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Martin Bruegel, Jean-Michel Chevet, Sebastien Lecocq, Jean-Marc Robin

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On the Crest of Price Waves or Steady as She Goes?
Explaining the Food Purchases of the Convent-School at Saint-Cyr 1703-1788*

Bruegel Martin[1], Chevet Jean-Michel[2] , Lecocq Sébastien[1], Robin Jean-Marc[3]

[1] *INRA, UR 1303 ALISS, 65 boulevard de Brandebourg, 94200 Ivry-sur-Seine Cedex, France.*
Emails: Martin.Bruegel@ivry.inra.fr. , Jean-Michel.Chevet@ivry.inra.fr.

[2] *ADES-UMR 5185, ISVV-INRA, 210 chemin de Leysotte, CS 50008, 33800 Villenave d'Ornon Cedex, France.*
Email: Jean-Michel.Chevet@ivry.inra.fr.

[3] *Paris School of Economics, University Paris 1 Pantheon Sorbonne, and University College London, 106-112 boulevard de l'Hôpital, 75600 Paris Cedex 13, France.*
Email: Jean-Marc.Robin@univ-paris1.fr.

Abstract: The analysis of 85 years of food purchases at the richly endowed Saint-Cyr convent school in the 18th century probes determinants of consumption, its short-term variations and long-term shifts. The data lend themselves to econometric examination because the institution relied on market provisioning for all goods, although smaller quantities of fruits, vegetables and eggs (for the sick) produced within the institution's walls, complemented registered purchases. The estimation of a demand system shows that fluctuations in prices and revenues manage quite well to explain short-range variations in quantities and budget shares. However, they fail to capture long-term shifts in Saint-Cyr's food basket. Econometric reasoning directs toward an investigation of structural change but does not provide any de…nitive conclusion, making the empirical examination of budget parts the best venue to explore secular modifications. The results indicate the need to rethink many long-term relationships positied, in the past as well as the present: an analytical narrative based on economic and other variables explains long-term shifts at Saint-Cyr and suggests that tastes and prices evolve in separate dimensions at different speed.

Keywords: Consumer behavior, Price variations, Preference evolution, Short/long run; Historical data.

JEL codes: A12, D12, N33.

**Do not quote without authors' approval*

1 Introduction

Historical data carry three notable benefits for inquiries into consumption shifts. They chronicle behavior in the long run. They allow for comparison with different temporal or spatial contexts. And as records, they offer the possibility to test the pertinence and power of competing explanations. Here we propose to take advantage of a century-long account of food purchases at a French boarding school during the 18th century. Its meticulously kept ledgers allow for the construction of a data base containing almost one hundred years of information on the price and quantity of annual food purchases.[1] Why bother with such dusty files? First, because conventional, recent data confine contemporary studies to narrow time slices. Such series, hardly ever exceeding thirty years in length and often much shorter, make it virtually impossible to examine dynamic factors influencing consumption. Furthermore, many such studies focus on a single group of products, often meat, to the exclusion of all other perishables, the operational presumption being that interactions between the studied and the excluded commodities do not mar results. Then there is the amplitude of variations in prices. Contemporary runs show some spatial and temporal heterogeneity but, when all things are considered, their stability largely outweighs their volatility. Not so historical long-term data: the 18th century saw major subsistence crises with consequential price jumps that exceeded the secular upward trend in prices. Even quieter periods registered significant price changes. It is their effect on provisioning that we examine.

Our investigation receives a boost from the relative simplicity of historical markets. The Saint-Cyr accounts present the advantage of capturing an entire system of provisioning. Wheat, meat, dairy, vegetables, fruit and groceries, all show up, and their identification is all the easier as their form varies little. Milk, for one, was a unique, identifiable bulk product, a far cry from today's beverage whose marketing heightens the effects of branding and product differenciation. Meat purchases concerned bovine carcasses and some mutton; only very occasionally did a *rôtisseur* deliver grilled chicken. Trifling modifications of the goods' attributes, minor product innovations even over the long haul, and all but inexistent advertising help the modelling of prices. They reduce problems of aggregation and increase confidence in the measure of price effects. Not only are the series long and complete, they emanate from a single consumer. This we test: changes in individual staffing of the managing office (the *économe*) over the nine decades did not inflect the institution's decision making.

But does the historical context warrant the application of modern econometric know-how? In other words, how about the danger of anachronism, the subrepticious attribution of familiar, taken-for-granted contemporary motives and values to an 18th-century consumer? Literary documentation discards such worries. Administrative rules at Saint-Cyr stipulated, "the person who

[1] All accounting sources on the Maison Royale de Saint-Cyr are located at the Archives Départementales des Yvelines (henceforth AD Yvelines), D246-D263, D446-449, D474.

will be in charge of food provisioning must be reliable, intelligent and disinterested; she must not stop at one sole merchant of each sort as he may possibly abuse her trust but must go to all stalls and shops to locate the best merchandise and to find merchants who will provide goods at a lower price".[2] An outside but well-connected observer emphasized the institution's insistance on the selfsame qualities. The bursar "must keep expenses low, must not waste anything but buy only prime goods, be well informed about markets and provisioning (...) keep up with prices of everything and avoid being cheated".[3] The search for the best price at times turned into sprees that required sanctions: catching the opportunity to venture beyond the school walls, the sisters loitered and returned with some delay to turn in their vegetables (Madame de Maintenon to Madame de Fontaines, Dec. 1696, in Langlois ed., 1939, 5: 157). Only the immense quantities of fresh meat consumed at Saint-Cyr warranted an exception to the rule of daily price comparisons: over the century, the institution signed contracts with a single butcher for several years, imposing its conditions with respect to quantity, quality and price of the meat delivered every day. Accounting perspicacy extended into the future. This 18th-century consumer thought ahead. Indeed, budgeting included the informed interpolation of revenues to come. It integrated past revenues to estimate forthcoming proceeds. Whether these projections bounded budgetary decisions is a query to address.

And indeed, most everything had a price. Flour coming from the institution's endowment in farms entered the books as an expense, whereas total rental payments were recorded on the income side. Game from the foundation's forests had a price tag attached, too. Garden produce eventually formed an exception, and so did eggs destined for the sick. The original resolve to avoid indoor production weakened in the face of the prestige value of a pleasure park that also sported a few vegetable and herbal patches. Their produce ended up in the infirmary, of course ("let food by thy first medicine"), and next to other, boughten greens in the kitchen. Medical practice recommended fresh eggs for the sick, and by 1728 the school's governing board approved the construction of a chicken shed attached to the wing that housed the infirmary.[4] Other sources of distorsion exerted minimal effect. The classic charity of religious institutions mattered at Saint-Cyr, but prohibition struck the distribution of leftover foods to the area's poor. Such almsgiving seemed to have occurred, however its instances were "few and far between", and from the institution's early days it was clear that its mission was, in the words of its founder Madame

[2] Mémoire de Monsieur Mauduyt sur l'administration de l'intérieur de la Maison de Saint-Cyr, fol. 4, no date (1710-1745), Archives d'Ormesson, 144 AP 145, Archives Nationales.

[3] Mémoire de ce qui s'observe dans la royale Maison de Saint-Louis établie à Saint-Cyr, fol. 25-26, no date (mid-18th century), Ms. Nlle. Acq. Fr 10677, Bibliothèque Nationale de France.

[4] On the original intent to buy everything and forgo kitchen garden and henhouse, see *Mémoires de Manseau, intendant de la Maison Royale de Saint-Cyr*, publiés d'après le manuscrit autographe par Achille Taphanel (Versailles, 1902: 69-70). Prestige came with a cost, and the chief gardener at Saint-Cyr received a very good salary, see Contrats, D446, AD Yvelines; a renewal of the contract in 1779 justified a salary hike from 3500 to 3650 livres tournois because "two squares of the garden, formerly used to produce hay, are now laid down in vegetables, which increases the gardeners' work load". On eggs for the infirmary, see Milhiet (1999: 79).

de Maintenon, "to educate the Demoiselles, not to feed the poor" (Madame de Maintenon to Madame du Pérou, May 30, 1696, in Langlois ed., 1939, 5: 65). As caution and measure presided over food provisioning, alimentary *caritas* fell within the abhorred category of waste.[5] It did not constitute an incentive to splash out on extra provisions (as it did at other Christian establishments). Thus, parcimony determined consumer conduct at Saint-Cyr. Its accounting data afford a reliable record of the foods provided to the school's inmates and pedagogical staff.

Having ascertained the legitimacy of using these purchasing data as a laboratory to examine the determinants of provisioning, it is the evolving composition of Saint-Cyr's 18th-century food basket which we wish to explain. Does the relatively simpler universe of goods and their varieties help our ability to ascertain the determinants of alimentary purchases at Saint-Cyr? Do the same factors influence short-term variations and long-term modifications? Can we differentiate the weight of social expectations, the lengthy push of arising or disappearing tastes, the fleeting pull of prices, and their trends in the composition of the menus offered in the school's dining hall throughout the century? To accomplish this fundamental investigation, we start out in Section 2 with a presentation of the community at Saint-Cyr; we then briefly review the accomplishments of recent research that attempted to tell apart taste, preferences and prices in describing consumption dynamics in historically removed as well as more recent contexts. Our own model benefits from the limits pointed out by our predecessors, and its logic appears in Sections 3 and 4. The final section summarizes our results and their implications for future research.

2 The Convent-School of Saint-Cyr: Assets, Diet and Food Purchases

Hers was quite a success story. Born into the noble but destitute D'Aubigné family, Françoise (1635-1719) caught Louis XIV's eye, became his favorite mistress and received the title of Marquise de Maintenon before eventually marrying the sun king in 1683. The splendor of the court did not blind Madame de Maintenon to the fate of aristocratic girls in need. She persuaded Louis XIV to endow a religious institution to raise and educate the orphaned daughters of the impecunious nobility. Hence the foundation of the convent-school of Saint-Cyr in 1685. Its boarding capacity of 250 pupils was constantly filled between 1695 and 1792. Girls aged seven to twelve years entered the establishment and left it as women on their twentieth birthday at the latest. The pupils' average age throughout the school's existence lay between 14 and 15 years.[6] Sixty nuns were responsible for the boarders' intellectual and spiritual instruction, and they ate with their students. More wordly chores like cleaning, sowing and serving fell into the hands of domestics whose number increased from twelve at the beginning of the 18th century to

[5] On almsgiving, see Mémoire de ce qui s'observe, fol. 26; Chouet (1912: 207, 238-239).

[6] Our estimation; data base available on request. Our thanks to David Delobel for help with these genealogical records.

thirty-two around 1790. But they, like other personnel, including cooks, bakers and gardeners, saw their sustenance financed through separate budgets. Throughout the school's existence, the number of mouths to feed oscillated around 320, visitors and changing personnel included. The stability of the pupils' average age encourages the assumption that eaters' demographics did not vary significantly over the 18th century.

Monies to run Saint-Cyr mostly flowed from real estate acquired between 1685 and 1700. The land of the manor surrounding the school, the farms in the nearby Chevreuse valley, several priories, houses and woods added up to a property of roughly 6000 hectares (14'826 acres) in 1789. With 139'500 livres tournois (lt) in 1720, rents made up about 60 percent of the institution's revenues, an amount that climbed to 329'500 livres or 74 percent of an income of 441'000 livres in the decade before the Revolution. Royal allowances and wood sales complemented these proceeds whose accelerated increase after the 1750s owed much to the administrator's closer surveillance of rental payments in the context of improved agricultural production. Wealth distinguished Saint-Cyr. It ranked among the fifteen richest female abbeys out of 282 in 1770. Per capita income and expenses reflected such privilege. Rising from roughly 550 lt in 1700 to 1200 lt on the eve of 1789, it represented five to six times the wages of an agricultural laborer with a family toward the end of the Old Regime. Borrowing money to run the place never constituted a threat to the Saint-Cyr budget.

Assets like these, including seventeen farms of more than 100 hectares and eleven that were larger than 50 hectares, required careful supervision. To run the household required rigorous management. The effort to balance income and outlays generated a great many ledgers. Among them, the account books covering the period 1703 to 1789 form the archival stock on which we construct our analyses of food purchases, although they also contain information on other expenses, such as clothing, heating, lighting and schooling. Large volumes register yearly expenses whose detailed components figure, for the last few years of the era, in bills and receipts. Information on prices and quantities concern major or regularly purchased food items: grain, wine, meat, milk, butter and eggs. Lesser buys like olive oil, cheese, fish and sugar only show the expended amount, but invoices sometimes allow the calculation of volume and cost per unit. The accounting system distinguished exterior concerns from interior expenses while keeping track of the expected and realized revenues (Figure 2.1a). Although total food expenditure rose from a yearly average of 43'610 livres during the first decade of the 18th century to 80'311 livres before the Revolution (Figure 2.1c), their share in the overall outlays shrank from about one quarter to one fifth over the century (Figure 2.1d). Assets entailed obligations, and the need to repair farms and buildings and to maintain lands put pressure on the food budget.

[Figure 2.1 about here]

A per caput food outlay increasing from 140 to 250 livres between the beginning and the closing of the century bought a rich and varied diet throughout the 18th century. Even without including edible oils, fish, fruit, honey, legumes, sugar, and vegetables, for which only expense data are complete, the average number of available calories per person and per day never fell far below 2000, a total that contemporary medicine considers sufficient for 14-year-old women. The inmates in Amsterdam's middle-class orphanage had access to an average of 2740 calories per day in the 18th century. Food rations distributed at mid-18th century to French guards and sailors contained roughly 2500 to 3000 daily calories. Boarding schools for the male offspring of the aristocracy in the four decades preceding the Revolution provided an abundant allowance of well over 4000 calories, hinting at the hierarchical construction of needs that included the systematic distribution of leftovers. Our data suggest a diet at Saint-Cyr that falls above the eighth decile of the probable distribution of daily consumption of calories in France toward the end of the 18th century which Fogel built on the series of foodstuff availability established by Toutain (Filippini, 1965; Toutain, 1971; Frijhoff and Julia, 1975; McCants, 1992: 85; Fogel, 1992: 269; Grantham, 1995). All this suggests the ample food supply of the demoiselles at Saint-Cyr. The role of the school was to train noblewomen, the table carried markers of that distinction.

Cornucopia notwithstanding, the diet at Saint-Cyr displayed unexpected features (see Table 2.1). Bread, into which we have transformed the quantities of wheat delivered at the mill of Saint-Cyr, furnished between 50 and 60 percent of the available calories. Note that the difference to the approximately 50 percent of calories grains supplied in boarding schools diets elsewhere in France may contract because we lack data on some foods, yet the bread ration is still much larger than the one to furnish 33 to 40 percent of the calories in the alimentation of the Amsterdam orphanage. The subsistence of French peasants was in an utterly different realm: grains accounted for up to 80 percent of their energy supply. While grains kept stable in the caloric budget, the other staple drew a surprising itinerary. Meat purveyed 30 percent of the calories served on average in the refectory, but its contribution rose first and declined only to rise again. When averaged per day, game's contribution in the second half of the 18th century amounted to 19 grams, roughly eight percent of the average meat ration which oscillated around 250 grams per day in the second half of the 18th century. In contrast, the French aristocracy very much appreciated, and abused of, game and meat (gout was the typical aristocratic disease, and one that affected Louis XIV). Boarding school portions of meat also averaged one fifth of the available calories whereas the Amsterdam Burgerweeshuis rations contained a mere 7.5 percent of meat calories. Together wheat and meat added up to over 80 percent of the available calories at Saint-Cyr. This left only a fringe place for other products. With certain minimum requirements for menus and cooking, eggs and butter remained essentially stable in their parts over the century. Milk and wine took on larger shares, a fact whose effect on the health of the demoiselles warrants further exploration. While Amsterdam orphans received about 25 percent of their calories from dairy products, the pupils at Saint-Cyr, just like their male counterparts at boarding schools, had to put up with a lactose-poor diet in which dairy products furnished hardly four percent of the total amount of calories at the dawn of the century and somewhere between six and seven percent during its last decades. Milk's increasing share in the Saint-Cyr diet contrasts with its declining importance in England during the second half of the 18th century and its greater sensitivity to price changes in Amsterdam during the same period. In other European institutions, milk was typically produced on the premises, leaving no trace to quantify its consumption (Frijhoff and Julia, 1975: 495-496; Roche, 1983: 14-16; Shammas, 1984: 265-266; McCants, 1992: 87; McCants, 1993: 138; Krug-Richter, 1994; Flandrin, 1995; Flandrin and Montanari, 1996: 23-24, 602-603; Thoms, 2005: 586-588).

[Table 2.1 about here]

How to explain inertia and modification in the Saint-Cyr diet? The data invite an analysis in economic terms. With the help of a demand model we try to test whether market prices and budget constraints guide the convent-school's consumer behavior. Of course, the overall pattern of expenditures and its transformations captures our attention, but another question also motivates our inquiry. We would like to uncover whether changes in relative prices might unravel the relative nutritional improvement at Saint-Cyr over the course of the 18th century. Budget shares of different food groups (Figure A.1), their price and quantity indices (Figure A.2) are presented in the Appendix to facilitate the discussion of our reasonings.

Comparison helps. The analysis of provisioning at Saint-Cyr benefits from the insights and suggestions of earlier historical and contemporary studies, many of which struggled with lacunary data sets because self-produced goods (dairy, eggs, fruit, legumes, vegetables) were often left unaccounted. McCants's inquiry into the well-run Amsterdam Municipal Orphanage from 1639 to 1812 offers the opportunity to refine and contrast both methods and findings. The riddle pertains to the long-term modifications in the make-up of alimentary purchases (McCants, 1992, 1993: 138, 1995). The conundrum of price and taste in the shaping of consumer behavior did not escape McCants's attention. Yet her sensitive construction of the Burgerweeshuis records and her effort to root their generation in a specific social context do not quite harness the problem. With the adoption of Schokkaert and Van Der Wee's (1988) pioneer demand system to estimate the Amsterdam data McCants imports its frailty to furnish significant long-term parameters. Although the imposition of chronological and social discontinuity clarifies the picture, it does not provide the wherewithal to assess dietary modifications in the long term. The extent to which evolving tastes affect the composition of the orphans' monotonous but not meager burgerlijke diet remains obscured. This, of course, has been a problem to dog many an investigation into the dynamics of consumer behavior. Neither Burk (1951: 285) and Eales et al. (1997: 1157-1159), who used estimates at mean points and so erased dynamic factors, nor Chavas (1983) and McGuirk et al. (1995), who imposed break points to test for structural change overlooking, for example, methodological problems raised when it comes to the protracted process it takes to translate consumer concerns for health and nutrition into provisioning practices (Myers, 1989: 374), overcame Schultz's (1938: 57-58) caveat: "Our economic laws of change are simply empirical extrapolations of the present situation; they do not enable us to determine with certainty what, for example, the demand and supply situation will be at the next instant in time (...). The best we can do at the present stage is to make a study of a series of statical equilibria." In spite of the increased technical and computational sophistication since the knowledge of these limitations was put on paper, research continues to stumble on the selfsame difficulty (Davis, 1997). In what follows, we offer a series of reflections and procedures to make a step beyond the hurdles on the way toward an explanation of the dynamics of consumer behavior. The Saint-Cyr data refine the empirical basis and indeed present the possibility of estimating an entire food demand system over almost a century, all the while keeping track of other budgetary constraints. The results allow for a discussion of the meaning of structural change.

3 The Demand Model

In this section, we develop a simple demand model in order to explicit the relation between the series of consumptions, on one side, and the series of prices, incomes and expenditures, on the other side. Can we explain, and if so to what extent, the somewhat erratic changes in the series of quantities and budget shares, only from the information contained in the price and income series?

Basically, the idea is to consider food consumptions in the form of fractions of the total budget devoted to various food items, and to regress these budget shares on the logarithm of prices and the logarithm of total food outlay divided by a general food price index.[7] As the dataset provides information on both expenditures and quantities, a measure of prices can easily be obtained by computing the ratio of the former to latter. Unfortunately, quantities are missing for many goods (at least over long periods) and prices therefore cannot be calculated for them. Only the quantities of wheat, butchery meats, eggs, wine, milk and butter are available over the whole century, whereas expenditures are recorded for many other goods. These are regrouped into three additional categories: one is obtained by grouping all other meats (poultry, fish, game, fat bacon) and cheese, another one is fruits and vegetables, and the last one gathers together all remaining commodities, mainly groceries (edible oil, vinegar, rice, sugar, etc.). We thus construct nine budget shares and six logged-prices. In addition to food expenditure, the dataset contains information on the institution's interior and total expenditures, and on its actual and expected incomes.[8] All expenditure and income variables are divided by the same global food price index and expressed in logarithms.

[7]An implicit assumption here is that food is weakly separable from all the other goods, which means that a change in the prices of the latter affects the demand for a food item only through its effect on the food budget.

[8]The accounting books of the administrator of the institution indeed declares both actual and expected income.

Before turning to the detailed exposition of the demand system, we feel it necessary to discuss further both our modelling strategy and the statistical properties of our data, two points which obviously are closely related. Static models generally do not provide reasonable explanations of time series data. Developed within the framework of the equilibrium theory of consumer demand, they assume that consumers fully adjust to price and income changes instantaneously. In other words, consumers are always in equilibrium and there is no distinction to make between their behavior in the short run and in the long run. Anderson and Blundell (1983) suggest that consumers are unlikely to adjust to equilibrium in every time period, arguing that habit persistence, adjustment costs, incorrect expectations and misinterpreted real price changes are among many possible reasons for such short-run behavior. This may explain, in particular, why static demand systems often fail to satisfy most testable restrictions derived from consumer theory (Muellbauer and Pashardes, 1992). Appropriate modelling of the dynamics is therefore essential. Different strategies can be considered depending on the statistical properties of the data.

3.1 Long-Run Evolution

Many contributions to the empirical demand analysis assume that the time series data used are stationary. Yet there is evidence in the literature that series of budget shares, prices, real income or expenditure are not (see Attfield, 1997: 61). Apart from budget shares which, by construction, are bounded and thus expected to be stationary in the very long run, most economic time series trend upward over time and therefore seem to violate the stationarity assumption (as can be seen in Figures 2.1 and A.2a). It is well-known that the usual asymptotic results derived in the standard econometric theory cannot be expected to apply if the variables in a regression model are generated by a nonstationary process, and that least squares estimation of such a model tends to be spurious (Granger and Newbold, 1974). Two simple ways to tackle the problem when using such series are either to detrend them when they are trend-stationary or to difference them when they have unit roots prior to use. Differencing a time series that has unit roots has for undesirable consequence to completely discard the long-run information contained in the data; it thus makes it impossible to model a potential long-term equilibrium relationship between a set of economic variables. Nonetheless, it remains the best solution when the series entering the model are not integrated of the same order. The resulting model is then static: consumptions are explained in terms of within period prices and total expenditure. However, under the assumption that preferences are intertemporally separable, it can still be given a dynamic, life-cycle consistent interpretation: commodity expenditures are determined according to a two-stage budgeting scheme, expected life time budget being first allocated across periods, and each period's optimal budget being then distributed across goods given current prices (Blundell, 1988: 39). Note that to enable the budget constraint to be written as a single life time (expected) budget constraint, perfect capital markets must be assumed, which is unlikely the case at least in the 18th century. Another approach is possible if the variables are all integrated of the same order and if there exists some linear combination of those variates that is stationary. Under these two conditions, the variables are said to be cointegrated and must therefore obey an equilibrium relationship in the long run, although they may diverge substantially from equilibrium in the short run. A very convenient way to deal with such series is to use Vector Error Correction (VEC) models, which incorporate both dynamic short-run behaviors, through differenced variables, and long-run equilibrium behaviors, through cointegrating relationships between the variates in levels (Engel and Granger, 1987). These modelling strategies are quite different from one another and the main technique for choosing between them consists in testing for unit roots.

An important issue in testing for unit roots in a series is trend specification. If the trend is misspecified, then unit root tests can be inconsistent — more precisely, they are inconsistent when the trend is underspecified, while their power is reduced when the trend is overspecified. This case obtains when a series containing a linear trend is tested without being detrended. This extends to other types of trends as well, and in particular to misspecification of a piecewise-linear trend (a "broken" trend) as a single linear trend (see Stock, 1994: 2783, and references therein). Perron (1989a, 1989b) and Rappoport and Reichlin (1989) suggest that the broken-trend model provides a useful description of a wide variety of economic time series, and that if the break date is known a priori, then detrending can be done by correctly specifying it. Most series plotted in Figures 2.1, A.1 and A.2 show a rather nonlinear pattern however, and assuming a piecewise linear trend may not be appropriate.[9] Instead, trends are approximated by smoothing each series with a moving-average filter. Basically, we construct new series in which each observation is an average of nearby observations in the original series. We use a uniformly weighted symmetric moving average over a ten years interval: the first 5 lagged values, the current value and the first 5 forward terms of the series are averaged with each term receiving a weight of one. The interval width is chosen small enough to allow a good approximation of the long-run trend, but not too small so as to capture as few as possible short-run variations that could be economically explained. Note that results are mainly unaffected using a width twice as large. This way of approximating trends works well for most series (see budget shares in Figure 3.1), but it does not for butchery meats and milk price series because of the stair shape they take in some portions. For these two series, we specified a parametric trend: for butchery meats, linear from 1703 to 1726, constant from 1727 to 1769 with a jump in 1744, and then linear from 1770 to 1788; and for milk, constant over the whole period with jumps in 1727 and 1770. Detrended series are then obtained substracting the estimated trends from the original series.

[Figure 3.1 about here]

[9] In fact, no common parametric specification for trends was found appropriate (for instance, a second-order polynomial trend was leading to strong colinearity issues in the estimations that follow).

Table 3.1 reports, for all the detrended variables that we may use in the estimation, the results obtained using two versions of the Dickey-Fuller test for unit roots: one is the standard Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979), the other is the Dickey-Fuller GLS (DF-GLS) test, which is a modified ADF test where the time series is transformed via a Generalized Least Squares (GLS) regression before performing the test and which is known to have significantly greater power than the ADF test (see Elliott et al., 1996). The number of lags of the first-differenced variable to include in the tests in order to account for serial correlation is chosen so as to minimize the Schwarz Information Criterion. In both tests, the null hypothesis is that the variable has a unit root, and the alternative is that it is stationary around zero. From a qualitative point of view, the two tests give identical results: out of 20 series, the null hypothesis is rejected in 17 cases at the 1% level, 18 case at the 5% level and 19 cases at the 10% level by the DF-GLS tests; it is rejected in all cases by the ADF tests. At the loosest confidence level, both tests thus indicate that all our variables are stationary, except one (namely, the logarithm of total expenditure in real terms). All these results suggest that there is no long-run equilibrium relationship between our variables, as far as the annual observation unit does not already pertain to the long term, and that detrending is the most appropriate operation to apply before using our series. Doing so means that we will focus on the influence that short-term variations in prices may have had on the institution's consumption pattern. This does not preclude the possible existence of some long-term effects; it acknowledges that if such effects could be accounted for in a parametric demand system (adding properly specified trend variables), they would remain unexplained. This first finding does not mean that nothing more can be said about long-run developments. They will be investigated at the end of the present section, as well as in Section 4 using nonparametric approaches.

[Table 3.1 about here]

3.2 Short-Run Variations

The model that we choose to estimate is a simple version of the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980a). This specification is particularly convenient since it is both as general as the class of flexible functional form models, which are models whose functional form has enough parameters to be regarded as a reasonable approximation to whatever the true unknown function may be, and much simpler to use (see Deaton and Muellbauer, 1980b: 75). Formally, let n_1 and n_0 be the sets of commodities whose quantities are respectively observed and unobserved in the data, and let $n = n_0 + n_1$. Denote w_{it} the budget share of good $i \in n$ at time $t = 1703, ..., 1788$, p_{it} the corresponding price for $i \in n_1$, and x_t total food outlay. The model can be written as

$$w_{it} = \alpha_i + \sum_{j \in n_1} \gamma_{ij} \ln(p_{jt}) + \beta_i \ln(x_t/P_t) + u_{it}, \qquad i = 1, ..., n, \tag{3.1}$$

where u_{it} is unobserved and reflects the effects of all unobserved explanatory variables, and P_t is the Stone price index

$$\ln P_t = \sum_{i \in n_1} \overline{w}_i \ln(p_{it}), \qquad (3.2)$$

where $\overline{w}_i$ denotes the average budget share of good i over time. In order to control for first-order serial correlation that we detected in the residuals of two equations (milk and groceries), we incorporate habit formation by expressing each intercept α_i as a linear function of all budget shares, lagged one period (using more lags does not improve the results)

$$\alpha_i = \alpha_{i0} + \sum_{j \in n} \alpha_{ij} w_{jt-1}. \qquad (3.3)$$

Because the consumer, in each period, takes into account his past consumption but does not recognize the impact of present consumption on future tastes, this way of modelling habit formation is said to be myopic (or naive). The advantage is that intertemporal preferences are still separable, which means that the two-stage budgeting property still holds and that the estimation of a demand system including lagged budget shares is allowed (Alessie and Kapteyn, 1991: 405). Note that the whole demand system then has the form of a first-order Vector Auto-Regressive (VAR) model, where budget shares are the only endogenous variables.

We could estimate the system (3.1), either equation-by-equation using Ordinary Least Squares (OLS), or all equations simultaneously, removing one from the estimation process and recovering its parameters afterwards through the adding-up restriction,[10] using Seemingly Unrelated Regressions (SUR). However, food expenditure x_t is also the result of a decision. It is clear from Figure 2.1 that after 1760 the income of the institution increases more quickly than its food budget. Therefore, in order to correct for potential simultaneity biases, we shall characterize the decision concerning food consumption as a whole (i.e. both food with respect to other commodities and within-food budget allocation) using Instrumental Variable (IV) techniques. Traditional IVs, namely income variables (past and current), are not significantly correlated to total food expenditure at any conventional confidence level; in fact, lagged food budget turns out to be the only variable showing the required properties.[11] The reduced form equation is therefore as follows

$$\ln(x_t/P_t) = a + \sum_{i \in n_1} c_i \ln(p_{it}) + b \ln(x_{t-1}/P_{t-1}) + \sum_{i \in n} d_i w_{it-1} + v_t, \qquad (3.4)$$

where v_t is the equation error term. The OLS estimates of (3.4) are presented in Appendix, Table A.1. Lagged share for wheat is excluded from the set of regressors, in both the reduced form and the demand system, because of perfect multicolinearity with the other explanatory variables.

[10] Identical estimates are obtained regardless the equation chosen to be removed. This is a property of so-called singular systems of equations, where the dependent variables sum up to a constant over equations and the set of independent variables is common to all equations.

[11] It is both significantly correlated to the current food budget and uncorrelated to residuals in all demand equations.

The overall fit is relatively poor with a $\overline{R}^2$ equal to 0.200, but Ramsey's regression specification error test fails to reject the null hypothesis that the equation has no omitted variables. There is no unexplained dynamics in the residuals $\widehat{v}_t$ either, as can be seen from the Breusch-Godfrey statistic which clearly is not significant. Regarding the identifying IV, the past value of total outlay has a significant and positive impact of about one half, indicating a rather strong inertia in the series.

The simultaneous determination of budget shares w_{it} and total food outlay x_t may imply a correlation between the error terms u_{it} and v_t (say some unobserved explanatory variables condition both budget allocation and budget determination). Let us decompose u_{it} into the sum of a term reflecting this correlation plus an independent shock

$$u_{it} = \rho_i v_t + \varepsilon_{it}. \tag{3.5}$$

In practice, v_t is replaced by its estimation $\widehat{v}_t$, and budget shares w_{it} are regressed on logged-prices $\ln p_{jt}$, the logarithm of real total outlay $\ln(x_t/P_t)$, lagged budget shares w_{jt-1}, and residuals $\widehat{v}_t$. Applying OLS to each demand equation separately and SUR to the whole system then provide the same parameter estimates as Two-Stage Least Squares (2SLS) and Three-Stage Least Squares (3SLS), respectively. In addition, testing whether the estimated parameter of $\widehat{v}_t$ is significant or not in these regressions is a direct test of exogeneity: if $\widehat{\rho}_i$ is significant, then it is possible to reject the null hypothesis of no correlation between perturbations u_{it} and v_t. In this case, omitting to control for this correlation would yield biased estimates.

Before turning to estimation results, let us give some precisions on the interpretation of parameters. As mentioned above, the demand model is estimated using detrended series in order to avoid spurious regression issues. Consequently, it can be seen as a model measuring short-term effects. However, parameters in equation (3.1) are structural parameters describing preferences of the *économe*, and as any structural parameter they should be as relevant in the long run as in the short run. Formally, if we denote y_t the vector stacking all detrended variables and given that $y_t = \widetilde{y}_t - \overline{y}_t$, where $\widetilde{y}_t$ is the original (non detrended) series and $\overline{y}_t$ its long-run trend (computed as moving-averages), we can write three models — a short-term model (as above) where fluctuations of budget shares around their trend are explained by those of prices and total food budget, a long-term model (replacing y_t by $\overline{y}_t$) where trends in prices and food outlay explain, up to a constant, trends in budget shares, and a full model (replacing y_t by $\widetilde{y}_t$) encompassing both short-term and long-term effects — with a single set of structural parameters.[12] An additional advantage of estimating the short-run model is that it helps eliminate at least partly the potential source of endogeneity of x_t. Rewriting (3.5) in terms of original and trend series, we get $u_{it} = \rho_i(\widetilde{v}_t - \overline{v}_t) + (\widetilde{\varepsilon}_{it} - \overline{\varepsilon}_{it})$, and we see that $\widetilde{v}_t - \overline{v}_t$ will be almost zero if $\widetilde{v}_t$ evolves slowly. In this case, estimates of ρ_i will not be different from zero.

[12]Except constant terms: as they vanish in the short-run model, their estimates should be zero.

[Table 3.2 about here]

Table 3.2 summarizes the SUR estimation results. As can be seen at the bottom of the table, the exogeneity of total food expenditure, indeed, cannot be rejected for any food categories, whether these are considered separately (ρ estimates are all insignificant) or jointly (a joint test yields a χ^2_8 equal to 9.59 with a P-value of 0.295). Consequently, more efficient estimates and statistics can be obtained applying SUR to the system under the null that food outlay is exogeneous, that is without (3.5). All the results reported in the rest of the table therefore come from this reestimation. The overall quality of fit fairly differs from one equation to another, with $\overline{R}^2$s ranging from 0.046 for fruits and vegetables to 0.770 for butchery meats.[13] Other direct tests of model's quality are provided by Breusch-Godfrey and Ramsey Reset statistics. Breusch-Godfrey tests show that serial correlation in residuals cannot be detected any longer when lagged budget shares are added to the set of independent variables, while Ramsey statistics indicate that some specification issues may only subsist in the egg equation.[14] As expected, all intercepts are very close to zero and insignificant. Prices seem important in explaining budget shares, especially for butchery meats and wheat: out of six prices, five and three are significant in the butchery meats and wheat equations, respectively. Variations in food expenditure play a role as well, total outlay being significant in six equations (wheat, butchery meats, eggs, milk, butter and groceries). Eventually, the estimated coefficients of the lagged dependent variables suggest that habit formation is more important for milk and groceries, whose budget shares are significantly influenced by their respective past value, than for the other food items.

[Table 3.3 about here]

Budget and price elasticities provide a more straightforward device to analyse the short-run effects of total food outlay and prices on consumption. Table 3.3 presents these elasticities evaluated at the sample mean point. Budget elasticities are computed by evaluating the relative effect of a small increase of food expenditure on each quantity.[15] First note that a small and insignificantly different from zero elasticity of quantities with respect to food outlay is obtained for butter and milk. It means that when the orphanage's total food expenditure increased the demoiselles did not increase (nor decrease) their consumption of the two items. This is also

[13]The absence of a permanent market most likely explains the low adjustment for fruits and vegetables since the purchased quantities may have supplemented the school's own garden and fruit-tree production.

[14]Note that such reassuring results could not be obtained when model (3.1) was augmented with a parametric trend and estimated on original series.

[15]The elasticity of commodity i with respect to total expenditure x is computed as $e_i = 1 + \beta_i / w_i$. It follows that a commodity whose budget share increases when total expenditure increases ($\beta_i > 0$) always has an elasticity greater than one (luxury good), and a commodity whose share decreases when total expenditure increases ($\beta_i < 0$) always has an elasticity lower than one (necessary good). A commodity whose share changes are uncorrelated with total expenditure changes ($\beta_i = 0$; its consumption is a fixed share of total outlay whatever its value if prices remain constant) has an elasticity of one.

true, to a lower extent, of butchery meats and eggs, whose budget elasticities are significant but small: if their consumption increased with the institution's food budget, it did less than proportionately. All these commodities come out clearly as necessary goods. Other meats as well as fruits and vegetables seem mainly unaffected by changes in food outlay; the fact that, for these commodities, food expenditure parameters β_i are not significantly different from zero implies that their budget elasticities are not significantly different from one. The last group of commodities, the luxury goods, is made of the goods whose shares are positively and significantly correlated with total outlay: wine, groceries and wheat. This last result is less surprising than it appears at first sight if we take into account that crises increased the share of food expenditures in the institution's total outlays while at the same time increasing the monies spent on wheat. For example, the ratio of food-to-total expenditure in 1709 is by 10 percent higher than in nearby years, with the share of wheat at its peak (56 percent) and the share of butchery meats at its lowest point (23 percent). And indeed, adding dummy variables to control for the 7 main peaks and lows observed in the quantity of wheat consumed (see Figure A.2) brings the budget elasticity down to unity. Note that McCants' first estimation resulted in even higher values which she explained by the Amsterdam orphanage's capacity to store wheat and rye (McCants, 1995: 202-203). At Saint-Cyr, it was not an opportunity but a constraint that helps explain the luxury status of wheat. We note a significant difference between the results calculated for two sub-periods (1703-1742, 1743-1788): while wheat, with a budget elasticity of 2.3, still comes out as a luxury good in the first sub-period, characterized by more frequent subsistence crises and a higher volatility of purchased quantities, it becomes a necessity in the second, with a budget elasticity equal to 0.7.[16]

Two sorts of price elasticities are calculated here. The first are the usual uncompensated price elasticities which measure the relative change in consumption induced by a relative change in prices, holding food expenditure constant. Each of these elasticities combine both a substitution effect and an income effect (since budget is maintained constant, its real value decreases when a price increases). Therefore, in order to study the substituabilities between commodities, we also compute the compensated price elasticities, in which the decrease in real budget implied by the price increase is exactly compensated.[17] First, it is worth noting that the own-price elasticities for butchery meats are very small and not significantly different from zero, which means that their consumption is not affected by price changes. This result, as well as the relative budget inelasticity of butchery meats, seems consistent with instructions given to the abbesse by the board of trustees and translated in contracts with the butcher: an order from 1714 advised "to offer only very good cuts, well conditioned, such as served at the best tables ... and to reject pieces

[16]Budget elasticities for milk and butter also differ significantly over these two sub-periods, but they remain within the same range (necessities).

[17]The uncompensated elasticity of commodity i with respect to the price of commodity j is $e^u_{ij} = -\delta_{ij} + (\gamma_{ij} - \beta_i w_j)/w_i$, where δ_{ij} is the Kronecker delta which equals one if $i = j$ and zero otherwise. The compensated elasticity is given by $e^c_{ij} = e^u_{ij} + w_j e_i$.

of the so-called low butchery" (D446, AD Yvelines). Wheat consumption is affected by price changes through an income effect only (own-price elasticity being zero when compensated and significantly negative when uncompensated). All other groups of commodities have significant and negative, though relatively small, own-price elasticities, butter and, to a lower extent, wine appearing more sensitive to price changes than milk, wheat and eggs.

Regarding compensated and uncompensated cross-price elasticities, few are significant. Let us focus on compensated values. All significant elasticities are located above the diagonal, which means that there is no symetry in price effects. Consider, for instance, the relationship between butchery meats, milk and butter: an increase in the price of milk or butter has a positive and significant effect on the quantity of butchery meats consumed (which are then substitutes for milk and butter), but an increase in the price of butchery meats has no significant impact on milk and butter consumptions. Milk by far is the most connected among the items: an increase in the price of milk is followed by a decrease of wheat, and other meats and cheese demand (which seem to act as complements to milk) and an increase in the consumption of butchery meats, fruits and vegetables, and groceries (which appear as substitutes to milk). But the main result concerns the luxury commodities: other meats and cheese are substitutes for wheat; groceries are substitutes for butchery meats. It implies not only that the consumption of these goods increases more than proportionally with food expenditure, but also that they benefit from increases in the prices of wheat and butchery meats, this effect being all the more important that wheat is also found to be a complement to butchery meats.

In the modelling framework retained in this section, economic variations (in prices, incomes, expenditures and past budget shares) do play a role in the explanation of short-run fluctuations in food consumption patterns at Saint-Cyr. An overview can be given comparing detrended shares to model's predictions in Figure 3.2. In general, the model manages to reproduce short-term variations. This is particularly true for butchery meats and wheat, which are by far the largest sources of expenses. This is less true of wine, however: the series of prices, quantities and shares fluctuate a lot, but fluctuations in prices do not seem to predict well those in quantities. Thus, institutional wealth did not allow the *économe* to escape the hold of the foods' prices. Not more so, in any case, than the food and drink consumed at Saint-Cyr contradicted market imperatives. The fact that the food budget reacted to crises, when prices rose and scarcity obtained, confirms the institution's insertion in the market economy. Status and market were not opposed to each other. They marched hand in hand.

[Figure 3.2 about here]

But what about long-run evolutions? Do trends in economic variables help explain long-term changes in budget shares? Figure 3.3 presents the actual (non detrended) budget shares together with the corresponding model's predictions obtained replacing detrended price and expenditure series by their non detrended counterpart. It seems that four situations can be distinguished. First, it is hard to draw any conclusion from the exercise for wheat and eggs, whose consumption is fairly stable over the century. The model works pretty well in predicting long-term trends for groceries and other meats and cheese. Important discrepancies between predictions and observations are found for the other groups, however. Some concentrate on a particular subperiod. In the case of butchery meats for instance, predictions appear reasonable until the late 1750s but the model fails to predict the fall and the rise of consumption that followed. This is also true for milk and butter, where issues mainly show up before 1725 and after 1765, respectively. The most severe errors in model's predictions are observed for wine and, especially, fruits and vegetables: while their actual consumption rises over the whole century, the model predicts a decline.

[Figure 3.3 about here]

As we stated at the beginning of the section, the model does not allow us to characterize long-run evolutions: economic change alone is not sufficient to capture the long-term trend of budget shares. Yet, if the increase of the food budget over the century left the composition of the diet unchanged in many goods, how to explain the observed shift of consumption away from butchery meats and towards milk, fruits and vegetables as well as groceries, suggesting that the food diet and the sources of nutrients were more and more diversified at Saint-Cyr?[18]

4 Structural Change and Long-Term Developments

Two conclusions are usually drawn from the presence of significant unexplained trends in consumption series. The first is that structural changes have occurred over time. We could try to test for structural changes estimating our demand system (3.1), augmented with a well-specified parametric trend, on the original series, and checking for parameter stability, significance of trends or serial correlation in residuals. This would not be correct, however, given that all the results would be conditional on the functional form (3.1) being correct.[19] As argued by Chalfant and Alston (1988), a definitive test for structural change would involve only the hypothesis that preferences are stable, not that they are stable and of a particular form. The other conclusion, indeed, is that the model is misspecified.

Nonparametric approaches of structural changes make it possible to test the null hypothesis that there is a stable set of preferences, so that variations in observed quantities can be explained by changes in relative prices and expenditures, avoiding the specification bias likely with arbitrarily selected functional forms. They simply consist in checking for consistency of the series of prices and quantities with this hypothesis using revealed preference axioms. For instance, the

[18] Similar unexplained shifts are quite often reported in the literature. See, for example, the results obtained by Deaton (1974) and further discussed in Deaton and Muellbauer (1980b: 70-72).

[19] Such an assumption would be unlikely at least for the trend, the specification of which has to be both correct and identical in all equations (so as to preserve the singularity of the system).

Strong Axiom of Revealed Preferences (SARP) is equivalent to the existence of a well-behaved utility function, so that when it is satisfied by the data, there is a stable demand system that fully explains observed consumptions. Conversely, the axiom need not hold when structural changes occur, so a test for violations of SARP enables the identification of changes in preferences.

4.1 Revealed Preference Tests

Denote $p_t = (p_{1t}, ..., p_{nt})'$ and $q_t = (q_{1t}, ..., q_{nt})'$ the n-vectors of prices and quantities consumed in year t, and consider the following definitions (Varian, 1982). According to revealed preference theory,

1. a bundle of goods consumed at time t, q_t, is directly revealed preferred to a bundle of goods consumed at time t', $q_{t'}$, written $q_t R^0 q_{t'}$, if the latter was affordable at the price of time t, that is if $p_t' q_t \geq p_t' q_{t'}$;

2. q_t is indirectly revealed preferred to $q_{t'}$, written $q_t R q_{t'}$, if there exists a sequence $(q_u, q_v ..., q_w)$ such that $p_t' q_t \geq p_t' q_u$, $p_u' q_u \geq p_u' q_v$, ..., $p_w' q_w \geq p_w' q_{t'}$; in this case, we say that the relation R is the transitive closure of R^0.

In what follows, we examine the consistency of our data with two revealed preference axioms: the weak and the strong axioms.[20] According to the Weak Axiom of Revealed Preferences (WARP), $q_t R^0 q_{t'}$ implies *not* $q_{t'} R^0 q_t$ for $t \neq t'$. This can easily be tested by forming a matrix Φ with typical element $\Phi_{tt'} = p_t' q_{t'}$, so that each element $\Phi_{tt'}$ represents the cost at time t prices of purchasing the set of goods consumed at time t'. The elements in each column therefore give the cost at various prices of a fixed bundle, and the elements in each row give the cost of various bundles at constant prices. If the actual expenditure at time t exceeds the cost of bundle $q_{t'}$ at time t prices, so that $\Phi_{tt} \geq \Phi_{tt'}$, then $q_t R^0 q_{t'}$. Violation of WARP occurs if it is also true that bundle q_t was affordable at time t', so that $\Phi_{t't'} \geq \Phi_{t't}$ and thus $q_{t'} R^0 q_t$. The absence of violation in the data is consistent with stable preferences over the period. Conversely, any violation of WARP must be interpreted as evidence of a change in preferences between time t and time t'. For example, if a bundle consumed at time t was affordable at time t' but was rejected in favor of a bundle with more wheat and less meat, it implies a preference for the bundle with more wheat. If the latter was affordable at time t but was not chosen, we would conclude that, between t and t', preferences have shifted to wheat and away from meat.

Finding no violation of the weak axiom is a necessary but not a sufficient condition to the existence of a stable set of preferences. It is also necessary to check that the strong axiom is satisfied. Similarly to WARP, SARP holds if $q_t R q_{t'}$ implies *not* $q_{t'} R q_t$ for $t \neq t'$. Basically, testing for SARP amounts to search for intransitivities in the data, to see whether bundles q_t, $q_{t'}$ and $q_{t''}$ can be found such that $q_t R^0 q_{t'}$, $q_{t'} R^0 q_{t''}$ and $q_{t''} R^0 q_t$. The data are consistent if

[20] All results are, as in the parametric case, conditional on food being weakly separable from other goods.

no such intransitivities are found in the matrix Φ. To test for SARP, we need to construct the transitive closure R of R^0. We use Warshall's algorithm described in Varian (1982). When no violation is found, it can be said that the data have been generated by the maximization of a stable, well-behaved utility function by a representative consumer. Conversely, detecting a violation of SARP is, strictly speaking, enough to reject the hypothesis of stable preferences maximization. In practice however, some violations might be found in most data sets not because of inconsistency with the axiom but because of measurement errors. To determine whether the data satisfy SARP (or WARP), it may therefore be more reasonable to use the violation rate, defined as the percentage of couples that violate the axiom. Then, a violation rate of 5 percent, a standard significant test critical value, can be used as a criterion for the rejection of the axioms (see Famulari, 1995). Furthermore, when a WARP or SARP violation is found, we use Afriat's (1973) efficiency index to measure its importance. Let $e \in]0,1]$, redefine the direct revealed preference relation as $q_t R^0(e) q_{t'}$ if $e p_t' q_t \geq p_t' q_{t'}$, and define SARP($e$) and WARP($e$) replacing R by $R(e)$ and R^0 by $R^0(e)$ in SARP and WARP definitions, respectively. Note that when $e = 1$, $R(e) = R$ and $R^0(e) = R^0$. Denote e^* the largest value of e such that a SARP, or WARP, violating couple of bundles satisfies SARP(e^*), or WARP(e^*). Then, a violation with e^* equal to 0.8 is more important than a violation with e^* equal to 0.9.

A well-known drawback of revealed preference tests applied to time series data is that they often lack power to reject the axioms. As mentioned in the previous section, most economic time series trend upward over time, with income (and budget) growth much more important than period-to-period relative price variations. As a consequence, each year is revealed preferred to the preceding years in the sense that it is typically possible in a given year to purchase the consumption bundles of each of the previous years (see Varian, 1982). This makes it unlikely to find a violation of revealed preference axioms. One simple solution is to select couples of bundles whose costs, at fixed prices, are not too different from each other. Famulari (1995) proposes to evaluate all bundles at a reference price vector, say p_0, and to retain for the tests any couple $(q_t, q_{t'})$ satisfying the rule $2(p_0' q_t - p_0' q_{t'})/(p_0' q_t + p_0' q_{t'}) \leq \kappa$, with κ an arbitrarily defined threshold. Then, only couples whose costs at p_0 differ by at most κ are kept to perform the tests. As it is precisely those couples with small differences in costs that provide the strongest tests, the lower κ the larger the power of the tests.[21]

An additional problem arising in our context is that the construction of the matrix Φ requires to observe both quantities and prices for all groups of goods. In our data however, quantities are missing for three sets of foods (only expenditures are observed). If preferences over the six groups with observed quantities are assumed not to be separable from the three others, which is probably the case, and if we do not account for the latter, then it is possible to rationalize any

[21]Given that only one person was in charge of the food purchases for all the people living in the institution, our data can be seen as describing the behavior of a representative consumer. No violation of revealed preference conditions on these data can therefore be attributed to an inappropriate aggregation of individual behaviors.

set of prices and quantities for the first six (Varian, 1985). Thus, omitting these three groups makes it impossible to test for WARP and SARP. To cope with our lacunary data, we choose to apply the same coefficient of augmentation as we find for the set of foods with complete figures to the set of foods for which we know only the expenditures. In other words, if at time t the actual expenditure on foods with missing quantities represents say 10 percent of the food budget $p_t' q_t$, the expenditure on them at time t' prices is computed so as to represent 10 percent of the food budget $p_{t'}' q_t$.[22]

Table 4.1 presents the number of couples violating WARP and/or SARP, together with the corresponding violation rate (in parentheses). For each axiom, it reports the results obtained for the set of all possible couples in the first column, and for the sets of couples remaining after deleting those whose costs at constant prices differ by more than $\kappa = 20$, 15, 10, 5 and 1 percent in the next five columns. Prices observed in the first year of the sample, 1703, are chosen as reference prices p_0; choosing any other year has no qualitative impact on the results. From the top to bottom rows, the number of violations is given for decreasing values of Afriat's efficiency index, e. Let us first look at the results when $e = 1.00$. As shown in the first column, out of 3655 possible couples, 62 (1.7 percent) violate WARP and 214 (5.9 percent) violate SARP. This is few and the vast majority of couples thus fail to reject the two axioms. In both cases, however, violations do not concentrate on a particular subperiod but rather spread over the whole century. Out of 86 years, only 21 show no violation of SARP (32 for WARP), with the largest number of subsequent consistent years being four, from 1721 to 1724.

The violation rates discussed above are obtained using all couples of bundles, including those that are unlikely to violate the axioms. In the next five columns, the count of violations is restricted to couples with a difference in expenditures (at reference prices) at most equal to κ. Still focusing on rows where $e = 1.00$, we see that the number of violating couples does not vary much until $\kappa = 1$ percent, which indicates that violations are primarily found among bundles with similar costs: 96.7 percent of all SARP violations and 93.5 percent of all WARP violations still occur when $\kappa = 5$ percent. Up to that threshold, almost all couples that are eliminated are those that trivially respect the axioms. Calculating violation rates using only bundles with similar expenditures therefore improves the power of the tests. As the number of couples kept for this calculation decreases with κ, the percentage of violating couples increases proportionally: from 1.7 to more than 6 percent for WARP and from 5.9 to more than 21.4 percent for SARP. Hence, although 5.9 percent only of all possible couples reject the hypothesis of stable preferences maximization, the fact that more than one fifth of those providing the highest power tests are inconsistent should clearly be a source of concern.

[22] This is admittedly a strong hypothesis, as the share of the three groups with missing quantities increased from 15 to 23 percent in the food budget between the beginning and the end of the century. Working on the six budget parts with known quantities only, based on an equally strong but less realistic assumption, yields the same qualitative results (see Appendix, Table A.2).

[Table 4.1 about here]

How important are these violations? Consider the results when e is lower than unity. A small diminution of Afriat's efficiency index induces a large reduction in the number of violations. When $e = 0.99$, this number is divided by more than two regardless the value of κ. In the first column, for example, only 23 (0.6 percent) and 91 (2.5 percent) couples of bundles remain inconsistent with WARP and SARP, respectively. This suggests that there are many couples in our sample that "almost" satisfy the axioms. Similarly, the number of years showing no violation of the axioms is now much larger (42 for SARP and 54 for WARP), and though violations still seem fairly dispersed over the century, many of them (85 percent) concentrate on three subperiods about 15-years long: for SARP, 20 percent of violations occur between 1703 and 1717, 29 percent between 1731 and 1748, and 36 percent between 1768 and 1782. A comparable pattern emerges when $e = 0.98$. SARP is violated by 10 couples and WARP by 5 couples, with all violations taking place within the subperiods defined above and whose range can further be reduced to 1709-1711, 1734-1746, and 1770-1782. Some violations appear very robust however, as those 3 couples — (q_{1709}, q_{1711}), (q_{1709}, q_{1734}), (q_{1711}, q_{1734}) — that violate SARP, among which the first two do not satisfy WARP either, when $e = 0.97$ and 0.96, and the one (q_{1709}, q_{1734}) that still violates both axioms until $e = 0.93$. This does not change when the count is restricted to couples of bundles with similar costs if $\kappa = 20$ and 15 percent, but it does if $\kappa = 10$ and 5 percent: no couple is then found to be inconsistent with WARP and only one (q_{1711}, q_{1734}) violates SARP when $e = 0.97$ and 0.96. Note that such a result does not mean that the axioms are satisfied by the data. It simply indicates that the two additional violations found in the less restricted samples are actually related to bundles with fairly different costs, and that using too restrictive values for κ to get rid of trivially consistent couples may also eliminate violations.[23] These results — the important violation rates found among couples with similar costs when e equals unity and the persistence of some violations as e decreases — seem therefore robust enough to suggest a change in preferences that calls for interpretation.

Let's note that the years that turn up in WARP and SARP are years of crises. That is, exogeneous shocks (short-term price hikes, scarcity of goods) affected the institution's budget and effected a change in preferences. But these predicaments were short-lived. Nothing precluded the return to the preferences that obtained prior to the crisis. This temporal instability is emphatically not the same as a change in tastes. However, past experience suggests that exceptional circumstances may induce long-term changes in the taste — as well as the distaste

[23] Also note that, although a similar picture can be drawn when tests are conducted on the subset of 6 groups with quantities (Table A.2), the couples violating the axioms slightly differ. Indeed, when $e = 0.96$ and 0.95, SARP-inconsistent couples are (q_{1709}, q_{1713}), (q_{1709}, q_{1736}) and (q_{1713}, q_{1736}), and the only WARP-inconsistent couple is (q_{1709}, q_{1736}), this last couple violating both axioms until $e = 0.92$. When the count is resctrited to couples differing by at most 5 percent, we find no violation of WARP and only one (q_{1713}, q_{1736}) of SARP.

— for certain foods. Thus we turn to an examination of the determinants of the food basket's long-term development.

4.2 Historical Analysis

Even though the structural model fails to predict overall long-term shifts in food purchases at Saint-Cyr, the evolution of budget parts and quantities of goods provides a venue to explore secular modifications of its consumption patterns. It turns out that the late 1730s and early 1740s, one of the subperiods found to be notable when it comes to violations of the WARP and SARP hypotheses, emerge as a period of a bundle of small, but altogether significant changes in the institution's consumer behavior that seem unrelated to short-term impacts (neither subsistence nor financial crisis rocked the boat around 1740 as the economy was in a phase of recovery). The share of food purchases in total expenditures began to decline. The budget part and quantities of butchery meat entered their downward slope during this period precisely as the consumption of game took off after almost forty years of only sporadic appearances on the menu. And finally, purchases of sugar (factored in with groceries) became more regular as well as more important while fruit weighed in more heavily thereafter in the school's budget. This latter development escapes our structural model which predicted a severe drop of fruits and vegetables in the long run while it captured the dynamics in groceries. Having pushed the econometric analysis as far as possible, other parameters must now contribute to the explanation of the evolving composition of Saint-Cyr's food basket.

Over the 18th century, the *économe* aimed to buy somewhat over 60 muids of wheat per year, and this at whatever cost (see Figure A.2). Subsistence crises put limits on this endeavor and they compromised the daily consumption of a pound of white bread per person; the dramatic situation of 1709 even induced a modification in milling, for the bread in this year of hunger across France was uncharacteristically brown at Saint-Cyr (Chouet, 1911: 131). Wheat anchored consumption at the convent school. Its budget share proved volatile in the short term but showed a slight tendency to decline in the long run (from about 27 to 22 percent). The aristocratic taste for meat and Saint-Cyr's ambition to provide constant quantities notwithstanding, its consumption moved in waves (Figure A.2b) that our structural model fails to capture after 1750. While disposable quantities plunged from about 350 to 300 grams per day and person in the pivotal 1740s, a small part of the drop-off to 250 daily grams in the 1760s was made up by game. Its budget share took off definitely in 1740, although it stayed at a paltry 1.5 percent on average throughout the rest of the institution's existence. An estimation of consumed quantities in the 1770s yields a daily ration of roughly twenty grams of feathered and ground game (AD Yvelines, D448 and D449). The secular diminution effected a decline in the budget share of butchery meat from roughly 40 percent in the beginning of the century to about 31 percent on the eve of the French Revolution, whereas expenses at the butcher's peaked at over 45 percent in the late 1730s. To sum up: the heavy weights in food expenses, most clearly butchery meat, lost budgetary ground in the course of the 18th century. In contrast, most other goods saw their budgetary importance increase with the century. The explanation of this shift hinges on goods that benefitted from the budgetary reallocation.

Did butchery meat yield to milk, whose consumption tripled in the course of the century? A comparison of their quantitative trajectories milits against the assumption of a partial substitution effect. Through the 1740s, the purchased quantities of both commodities grew, steeply in the case of milk, gently in the case of meat. The early 1740s saw them decline, and while milk consumption tended slightly upwards through the 1780s, meat continued to drop. The pace of increase accelerated for both foods in the last decade of the Ancien Régime. These dynamics provide no evidence that the cutback of meat on the menu favored the rise of milk, whose part in the food budget increased from somewhat less than 2 percent at the beginning of the 18th century to about 4 percent in the last decade of the institution's existence. The two patterns seem independent. An explanation of the growing importance of milk, the major provider of calcium by the time the convent-school was shut down, must first acknowledge its particular place in the medical arsenal; galenic medecine held it in poor esteem as a foodstuff but recommended it against pulmonary disease which happened to send many a Saint-Cyr inmate to the infirmary indeed (Lavallée, 1856: 245). Madame de Maintenon, for one, encouraged its use when illness struck in 1696 (Madame de Maintenon to Madame de Fontaines, Sept. 7, 1696, in Langlois ed., 1939, 5: 96-97). While such therapeutic application persisted in the 18th century, the prejudice against milk seemed to fade (Laurioux, 1994: 30-42) to a degree that allowed it to enter the diet (Picco does not report an increase in the number of patients at the infirmary over the eighteenth century, see Picco, 2000). By mid-century, milk occasionnally replaced the evening soup (BnF MS 10678, Mémoire de ce qui s'observe, p. 24). That requalification as a foodstuff surely added to Saint-Cyr's alimentary purchases but without affecting its consumption of meat.

Cooking constraints curbed the influence of prices. Their secular developments diverged notably. The price of butter more than doubled the progression of meat while eggs outpaced it by 50 percent. Their respective quantities could not suffer trimming without compromising gastronomic standards at Saint-Cyr, however much that measure would have contributed to the persistance of the original budget. So their shares increased from about 2.5 to 4.5, and 6 to 8 percent (it is worth noting here that the crisis years of 1724 and 1725 compressed butter consumption into its nadir). The culinary imperative put pressure on the budget, of course, and the incurred expenses affected the costliest item on the institutional shopping list — the one where economies of expenditures resulted in substantial savings: butchery meats.

But there is more to ingredients than butter and eggs. Sugar figured most prominently among the items whose importance increased in the budget and on the menu. While its share in food expenditures grew from 1.5 to more than 5 percent, consumption expanded from less than 1000 pounds per year in the first decade of the 18th century to roughly 5000 pounds in its last. The secular expansion translated into a climb from 4 to 20 grams per person and per day. Here again, the 1730s appear as a turning point. Growth proceeded faster in the first half of the century than in the second half, but purchases are more regular after the first third of the 18th century. The development of a provisioning routine — the move away from opportunist purchases after the 1730s — owed much to the increased supply as overseas plantations grew and exportations to metropolitan France expanded. Increased supply stimulated the taste for sugar. Price played only a minor role in the development. It varied throughout the century between 14 and 21 sols per 1000 pounds, peaking in times of war. Then, as in the War of the Austrian Succession (1740-1748) and the French-and-Indian or Seven-Years War (1756-1763), acquired quantities got pushed down without, however, reversing the secular tendency to indulge the pensionnaires' sweet tooth. That is, purchases picked up as soon as prices came down. By the American Revolutionary War, however, the demand was so strongly rooted in eating habits as to prevail over a price hike. Consumed quantities grew in spite of it. And eating there was! For the ledgers at Saint-Cyr do not record a single exotic good transformed into sweet, stimulating beverages: chocolate, tea and coffee did not make it into the convent-school where pupils and nuns were ever more likely to indulge in pastry as the century went by.

Incidentally, sweetness appears the key to another modification of consumer conduct. The expense on fruit and berries grew from 1 to almost 4 percent in the school's budget while the outlays for preserved fruit consumed during lent remained stable at about 1 budget percent throughout the century. Our sources remain silent on acquired quantities, and the purchases may also have supplemented produce from the school's gardens and orchards (which, as we have seen, took on a minor role in provisioning as the century advanced). But the fact remains that the *économe* at Saint-Cyr was willing to spend more money on fresh fruit in the course of the century, whether to satisfy increasing demand or to avoid depriving the demoiselles of their habitual level of fruit consumption, in cakes prepared on the premises or as fresh apples, apricots, cherries, pears, plums and peaches arriving as desserts (BnF MS 10678, Mémoire de ce qui s'observe, p. 24).

The forms different food expense indices took in the course of the century bolster the assertion that the rising taste for sweets and the corollary requirement of butter and eggs necessary to its gratification combined to bring down expenses for butchery meats. Figure 4.1 reproduces the secular evolution of outlays made on meat (butchery and game) and other food groups. When indices of butter, eggs, sugar and wine augment the index for meat, they espouse the dynamics of the index for total food expenses even after the 1740s and the reduction of outlays for meat. All other groups responded to different economic cycles and so imparted various impulses to the long-term pattern of food expenditures without aligning themselves on its general form. This is additional evidence to clinch the point. Meat consumption declined in order to maintain the quantities of butter and eggs required in a rich cuisine. Furthermore, the reduction favored the epochal shift toward a sweeter diet.

[Figure 4.1 about here]

The modification of taste was, however, not the only factor to propel food expenses at Saint-Cyr. Other budget constraints increasingly mattered as the institution grew older. The share of food in total expenditures tended upwards through the 1740s, then shrunk. The reversal coincided *grosso modo* with the beginning of meat's quantitative descent on the menu. The 1750s confirmed the lesser weight of food expenses with respect to all other financial concerns at Saint-Cyr. It thus appears reasonable to conclude that these arising pressures (maintenance of farms and buildings, overhead, infirmary and so on) contributed to intensify the stress on expenses, and butchery meat carried the burden.

The analysis of the long term demonstrates a change in taste but this modification owed much to an important innovation: the rise of sugar production and its diffusion in Europe. At the threshold of the 18th century, price did not compete with pleasure when it came to sugar, yet once its taste was known and liked, Caribbean sugar rapidly became an economic item. Other modifications were due to medical practices (milk), budgetary restraint (meat) and culinary necessity (butter and eggs). In the long run, then, several elements combined into a system, the configuration of which privileged sometimes one, sometimes the other of its constituents as the main explanatory factor. No *primum movens* could account for the sum of the changes as the configuration of the explanatory variables evolved with time.

5 Conclusions and Implications for Future Research

Economics mattered a great deal to the manager of the institutional purse at Saint-Cyr. Invidious waste to trumpet the convent-school's aristocratic lineage and to exhibit its symbolic proximity to the Versailles court never propelled its food purchases. Ostentation may have driven royal expenses to exhibit the king's distance from everyday material concerns and to showcase his country's riches, thereby recklessly draining resources that could have financed other projects (Elias, 1992: 98-106); it had no impact on purchasing patterns at Saint-Cyr where, on the contrary, different concerns (capital investments, building and farm maintenance, dowries for pupils leaving the school at 20 years of age, etc.) constrained the food budget. Throughout the century, aristocratic values and expectations determined the quantity of the available daily ration (clearly over 2000 kcal and probably closer to 2500 kcal per inmate) and the quality of foods (white, not brown *wheaten* bread; above all muscle and little organ meat, but no lowly *charcuterie* at all; fresh rather than preserved fish, for example). Strict accounting principles governed food logistics from buying to disposing. Efficiency was to guide food acquisition: cautious, even shrewd purchases aimed at keeping a consistently optimal relation between financial means and consumption ends. *Market attunement*: Good, if circumstantial evidence in the accounting ledgers suggests that even while increasing their budget part from one to five percent in the course of the century, price considerations long determined the purchase of white or brown sugar (*cassonade*). They were substitutes: when the price of sugar went up, the ratio of sugar to the less refined cassonade declined (honey was consumed in small quantities). *Instrumental rationality*: As if to illustrate the establishment's determination to live by its book-keeping principles and mark an example of commercial discipline early on, the school terminated the contract of a master baker who had not lived up to the rules in 1688, immediately launched a search to replace him, and eventually decided that the most cost-conscious solution was to bake bread on the premises of Saint-Cyr itself; thus, two bakers joined the staff (*Mémoires de Manseau*, 1902: 99). Foul eggs concealed in the purchased lots were to be returned to the seller (*Mémoires de Manseau*, 1902: 118). That is, economic imperatives directed provisioning at Saint-Cyr in the 18th century. The question is twofold. First, was the program successful from the institution's point of view? And second, do prices and revenues explain alimentary provisioning practices at Saint-Cyr throughout the 18th century to scholarly satisfaction? The response to these queries requires several keys, and reality being complex, we highlight both, the nebulous zones that more research needs to sound out, and the robust knowledge that this analysis has produced.

There is no doubt that revenues and prices help explain short-range variations in purchases. However, they are difficult to use in a formal model to capture long-term shifts in Saint-Cyr's food basket. Budget parts and food quantities responded to transitory oscillations in economic variables. Prices, food expenditure and past consumption explain 57 and 77 percent of the short-term variations of the most important budget parts, wheat and butchery meats, respectively. The shares of butter, other meats and cheese, and eggs replicated such fluctuations quite neatly, fruits and vegetables much less so, while the short-term swings of milk, groceries and wine fell in-between. A more refined picture emerges from the analysis of elasticities. Substitutions profited mostly groceries at the expense of butchery meat, wine and milk, and other meats and cheese whose availability increased with a rise in the price of wheat. To some extent, then, the school's intendant carried out Madame de Maintenon's injunction to "diversify foods so that they eat better" (Madame de Maintenon to Madame du Pérou, May 30, 1696, in Langlois ed., 1939, 5: 66). However, butchery meats resisted price changes in the short run because it was considered an indispensable good whose consumption could not suffer diminution. Robustness characterized this taste for meat: it was stable in the short run because social norms constrained, or defined, its uses.[24]

Provisioning's protracted movements, however, escape our model's predictions. The explanation of the long term requires different variables than the short range. To be sure, ebb and flow of different budget parts (Figure A.1) over the 18th century corroborate Saint-Cyr's aim to provide

[24] Madame de Maintenon instructed the Mother Superior in 1696, "provide the quantity of meat stipulated in the house rules; you are obliged to do so" (Madame de Maintenon to Madame de Fontaines, Dec. 1696, in Langlois ed., 1939, 5: 157).

a varied diet. A small, often less than a five percent increase in the shares of fruit and vegetables, groceries (mostly sugar), milk and butter, offset the roughly 15 percent drop in the budget part of butchery meats. But these modifications, tested for a utility maximizing propeller and taste stability, suggest the difficulty to make consistent consumer choices. As a matter of fact, much indicates that preferences revealed in budget shares and consumed quantities shifted over time and, moreover, that the *économe* struggled to keep the budget in good shape: change implied costs. For instance, the forty-year period between 1727 and 1767 quite consistently registered additional expenses when checked against the institution's original food basket (see Figure 5.1). In other words, had that mix of goods persisted in time, Saint-Cyr would have saved money. It is only after the mid-1760s that modifications in purchases induced lower expenditures when compared to the cost of the original food basket at current prices. All this suggests that the hold on matters economic and alimentary tightened after the school's first sixty years of existence. In short, the mere intention to behave rationally was not enough to do so.

[Figure 5.1 about here]

These are the explanatory limits of our formal model. It fails to account for long-term developments in the food demand system at Saint-Cyr. It does, however, "sense" the importance of contingent events that unhinged the institution's market-oriented, rational behavior. There is nothing disheartening in this conclusion. With Schultz, we know that, unlike equilibria, "historical change cannot be conveniently subsumed in a mathematical formula" (Schultz, 1938: 55). However realistic the model's assumptions in the case of Saint-Cyr appeared to be, they exhaust neither historical reality nor the number of other available strategic or behavioral possibilities. An explanation of Saint-Cyr's long-term food basket sends us back to the archives in search for other data to shed light on Saint-Cyr's economic behavior. Qualitative and, at times, circumstantial evidence thus contributes to make sense of quantitative series. The econometric model yields to a narrative whose pertinence derives from other, contextual evidence.

Historical contigency mattered. Take expected revenues. The projections aimed at gauging the parameters of budget parts. Yet returns from farms proved difficult to project. The forecast hit four times in ten within a boundary of five percent but the *économe* had to adjust to a shortfall of more than five percent every third year. The size of the difference between anticipated and actual income influenced purchases with a one-year lag. Still, underperformances more often than not came in sequences: 1708-1710, 1720-1723, 1734-1738, 1759-1765 (and particularly 1759-1761), 1779-1784 were series of years in which projections turned out quite direly wrong as actual revenues were off by more than 10 percent from expected ones. Failed adjustments thus came in cascades. Prudence and know-how in financial prognoses did not avert overly optimistic forecasts that ended up with deficits three, four, five years in a row. Many of the periods in which reality shortchanged expectations concided with crises: supply shortages of wheat in 1709, financial troubles in the early 1720s, and increasingly the consequences of wars that bled the kingdom's treasuries after the late 1740s. Price storms shook up even such a well-endowed consumer as the convent-school at Saint-Cyr. Then the bursar struggled to keep the institutional ship steady. Serendipity rather than a standard scenario helped weather these turbulent times. They upset the institution's routine management and tried its alimentary protocol. Each crisis generated a singular, not necessarily the most cost-effective food basket — as the hoarding of wheat and the consequent soaring of the food budget in 1709 aptly demonstrated.

Still, food budget equation (3.4) looks like an Euler equation, where food outlay at time t does not depend on income conditional on food outlay at time $t-1$. However, it is hard to believe that food expenditure is independent from income when the two series put on top of each other move so synchronically (see Figure 2.1b). This militates in favor of further investigation on the relation between consumption and income. Given that, in addition to actual income, food and non-food expenses, expected income is observed in our data, we are *a priori* in a better situation than Hall and Mishkin (1982) to estimate their model. Indeed, we could assume, as they do, that income is the sum of a deterministic trend, a random walk, and a stationary moving-average process. Then, expected income could be modelled as the expectation of this expression, and total expenditure using Euler's equation. Such an inquiry presents a fine opportunity to test whether the life-cycle hypothesis is relevant on these data.

Old-regime institutions had in fact forged contractual means to cope with uncertainty and to introduce steadiness and stability into provisioning (Couperie, 1970). The convent-school at Saint-Cyr eschewed this model in favor of regular market transactions — except for the most important budgetary item: butchery meat. Exclusive supply contracts bound a master butcher to the institution.[25] Such relations lasted for many years, often beyond the 3- or 6-year period for which they were originally concluded. Master butcher Michel Le Moine of the village of Saint-Cyr signed his agreement on September 22, 1762, and it was renewed one last time on October 25, 1786 (the vicissitudes of the Revolution signified the end of the institution). These contracts stipulated, throughout the 18th century, the same cuts and the same quantities of meats expected daily at Saint-Cyr. And yet, their success in fixing unit prices for years with adjustments occurring usually when the contractual term expired, did not — could not? — stem the secular ups and downs in meat consumption. Everyday practice diverged notably from social aspiration and its legal expression as the century moved along. The demand system's variables fail to account for such changes.

Consumption shifts thus introduce a different temporal scale and with it, different determinants of consumer behavior. Testing for structural change on this household's food budget between 1703 and 1788 furnishes information to bolster the case for an evolution in tastes, that is, a change in the utility assigned to the different items in the food basket in the course of the century. It is worth pointing out, however, that all but one period during which makeovers

[25] Contracts in AD Yvelines, D 446.

happened according to the theory of revealed preferences are either bounded by crises (e.g., 1709 at the beginning, 1734 at the end) or marked by economic upheaval (1774-1782). Only the late 1730s emerge as a turning point in food budgeting whose occurrence seems unrelated to economic emergencies. This is not to deny the impact of other financial commitments; on the contrary, housing and land management did make claims on the institution's overall budget after its first half century of existence. But these findings invite prudence when structural changes are investigated on aggregate data and shorter time spans with a lesser incidence of economic strain; they emphasize the necessity of the series' careful inscription in the historical contexts. In the case of Saint-Cyr, budgetary stress pushed down the food part in total expenditures. It imposed choices that gradually modified the composition of the inmates' diet. Butchery meat bore the brunt of this pressure, but its position was further weakening in the face of ever more readily accessible sugar. The rising consumption of sugar from the Caribbean owed little to its price and much to its expanding supply. Availability drove the diet's shift toward sweeter goods, with sugar leading the way for fruits to be combined in stews and pastry. Prices and tastes, this exploration shows, evolved in different dimensions, and their interactions in the long run require examination. Here we touch upon the general problem of supply in research on consumption: for instance, the industrialization of poultry production in post-World War II North America and Europe altered the progressive inclination to purchase chicken probably as much, if not more than, the role of relative prices in consumers' decision to buy white meat (see Davis, 1997). It is a point of which many studies on structural change lose sight when they apply static models to dynamic configurations.

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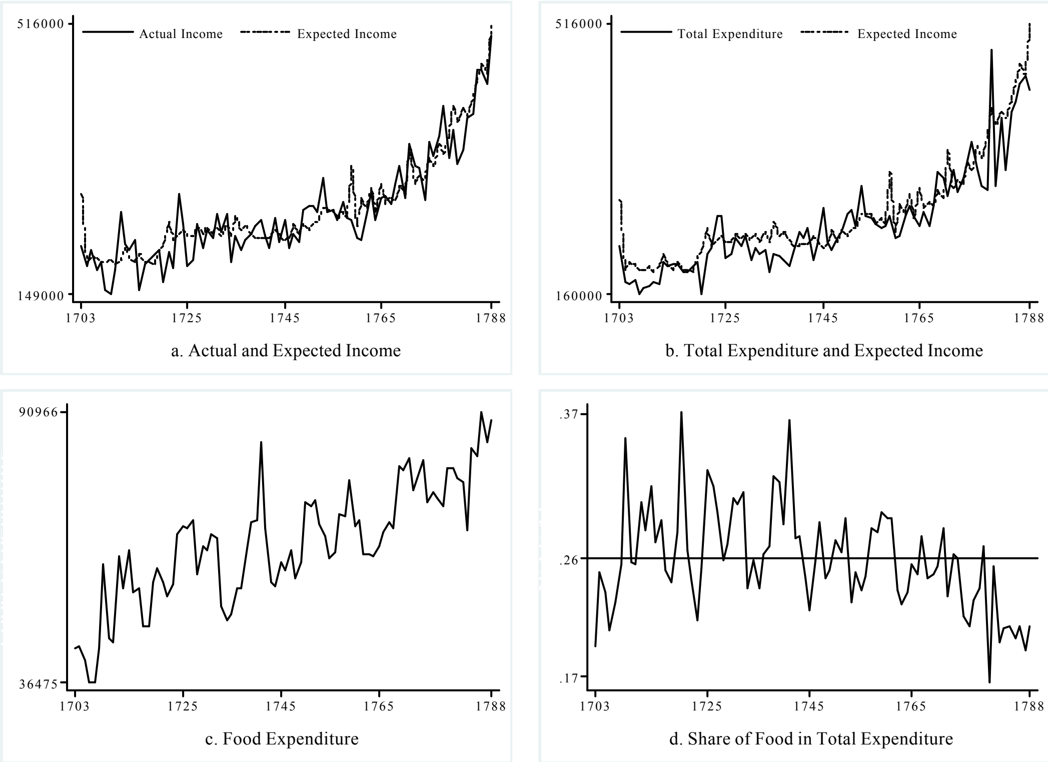


Figure 2.1: Expenditures and Income Series

Table 2.1: Sources of Calories

	Bread	Meats	Eggs	Milk	Butter	All
	Quantities (calories/person/day)					
1703-10	1293	618	85	33	113	2142
1711-20	1059	704	83	47	97	1990
1721-30	1016	713	82	58	97	1966
1731-40	1048	757	72	66	90	2033
1741-50	1220	697	84	76	90	2167
1751-60	1123	651	96	79	105	2054
1761-70	1146	557	90	75	105	1973
1771-80	1121	537	87	81	105	1931
1781-88	1150	583	98	105	113	2049
	Percent of Total Amount of Calories per Day					
1703-10	60.3	28.9	4.0	1.5	5.3	100
1711-20	53.2	35.4	4.2	2.3	4.9	100
1721-30	51.7	36.3	4.2	2.9	4.9	100
1731-40	51.5	37.2	3.6	3.3	4.4	100
1741-50	56.3	32.2	3.9	3.5	4.1	100
1751-60	54.7	31.7	4.7	3.8	5.1	100
1761-70	58.1	28.2	4.6	3.8	5.3	100
1771-80	58.1	27.8	4.5	4.2	5.4	100
1781-88	56.1	28.5	4.8	5.1	5.5	100

Note: Precision only to avoid rounding errors.

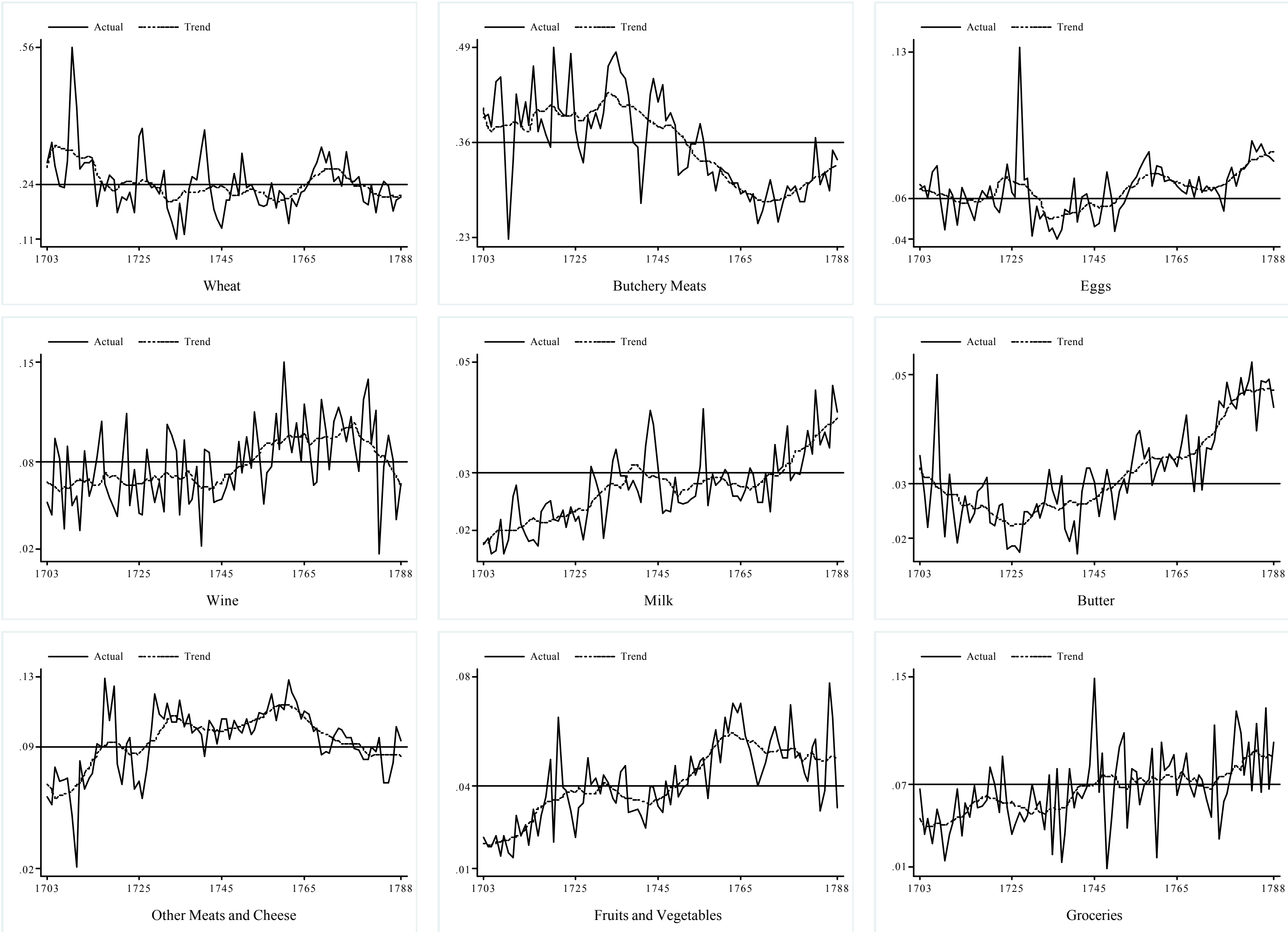


Figure 3.1: Budget Shares, Actual Series and Trends

Table 3.1: Unit Root Tests

	Lag	DF-GLS Stat.	ADF Stat.
Shares			
Wheat	4	-6.396^{***}	-6.672^{***}
Butch. meats	2	-5.756^{***}	-6.710^{***}
Eggs	1	-6.007^{***}	-6.813^{***}
Wine	1	-5.975^{***}	-8.115^{***}
Milk	3	-7.378^{***}	-7.661^{***}
Butter	1	-5.266^{***}	-7.948^{***}
Other meats	1	-4.502^{***}	-5.902^{***}
Fruits, veg.	1	-6.996^{***}	-7.443^{***}
Groceries	1	-4.296^{***}	-7.001^{***}
Log prices			
Wheat	1	-5.858^{***}	-6.736^{***}
Butch. meats	2	-2.308^{**}	-5.594^{***}
Eggs	1	-6.576^{***}	-7.083^{***}
Wine	2	-6.760^{***}	-7.771^{***}
Milk	1	-3.839^{***}	-6.422^{***}
Butter	1	-6.171^{***}	-7.194^{***}
Log expenditures			
Food	1	-5.148^{***}	-5.859^{***}
Interior	2	-6.330^{***}	-7.829^{***}
Total	10	-1.012	-4.340^{***}
Log incomes			
Actual	2	-4.819^{***}	-8.273^{***}
Expected	1	-2.031^{*}	-5.382^{***}

Notes: H_0 = Unit root, H_1 = Stationary; Obs. = 85 − Lag; Lag determined by Schwarz criterion; *,** and *** indicate that H_0 can be rejected at the 10%, 5% or 1% level.

Table 3.2: Demand System Estimates

	Wheat	Butch. meats	Eggs	Wine	Milk	Butter	Other meats	Fruits, veg.	Groceries
Constant	−0.001 (0.004)	0.001 (0.002)	0.000 (0.001)	−0.000 (0.002)	0.000 (0.000)	−0.000 (0.000)	−0.000 (0.001)	−0.000 (0.001)	0.000 (0.002)
Log prices (t)									
Wheat	0.169 (0.018)*	−0.086 (0.010)*	−0.015 (0.004)*	−0.013 (0.010)	−0.003 (0.002)	−0.007 (0.002)*	−0.008 (0.005)	−0.011 (0.004)*	−0.026 (0.010)*
Butch. meats	−0.225 (0.066)*	0.214 (0.035)*	−0.023 (0.015)	0.022 (0.038)	−0.002 (0.007)	−0.011 (0.007)	−0.014 (0.017)	−0.031 (0.016)	0.070 (0.037)
Eggs	0.020 (0.028)	−0.030 (0.015)*	0.040 (0.006)*	0.005 (0.016)	−0.007 (0.003)*	−0.003 (0.003)	−0.006 (0.007)	−0.006 (0.007)	−0.014 (0.016)
Wine	−0.015 (0.016)	−0.027 (0.008)*	−0.006 (0.004)	0.026 (0.009)*	−0.002 (0.002)	−0.005 (0.002)*	−0.006 (0.004)	0.001 (0.004)	0.033 (0.009)*
Milk	−0.220 (0.071)*	0.130 (0.038)*	0.010 (0.016)	0.001 (0.041)	0.012 (0.007)	0.001 (0.007)	−0.065 (0.018)*	0.037 (0.017)*	0.094 (0.039)*
Butter	0.028 (0.025)	0.017 (0.014)	0.002 (0.006)	−0.043 (0.015)*	0.003 (0.003)	−0.000 (0.003)	0.009 (0.007)	−0.007 (0.006)	−0.010 (0.014)
Log food outlay	0.212 (0.052)*	−0.301 (0.028)*	−0.029 (0.012)*	0.054 (0.030)	−0.017 (0.005)*	−0.025 (0.005)*	0.016 (0.014)	0.001 (0.013)	0.089 (0.029)*
Shares ($t-1$)									
Butch. meats	0.045 (0.104)	0.043 (0.055)	−0.040 (0.023)	0.037 (0.060)	−0.036 (0.010)*	−0.011 (0.010)	−0.009 (0.027)	0.002 (0.025)	−0.032 (0.058)
Eggs	0.023 (0.403)	−0.042 (0.214)	0.039 (0.089)	−0.047 (0.232)	0.018 (0.040)	−0.014 (0.040)	0.087 (0.104)	0.053 (0.096)	−0.117 (0.225)
Wine	−0.116 (0.187)	−0.085 (0.099)	−0.121 (0.041)*	−0.107 (0.107)	0.024 (0.019)	0.044 (0.019)*	0.142 (0.048)*	0.044 (0.045)	0.174 (0.104)
Milk	−2.529 (1.068)*	1.225 (0.568)*	−0.485 (0.237)*	−0.539 (0.614)	0.208 (0.106)*	−0.023 (0.106)	0.182 (0.277)	−0.129 (0.255)	2.090 (0.597)*
Butter	0.960 (0.964)	−0.405 (0.513)	−0.126 (0.214)	−1.263 (0.554)*	0.193 (0.096)*	0.094 (0.095)	0.474 (0.250)	0.078 (0.230)	−0.005 (0.538)
Other meats	−0.070 (0.349)	−0.203 (0.186)	−0.033 (0.078)	0.244 (0.201)	−0.048 (0.035)	0.014 (0.035)	0.084 (0.090)	−0.090 (0.083)	0.102 (0.195)
Fruits, veg.	−0.397 (0.449)	−0.133 (0.239)	−0.104 (0.100)	−0.205 (0.258)	0.034 (0.045)	0.000 (0.044)	0.322 (0.116)*	−0.024 (0.107)	−0.286 (0.251)
Groceries	0.237 (0.165)	0.054 (0.088)	−0.006 (0.037)	−0.057 (0.095)	−0.026 (0.016)	−0.014 (0.016)	0.053 (0.043)	0.002 (0.039)	−0.243 (0.092)*
Exog. test ($\widehat{v}_t$)	−0.060 (0.154)	0.076 (0.081)	−0.063 (0.033)	0.113 (0.088)	0.006 (0.015)	−0.019 (0.015)	−0.042 (0.040)	0.002 (0.037)	−0.013 (0.086)
AR(1) test (χ^2_1)									
Uncorrected	0.320 (0.572)	3.640 (0.056)	0.329 (0.566)	1.305 (0.253)	4.146 (0.042)	0.005 (0.946)	0.259 (0.611)	0.436 (0.509)	6.648 (0.010)
Corrected	0.002 (0.965)	0.877 (0.349)	1.574 (0.210)	1.873 (0.171)	3.792 (0.051)	0.478 (0.489)	1.090 (0.296)	0.033 (0.856)	0.022 (0.883)
Spec. test (F^{45}_{24})	1.23 (0.295)	1.58 (0.114)	2.43 (0.011)	0.89 (0.636)	1.03 (0.484)	1.22 (0.303)	1.73 (0.076)	1.53 (0.130)	1.17 (0.348)
$\overline{R}^2$	0.573	0.770	0.351	0.211	0.285	0.405	0.397	0.046	0.229

Notes: Standard errors (P-values for specification error and AR tests) in parentheses; * Significant at the 5% level.

Table 3.3: Elasticities Estimates

	Wheat	Butch. meats	Eggs	Wine	Milk	Butter	Other meats	Fruits, veg.	Groceries
Food expenditure elasticities									
Food outlay	1.879 (0.218)*	0.156 (0.078)*	0.543 (0.182)*	1.686 (0.384)*	0.364 (0.190)	0.225 (0.163)	1.169 (0.145)*	1.034 (0.301)*	2.362 (0.447)*
Uncompensated price elasticities									
Prices									
Wheat	−0.511 (0.087)*	−0.039 (0.031)	−0.188 (0.095)	−0.329 (0.153)*	0.031 (0.075)	−0.017 (0.064)	−0.123 (0.058)*	−0.278 (0.119)*	−0.724 (0.178)*
Butch. meats	−1.250 (0.285)*	−0.098 (0.102)	−0.196 (0.238)	0.040 (0.501)	0.141 (0.248)	−0.056 (0.214)	−0.209 (0.189)	−0.757 (0.393)	0.574 (0.583)
Eggs	0.029 (0.120)	−0.032 (0.043)	−0.352 (0.100)*	0.021 (0.211)	−0.196 (0.104)	−0.030 (0.091)	−0.079 (0.080)	−0.137 (0.166)	−0.293 (0.246)
Wine	−0.133 (0.064)*	−0.008 (0.023)	−0.061 (0.053)	−0.718 (0.112)*	−0.021 (0.055)	−0.087 (0.046)	−0.077 (0.042)	0.023 (0.088)	0.400 (0.130)*
Milk	−0.939 (0.293)*	0.388 (0.105)*	0.171 (0.245)	−0.005 (0.516)	−0.559 (0.255)*	0.047 (0.220)	−0.694 (0.195)*	0.893 (0.404)*	1.389 (0.600)*
Butter	0.090 (0.104)	0.075 (0.037)*	0.053 (0.087)	−0.569 (0.184)*	0.126 (0.091)	−0.991 (0.078)*	0.094 (0.069)	−0.173 (0.144)	−0.192 (0.214)
Compensated price elasticities									
Prices									
Wheat	−0.059 (0.075)	−0.002 (0.027)	0.013 (0.062)	0.076 (0.131)	0.119 (0.065)	0.037 (0.054)	0.159 (0.050)*	−0.029 (0.103)	−0.155 (0.153)
Butch. meats	−0.580 (0.276)*	−0.043 (0.099)	−0.003 (0.231)	0.642 (0.486)	0.271 (0.241)	0.025 (0.208)	0.208 (0.184)	−0.388 (0.381)	1.416 (0.566)*
Eggs	0.149 (0.117)	−0.022 (0.042)	−0.317 (0.098)*	0.129 (0.206)	−0.173 (0.102)	−0.016 (0.088)	−0.005 (0.078)	−0.071 (0.161)	−0.142 (0.239)
Wine	0.015 (0.066)	0.004 (0.024)	−0.019 (0.055)	−0.585 (0.116)*	0.008 (0.057)	−0.070 (0.047)	0.015 (0.044)	0.105 (0.091)	0.586 (0.135)*
Milk	−0.887 (0.293)*	0.393 (0.105)*	0.186 (0.245)	0.041 (0.516)	−0.549 (0.255)*	0.053 (0.220)	−0.662 (0.195)*	0.921 (0.405)*	1.454 (0.601)*
Butter	0.150 (0.106)	0.080 (0.038)*	0.070 (0.089)	−0.515 (0.186)*	0.138 (0.092)	−0.984 (0.079)*	0.131 (0.070)	−0.140 (0.146)	−0.117 (0.217)

Notes: Standard errors in parentheses; * Significant at the 5% level.

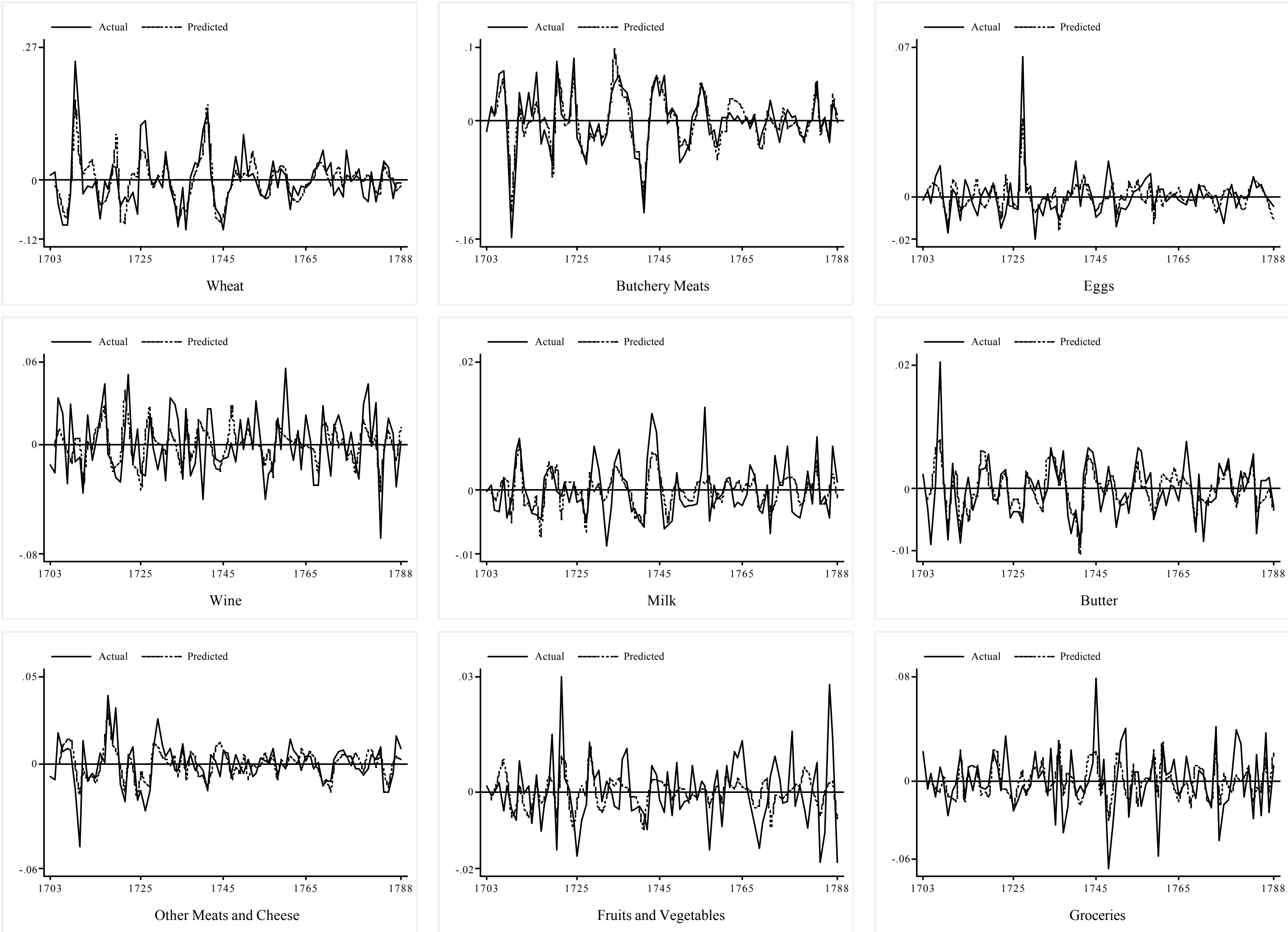


Figure 3.2: Budget Shares, Detrended Series and Model's Short-Run Predictions

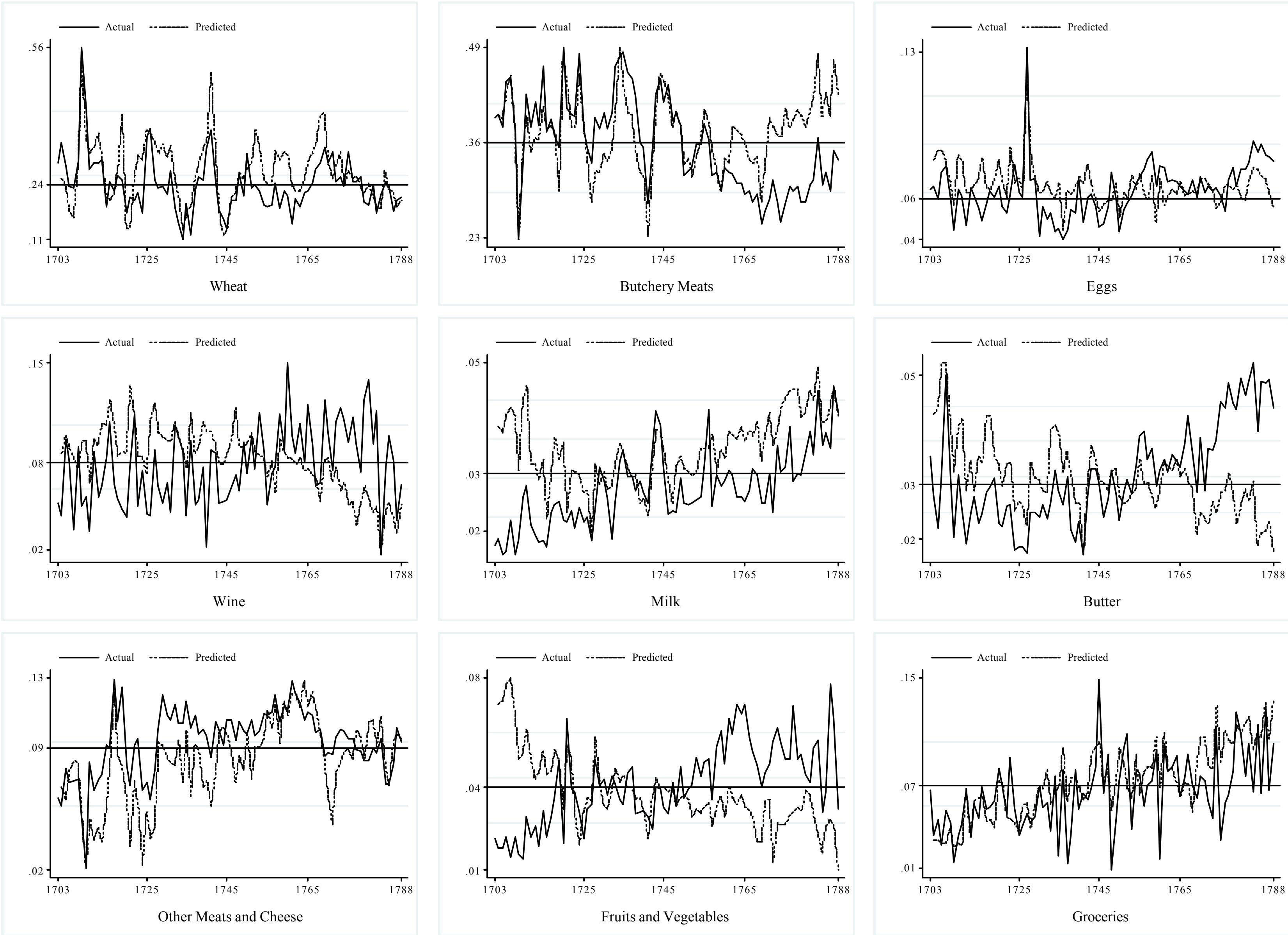


Figure 3.3: Budget Shares, Actual Series and Model's Long-Run Predictions

Table 4.1: Number of Violations (%) — 9 groups

		κ				
		0.20	0.15	0.10	0.05	0.01
SARP						
$e = 1.00$	214 (5.9)	214 (7.1)	213 (8.4)	211 (11.3)	207 (21.4)	86 (39.8)
0.99	91 (2.5)	91 (3.0)	90 (3.6)	88 (4.7)	85 (8.8)	31 (14.4)
0.98	10 (0.3)	10 (0.3)	10 (0.4)	8 (0.4)	8 (0.8)	0 (0.0)
0.97	3 (0.1)	3 (0.1)	3 (0.1)	1 (0.1)	1 (0.1)	
0.96	3 (0.1)	3 (0.1)	3 (0.1)	1 (0.1)	1 (0.1)	
0.95	1 (0.0)	1 (0.0)	1 (0.0)	0 (0.0)	0 (0.0)	
0.94	1 (0.0)	1 (0.0)	1 (0.0)			
0.93	1 (0.0)	1 (0.0)	1 (0.0)			
0.92	0 (0.0)	0 (0.0)	0 (0.0)			
WARP						
$e = 1.00$	62 (1.7)	62 (2.1)	61 (2.4)	59 (3.2)	58 (6.0)	34 (15.7)
0.99	23 (0.6)	23 (0.8)	22 (0.9)	20 (1.1)	19 (2.0)	10 (4.6)
0.98	5 (0.1)	5 (0.2)	5 (0.2)	3 (0.2)	3 (0.3)	0 (0.0)
0.97	2 (0.1)	2 (0.1)	2 (0.1)	0 (0.0)	0 (0.0)	
0.96	2 (0.1)	2 (0.1)	2 (0.1)			
0.95	1 (0.0)	1 (0.0)	1 (0.0)			
0.94	1 (0.0)	1 (0.0)	1 (0.0)			
0.93	1 (0.0)	1 (0.0)	1 (0.0)			
0.92	0 (0.0)	0 (0.0)	0 (0.0)			
Obs.	3655	3019	2531	1862	967	216

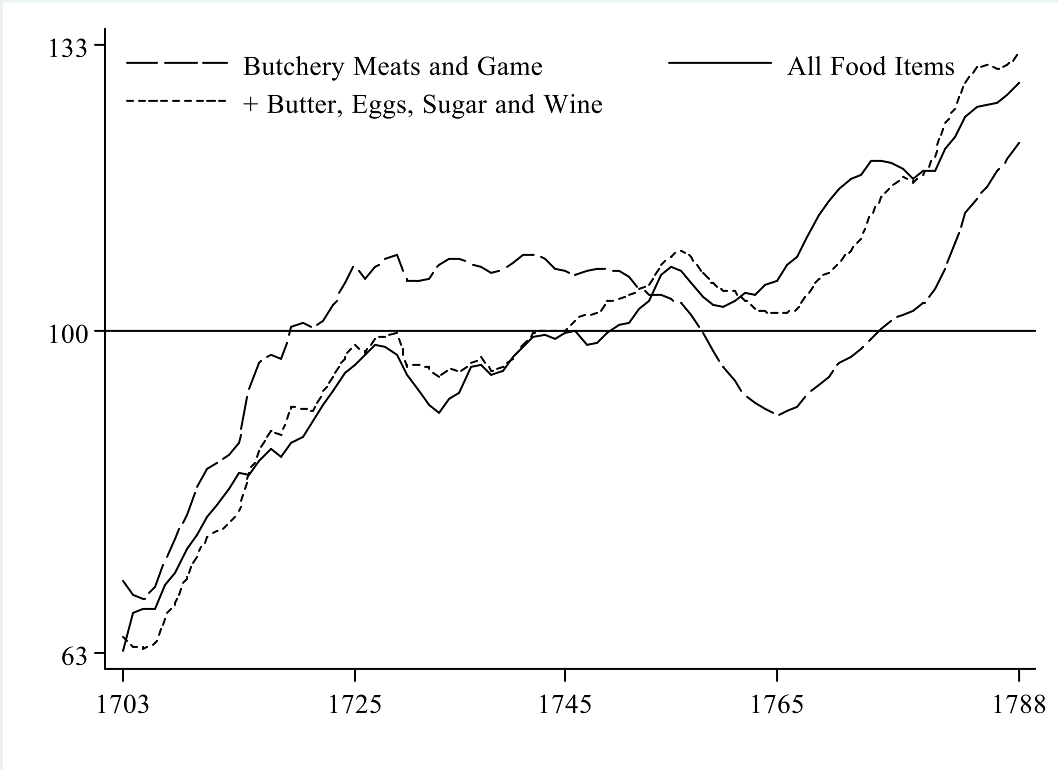


Figure 4.1: Food Expenditure Trend Indices (Mean = 100)

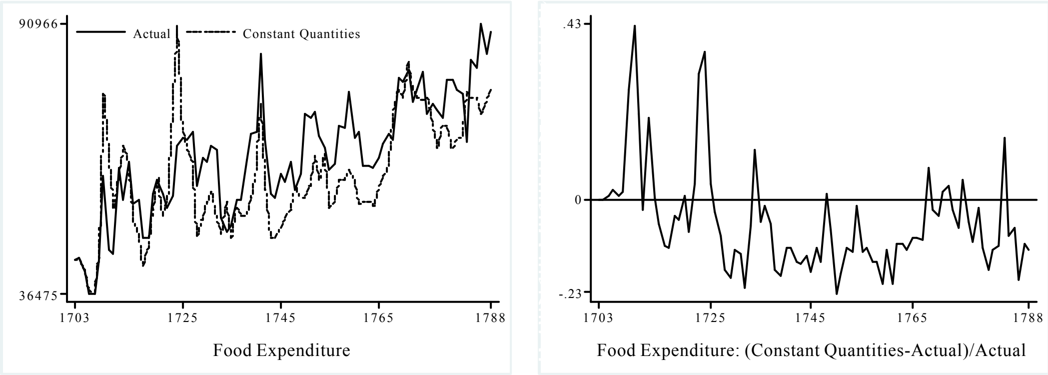


Figure 5.1: Cost of 1703 Food Basket at Current Prices

Appendix

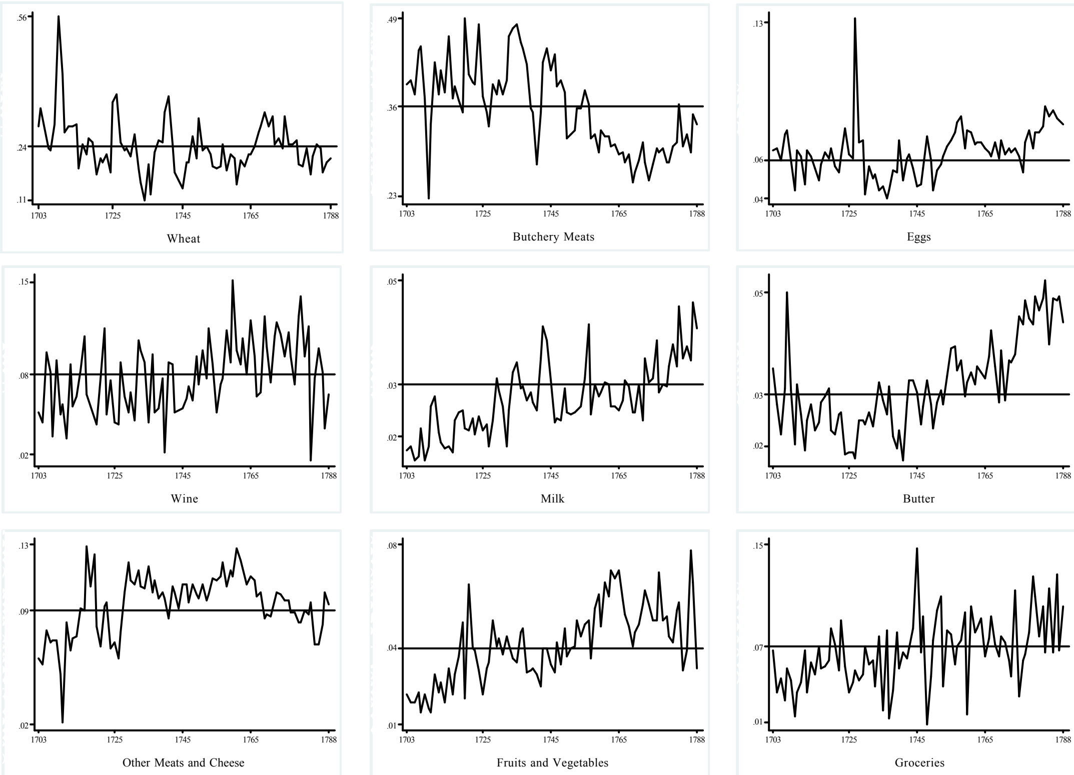
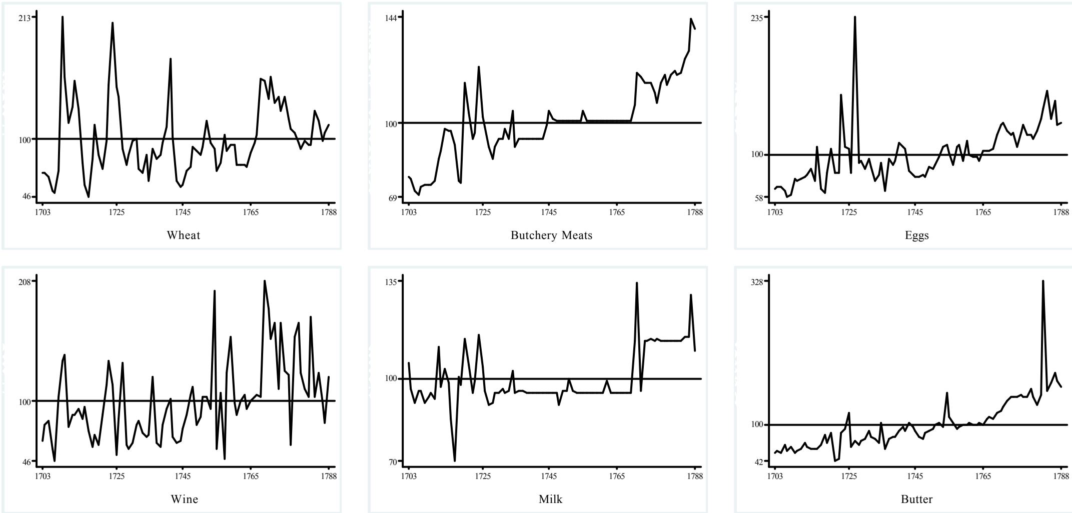


Figure A.1: Budget Shares

a. Price Indices



b. Quantity Indices

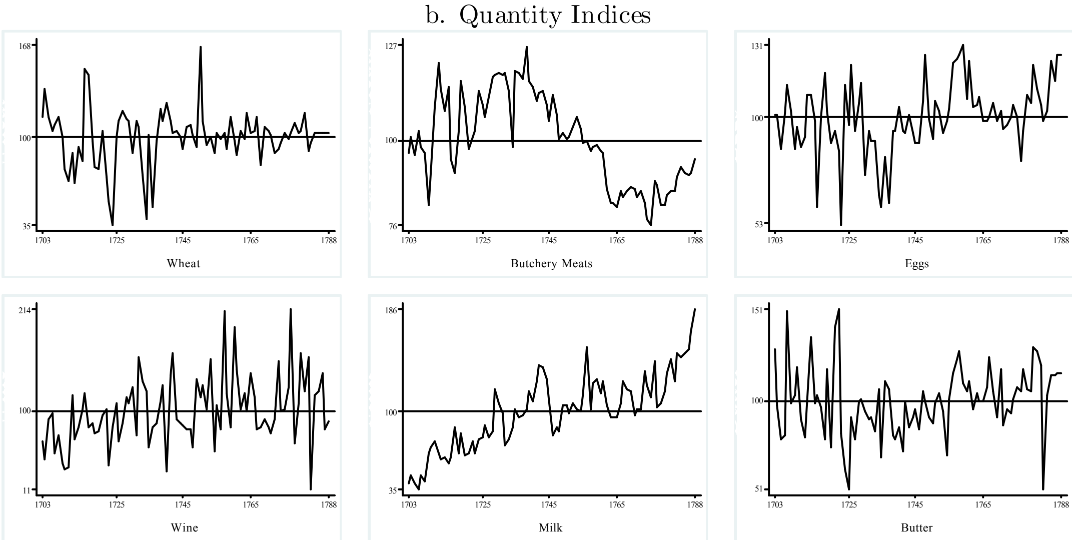


Figure A.2: Price and Quantity Indices (Mean = 100)

Table A.1: Reduced Form Estimates

	Log food outlay
Constant	0.000 (0.008)
Log prices (t)	
Wheat	¡ 0.001 (0.039)
Butch. meats	¡ 0.058 (0.142)
Eggs	0.099 (0.059)
Wine	¡ 0.089 (0.033)¤
Milk	¡ 0.032 (0.151)
Butter	¡ 0.044 (0.056)
Shares (t ¡ 1)	
Butch. meats	0.400 (0.269)
Eggs	1.350 (0.846)
Wine	¡ 0.609 (0.398)
Milk	0.431 (2.285)
Butter	¡ 1.215 (2.072)
Other meats	¡ 0.007 (0.792)
Fruits, veg.	¡ 0.804 (0.962)
Groceries	¡ 0.583 (0.364)
Log food outlay (t ¡ 1)	0.471 (0.144)¤
AR(1) test (χ^2_1)	0.749 (0.387)
Spec. test (F^{45}_{24})	0.87 (0.669)
$\overline{R}^2$	0.200

Notes: Standard errors (P-values for speci…cation error and AR tests) in parentheses;

¤ Signi…cant at the 5% level.

Table A.2: Number of Violations (%) — 6 groups

		κ				
		0.20	0.15	0.10	0.05	0.01
SARP						
e = 1.00	356 (9.7)	356 (10.9)	356 (12.5)	349 (16.2)	332 (28.6)	149 (63.4)
0.99	98 (2.7)	98 (3.0)	98 (3.5)	95 (4.4)	88 (7.6)	33 (14.0)
0.98	10 (0.3)	10 (0.3)	10 (0.4)	9 (0.4)	6 (0.5)	1 (0.4)
0.97	5 (0.1)	5 (0.2)	5 (0.2)	4 (0.2)	2 (0.2)	1 (0.4)
0.96	3 (0.1)	3 (0.1)	3 (0.1)	2 (0.1)	1 (0.1)	0 (0.0)
0.95	3 (0.1)	3 (0.1)	3 (0.1)	2 (0.1)	1 (0.1)	
0.94	1 (0.0)	1 (0.0)	1 (0.0)	1 (0.0)	0 (0.0)	
0.93	1 (0.0)	1 (0.0)	1 (0.0)	1 (0.0)		
0.92	1 (0.0)	1 (0.0)	1 (0.0)	1 (0.0)		
0.91	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
WARP						
e = 1.00	75 (2.1)	75 (2.3)	75 (2.6)	75 (3.5)	72 (6.2)	42 (17.9)
0.99	16 (0.4)	16 (0.5)	16 (0.6)	16 (0.7)	13 (1.1)	6 (2.6)
0.98	4 (0.1)	4 (0.1)	4 (0.1)	4 (0.2)	2 (0.2)	0 (0.0)
0.97	2 (0.1)	2 (0.1)	2 (0.1)	2 (0.1)	0 (0.0)	
0.96	1 (0.0)	1 (0.0)	1 (0.0)	1 (0.0)		
0.95	1 (0.0)	1 (0.0)	1 (0.0)	1 (0.0)		
0.94	1 (0.0)	1 (0.0)	1 (0.0)	1 (0.0)		
0.93	1 (0.0)	1 (0.0)	1 (0.0)	1 (0.0)		
0.92	1 (0.0)	1 (0.0)	1 (0.0)	1 (0.0)		
0.91	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
Obs.	3655	3256	2837	2156	1160	235

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