Appendix A Price Data for Canadian Markets

The main source of wheat prices for Canada is derived from the work of Geloso (2019) and Geloso and Lindert (2020) who used the accounts books of religious congregations around Quebec City from 1688 to 1858 to create a price series for wheat and flour. The prices were reported in *minots* (a French unit of volume which reflects the cultural background of the area) and in *livres* (a French monetary unit). Geloso argues that these prices are close to retail prices. Ouellet et al. (1982) provided the same information for retail wheat prices in Montreal from 1767 to 1858. There is also a series for flour but there are gaps in it. To complete the Montreal wheat prices pre-1767, we used the prices reported by Dechêne (1994). The prices in Montreal were reported in the same units as for Quebec City. We used the conventional conversion ratios from *minots* to bushels provided by Canadian historians (Rousseau 1983; Geloso 2019b) and the exchange rates provided by McCullough (1984) are used to convert from *livres* to shillings Sterling. This allowed us to create price series for Quebec and Montreal that cover the period from 1720 to 1858. The price data for Ontario was taken from the work of McCalla (1993). We used his retail prices for Central Ontario because they had the longest continuous coverage and the fewest gaps of all his series. His prices were reported in shillings of the Halifax denomination (which was below 1:1 with the Sterling) per bushels. We also used the exchanges rates McCullough (1984) provided to convert to Stirling.

Are these series representative of what was happening in the hinterland? We can answer in the positive thanks to recent work by Geloso (2022). Using the coefficient of variation (standard deviation divided by the mean) of prices between Quebec City and Montreal in 1828-1832, Geloso finds a value of 0.134. He then compared this with the census of 1831 which provided a cross-section of wheat prices for more than 200 parishes in Quebec spanning all over the entire colony. He found a coefficient of variation of 0.097 – a trivial differences with the Quebec City and Montreal one. This suggests that we can use these two important port cities as evidence to speak about market integration from Canada's vantage point. In addition, Geloso also employed the wheat price data for 13 rural parishes between 1764 and 1839 near Montreal produced by Ouellet et al. (1982) using tithe records. These series were unbalanced as many years were missing and the gaps differed by parish. Nevertheless, he inspected whether the coefficient of variation in each of these parishes with Montreal followed the same trend as the coefficient of variation between Montreal and Quebec City. The effect of time post-1760 was towards a -0.008 per annum in the coefficient of variation for Quebec City and Montreal. On average, the average coefficient of variation between Montreal and each of the 13 rural parishes showed a time trend of -0.005. This further reinforces our belief that, although we would have preferred a broader sample of cities, Montreal and Quebec City speak to market integration.

Appendix B Pre-estimation Analysis

Figures B1-B2 shows the recursive analysis of an unrestricted VAR

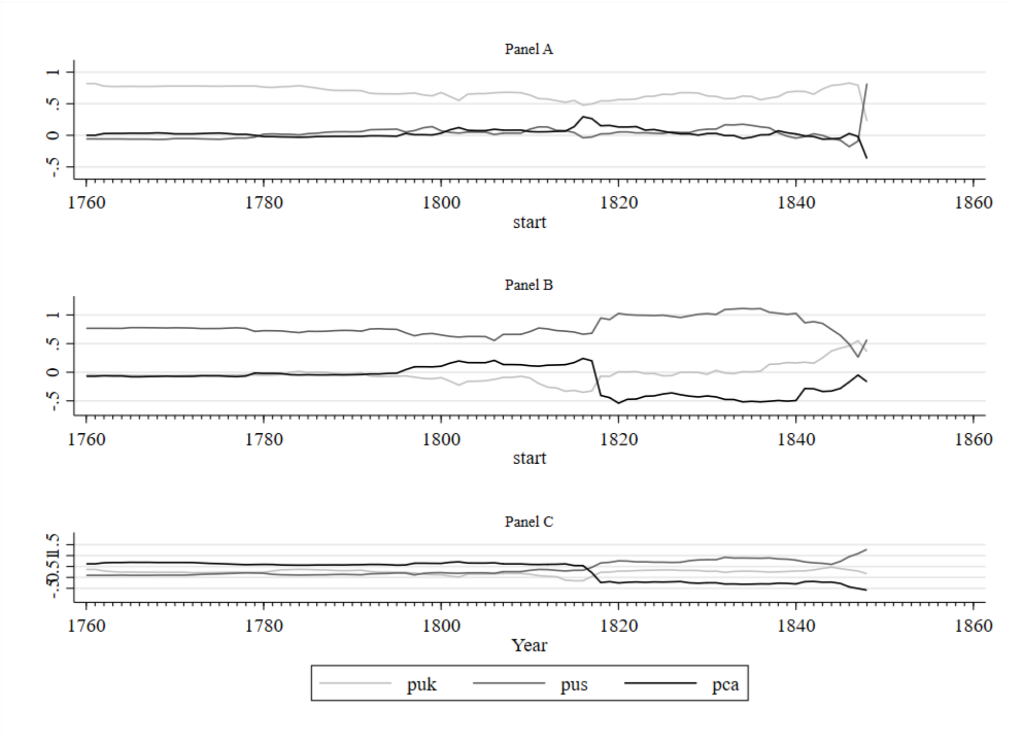

Figure B1: Backward recursively estimated VAR coefficients

Note: Backward recursively estimated coefficients with end year fixed at 1857. Panel A shows the estimated coefficients for the relationship between p_{uk} and the lagged variables p_{uk}, p_{us} and p_{ca}. Panel B shows the estimated coefficients for the relationship between p_{us} and the lagged variables p_{uk}, p_{us} and p_{ca}. Panel C shows the estimated coefficients for the relationship between p_{ca} and the lagged variables p_{uk}, p_{us} and p_{ca}.

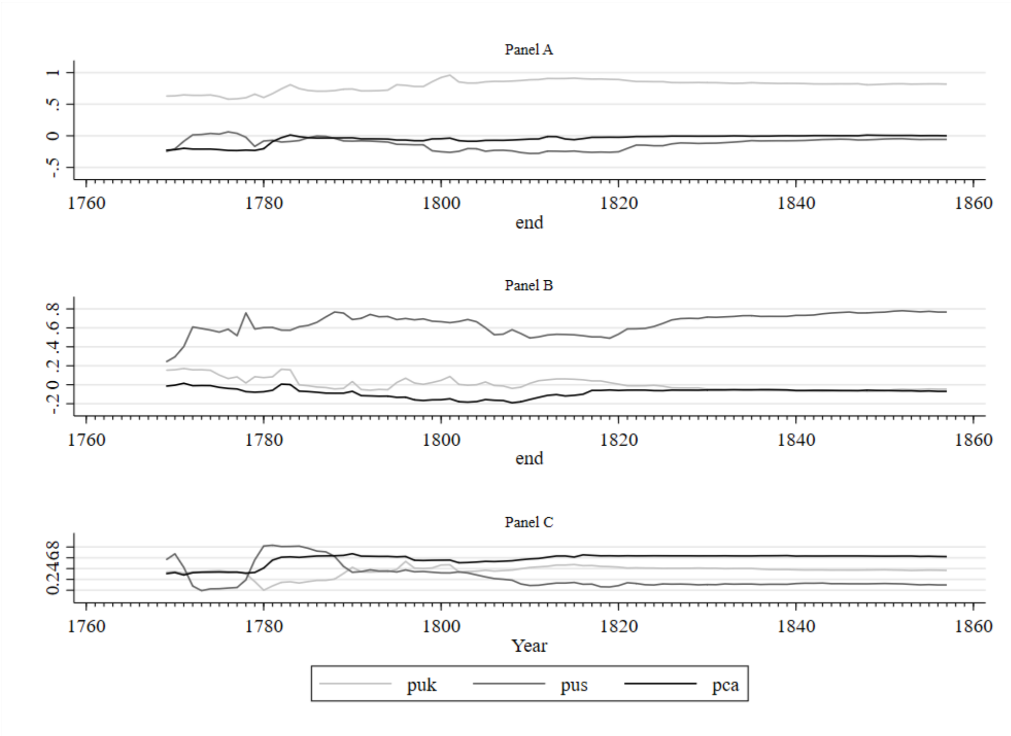

Figure B2: Forward recursively estimated VAR coefficients

Note: Forward recursively estimated coefficients with start year fixed at 1760. Panel A shows the estimated coefficients for the relationship between p_{uk} and the lagged variables p_{uk}, p_{us} and p_{ca}. Panel B shows the estimated coefficients for the relationship between p_{us} and the lagged variables p_{uk}, p_{us} and p_{ca}. Panel C shows the estimated coefficients for the relationship between p_{ca} and the lagged variables p_{uk}, p_{us} and p_{ca}.

Table B1: Wald test for structural breaks

Independent variable	Wald test	***p*-value**
	Testing 1783 and 1822 together	
puk	13.2594	0.5140
pus	20.3549	0.1193
pca	24.9768	0.0348
	Testing 1783	
puk	1.2845	0.9888
pus	5.3673	0.6152
pca	11.1328	0.1329
	Testing 1822	
puk	12.0257	0.0997
pus	12.7695	0.0779
pca	11.4731	0.1193

Note: This table shows the test statistics for the Wald test looking for known structural break dates. H_0: no structural break. The first part shows the statistic when testing both break dates together.

The following is the analysis of the unrestricted VAR, to assure the model is well specified.

Lag-order selection criteria

Sample: **1764** thru **1783** Number of obs = **20**

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	18.7176				.000042	-1.57176	-1.5426	-1.4224
1	43.4985	49.562	9	0.000	8.7e-06*	-3.14985	-3.03323*	-2.55241*
2	49.831	12.665	9	0.178	.000012	-2.8831	-2.679	-1.83758
3	58.1969	16.732	9	0.053	.000016	-2.81969	-2.52812	-1.32609
4	70.5133	24.633*	9	0.003	.000018	-3.15133*	-2.7723	-1.20966

* optimal lag
Endogenous: **puk pus pca**
Exogenous: **_cons**

Figure B3: Selection-order criteria for the period 1760-1783

Lag-order selection criteria

Sample: **1783** thru **1822** Number of obs = **40**

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-9.98735				.000384	.649368	.695166	.776033
1	39.3547	98.684*	9	0.000	.000051*	-1.36773*	-1.18454*	-.86107*
2	45.3102	11.911	9	0.218	.00006	-1.21551	-.894921	-.328849
3	50.8072	10.994	9	0.276	.000073	-1.04036	-.582375	.226301
4	58.7845	15.955	9	0.068	.00008	-.989225	-.393845	.657433

* optimal lag
Endogenous: **puk pus pca**
Exogenous: **_cons**

Figure B4: Selection-order criteria for the period 1783-1822

Lag-order selection criteria

Sample: **1822** thru **1857** Number of obs = **36**

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	52.2073				.000013	-2.73374	-2.68768	-2.60178
1	88.3856	72.357	9	0.000	2.9e-06	-4.24364	-4.05941	-3.7158*
2	101.44	26.11*	9	0.002	2.3e-06*	-4.46891*	-4.14651*	-3.54519
3	108.582	14.283	9	0.113	2.7e-06	-4.36566	-3.90509	-3.04606
4	116.197	15.23	9	0.085	3.1e-06	-4.28872	-3.68997	-2.57324

* optimal lag
Endogenous: **puk pus pca**
Exogenous: **_cons**

Figure B5: Selection-order criteria for the period 1822-1857

```
22 . ***** 1761-1783 *****
23 . vec puk pus pca if Year <= 1783, trend(rtrend) lags(1)

   Vector error-correction model

   Sample: 1761 thru 1783                         Number of obs     =         23
                                                  AIC               =  -3.001167
   Log likelihood =  43.51342                     HQIC              =  -2.889421
   Det(Sigma_ml)  =  4.56e-06                     SBIC              =  -2.556843

   Equation           Parms    RMSE     R-sq      chi2     P>chi2
   ----------------------------------------------------------------
   D_puk                2     .110396   0.0724   1.561243   0.4581
   D_pus                2      .14497   0.0091   .1832395   0.9125
   D_pca                2     .159657   0.6118   31.52204   0.0000
   ----------------------------------------------------------------

   ------------------------------------------------------------------------------
                |  Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
   -------------+----------------------------------------------------------------
   D_puk        |
           _ce1 |
            L1. |    .0082953   .0151896     0.55   0.585    -.0214757    .0380663
                |
          _cons |    .0256216   .0236433     1.08   0.279    -.0207185    .0719617
   -------------+----------------------------------------------------------------
   D_pus        |
           _ce1 |
            L1. |   -.0046806   .0199468    -0.23   0.814    -.0437756    .0344144
                |
          _cons |    .0115899   .0310482     0.37   0.709    -.0492634    .0724433
   -------------+----------------------------------------------------------------
   D_pca        |
           _ce1 |
            L1. |   -.1230985   .0219676    -5.60   0.000    -.1661541   -.0800429
                |
          _cons |    .0012859   .0341936     0.04   0.970    -.0657324    .0683041
   ------------------------------------------------------------------------------

   Cointegrating equations

   Equation           Parms    chi2     P>chi2
   -------------------------------------------
   _ce1                 2   27.88887   0.0000
   -------------------------------------------

   Identification:  beta is exactly identified

                    Johansen normalization restriction imposed
   ------------------------------------------------------------------------------
           beta |  Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
   -------------+----------------------------------------------------------------
   _ce1         |
            puk |           1          .        .       .            .           .
            pus |   -1.935941   2.329577    -0.83   0.406    -6.501829    2.629946
            pca |    4.285217   .8293486     5.17   0.000     2.659724     5.91071
         _trend |   -.1800915    .059614    -3.02   0.003    -.2969328   -.0632503
          _cons |   -9.717575          .        .       .            .           .
   ------------------------------------------------------------------------------
```

```
24 . ** autocorrelation **
25 . veclmar, mlag(3)
```

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	5.9541	9	0.74450
2	6.5272	9	0.68621
3	7.3720	9	0.59845

H0: no autocorrelation at lag order

```
26 . ** normality **
27 . vecnorm, jbera skewness kurtosis dfk
```

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_puk	4.108	2	0.12820
D_pus	3.397	2	0.18293
D_pca	3.836	2	0.14687
ALL	11.342	6	0.07836

Skewness test

Equation	Skewness	chi2	df	Prob > chi2
D_puk	-.14992	0.079	1	0.77912
D_pus	.11708	0.048	1	0.82662
D_pca	.01842	0.001	1	0.97251
ALL		0.128	3	0.98830

Kurtosis test

Equation	Kurtosis	chi2	df	Prob > chi2
D_puk	.85399	4.030	1	0.04471
D_pus	1.0435	3.349	1	0.06723
D_pca	.9064	3.835	1	0.05019
ALL		11.214	3	0.01062

dfk estimator used in computations

```
 9 .
10 . ***** 1783-1822 *****
11 . vec puk pus pca if Year >= 1783 & Year <= 1822, trend(rtrend) rank(2) lags(1)

   Vector error-correction model

   Sample:  1783 - 1822                              Number of obs     =        40
                                                     AIC               =  -1.252306
   Log likelihood =  38.04613                        HQIC              =  -1.053846
   Det(Sigma_ml)  =    .00003                        SBIC              =  -.7034204

   Equation           Parms      RMSE     R-sq      chi2     P>chi2
   ----------------------------------------------------------------
   D_puk                3      .209108   0.0438   1.649734   0.6482
   D_pus                3      .239269   0.2330   10.93803   0.0121
   D_pca                3      .227315   0.2216    10.2502   0.0166
   ----------------------------------------------------------------
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
D_puk						
_ce1 L1.	-.1359562	.1898415	-0.72	0.474	-.5080388	.2361263
_ce2 L1.	-.114799	.1766584	-0.65	0.516	-.4610431	.2314451
_cons	-.0010898	.0338895	-0.03	0.974	-.067512	.0653324
D_pus						
_ce1 L1.	.2068049	.2172239	0.95	0.341	-.2189461	.6325559
_ce2 L1.	-.6559478	.2021393	-3.25	0.001	-1.052133	-.2597621
_cons	.0002616	.0387776	0.01	0.995	-.0757412	.0762643
D_pca						
_ce1 L1.	.6438478	.2063706	3.12	0.002	.2393688	1.048327
_ce2 L1.	-.1479011	.1920397	-0.77	0.441	-.524292	.2284898
_cons	-.0003141	.0368402	-0.01	0.993	-.0725196	.0718913

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	1	14.47316	0.0001
_ce2	1	6.31303	0.0120

Identification: beta is exactly identified

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
_ce1						
puk	1	.	.	.	.	.
pus	-5.55e-17	.	.	.	.	.
pca	-.4396558	.1155663	-3.80	0.000	-.6661616	-.21315
_trend	-.0061066	.0041884	-1.46	0.145	-.0143158	.0021026
_cons	-2.432075	.	.	.	.	.
_ce2						
puk	0	(omitted)				
pus	1	.	.	.	.	.
pca	-.3330114	.1325379	-2.51	0.012	-.592781	-.0732418
_trend	.0045001	.0048035	0.94	0.349	-.0049147	.0139148
_cons	-1.99716	.	.	.	.	.

```
12 . ** autocorrelation **
```

```
13 . veclmar, mlag(3)

  Lagrange-multiplier test
```

lag	chi2	df	Prob > chi2
1	9.4868	9	0.39361
2	8.6209	9	0.47297
3	7.8266	9	0.55171

```
  H0: no autocorrelation at lag order

14 . ** normality **
15 . vecnorm, jbera skewness kurtosis dfk

  Jarque-Bera test
```

Equation	chi2	df	Prob > chi2
D_puk	3.256	2	0.19635
D_pus	2.554	2	0.27881
D_pca	2.096	2	0.35061
ALL	7.906	6	0.24505

```
  Skewness test
```

Equation	Skewness	chi2	df	Prob > chi2
D_puk	.61962	2.560	1	0.10963
D_pus	-.15451	0.159	1	0.68993
D_pca	-.10781	0.077	1	0.78073
ALL		2.796	3	0.42412

```
  Kurtosis test
```

Equation	Kurtosis	chi2	df	Prob > chi2
D_puk	2.3537	0.696	1	0.40408
D_pus	1.8012	2.395	1	0.12170
D_pca	1.8995	2.019	1	0.15538
ALL		5.110	3	0.16391

```
  dfk estimator used in computations

16 .
17 . ***** 1822-1857 *****
18 . vec puk pus pca if Year >= 1822, trend(rtrend) rank(2) lags(2)

Vector error-correction model

Sample:  1822 - 1857                         Number of obs     =         36
                                             AIC               =  -4.350889
Log likelihood =   100.316                   HQIC              =  -4.013134
Det(Sigma_ml)  =  7.62e-07                   SBIC              =  -3.383183
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_puk	6	.100598	0.5663	37.86006	0.0000
D_pus	6	.16084	0.2225	8.299976	0.2169
D_pca	6	.109122	0.6604	56.40084	0.0000

		Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_puk							
	_ce1 L1.	-.7936675	.1805622	-4.40	0.000	-1.147563	-.439772
	_ce2 L1.	-.2615836	.1721171	-1.52	0.129	-.5989269	.0757597
	puk LD.	.7026467	.1652012	4.25	0.000	.3788583	1.026435
	pus LD.	.1878505	.2167556	0.87	0.386	-.2369827	.6126837
	pca LD.	-.1315484	.1923331	-0.68	0.494	-.5085143	.2454176
	_cons	-.0049329	.0171484	-0.29	0.774	-.0385431	.0286773
D_pus							
	_ce1 L1.	-.3387399	.2886912	-1.17	0.241	-.9045642	.2270845
	_ce2 L1.	.0076303	.2751887	0.03	0.978	-.5317297	.5469903
	puk LD.	.1934986	.2641313	0.73	0.464	-.3241892	.7111864
	pus LD.	.272077	.3465589	0.79	0.432	-.4071659	.9513199
	pca LD.	-.3779935	.307511	-1.23	0.219	-.980704	.224717
	_cons	.010386	.0274176	0.38	0.705	-.0433515	.0641236
D_pca							
	_ce1 L1.	.1931459	.195862	0.99	0.324	-.1907366	.5770284
	_ce2 L1.	.6664721	.1867013	3.57	0.000	.3005443	1.0324
	puk LD.	.333213	.1791994	1.86	0.063	-.0180113	.6844373
	pus LD.	-.0097969	.2351222	-0.04	0.967	-.470628	.4510342
	pca LD.	.1301095	.2086303	0.62	0.533	-.2787983	.5390174
	_cons	-.002055	.0186014	-0.11	0.912	-.0385132	.0344031

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	1	.2319183	0.6301
_ce2	1	53.17834	0.0000

Identification: beta is exactly identified

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
puk	1	.	.	.	.	.
pus	0	(omitted)				
pca	-.103049	.2139816	-0.48	0.630	-.5224453	.3163472
_trend	.005008	.0029602	1.69	0.091	-.0007938	.0108099
_cons	-3.793904	.	.	.	.	.
_ce2						
puk	-2.78e-17	.	.	.	.	.
pus	1	.	.	.	.	.
pca	-1.751046	.2401211	-7.29	0.000	-2.221675	-1.280418
_trend	-.0052756	.0033218	-1.59	0.112	-.0117862	.001235
_cons	3.514806	.	.	.	.	.

```
19 . ** autocorrelation **
20 . veclmar, mlag(3)
```

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	12.4225	9	0.19053
2	9.3853	9	0.40249
3	16.2816	9	0.06123

H0: no autocorrelation at lag order

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_puk	1.782	2	0.41034
D_pus	2.161	2	0.33947
D_pca	0.406	2	0.81616
ALL	4.349	6	0.62962

Skewness test

Equation	Skewness	chi2	df	Prob > chi2
D_puk	-.10064	0.061	1	0.80529
D_pus	-.13207	0.105	1	0.74632
D_pca	-.04552	0.012	1	0.91122
ALL		0.178	3	0.98108

Kurtosis test

Equation	Kurtosis	chi2	df	Prob > chi2
D_puk	1.9289	1.721	1	0.18960
D_pus	1.8292	2.056	1	0.15160
D_pca	2.4876	0.394	1	0.53028
ALL		4.171	3	0.24361

dfk estimator used in computations

Johansen tests for cointegration
Trend: Restricted — Number of obs = 23
Sample: 1761 thru 1783 — Number of lags = 1

Maximum rank	Params	LL	Eigenvalue	Trace statistic	Critical value 5%
0	3	32.100146	.	40.1645*	42.44
1	9	43.513422	0.62934	17.3380	25.32
2	13	50.510774	0.45581	3.3433	12.25
3	15	52.182407	0.13529		

Maximum rank	Params	LL	Eigenvalue	Eigenvalue Maximum	Critical value 5%
0	3	32.100146	.	22.8266	25.54
1	9	43.513422	0.62934	13.9947	18.96
2	13	50.510774	0.45581	3.3433	12.52
3	15	52.182407	0.13529		

Maximum rank	Params	LL	Eigenvalue	SBIC	HQIC	AIC
0	3	32.100146		-2.38234	-2.493199	-2.530447
1	9	43.513422	0.62934	-2.556843	-2.889421	-3.001167
2	13	50.510774	0.45581	-2.620005*	-3.100395*	-3.261806
3	15	52.182407	0.13529	-2.492713	-3.047009	-3.233253

* selected rank

Figure B6: Johansen tests for cointegration 1760-1783

Johansen tests for cointegration
Trend: rtrend — Number of obs = 40
Sample: 1783 - 1822 — Lags = 1

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	3	20.090057	.	40.9774*	42.44
1	9	31.428991	0.43275	18.2995	25.32
2	13	38.046125	0.28169	5.0653	12.25
3	15	40.578753	0.11894		

maximum rank	parms	LL	eigenvalue	max statistic	5% critical value
0	3	20.090057	.	22.6779	25.54
1	9	31.428991	0.43275	13.2343	18.96
2	13	38.046125	0.28169	5.0653	12.52
3	15	40.578753	0.11894		

maximum rank	parms	LL	eigenvalue	SBIC	HQIC	AIC
0	3	20.090057		-.7278369	-.8087045	-.8545029
1	9	31.428991	0.43275	-.7414517*	-.9840543	-1.12145
2	13	38.046125	0.28169	-.7034204	-1.053846*	-1.252306
3	15	40.578753	0.11894	-.6456079	-1.049946	-1.278938

Figure B7: Johansen tests for cointegration 1783-1822

Johansen tests for cointegration

Trend: rtrend Number of obs = 36

Sample: 1822 - 1857 Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	12	75.148239	.	57.9590	42.44
1	18	90.852526	0.58208	26.5504	25.32
2	22	100.31601	0.40889	7.6235*	12.25
3	24	104.12775	0.19084		

maximum rank	parms	LL	eigenvalue	max statistic	5% critical value
0	12	75.148239	.	31.4086	25.54
1	18	90.852526	0.58208	18.9270	18.96
2	22	100.31601	0.40889	7.6235	12.52
3	24	104.12775	0.19084		

maximum rank	parms	LL	eigenvalue	SBIC	HQIC	AIC
0	12	75.148239		-2.980396	-3.324005	-3.508236
1	18	90.852526	0.58208	-3.255603	-3.771017	-4.047363
2	22	100.31601	0.40889	-3.383183*	-4.013134*	-4.350889
3	24	104.12775	0.19084	-3.395862	-4.083081	-4.451542

Figure B8: Johansen tests for cointegration 1822-1857

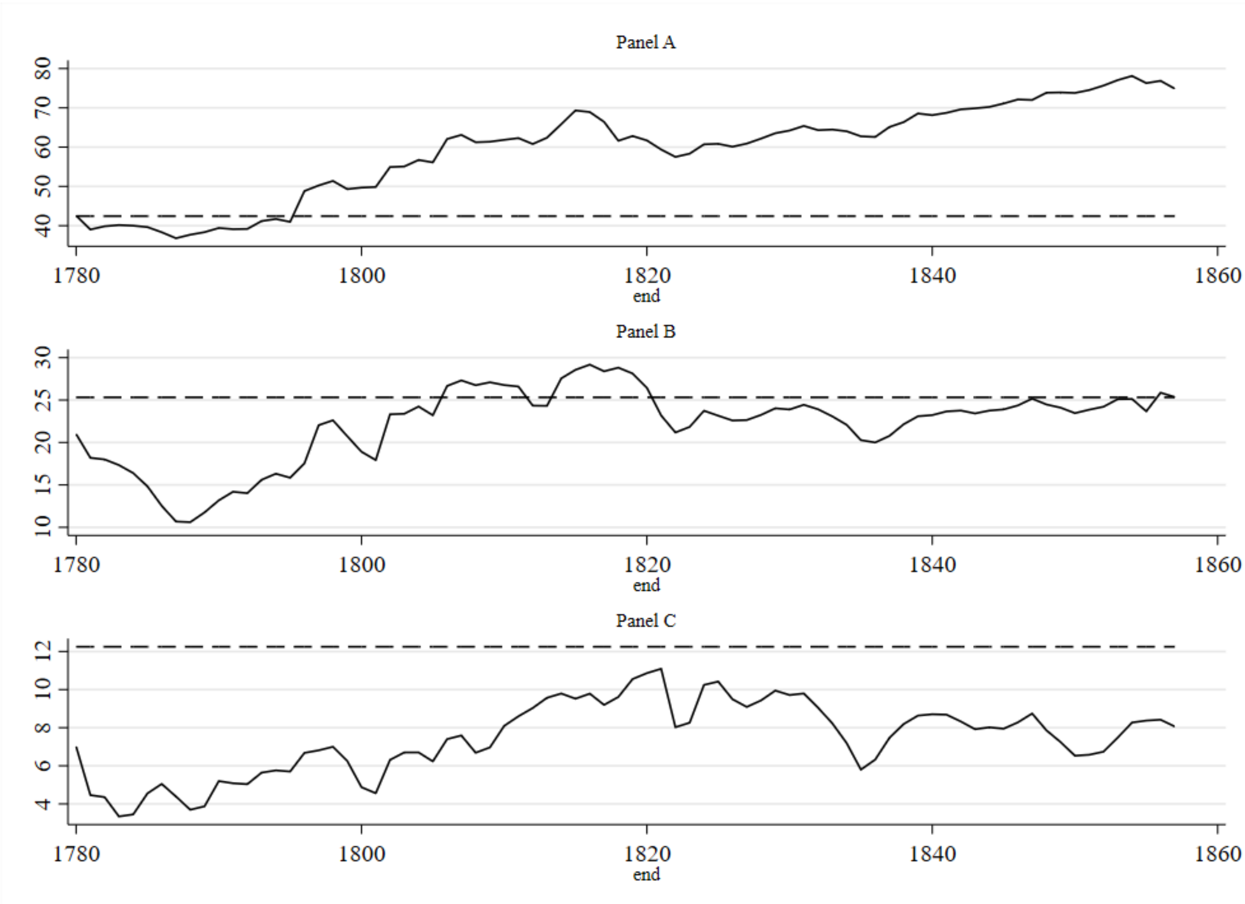

Figure B9: Recursively calculated trace statistics for cointegration rank, 1760-1783

Note: The start year is held fixed while the end year changes. Panel A represents the trace statistic for the null hypothesis $H_0\colon rank \leq 0$. Panel B represents the trace statistic for the null hypothesis $H_0\colon rank \leq 1$. Panel C represents the trace statistic for the null hypothesis $H_0\colon rank \leq 2$. The dashed lines represent the critical values at the 5% level.

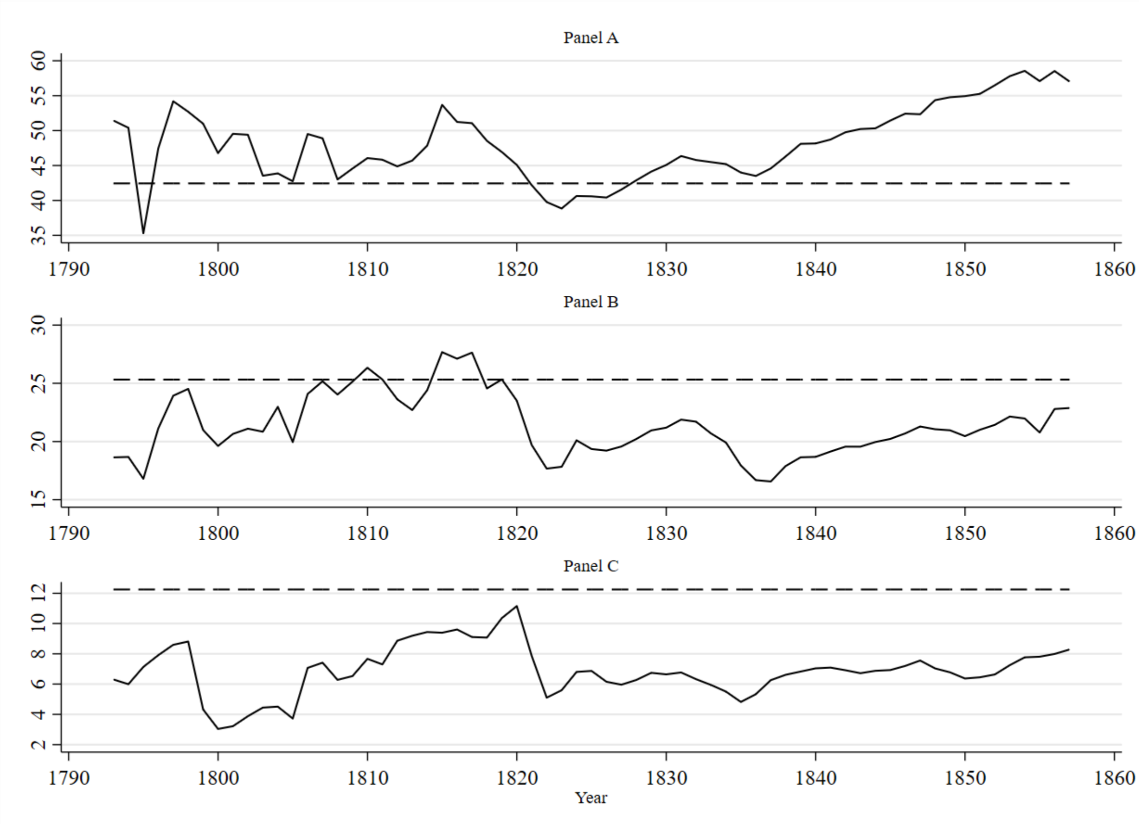

Figure B10: Recursively calculated trace statistics for cointegration rank, 1783-1822

Note: The start year is held fixed while the end year changes. Panel A represents the trace statistic for the null hypothesis $H_0\!: rank \leq 0$. Panel B represents the trace statistic for the null hypothesis $H_0\!: rank \leq 1$. Panel C represents the trace statistic for the null hypothesis $H_0\!: rank \leq 2$. The dashed lines represent the critical values at the 5% level.

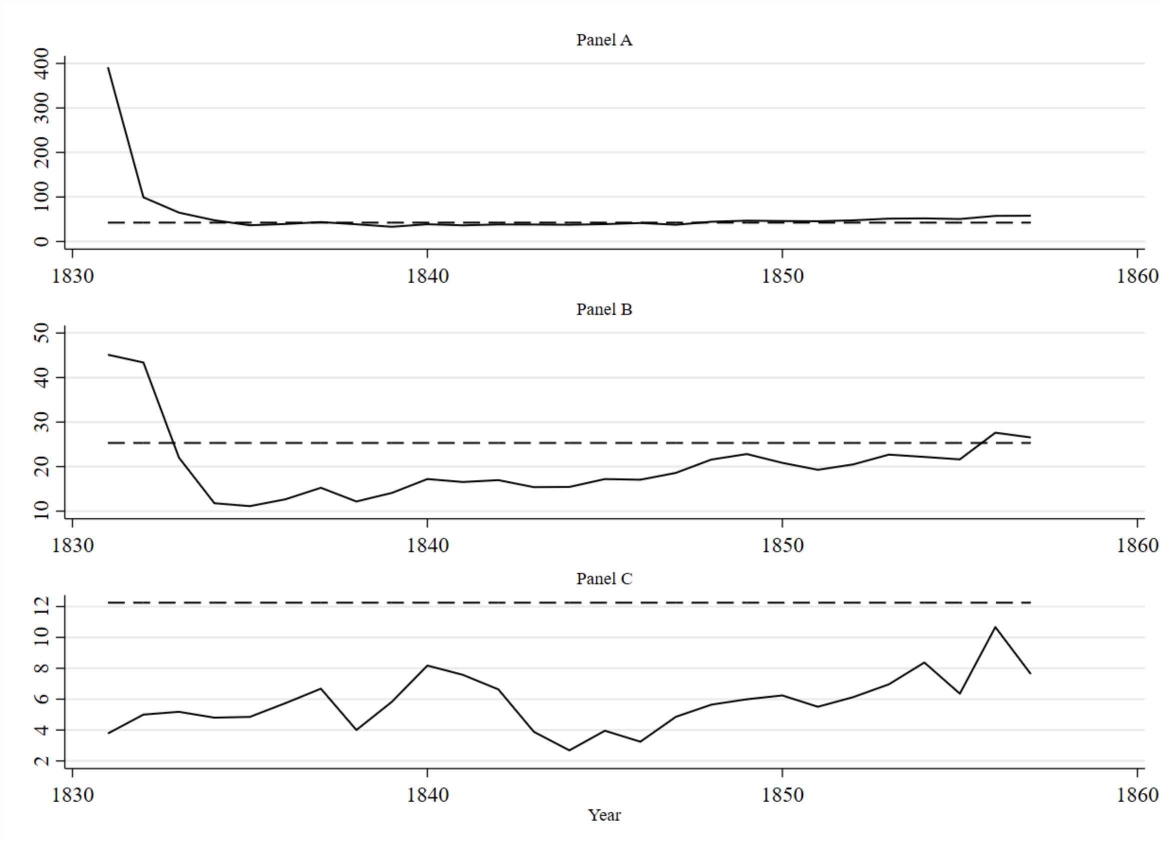

Figure B11: Recursively calculated trace statistics for cointegration rank, 1822-1857

Note: The start year is held fixed while the end year changes. Panel A represents the trace statistic for the null hypothesis $H_0\colon rank \leq 0$. Panel B represents the trace statistic for the null hypothesis $H_0\colon rank \leq 1$. Panel C represents the trace statistic for the null hypothesis $H_0\colon rank \leq 2$. The dashed lines represent the critical values at the 5% level.

```
SYS( 1) Cointegrated VAR (using Data no Ontario (oct 2022).xls)
        The estimation sample is: 1761 - 1783

Cointegrated VAR (1) in:
[0] = puk
[1] = pus
[2] = pca
Unrestricted variables:
[0] = Constant
Restricted variables:
[0] = Trend
Number of lags used in the analysis: 1

General cointegration restrictions:
&3=0; &5=1;
&0=0; &1=0;

beta
puk         0.00000
pus        -0.59718
pca          1.0000
Trend     -0.038883

Standard errors of beta
puk         0.00000
pus         0.57443
pca         0.00000
Trend      0.014032

alpha
puk        -0.00000
pus        -0.00000
pca        -0.49895

Standard errors of alpha
puk         0.00000
pus         0.00000
pca        0.084810

Restricted long-run matrix, rank 1
                puk          pus          pca        Trend
puk        -0.00000      0.00000     -0.00000      0.00000
pus        -0.00000      0.00000     -0.00000      0.00000
pca        -0.00000      0.29797     -0.49895     0.019401

Standard errors of long-run matrix
puk         0.00000      0.00000      0.00000      0.00000
pus         0.00000      0.00000      0.00000      0.00000
pca         0.00000     0.050647     0.084810    0.0032976

Moving-average impact matrix
       1.0000  2.1684e-019  3.5345e-017
 -1.1194e-017       1.0000 -3.9567e-034
 -9.6318e-017      0.59718 -3.4044e-033

log-likelihood     43.0876003  -T/2log|Omega|     140.994359
no. of observations        23  no. of parameters           6
rank of long-run matrix     1  no. long-run restrictions   3
beta is identified

LR test of restrictions: Chi^2(3) =  0.85164 [0.8371]

Switching (scaled linear) using analytical derivatives (eps1=0.0001; eps2=0.005):
Strong convergence
```

Figure B12: Regression results from the cointegrated VAR, 1760-1783

```
SYS( 2) Cointegrated VAR (using Data_noOntario (nov 2020).xls)
        The estimation sample is: 1783 - 1822
Cointegrated VAR (1) in:
[0] = puk
[1] = pus
[2] = pca
Unrestricted variables:
[0] = Constant
Restricted variables:
[0] = Trend
Number of lags used in the analysis: 1
General cointegration restrictions:
&7=1; &8=0;     &9=0;
&11=0; &12=1; &13=0;

&0=0; &1=0;
&3=0;
&4=0;

beta
puk        -0.46627      -1.6555
pus          1.0000      0.00000
pca         0.00000       1.0000
Trend       0.00000      0.00000
Standard errors of beta
puk         0.20269      0.27556
pus         0.00000      0.00000
pca         0.00000      0.00000
Trend       0.00000      0.00000
alpha
puk        -0.00000     -0.00000
pus        -0.47351     -0.00000
pca        -0.00000     -0.37110
Standard errors of alpha
puk         0.00000      0.00000
pus         0.11104      0.00000
pca         0.00000     0.073830

Restricted long-run matrix, rank 2
                puk          pus          pca        Trend
puk         0.00000     -0.00000     -0.00000     -0.00000
pus         0.22078     -0.47351     -0.00000     -0.00000
pca         0.61437     -0.00000     -0.37110     -0.00000

Standard errors of long-run matrix
puk         0.00000      0.00000      0.00000      0.00000
pus        0.051774      0.11104      0.00000      0.00000
pca         0.12223      0.00000     0.073830      0.00000

Moving-average impact matrix
       1.0000  2.3202e-017 -2.2660e-017
      0.46627  1.0818e-017 -1.0566e-017
       1.6555  3.8412e-017 -3.7514e-017

log-likelihood      36.2694286  -T/2log|Omega|      206.542053
no. of observations         40  no. of parameters            7
rank of long-run matrix      2  no. long-run restrictions    6
beta is identified

LR test of restrictions: Chi^2(6) =   3.5534 [0.7369]
```

Figure B13: Regression results from the cointegrated VAR, 1783-1822

```
SYS( 3) Cointegrated VAR (using Data_noOntario (nov 2020).xls)
        The estimation sample is: 1822 - 1857
Cointegrated VAR (2) in:
[0] = puk
[1] = pus
[2] = pca
Unrestricted variables:
[0] = Constant
Restricted variables:
[0] = Trend
Number of lags used in the analysis: 2
General cointegration restrictions:
&7=0; &6=1;
&10=0; &12=1;
&1=0;
&2=0; &3=0;
&4=0;

beta
puk          1.0000      0.00000
pus         0.00000     -0.76224
pca        -0.57818       1.0000
Trend     0.0051740    0.0040646

Standard errors of beta
puk         0.00000      0.00000
pus         0.00000      0.10909
pca         0.13160      0.00000
Trend     0.0018935    0.0018548

alpha
puk        -0.75752     -0.00000
pus        -0.00000     -0.00000
pca        -0.00000     -0.88763

Standard errors of alpha
puk         0.12524      0.00000
pus         0.00000      0.00000
pca         0.00000      0.17527

Restricted long-run matrix, rank 2
                puk          pus          pca        Trend
puk        -0.75752      0.00000      0.43798   -0.0039195
pus        -0.00000      0.00000      0.00000     -0.00000
pca        -0.00000      0.67659     -0.88763   -0.0036079

Standard errors of long-run matrix
puk         0.12524      0.00000     0.072413   0.00064802
pus         0.00000      0.00000      0.00000      0.00000
pca         0.00000      0.13360      0.17527   0.00071239

Moving-average impact matrix
      0.00000      0.46554  3.6493e-017
      0.00000       1.0563  8.2804e-017
      0.00000      0.80519  6.3117e-017
log-likelihood      96.1708049  -T/2log|Omega|      249.416166
no. of observations         36  no. of parameters           18
rank of long-run matrix      2  no. long-run restrictions    4
beta is identified

LR test of restrictions: Chi^2(4) =    8.2904 [0.0815]
```

Figure B14: Regression results from the cointegrated VAR, 1822-1857

Appendix C Recursive CVAR Analysis

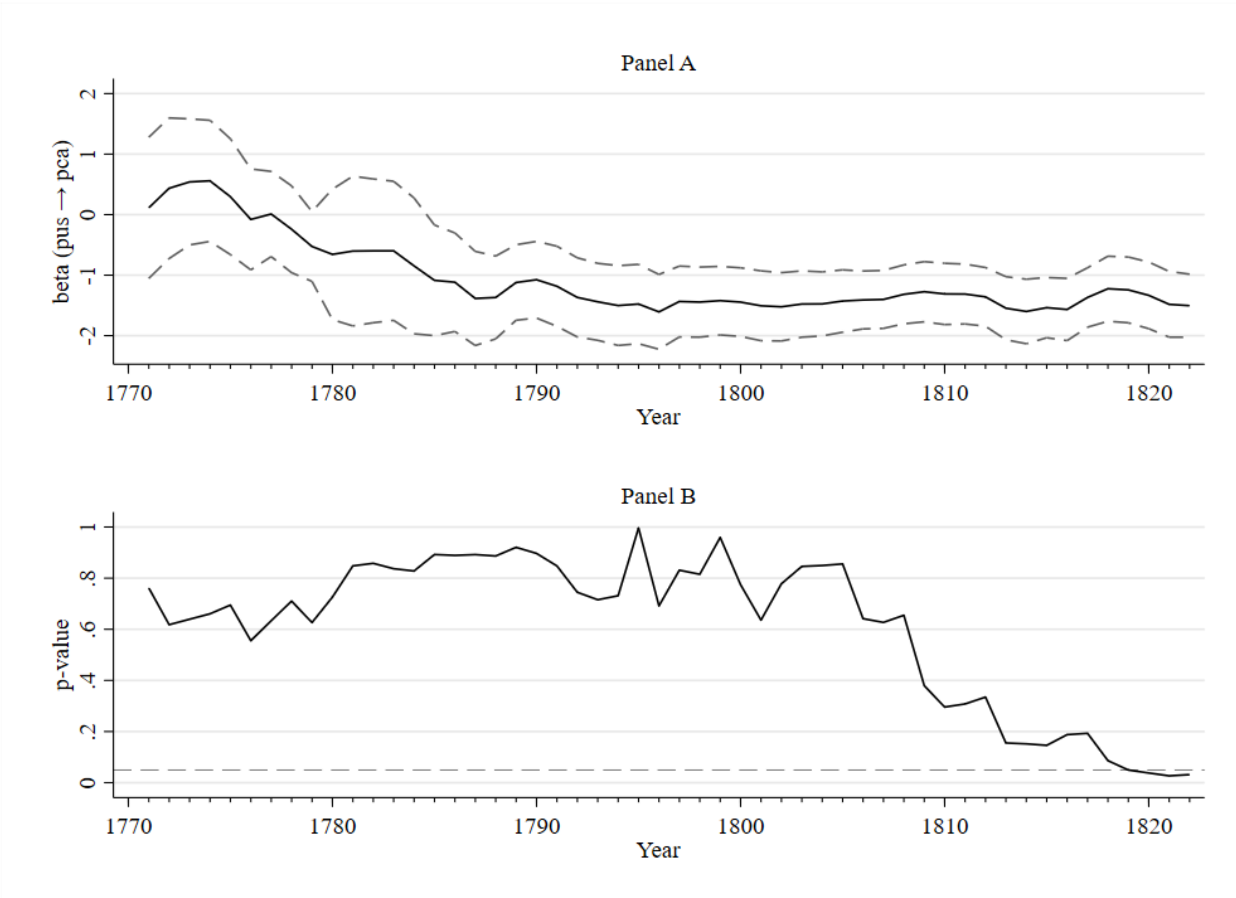

Figure C1: Forward recursively estimated coefficient and p-values for the period 1760-1783

Note: The start year is fixed at 1760 while the end year changes. Panel A illustrates the estimated beta coefficient from equation 2, while the dashed lines represent 2x standard errors. Panel B illustrates the p-value for acceptance of the imposed restrictions.

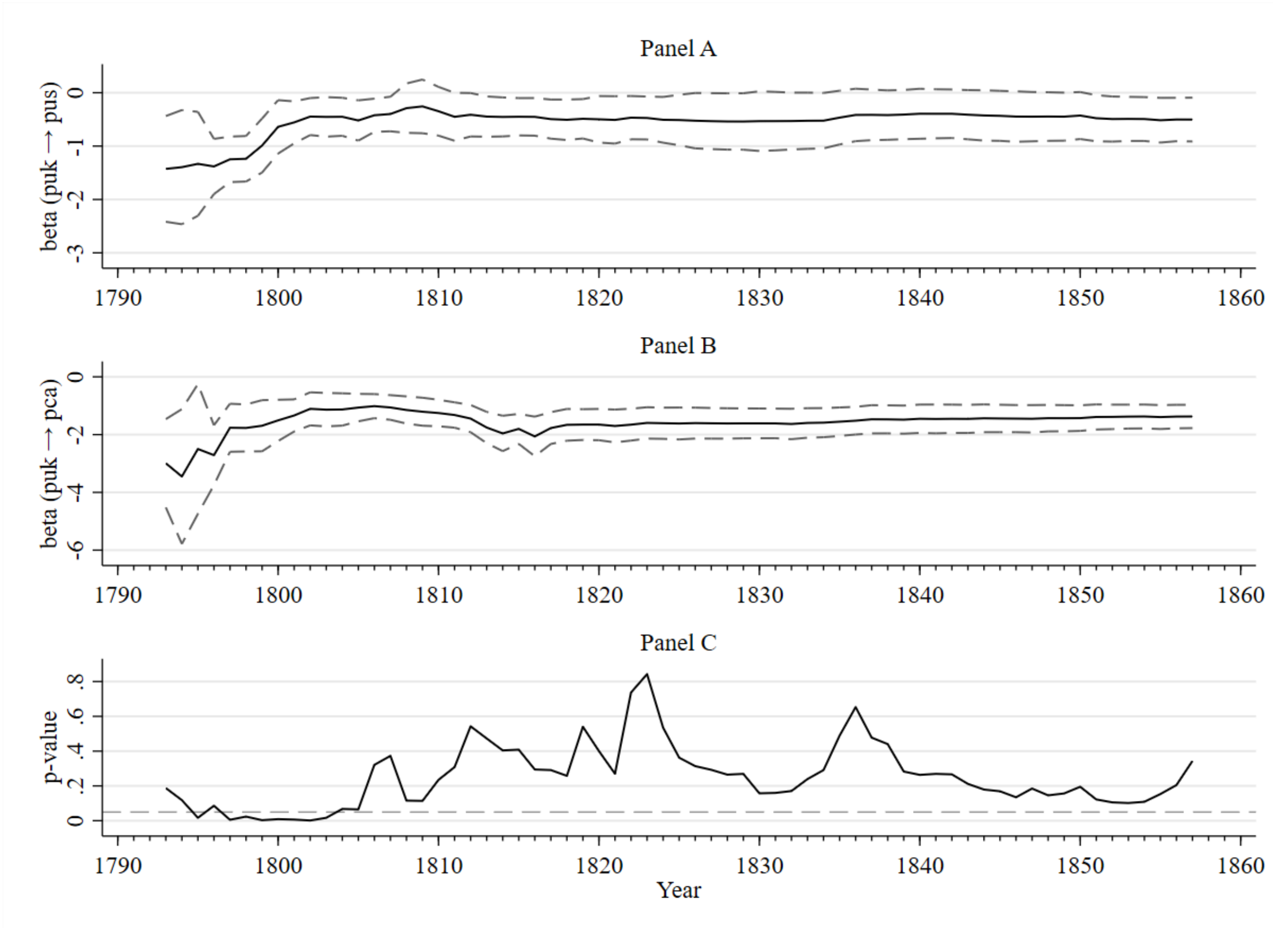

Figure C2: Forward recursively estimated coefficients and p-values for the period 1783-1822

Note: The start year is fixed at 1783 while the end year changes. Panel A illustrates the estimated beta coefficient between the UK and the US from equation 3, Panel B illustrates the estimated beta coefficient between the UK and Canada while in both, the dashed lines represent 2x standard errors. Panel C illustrates the p-value for acceptance of the imposed restrictions.

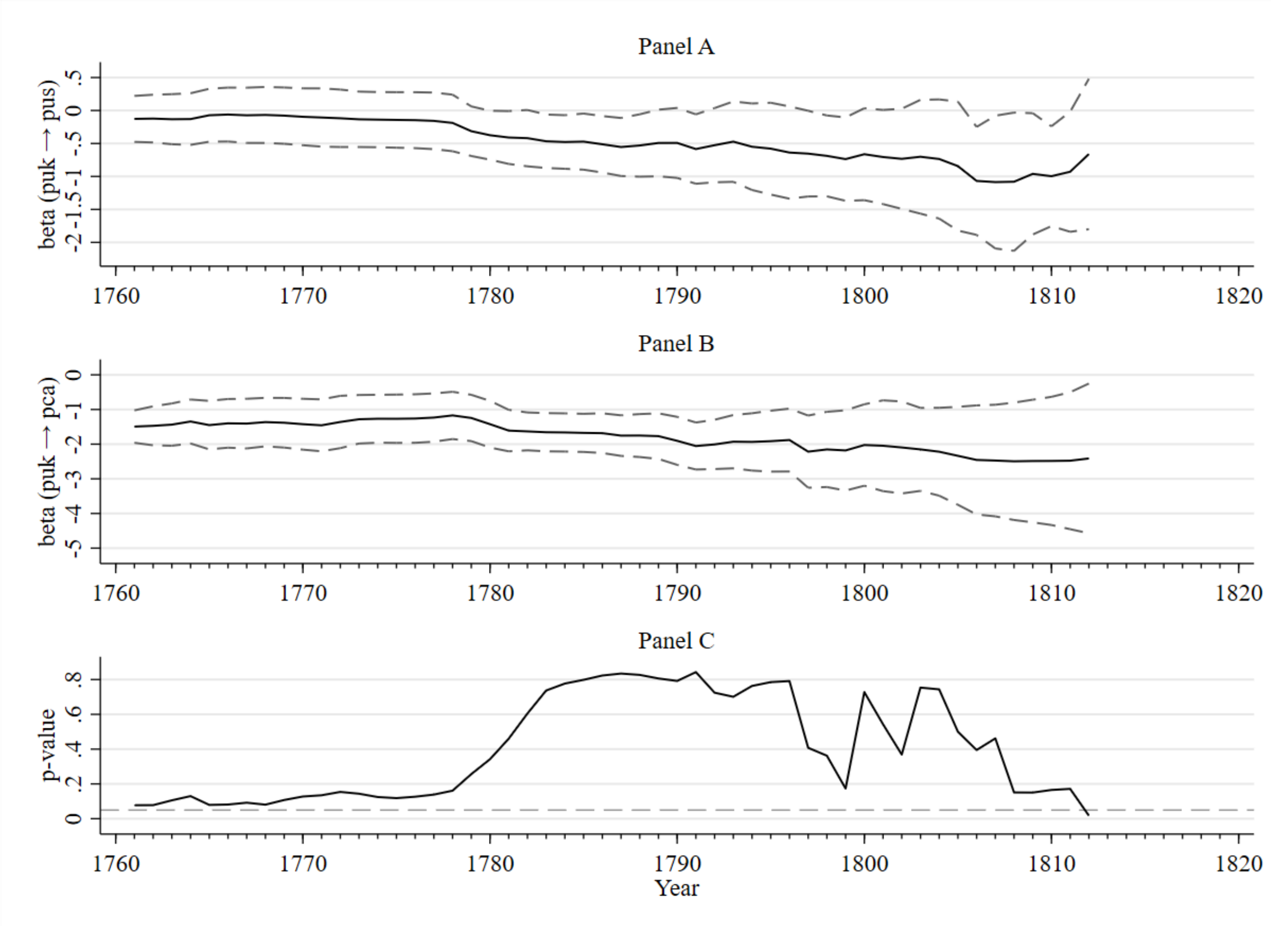

Figure C3: Backward recursively estimated coefficients and p-values for the period 1783-1822

Note: The end year is fixed at 1822 while the start year changes. Panel A illustrates the estimated beta coefficient between the UK and the US from equation 3, Panel B illustrates the estimated beta coefficient between the UK and Canada while in both, the dashed lines represent 2x standard errors. Panel C illustrates the p-value for acceptance of the imposed restrictions.

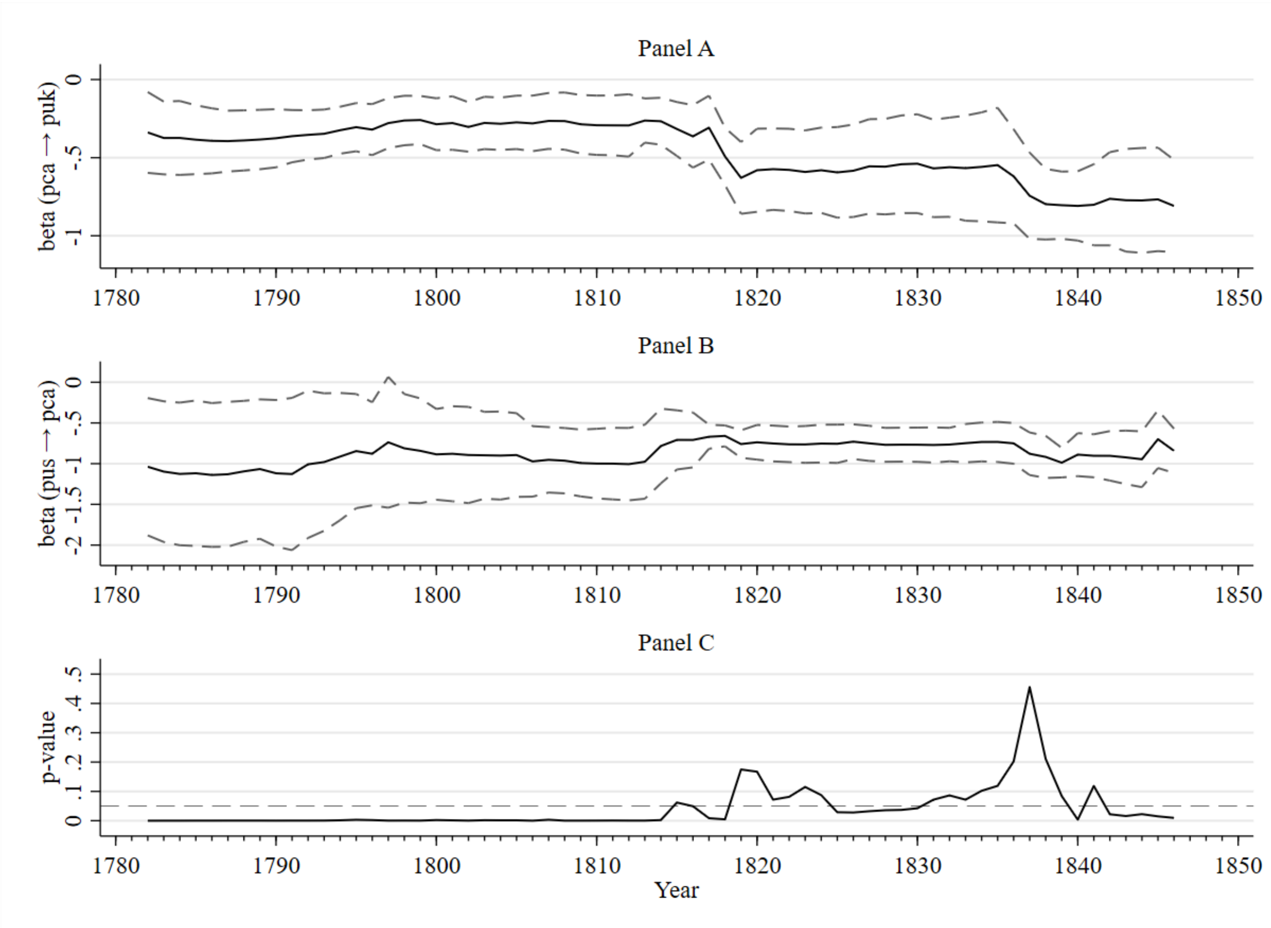

Figure C4: Backward recursively estimated coefficients and p-values for the period 1822-1857

Note: The end year is fixed at 1857 while the start year changes. Panel A illustrates the estimated beta coefficient between the Canada and UK from equation 4, Panel B illustrates the estimated beta coefficient between the US and Canada while in both, the dashed lines represent 2x standard errors. Panel C illustrates the p-value for acceptance of the imposed restrictions.

Appendix D Results including Central Ontario

The following shows the results of the CVAR analysis when including price data for Central Ontario in the Canadian average price. Observations for Central Ontario start only in 1787, so the results for the first period (1760-1783) are not affected by the inclusion of the additional observations. Figures 1D and 2D illustrate a comparison between the estimated alpha and beta coefficients from equations 3-4 and D2-D3. It can be seen that there are no statistically significant differences.

Estimated equation for the period 1760-1783

$$\begin{bmatrix} \Delta p_{uk_t} \\ \Delta p_{us_t} \\ \Delta p_{ca_t} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \mathbf{-0.4990} \end{bmatrix} [\{p_{ca} - 0.5972 p_{us} - \mathbf{0.0389}\}_{t-1}] + \cdots \quad \text{(D1)}$$

$Chi^2(3) = 0.8516$ [0.8371]

Estimated equation for the period 1783-1822

$$\begin{bmatrix} \Delta p_{uk_t} \\ \Delta p_{us_t} \\ \Delta p_{ca_t} \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ \mathbf{-0.5059} & 0 \\ 0 & \mathbf{-0.2887} \end{bmatrix} \begin{bmatrix} \{p_{us} - \mathbf{0.4636} p_{uk}\}_{t-1} \\ \{p_{ca} - \mathbf{1.525} p_{uk}\}_{t-1} \end{bmatrix} + \cdots \quad \text{(D2)}$$

$Chi^2(6) = 6.7040$ [0.3491]

Estimated equation for the period 1822-1857

$$\begin{bmatrix} \Delta p_{uk_t} \\ \Delta p_{us_t} \\ \Delta p_{ca_t} \end{bmatrix} = \begin{bmatrix} \mathbf{-0.7097} & 0 \\ 0 & 0 \\ 0 & \mathbf{-0.9417} \end{bmatrix} \begin{bmatrix} \{p_{uk} - \mathbf{0.5045} p_{ca} + \mathbf{0.0060} t\}_{t-1} \\ \{p_{ca} - \mathbf{0.8436} p_{us} + \mathbf{0.0023} t\}_{t-1} \end{bmatrix} + \cdots \quad \text{(D3)}$$

$Chi^2(4) = 6.9233$ [0.1400]

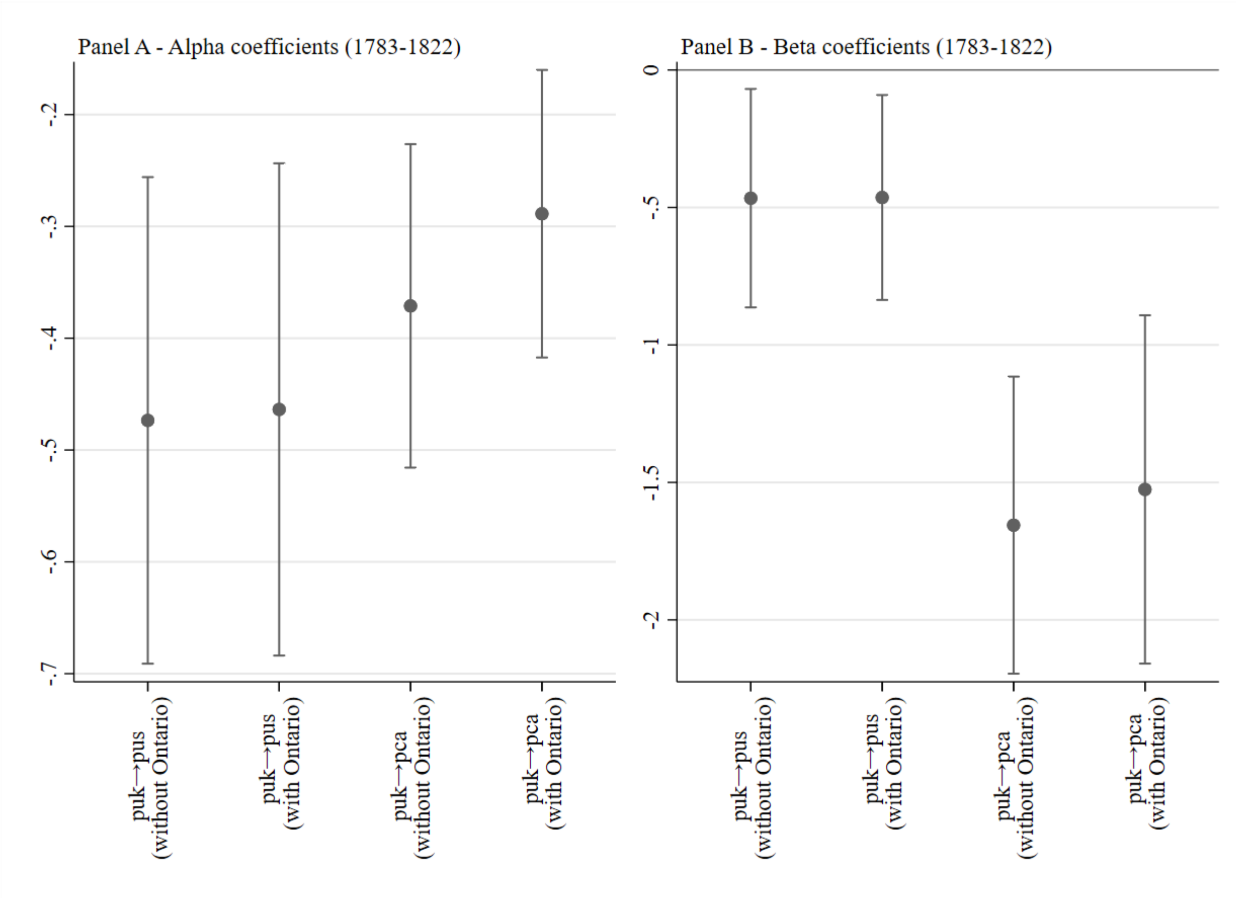

Figure D1: Comparison of point estimates with and without Central Ontario included in price data (1783-1822)

Note: Panel A illustrates the estimated alpha coefficients from equations 3 (without Ontario) and D2 (with Ontario) and Panel B illustrates the estimated beta coefficients from equations 3 (without Ontario) and D2 (with Ontario). Reported confidence intervals are at the 5% level.

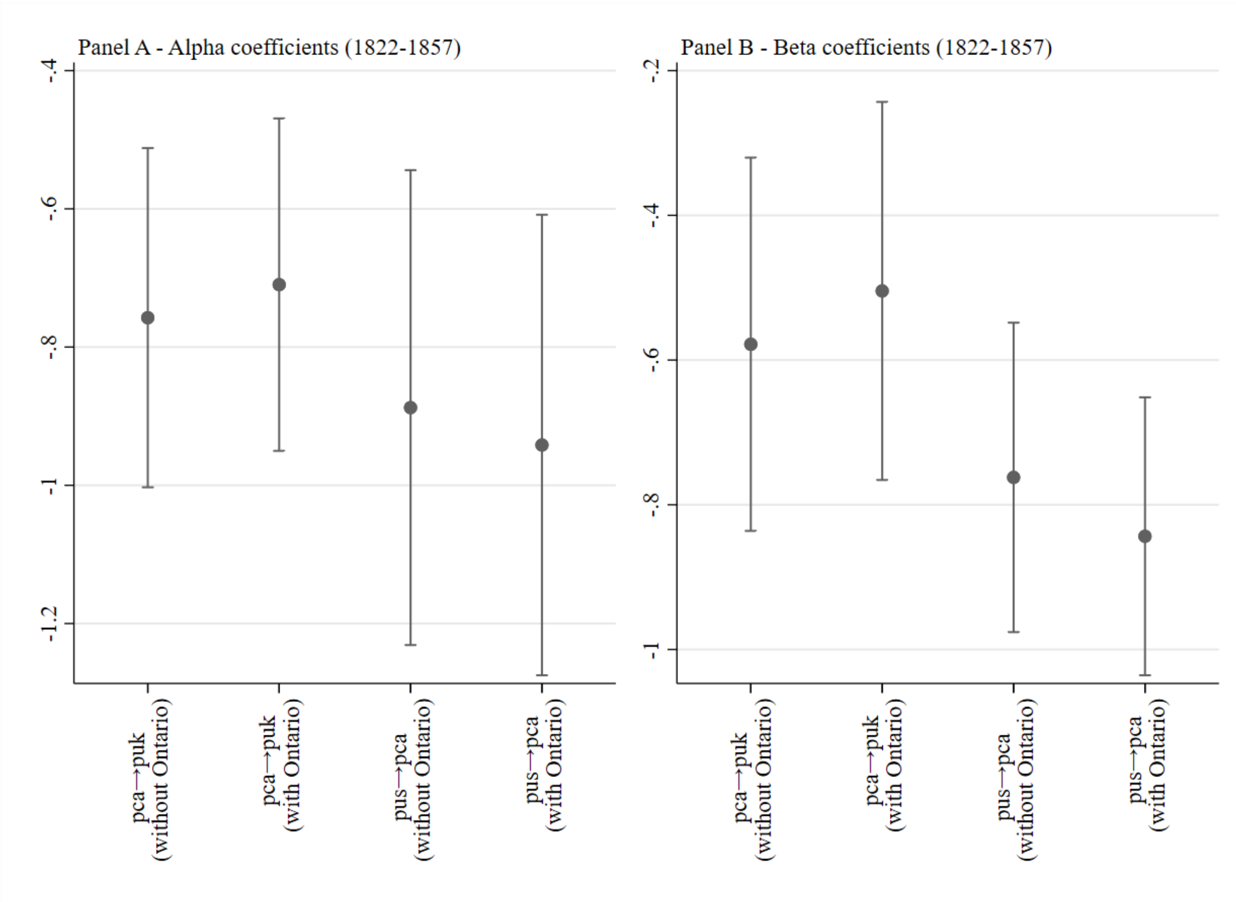

Figure D2: Comparison of point estimates with and without Central Ontario included in price data (1822-1857)

Note: Panel A illustrates the estimated alpha coefficients from equations 4 (without Ontario) and D3 (with Ontario) and Panel B illustrates the estimated beta coefficients from equations 4 (without Ontario) and D3 (with Ontario). Reported confidence intervals are at the 5% level.