual data.

Trade: I assume that the output of the wholesale/retail trade sector is proportional to the volume of imports and the volume of manufacturing output less sugar and tobacco. I outline the quantity index for imports later. The weights for imports and manufacturing come from the gross output data in the 1939 census of manufactures.

Banking and Insurance: I assume that the output of the financial sector is proportional to the real value of deposits in the banking system. After 1923, deposits are from Di Venuti (1950). For 1907 to 1922, I take deposits from the Annual Report of the Governor. To obtain deposits from 1900 to 1907, I interpolate between the estimates for 1899 and 1907 from Di Venuti (1950). I deflate the nominal deposits by the import price index described later. There is a dramatic fall in nominal deposits between 1932 and 1936 with a recovery thereafter.

Government: I assume that output is proportional to total employment in the public sector where employment is from the Census and Perloff (1950). The approach assumes constant productivity of workers. I interpolate between census years.

Services: There are two components– domestics and all other services. For domestics, I set output equal to employment as taken from the census and Perloff (1950). I also set the output of other services equal to employment. The approach is standard but it imposes an assumption of zero productivity growth. The weights in the sub-index are GDP weights.

The sectoral indices are in Table 5a. Note that GDP in 1940 is $277.4 million dollars see Perloff (1950).

Table 5a
Sectoral Indices
1940 = 100

Year	Agriculture	Manu	Construct	Trans	Utilities	Comm	Trade	Government	Finance	Services	GDP
1900	33	16	10	3	2	1	10	18	6	45	23
1901	34	16	10	3	2	1	11	18	7	46	24
1902	34	17	17	4	3	2	15	19	8	47	25
1903	36	19	17	5	3	2	16	19	10	48	26
1904	37	20	16	5	3	2	15	19	11	48	27
1905	41	24	20	6	3	3	19	20	12	49	29
1906	40	24	24	8	3	3	23	20	14	50	30
1907	42	26	36	9	7	4	27	20	15	51	31
1908	44	28	33	9	8	5	26	21	17	52	32
1909	48	32	36	10	8	6	28	21	21	52	35
1910	49	33	42	11	8	7	30	21	29	53	36
1911	50	36	56	13	8	9	37	22	33	52	38
1912	52	36	65	15	12	11	41	23	28	52	39
1913	50	36	57	15	14	17	35	24	31	51	38
1914	50	33	52	16	16	19	34	25	28	50	38
1915	50	32	40	15	18	21	32	27	26	49	37
1916	58	41	39	18	21	23	37	28	39	49	43
1917	61	45	51	20	22	25	41	29	37	48	45
1918	59	44	42	19	24	28	39	30	30	47	44
1919	56	37	36	19	25	31	34	32	31	47	41
1920	62	44	39	23	27	34	46	33	41	47	47
1921	61	44	66	26	26	38	56	35	38	49	49
1922	56	43	57	27	29	41	46	37	43	51	46
1923	53	46	51	28	34	46	51	40	54	54	48
1924	58	50	70	32	37	51	60	42	54	56	52
1925	70	57	60	41	41	56	62	45	56	59	58
1926	70	63	72	44	45	62	65	47	52	62	61
1927	75	71	77	47	49	69	71	50	53	66	65
1928	76	67	50	44	52	68	66	53	52	70	65
1929	67	70	65	42	56	68	68	56	47	74	64
1930	81	83	42	45	55	63	67	60	45	79	71
1931	76	79	38	46	53	63	68	63	50	81	70
1932	84	82	40	51	48	63	68	66	52	83	74
1933	79	79	52	52	49	63	67	70	51	85	73
1934	95	101	45	60	55	68	74	73	51	87	84
1935	78	83	56	60	57	74	69	77	52	89	76
1936	90	97	70	69	66	79	80	81	63	91	85
1937	95	110	82	78	69	79	94	85	76	93	93
1938	101	102	81	82	77	84	90	89	72	95	95
1939	85	86	80	89	90	89	81	94	81	97	88
1940	100	100	100	100	100	100	100	100	100	100	100

(iv) Adjusting GDP for terms of trade changes

Equation (1a), also given in the text, is the terms of trade adjustment to the volume of GDP.

(1a) T = effects on GDP of the terms of trade = $x\left(\frac{px}{p} - 1\right) + m(1 - \frac{pm}{p})$

I take nominal exports and imports from the Annual Report of the Governor. These data cover trade all trade, that is trade with US and other countries.

To implement the terms of trade adjustment requires price and volume indices for imports and exports. Perloff (1950) provides import and export price indices, see Perloff (1950, page 50), but he does not supply details of their construction. After creating price indices for imports and exports, I find similar results to his. I accept his price indices as he likely had access to better price data - particularly for textile exports. The Perloff price indices stop at 1913. I extrapolate his import price index to 1901 using the import price index from Smith (1936). To extend the Perloff export price index to 1901, I create a volume index of exports in 1914 prices. The index covers tobacco, cigars, coffee and sugar taken from the Report of the Governor. These items account for eight-six percent of exports in 1914. I use the implied export deflator to extend the Perloff export index to 1901.

Table 6a contains the price and volume indices.

Table 6a
The External Terms of Trade: 1901-1940
1940 = 100

	Trade Volume Indices		Price indices	
Year	Exports	Imports	Exports	Imports
1900				
1901	9	12	104	71
1902	17	17	81	73
1903	19	18	84	75
1904	21	17	84	73
1905	19	20	106	77
1906	28	26	91	78
1907	31	32	89	84
1908	33	29	101	83
1909	33	31	99	81
1910	40	34	102	85
1911	42	43	104	83
1912	47	48	114	84
1913	53	39	101	88
1914	51	39	91	86
1915	42	36	127	87
1916	50	39	146	94
1917	58	42	151	120
1918	47	40	170	149
1919	46	35	185	166
1920	53	50	311	178
1921	49	65	248	152
1922	64	50	122	119
1923	52	56	172	120
1924	57	68	169	123
1925	80	66	128	128
1926	77	67	140	134
1927	84	70	139	131
1928	92	65	128	132
1929	80	68	111	134
1930	96	58	112	135
1931	100	60	106	119
1932	100	60	94	96
1933	91	59	90	87
1934	101	59	93	101
1935	95	62	91	105
1936	104	71	104	111
1937	119	85	104	108
1938	88	84	101	104
1939	109	80	86	96
1940	100	100	100	100

Notes: Total exports for 1940 are $107.03 million and total imports are $92.35.

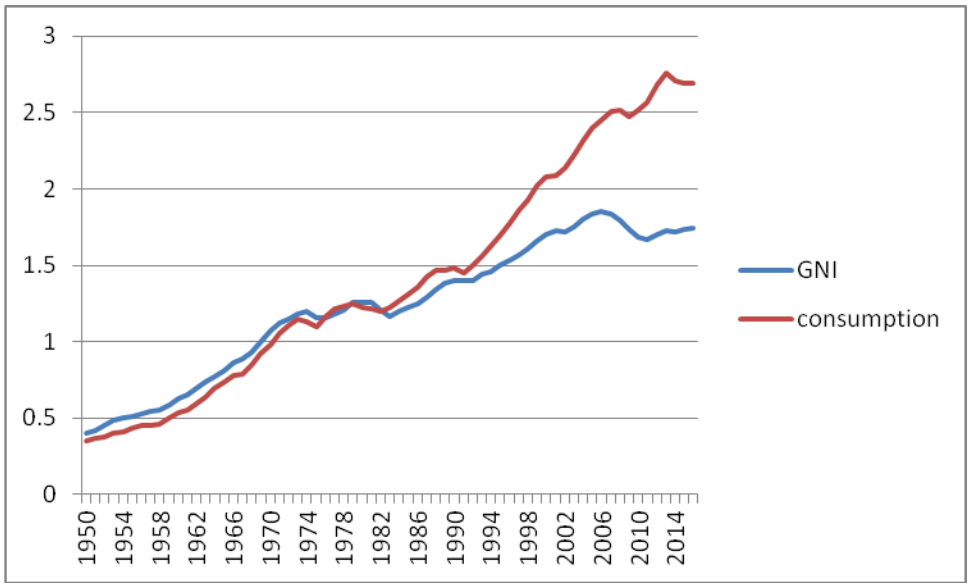
(v) Real GNI – 1900-2016

Table 7a provides three series on real GNI. The first series, GNI, is that used in Figure Six in the text. It covers the years from 1900 to 2016 connecting GNI from the Puerto Rican national accounts after 1940 to the GDP index of this paper for earlier years. To join the series, I assume that GDP grows at the same rate as GNI before 1940. As outlined in the text, the GNI series is not adjusted for changes in the external terms of trade. The omission leads to the very counterintuitive result shown by Figure 1a which graphs personal consumption, that is NIPA consumption, per capita against GNI in 1954 prices.

Figure 1a

Real GNI and real Consumption per capita 1950-2016

1954 prices



Source: Series Históricas ('50-'11p) to 2011 and after 2011 the Economic Report for the Governor and Legislative Assembly for Puerto Rico. Consumption and GNI are in constant 1954 prices.

The results are striking. Consumption starts at ninety percent of GNI during the early 1950's. By 2016, consumption was forty-five percent higher. What underlies the different

behavior of consumption and GNI? The answer lies in the terms of trade which improved by sixty percent. Before discussing the terms of trade adjustment, it is worth enquiring whether the improvement in the terms of trade is a statistical artifact arising from transfer pricing. Recall that transfer pricing occurs when multinational firms in Puerto Rico overstate profits. This will be reflected in under-invoicing of imports or over-invoicing of exports. Assume for the moment that transfer pricing leads to the overstatement of exports.[2] This can occur by an overstatement of quantities, a volume effect, or through overstating prices - a price effect. If quantities are overstated, then the GNI/GDP deflator for exports and hence overall GNI/GDP is not affected. If prices are overstated, then the export and GNI/GDP deflators are biased upwards and GNI growth is biased downwards.[3] Has transfer pricing influenced measured GNI growth for Puerto Rico? The suspiciously large improvement in the external terms of trade suggest that this is a possibility.[4]

To apply the terms of trade adjustment I use equation (2) in the text. For 1900 to 1940, I used the import price level to deflate trade as broader indices were not available. A more appropriate deflator for recent years is given by the domestic expenditure deflator see Kohli (2004). For this paper, I use the implicit deflator for consumption. The reason why I use consumption deflator rather than the overall expenditure deflator will be clear shortly.

[2] The argument also holds if transfer pricing occurs through the under-invoicing of imports.

[3] To date, the academic literature on this topic is sparse. Fitzgerald (2015) is a notable exception. He discusses the effects of transfer pricing on the national accounts for Ireland, an economy that shares with Puerto Rico a large difference between GNI and GDP and widespread transfer pricing.

[4] A comparison with the Irish case is again instructive. Since 1990, the external terms of trade have shown almost no change. This is a useful comparison as, like Puerto Rico, Irish exports are dominated by multinationals in the pharmaceutical and tech industries. Indeed, Ireland and Puerto Rico share many of the same US companies and they have a large bilateral trade.

The results for GNI after adjusting for changes in the external terms of trade are given as the GNI I series in Table 6a. Figure 2a compares the GNI and GNI I indices after 1950. The series move together until the early 1970's. After the oil crisis, the GNI I series implies much higher income levels reflecting the improvement in the external terms of trade. For recent years, GNI I is seventy percent above GNI. The size of the terms of trade adjustment reflects the large improvement in the terms of trade and the large share of exports in GNI.

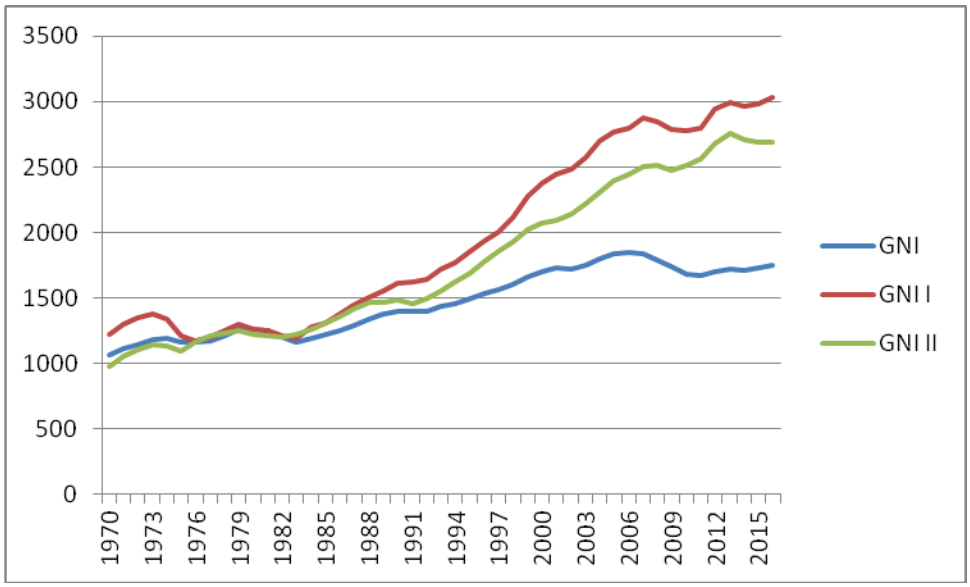
The GNI I series is measured in fixed 1954 prices. As argued in the text, this overstates growth as the implicit deflator for consumption is biased downward. There is enough information to reweight the implied consumption deflator. The GNI II series in Table 6a uses a reweighted implicit consumption deflator to deflate GNI. The deflator from 1954 to 1975 is a Fisher Ideal index formed from implicit consumption deflators derived from consumption in 1954 and 1975 prices while the deflator from 1975 to 2011 is a Fisher Ideal index of consumption deflators in 1975 and 2011 prices.

The results for GNI II are in Figure 2a.

Figure 2a

Real GNI per capita 1950-2011

1954 = 100



Source: Series Históricas ('50-'11p) to 2011 and after 2011 the Economic Report for the Governor and Legislative Assembly for Puerto Rico. GNI provides the series in 1954 prices while GNI I adjusts for changes in the external terms of trade using the implied consumption deflator to deflate trade. GNI II uses a re-worked consumption deflator to deflate GNI and trade. The deflator from 1954 to 1975 is a Fisher Ideal index formed from implicit consumption deflators derived from consumption in 1954 and 1975 prices while the deflator from 1975 to 2011 is a Fisher Ideal index of consumption deflators in 1975 and 2011 prices.

Using the revised GNI deflator reduces real income. For recent years, GNI II, is about eighty percent of GNI I which is still well above GNI.

The above results are meant as illustrative only. They underline the difficulties of calculating income growth for Puerto Rico given the distortions in the national accounts caused by the reliance on fixed 1954 prices and by the transfer pricing of US corporations on the Island. Unfortunately, there are no good alternative deflators for GNI. The CPI is unsatisfactory as it is a fixed weight index and hence cannot function as a deflator. One could use the US deflators but this give us the same results in section four in the text.

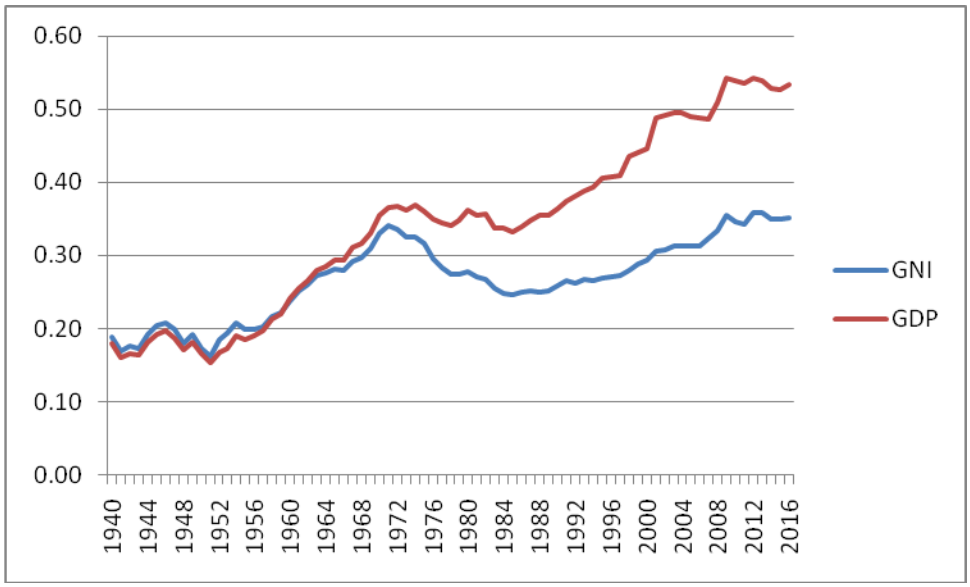
Table 7a also provides population and employment. I assume that employment is ninety-five percent of the labor force before 1950. In addition, I take the labor force from the census where I interpolate between each census. Population comes from Series históricas ('50-'11p). Maddison (2007) and the Economic Report of the Governor. After 1950, employment is from Series históricas ('50-'11p) and the Economic Report of the Governor.

Finally, it is important to keep in mind two other features of the national income for Puerto Rico. The first is the differences between GNI and GDP. Figure 3a compares Puerto Rican GDP and GNI from 1940 to 2016 to the US in current US dollars. At first, GDP behaves similarly to GNI. A gap appears in the 1960's. The gap grows larger after the mid-1970's. By the middle 2000's, the ratio of GNI to GDP is two thirds. Relative GDP per capita reaches 0.53 for recent years compared to a GNI ratio of 0.35.

Figure 3a

Relative GDP and GNI per capita – Puerto Rico and the US from 1940 to 2016

US = 100



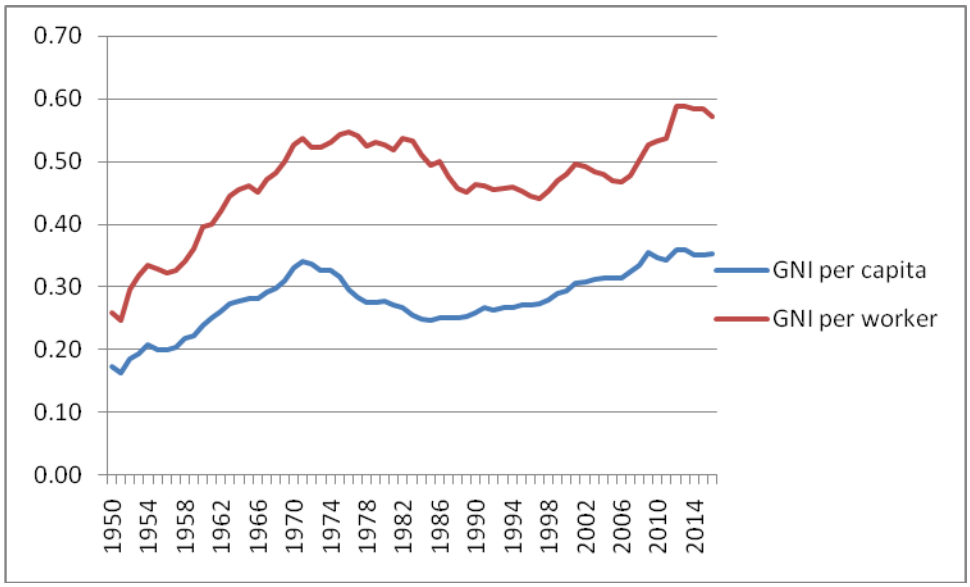
Source: Authors' calculations using Pico and Perloff (1951) for 1940 to 1950 and Series Históricas ('50-'11p) and the Economic Report for the Governor and Legislative Assembly thereafter for Puerto Rican GNI and GDP. The US data are from the BEA national accounts.

It is also worth highlighting the divergence between income per capita and per worker. Figure 4a compares GNI per capita and per worker since 1950 for the US and Puerto Rico. The ratio for GNI per worker is higher for all years increasing from 0.25 in 1950 to 0.55 by the early 1970's. The ratio declines during the 1980's but it returns 0.57 for 2016 – higher than the 1970's peak. The low ratio of employment to population for the island explains the per capita/per worker differences. For early years, this is due to age structure. For recent decades, it is likely explained by various social programs that reduce labor force participation, see Burtless and Sotomaryor (2006).

Figure 4a

Relative GNI per capita and per worker – Puerto Rico and the US from 1950 to 2016

US = 100



Source: The GNI estimates are from the sources outlined in Figure 3a. Population and employment for Puerto Rico are from Series Históricas ('50-'11p) and the Economic Report for the Governor and Legislative Assembly after 2011. The US employment estimates are from the conference board at https://www.conference-board.org/data/.

Table 7a

Real GNI, Population and Employment

Year	GNI	GNI I	Year	GNI	GNI I	GNI II	Year	GNI	GNI I	GNI II
1900	10	10	1941				1982	357	357	345
1901	11	11	1942				1983	348	348	344
1902	11	11	1943				1984	361	361	366
1903	12	12	1944				1985	372	372	382
1904	12	12	1945				1986	385	385	403
1905	13	13	1946				1987	401	401	427
1906	13	13	1947	64	64		1988	419	419	447
1907	14	14	1948	65	65		1989	435	435	461
1908	15	15	1949	72	72		1990	446	446	480
1909	16	16	1950	80	80	80	1991	450	450	484
1910	16	16	1951	84	84	83	1992	454	454	490
1911	17	17	1952	92	92	92	1993	469	469	510
1912	18	18	1953	98	98	98	1994	481	481	530
1913	17	17	1954	100	100	100	1995	497	497	552
1914	17	17	1955	103	103	104	1996	513	513	573
1915	17	17	1956	107	107	107	1997	531	531	590
1916	19	19	1957	111	111	110	1998	548	548	627
1917	20	20	1958	114	114	114	1999	570	570	668
1918	20	20	1959	123	123	126	2000	587	587	695
1919	19	19	1960	133	133	136	2001	596	596	716
1920	21	21	1961	142	142	145	2002	594	594	725
1921	22	22	1962	152	152	159	2003	607	607	749
1922	21	21	1963	165	165	175	2004	624	624	781
1923	22	22	1964	176	176	188	2005	636	636	795
1924	23	23	1965	190	190	206	2006	639	639	792
1925	26	26	1966	203	203	221	2007	631	631	801
1926	28	28	1967	212	212	229	2008	613	613	795
1927	30	30	1968	222	222	248	2009	590	590	780
1928	30	30	1969	243	243	270	2010	570	570	774
1929	29	29	1970	263	263	291	2011	562	562	773
1930	32	32	1971	279	279	314	2012	565	565	802
1931	32	32	1972	293	293	333	2013	564	564	805
1932	34	34	1973	308	308	347	2014	554	554	786
1933	33	33	1974	312	312	336	2015	550	550	779
1934	38	38	1975	306	306	308	2016	544	544	777
1935	35	35	1976	313	313	310				
1936	39	39	1977	325	325	327				
1937	42	42	1978	339	339	339				
1938	43	43	1979	358	358	355				
1939	40	40	1980	363	363	352				
1940	45	45	1981	367	367	352				

Notes: For GNI, GNI I and GNI II, 1954 = 100. There are no real GNI estimates for the Second World War. Nominal GNI per capita for 1954 is $501. GNI I and II begin with 1950 when the detailed data on consumption is available.

Table 7a- continued
Real GNP, Population and Employment

Year	Population	Employment	Year	Population	Employment	Year	Population	Employment
1900	959	315	1941	1935	502	1982	3271	719
1901	974	320	1942	1987	518	1983	3306	703
1902	990	326	1943	2033	533	1984	3335	743
1903	1006	331	1944	2062	544	1985	3363	774
1904	1022	336	1945	2099	557	1986	3392	798
1905	1039	342	1946	2141	572	1987	3420	862
1906	1056	347	1947	2162	581	1988	3447	909
1907	1073	353	1948	2187	591	1989	3479	948
1908	1090	358	1949	2197	594	1990	3517	963
1909	1108	364	1950	2206	596	1991	3550	977
1910	1126	370	1951	2227	596	1992	3574	977
1911	1144	372	1952	2231	604	1993	3600	999
1912	1162	373	1953	2216	571	1994	3632	1011
1913	1181	375	1954	2209	550	1995	3666	1051
1914	1199	376	1955	2232	540	1996	3704	1092
1915	1217	377	1956	2250	539	1997	3742	1128
1916	1235	378	1957	2255	558	1998	3770	1137
1917	1254	380	1958	2280	552	1999	3791	1147
1918	1273	381	1959	2311	555	2000	3805	1150
1919	1292	382	1960	2342	546	2001	3815	1144
1920	1312	384	1961	2384	543	2002	3821	1152
1921	1336	392	1962	2428	565	2003	3825	1188
1922	1359	401	1963	2473	568	2004	3826	1206
1923	1383	410	1964	2523	571	2005	3824	1238
1924	1407	419	1965	2568	583	2006	3813	1256
1925	1431	428	1966	2603	604	2007	3794	1263
1926	1455	437	1967	2623	634	2008	3772	1218
1927	1478	445	1968	2650	644	2009	3751	1168
1928	1502	454	1969	2685	654	2010	3731	1103
1929	1526	464	1970	2711	675	2011	3714	1077
1930	1552	474	1971	2751	686	2012	3657	1025
1931	1584	475	1972	2822	699	2013	3614	1015
1932	1615	476	1973	2869	738	2014	3564	993
1933	1647	478	1974	2881	745	2015	3504	984
1934	1679	479	1975	2914	744	2016	3442	1002
1935	1710	479	1976	2979	699			
1936	1743	480	1977	3046	678			
1937	1777	481	1978	3098	691			
1938	1810	482	1979	3141	722			
1939	1844	483	1980	3184	735			
1940	1880	484	1981	3228	753			

Notes: Population and employment is in thousands.

(vi) Cross-Checks

Table 8a provides quantity indices for clothing consumption and food imports along with a quantity index for food consumption for 1901 to 1940. The indices are in 1940 prices.

Clothing: I assume that clothing consumption is equal to clothing imports. Beginning in the early 1920's, Puerto Rico also imports textile raw materials used in the production of needlework and other textiles for export. I net out these imports by assuming that imports are forty percent of clothing exports based on data from the 1939 census of manufactures. I deflate the resulting estimate of net imports by the BLS wholesale price index for textiles products (E45) from the US historical Statistics (1975) where I change the price index to a fiscal year basis. I also construct an index for footwear imports (not reported). The index moves very closely with the clothing index described above.

Food import index. The index is a quantity index composed of the fish, meat, lard, rice, wheat flour, corn meal, beans and peas, and potatoes imports valued in 1940 prices. Quantities before 1929 are from Clark (1930), Page 608 Table III. After 1929, they are from the statistical annuals. I take prices from Perloff (1950) Table 84 assuming that they hold for 1940. The only important omission from the index are dairy products.

Food Consumption. To obtain the food index, I combine the food import index described above with data from the agricultural production index described in a previous section. The results are crude given that there are no estimates of changes in stocks and I have

no estimates of dairy imports. Thus, the index can provide at best an indicator of broad long run trends in food consumption.[5]

[5] There may also be a systematic a bias in the food index. Because the index is based on physical quantities, it will miss changes in food preparation and packaging see Usher (1976, 1980). The effects are likely to be small for Puerto Rico before 1940 given its low income. Quality change is not a problem for the clothing index as I obtain the clothing index through deflation. As Usher (1980) shows, deflation avoids the quality problem.

Table 8a

Indices for food and clothing consumption per capita along with food imports: 1901-1940
1940 = 100

Year	**Per capita Quantity Indices** Food imports	Clothing consumption	Food consumption
1900			
1901	35	31	60
1902	45	48	64
1903	43	47	63
1904	43	41	62
1905	47	55	66
1906	56	55	69
1907	61	72	71
1908	56	57	69
1909	62	75	73
1910	67	74	74
1911	70	98	75
1912	71	107	74
1913	69	73	70
1914	70	82	68
1915	66	85	65
1916	71	65	67
1917	67	75	64
1918	56	77	59
1919	66	51	64
1920	69	113	68
1921	80	107	74
1922	83	82	76
1923	87	75	78
1924	97	93	85
1925	92	90	83
1926	94	83	85
1927	97	94	90
1928	94	84	92
1929	95	71	95
1930	85	71	91
1931	87	83	91
1932	91	69	93
1933	100	55	96
1934	88	63	92
1935	90	57	92
1936	85	73	91
1937	91	74	94
1938	94	84	100
1939	85	76	91
1940	100	100	100

2. A US Puerto Rico comparison for 1950

To compare 1950 income and consumption for the US and Puerto Rico, I turn to the methodology developed by Gilbert and Kravis (1954, 1958) who compare income across the US and Western Europe using mainly quantitative indicators. Their approach differs from that of the International Comparison Program (ICP) where the focus is on price comparisons by means of large comparative price surveys. The example of food shows the differences between the price and the quantity approach. Gilbert and Kravis (1954, 1958) compare food using physical quantities of food where they obtain food quantities from food balance sheets and where the weights are domestic prices. In contrast, the ICP obtains prices for comparable food items by survey methods and then deflate relative food spending to yield implied quantities.

I do not have enough comparative price data for the US or Puerto Rico to implement the ICP approach. In contrast, the quantity data required by Gilbert and Kravis (1954) are available for both economies.

The results of the income comparison are in Table 9a. The second column gives the ratio of Puerto Rican to US consumption, investment, and government spending per capita in nominal terms. Overall, nominal Puerto Rican GNI per capita is seventeen percent of the US. The ratios for sub-components of spending are higher reflecting the fact that expenditures for Puerto Rico greatly exceeded income.

Table 9a

Comparing 1950 Expenditures on GNI per capita for the US and Puerto Rico

	Relative Puerto Rican and US per capita income levels			
	Nominal	Real comparison with prices of		
		Puerto Rico	US	Fisher Ideal
Consumption	0.24	0.30	0.37	0.33
Investment	0.09	0.10	0.11	0.11
Government	0.27	0.53	0.62	0.57
GNI	0.17	0.22	0.30	0.26

The final columns compare expenditures using US and Puerto Rican prices. As expected, the comparisons with US prices show Puerto Rico in a better light. Using the Fisher Ideal index, Puerto Rican GNI per capita is twenty-six percent of US levels while consumption is one third of US levels.

Table 10a gives the expenditure weights and the relative prices and quantities underlying the comparison in Table 9a. Where the comparison is by means of a quantitative indicator, the relative quantity is bolded. Where it is by a price comparison, the relative price is bolded.

The explanations for the sources and methods follow the Table.

Table 10a

Expenditure weights, relative prices and quantities for 1950

	Expenditure Weights		Relative	Relative Price and Quantity	
	US	Puerto Rico	Expenditures	P_{PR}/P_{usa}	Q_{PRr}/Q_{usa}
Consumption					
Food					
Rice	0.001	0.034	12.46	0.48	**25.79**
Wheat Flour	0.008	0.009	0.19	0.48	**0.39**
Corn Meal	0.001	0.002	0.69	0.56	**1.24**
Other cereals	0.000	0.002	0.75	0.84	**0.89**
Sweet Potatoes	0.000	0.003	1.15	0.44	**2.63**
Irish Potatoes	0.003	0.002	0.13	0.74	**0.18**
Other starchy vegetables	0.008	0.019	0.42	0.33	**1.29**
Oranges	0.002	0.001	0.08	0.09	**0.89**
Grapefruit	0.001	0.001	0.12	0.14	**0.86**
Pineapples	0.001	0.000	0.01	0.18	**0.03**
Other Fruit	0.009	0.010	0.20	0.33	**0.59**
Beans	0.001	0.020	4.15	0.86	**4.83**
Lard	0.002	0.011	1.09	0.71	**1.53**
Vegetable Oil and Fats	0.004	0.004	0.19	0.81	**0.23**
Fresh Milk	0.018	0.032	0.31	0.69	**0.45**
Evaporated	0.002	0.021	1.59	1.01	**1.58**
Cheese	0.003	0.002	0.15	0.61	**0.24**
Butter	0.005	0.001	0.05	0.66	**0.07**
Beef	0.032	0.033	0.18	0.66	**0.27**
Pork	0.035	0.034	0.18	0.43	**0.41**
Poultry	0.007	0.012	0.32	1.21	**0.27**
Fish	0.003	0.014	0.74	0.54	**1.37**
Eggs and Egg products	0.021	0.013	0.11	1.06	**0.11**
Sugar and Related Products	0.006	0.026	0.77	0.72	**1.06**
Non-Alcoholic Beverages	0.007	0.016	0.41	0.63	**0.66**
Alcoholic Beverages	0.012	0.057	0.83	0.79	**1.05**
Tobacco	0.008	0.027	0.58	1.65	**0.35**
Clothing and household textiles					
Footwear	0.011	0.026	0.41	0.68	**0.60**
Clothing and household textiles	0.065	0.077	0.21	**1.00**	0.21
Housing	0.056	0.059	0.19	0.62	**0.30**
Fuel light and water	0.024	0.023	0.16	**1.14**	0.14
Household Goods	0.069	0.074	0.19	**1.00**	0.19
Household and personal services					
Domestic services	0.009	0.019	0.36	0.31	**1.15**
Laundry, dry cleaning etc	0.013	0.010	0.13	**0.50**	0.27
Barber beauty shops etc	0.004	0.010	0.46	**0.50**	0.91

Table 10a - continued

	Expenditure Weights		Relative	Relative Price and Quantity	
	US	Puerto Rico	Expenditures	P_{PR}/P_{usa}	Q_{PR}/Q_{usa}
Transportation equipment and services					
Purchases of transportation equipment	0.035	0.013	0.06	1.06	**0.06**
Operation of transportation equipment	0.029	0.015	0.09	**1.06**	0.09
Public transport	0.012	0.034	0.52	**0.77**	0.68
Communication Services	0.009	0.019	0.38	3.01	**0.13**
Recreation and entertainment					
Entertainment	0.009	0.010	0.20	0.73	**0.27**
Hotels, Restaurants and Cafes	0.023	0.007	0.05	**0.50**	0.10
Books, newspapers and magazines	0.009	0.007	0.13	0.90	**0.15**
Other recreation	0.008	0.007	0.15	**0.50**	0.30
Health	0.040	0.044	0.20	0.63	0.31
Education	0.024	0.046	0.33	0.28	1.17
Miscellaneous	0.045	0.052	0.21	0.80	0.26
Investment					
Producer Durables	0.082	0.055	0.12	**1.10**	0.11
Construction					
Residential	0.050	0.038	0.13	**0.69**	0.19
Other	0.057	0.028	0.09	**0.69**	0.13
Nett change in Inventories	0.022	-0.010		**1.00**	
Nett Exports	0.005	-0.211		**1.00**	
Government					
General Administration					
Personnel	0.023	0.057	0.43	**0.30**	1.43
Goods and Services	0.011	0.042	0.66	**0.80**	0.83
Defense	0.054	0.042	0.14	**0.55**	0.25
	1.000	1.000	0.18		

Notes: government spending refers to local, state and federal spending. The spending on defense consists of federal expenditures in Puerto Rico.

Weights

For the US, I rely on Gilbert and Kravis (1954). The Puerto Rican weights are from Perloff (1950) Appendix Table 14. I make two adjustments to his estimates. First, I allocate government spending on education and healthcare to household consumption using his Table 42 on page 71. Second, I change the Puerto Rican weights to the Gilbert and Kravis (1954) classification.

Price and quantity comparisons

Food: Quantity comparison. The US and Puerto Rico do not disaggregate food expenditure in their national accounts. For the US, I used standard USDA food balance sheets. The starting point for Puerto Rico is the 1946 food balance sheet from Perloff (1950). I transform his quantities to 1950 levels using data from Pico and Perloff (1951). In addition, I add coffee omitted by Perloff. Prices come mainly from the ILO comparative price surveys. Unfortunately, these prices refer to 1951 and 1952 rather than 1950. While prices may be up to fifteen percent higher for both countries, relative prices did not appear to change much.

Multiplying prices by quantities yields total expenditure. For the US, the calculated expenditures are fifteen percent below total food spending in the national accounts. This is expected as there are omitted items (tea, soft drinks,) and the estimates ignore certain types of processing such as baby food. I assume an understatement of ten percent and I adjust quantities and prices accordingly. The situation for Puerto Rico is the opposite as the implied food spending is $145 whereas spending in the national accounts is $113. What accounts for this? I have confidence in the Puerto Rican food balance sheets. This leaves two possibilities.

First, as noted above, the ILO price data refer to 1951/1952 and exceed 1950. The adjustment brings spending to around $130. The other possibility is that the Puerto Rican national accounts understate food spending. Gilbert and Kravis (1954) show that the correct procedure in both cases is to reduce prices until implied spending equals spending in the national accounts. I follow their approach.

Alcohol: Quantity comparison. The comparison covers beer, spirits and wine. The US quantities are from the US Historical Abstracts. I calculate Puerto Rican consumption by combining production with import data. The only Puerto Rican prices for this category that I found are for beer. The quantity comparison therefore uses US prices from Ward and Devereux (2012).

Tobacco: Quantity comparison for cigarettes and cigars. The US consumption estimates are from the USDA *Tobacco Outlook*. The Puerto Rican numbers are from import data (cigarettes) and from the Statistical Annuals for cigars. I use US prices to value consumption in both countries. US cigarette prices are from the ILO. I assume that the US price for cigars is eight cents each.

Clothing: Price comparison. There are no natural quantity measures for clothing. Fortunately, Hulton (1953) gives the results of a comparison of clothing prices in San Juan with New York/New Orleans. He finds that clothing prices were almost identical. For shoes, I use a quantity comparison taking US production from Landsberg, Fishman and Fisher (1963) while I use shoe imports for Puerto Rico. The quantity comparison without adjusting for quality works out at 0.7. I assume 0.6 to allow for quality differences in footwear.

Housing. Quantity comparison. In terms of rooms, units per capita, running water etc, the 1950 Puerto Rican housing stock was approximately equal to that of Cuba. Ward and Devereux (2012) estimate the Cuba/US consumption ratio for housing at 0.3. I assume the same ratio holds for Puerto Rico.

Fuel and Light: Price comparison using prices for electricity and gas. The Puerto Rican prices are from the ILO. The US prices are from the ILO for electricity and the US Department of Interior *Natural Gas Production and Consumption* for gas. As expected, Puerto Rican prices are higher. The weights in the sub-index are two thirds electricity and one third gas.

Household goods. Price comparison. There is little to go on here save some isolated price data for soap etc. Following the clothing example, I assume the relative price is unity. This requires that the higher Puerto Rican wholesale prices, because of higher transports costs, be offset by lower wholesale/retail margins from lower wages.

Services: There are two components – domestics and all other services. For domestics, I use a quantity comparison given by the ratio of employment of domestics per capita. This yields a relative price that is consistent with what we know about relative unskilled wages (0.2) for 1950. The other services category is a price comparison given by an equally weighted index of relative wages of unskilled wages and the relative Puerto Rican/US nonfood relative price level.

Transportation: Purchases of transportation equipment – quantity comparison as the ratio of purchases of autos per capita. The Puerto Rican estimates are auto registrations from the Statistical Annuals and the US estimates are from Landsberg, Fishman and Fisher (1963). I assume equal quality which biases the results towards Puerto Rico. The operation of transport

equipment is a price comparison where I use the price implied by the auto comparison. Finally, for public transport I use the relative price from the BLS study (Puerto Rican weights) of Synder (1954).

Communication: Quantity comparison using phones per capita from the UN Statistical Yearbook.

Entertainment etc: *Entertainment* – quantity comparison given by cinema visits per capita from the UN Statistical Yearbook. *Hotels etc* - price comparison given by equally weighted index of unskilled wages (0.2) and the relative nonfood consumption deflator. *Books etc* - is a quantity index composed of an equally weighted index of newspaper circulation per capita and newsprint consumption from the UN Statistical Yearbook. *All other items* – a price comparison using the relative price from the hotels etc comparison.

Medical etc: Composed of sub- indices for doctors/dentists and medical costs assumed to consist of drugs. The doctors/dentists index is a quantity index of doctors/dentists per capita from the UN Statistical Yearbook where relative productivity is equal to one. I further assume that relative price of drugs etc is equal to one.

Education: Quantity comparison given by students per capita taken from the UN Statistical Yearbook. While this measure is widely used, it ignores differences in teacher student ratios, spending, days of instruction per year etc.

Misc: Price comparison equal to the non-food relative consumption deflator.

Investment: Investment: Price comparison. I assume that the relative price of producer durables is 1.1. Next, I construct the relative price index for structures as an equally weighted average of relative construction wages (from the ILO) and an assumed materials price of 1.00.

Government: Price comparison. The index equally weights relative skilled wages (0.3), as calculated from scattered wage data, and nonfood price index.

3. COLA Evidence on the Puerto Rican/US price level

The COLA studies compare relative price levels for San Juan and Washington DC with Washington DC weights. The first row of Table 11a provides the most recent COLA estimates. For all years, save one, San Juan prices exceed Washington. The difference is six percent in 1997 and nine percent in 1999. The exception is 2002 where COLA finds San Juan prices below Washington.[6]

Table 11a

Relative Puerto Rico/US Price Levels for consumption

	1994	1996	1997	1999	2002
		Washington DC weights			
San Juan/DC	103	101	106	109	97
San Juan/US	112	110	116	119	105
Puerto Rico/US	104	102	107	110	97
		Puerto Rican Weights			
Puerto Rico/US	88	87	91	94	82
		Fisher Ideal			
Puerto Rico/US	96	94	99	101	89

Source: The COLA estimates in row one are from Federal Register various issues. The adjustments are described in the text.

[6] The 2002 survey is, however, superior on methodological grounds to the earlier studies. It also appears to be the most recent.

To compare price levels between the US and Puerto Rico, I adjust San Juan and Washington prices to Puerto Rican and US levels respectively. The second row in Table 11a adjusts the Washington DC prices to a US level using a BEA study that compares price levels in Washington DC to the overall US for 2005 see Aten and D'Souza (2008) Table 2 page 68. The BEA finds the Washington price level exceeds the overall US price level by nine percent. I apply the 2005 adjustment factor to all years in Table 11a. The resulting San Juan price level is above US levels by some margin. For 1997, the difference is twenty percent.

I next adjust San Juan to a Puerto Rican price level. It is widely held in Puerto Rico that San Juan price levels exceed those for the rest of the Island. I do not have much evidence, however, on which to base an adjustment. For 1994, COLA surveyed Mayaguez finding that its prices were ninety percent of San Juan. I reduce San Juan prices by seven and a half percent to approximate Puerto Rico. The adjustment factor reflects the share of San Juan in the overall population of the island. The resulting estimates of the Puerto Rican/US price level are in the third row.

Finally, I adjust the price comparison to Puerto Rican weights. Given a negative correlation between prices and quantities, the price level with Puerto Rican Weights will be lower than with US or DC weights. The adjustment requires knowledge of the Paasche – Laspayres spread for Puerto Rico and the US. Following the usual terminology, Paasche is the result of a price comparison with Puerto Rican weights while Laspayres is the result of the comparison with US weights.

I do not have the Paasche – Laspayres spread for Puerto Rico and the US. On the other hand, we know a lot about the behavior of this ratio from the various rounds of the

International Comparison Program. The spread depends on the similarity of consumption patterns. For the 2005 round of the ICP, the lowest spread for US comparisons is 0.95 - for Ireland, see Deaton and Heston (2010) Table One, page 8. For Latin economies, the spread is much lower. For example, the spread for Brazil in 2005 is 0.66. To adjust to Puerto Rican weights, I assume that the Paasche – Laspayres spread is 0.85 – a little higher than for the US and Spain but well above other Latin Economies.[7]

Given this adjustment, the Puerto Rican price level is below the US. The final row provides the Fisher Ideal – the geometric average of the Puerto Rican and US weights. The results show, for the most part, a lower Puerto Rican price level. The estimates in Table 11a are best seen as educated guesses. Given the uncertainty with these conjectures, probably the best we can do is to assume that price levels are approximately equal.

There are other sources of data US/Puerto Rican price data. For example, various websites give crowd sourced individual price data for cities in Puerto Rico and the US. The best known site is *numbeo*.[8] As it turns out, the *numbeo* price data show a slight lower price level – around eight percent lower for 2017. How accurate are the crowd sourced comparisons? To find out, I regressed the numbeo estimates for various US cities against the BLS estimates cited earlier and the numbeo country estimates against the results in the latest version of the Penn

[7] The spread for the 1950 comparison in Table 9a is 0.8. This is likely an understatement given the lower quality of the 1950 data. We would however expect the spread to have diminished over time as US and Puerto Rico consumptions patterns converge.

[8] http://www.numbeo.com/common/. There are other sources such as https://www.expatistan.com. For the most part the results are broadly similar. The exception is http://coli.org/ which shows higher Puerto Rican price levels.

World Tables. The results of this exercise show that the *numbeo* data provide an unbiased, albeit very noisy, estimate of price levels.

As mentioned, the PWT (Penn World Tables), the World Bank's World Tables and the World Economic Outlook of the International Monetary Fund provide lower price level estimates than I assume. Their estimates are obtained from short cut regression approaches. Typically, the short cut approach estimates the relationship between ICP prices levels and other variables such as relative nominal income. The results are then used to generate price levels for countries where ICP price estimates are not available see Prados De la Escosura (2000) for a description and further references. For example, the ICP provides a short cut estimate of Puerto Rican price levels of 0.798 (World Bank (2014) page 77).

I prefer the COLA estimates because they use actual price data. Moreover, the ICP short cut estimates appear too low given COLA and the crowd sourced price data. As argued in the text, if the ICP short cut estimates are correct then this strengthens the results of the paper.

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