Evidence of Shifts in Tastes for Meat in the United States, 1980-1990

by Mark Schreiner and Donald Birchler
The Ohio State University
Department of Agricultural Economics
schreiner@gwbmail.wustl.edu

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I. Introduction

Over the past three decades in the United States, there has been a trend away from the consumption of "red meats" and toward "white meats" (Chavas, 1989). At least four forces may explain this trend. First, consumers could be substituting out of beef and into poultry and pork in response to changing relative prices (Moschini and Meilke, Menkhaus *et al*.). Second, incomes (and with it expenditures on meat) have increased, and the income elasticity of demand may be less for beef than for either poultry or pork. Third, changes in the value of the time of family members (such as might result from increased labor-market participation by women) may lead to changes in eating and cooking habits (Alston and Chalfant, 1988). Fourth, tastes may have shifted in response to increased information about the healthiness of saturated fat and cholesterol (Choi and Sosin; Chavas, 1983).

The causes of these trends have important policy implications for the meat industry. Consider, for example, the beef sector. If beef's market share has slipped relative to poultry's because productivity gains in the poultry sector have outstripped those in the beef sector and led to lower relative prices for poultry, beef producers should invest in research and development to lower the costs of producing and marketing their product. If beef's market share has fallen because poultry is easier and quicker to prepare, then beef producers should invest in developing and promoting products and recipes that decrease beef's cooking time. Finally, if tastes have shifted in response to health concerns, the beef industry may try to develop leaner cuts while informing consumers of the change in product quality via grading, labeling, and advertising.[1]

Many analyses have attempted to pinpoint the causes of the trend. The results, however, are inconclusive. Table 1 illustrates the variety of results produced with different

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[1] As discussed later, the pork industry seems to have had considerable success in just such a campaign.

bundles of meats, different data sets, and different overall approaches. The literature concerned with detecting a taste shift for meat may be summarized as follows:

- All evidence supports a taste shift away from beef;
- Most evidence supports a taste shift toward chicken;
- Some evidence supports a slight shift toward pork and fish;
- The shifts seem to be located in the mid-1970s;
- The results of parametric tests vary with the specification;
- The results of non-parametric tests have varied;
- The results of parametric and non-parametric tests do not match well;
- Data sets have had few observations.

Table 1

Review of Studies of Taste Shifts For Meat

Author	Year	Goods	N	Years	Parametric?	Shift(s)	Location
Sakong, Hayes	1993	Beef Chicken Pork	15	71-84	N	Beef down Chicken up Pork down	72-73
Alston, Chalfant	1991	Beef Chicken Pork Fish	37	47-83	N	None	None
Choi, Sosin	1990	Red Meat Poultry Other foods	32	53-84	Y	Red meat down	mid-70s
Moschini, Meilke	1989	Beef Chicken Pork Fish	84	67-87 (4 per year)	Y	Beef down Chicken up Fish up	75-76
Thurman	1987	Beef Poultry Pork	27	55-81	Y	Chicken up	73
Chavas	1983	Beef, Poultry Pork	31	50-80	Y	Beef down Poultry up	late-70s

This study attempts to detect taste shifts involving beef and veal, poultry, pork, and fish and seafood. We find evidence of a taste shifts toward poultry and toward pork. The shift toward poultry is probably best explained by increasing health consciousness, but the shift toward pork is best understood as the result of effective promotion. We also find that trends in the consumption of beef and seafood may be explained by changes in expenditures and in relative prices; that is, there is no evidence of a taste shift neither toward nor away from beef or fish. We avoid the pitfalls of specifying parametric tests by using Varian's (1982) Weak Axiom of Reveal Preference. We also develop a non-parametric statistical test that compensates for the non-statistical nature of WARP.

II. The Weak Axiom of Revealed Preference

WARP detects changes in consumption between pairs of bundles which cannot be explained by changes in expenditures nor by changes in relative prices. For example, the representative household in Figure 1 purchased bundle A in period *t* and bundle B in some later period *t+n*. In period *t,* bundle B and all other bundles on or below the budget line *t,t* were cheaper bundle A. If these bundles were cheaper than bundle A but were not purchased, it must be that they do not yield as much utility as bundle A. Bundle A is said to be *revealed preferred* to bundle B. [Bigger graph, bigger labels, nicer dot-bundles, labeling of axes, placement]

<u>Figure 1</u>

WARP Satisfied

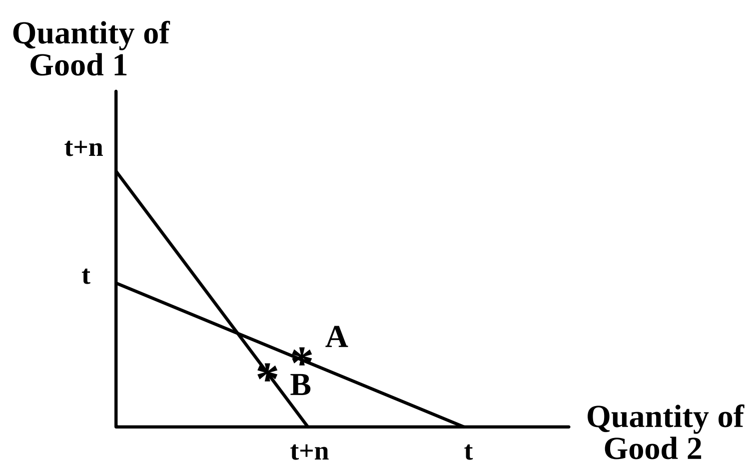
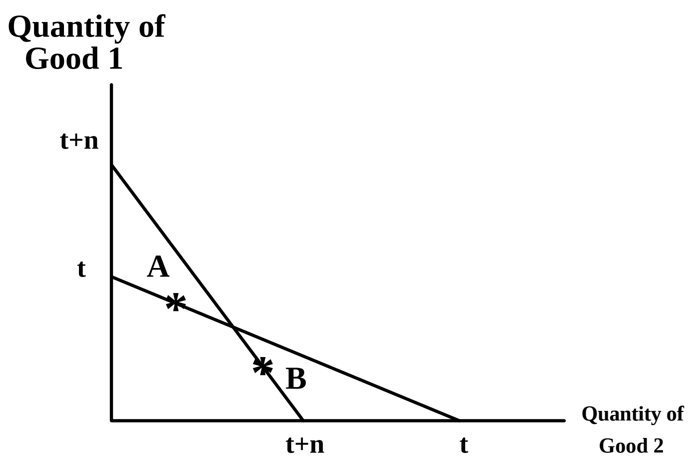


Figure 2 presents a different case. Both bundles A and B were affordable in both periods *t* and *t+n*. Thus, A is revealed preferred to B, and B is revealed preferred to A. WARP is violated if and only if two bundles are revealed preferred to each other because no reasonable, stable set of preferences could have generated such data.[2] Note also that the quantity consumed of good 2 increased over time while that of good 1 decreased. The idea behind this study is that there is some evidence of a taste shift if enough pairs of observations violate WARP and if the quantity consumed of a given good usually moves in one direction between the early observation and the late observation in a pair.

Figure 2

WARP Violated



If budget lines do not cross, bundles cannot each be revealed preferred to each other and thus WARP cannot be violated. Overlapping budget lines, however, do not imply that WARP will be violated, as illustrated in Figure 1, where bundle A is not affordable at time *t+n*.

[2] It is not possible to draw convex, non-crossing indifference curves tangent to the budget lines at the observed bundles.

III. Strengths and Weaknesses of Parametric and Non-parametric Approaches

Parametric tests for taste shifts for meat lead to fragile results because they require the essentially *ad hoc* specification of functional forms. Therefore, it is impossible to test for taste shifts without jointly testing for misspecification (Alston and Chalfant, 1991).

Although WARP avoids misspecification by not specifying functional forms, it has its own weaknesses as a method of detecting taste shifts:

- WARP is not a statistical test with associated probability statements; the data either satisfy WARP or they do not.[3] As such, "few" or "slight" violations may actually be due to random error but WARP itself cannot address this issue.[4]
- WARP is not a sensitive test. Even if tastes do shift, WARP may not be violated. Furthermore, budget lines tend to cross less often as data is more aggregated across time and across goods and as expenditures grow over time. Even if tastes do shift, WARP cannot be violated if budget lines do not cross.[5]
- WARP may indicate that tastes have shifted, but it is of no help in determining *why* tastes shifted. In contrast, parametric tests at least associate the change in some parameter with a possible cause.
- WARP by itself cannot distinguish between a violation caused by a long-term taste shift and one caused by seasonality in consumption.

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[3] After all, WARP is tests conformity with an *economic axiom*, not with a *statistical model*. Although it does not rely on specific functional forms or distributions, it is more appropriately labeled *non-statistical* rather than *non-parametric*. A non-statistical test will also be non-parametric.

[4] Varian (1985) proposes a test for the significance of violations of WARP, but the tests requires the assumption of a parametric distribution, destroying the original elegance of the non-parametric procedure.

[5] Alston and Chalfant (1991, p. 45) write, "It is difficult to learn much about demand with the aggregate per capita time-series data that are typically available. When the data are characterized more by long-term trends in prices, consumption, and total expenditure (and perhaps preferences) than by year-to-year relative price movements, it is difficult to sort out the causes of changes in consumption."

IV. A Non-parametric Test for Trends in WARP-violating Pairs

This paper has two innovations that minimize some of WARP's weaknesses. First, we use monthly data.[6] Increasing the frequency of sampling from annually or quarterly to monthly should limit the effects of WARP's low sensitivity because not only are there more budget lines, but also any given budget line is more likely to cross with any other given budget line because frequent sampling means greater price variation relative to expenditure variation. Second, we develop a non-parametric test that detects the presence of unusual trends in quantity movements for a good over time between observations in WARP-violating pairs. The test gives meaning to the idea that a good "usually" increases or "usually" decreases over time between observations in WARP-violating pairs by stating the likelihood that the observed pattern of WARP violations can be attributed to random error, seasonal tastes, or changes in expenditures or relative prices.

The test statistic used is the number of times the quantity of a good increases over time between paired observations in a set. This statistic is calculated for the WARP-violating set, and a non-parametric randomization test generates its distribution under the null hypothesis that the pattern of changes in quantity of a good between the early and later observation in the pairs in the WARP-violating set are attributable to random error, seasonal tastes, or changes in expenditures or relative prices, rather than a systematic taste shift.[7] The method used to control for seasonality when generating the null distribution is described in the appendix. If the number of times the quantity of a given good increases over time between WARP-violating pairs is unusually high or unusually low compared to the majority of test statistics generated for the randomly drawn sets, there is evidence for a long-run taste shift.

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[6] We know of no other non-parametric study of taste shifts for meat using monthly data nor having as many observations.

[7] Randomization (or permutation) tests have ideal properties, such as consistency and most-powerfulness, in spite of their completely non-parametric nature. Good references on randomization tests are Kennedy (1995) and Edgington (1980).

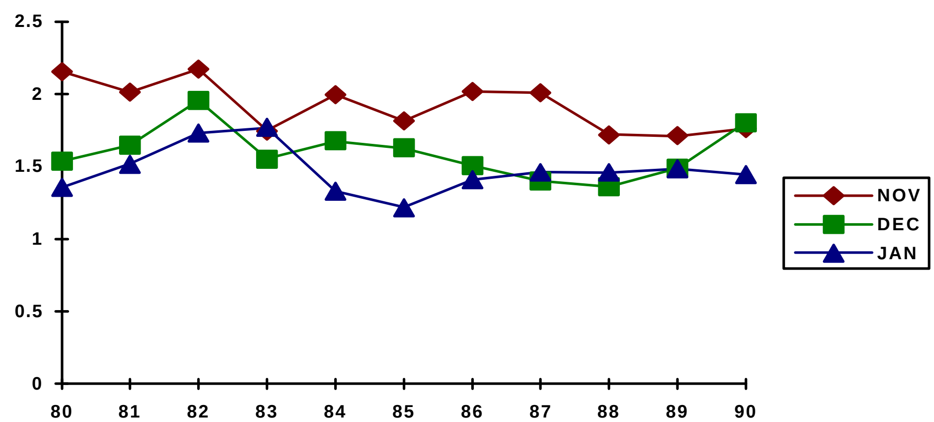
V. The Data Set and the Seasonality of Monthly Meat Consumption

The data set was derived from the Consumer Expenditure Survey of the Bureau of Labor Statistics. The weekly diary survey recorded household expenditures for meats as well as for other goods. These expenditures were weighted demographically, averaged, and divided by a price index to create a quantity index for the 132 months from January, 1980 to December, 1990. This study examines beef, poultry, pork, and fish.[8]

Monthly data complicates the analysis, however, because meat consumption is highly seasonal (Figure 3). [Let's keep this figure, but including October and November only. We can see Jan-Dec from figure 4]. In particular, the Thanksgiving holiday causes poultry consumption to jump in November every year. Poultry consumption is also unusually high in December, another traditional turkey month (Figure 4). By January, satiation sets in and poultry consumption declines. Clearly, tastes shift in favor of a particular type of poultry, namely turkey, every year in November with normal consumption patterns resuming after January. The rest of the year shows no glaring seasonality. [Bigger and black-and-white]

<u>Figure 3</u>

Poultry Consumption During October and November



[8] We treat these goods as separable from other consumption decisions even though the presence of WARP violations has been interpreted as a rejection of the maintained hypothesis of separability (Varian, 1982). Adopting this interpretation would preclude testing for taste change with WARP.

Seasonality creates difficulties for detecting taste shifts with WARP. Seasonal taste shifts may cause WARP violations even in the absence of long-run taste shifts. Many approaches may be used to handle seasonality. For example, the data could be deseasonalized with parametric methods. Such methods are subject, however, to the same critiques of parametric methods described earlier. It would be a shame to introduce parametric assumptions and the specter of misspecification after having used non-parametric methods in the rest of the analysis.

Figure 4

Average Monthly Poultry Consumption, 1980-1990

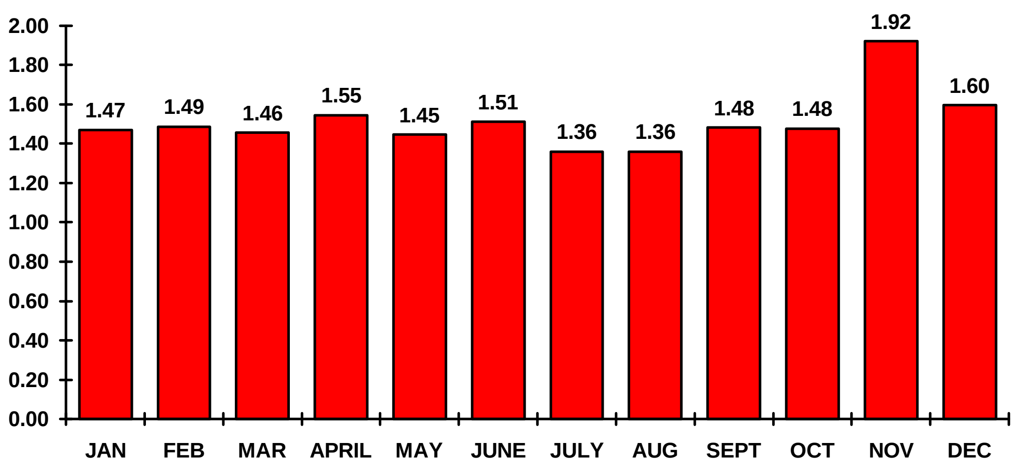


Table 2 shows that a disproportionate number of the WARP violations occurred in November, December, and January. For the final analysis, we decided to drop all observations on November, December, and January. This greatly reduced the concentration of WARP violations across months.[9] Although the statistical technique used here controls for seasonality, it is undesirable that the majority of violations of WARP would involve months where tastes for poultry are known to be unusual.(I am currently working on a technique to generate the null in our lietime withouthaving to drop these observations) In addition, enough WARP violations exist which do not involve these

[9] Only May seems to have a disproportionate number of violations.

months to give our test sufficient discriminatory power. Dropping these observations also simplified the computation of the null distribution of the test statistic.[10]

Table 2

Number of Observations Involved in WARP Violations By Month

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Full data	8	4	5	1	5	1	5	5	3	2	7	8
Partial data	NA	2	0	1	5	1	2	3	0	2	NA	NA

VI. Results

Table 3 shows how many times consumption of each meat increased or decreased between the earlier and later observations in the eight pairs that violated WARP when November, December, and January were excluded. For example, the test statistic for beef is two because the quantity of beef increased from the earlier to the later observation in a WARP-violating pair twice in eight chances. At first glance, this might seem to be a relatively low test statistic, suggesting evidence for a taste shift away from beef. The test statistic for both poultry and pork was seven, perhaps hinting at a taste shift toward those meats. Fish's statistic of four would seem to suggest no taste shift at all.

Table 3

Number of Increases and Decreases in WARP Violations

	Increases	Decreases
Beef and Veal	2	6
Poultry	7	1
Pork	7	1
Fish and Seafood	4	4

[10] With 25 violations, calculating the test statistic would have taken more than 4,000 years on a Pentium-based computer. Reducing the number of violations to eight decreased calculation time to about four hours.

Figures 5 through 8 show the probability densities of the null distributions of the test statistic under the null hypothesis for each meat. These are the exact distributions of the test statistics for the 1,409,994 sets of eight pairs of observations from the data set that match the characteristics of the WARP-violating set as described in the appendix. The unusualness of the quantity changes between pairs in the WARP-violating set is measured by how often a quantity change that extreme or more occurs in the null distribution.

Figure 7
Beefs's Test Statistic's Null Distribution

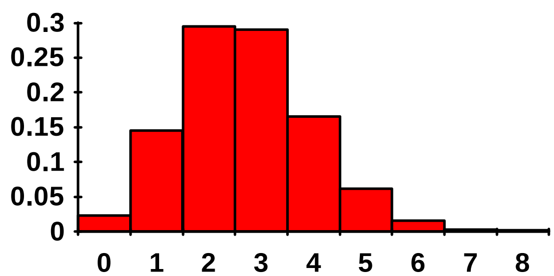


Figure 8
Chicken's Test Statistic's Null Distribution

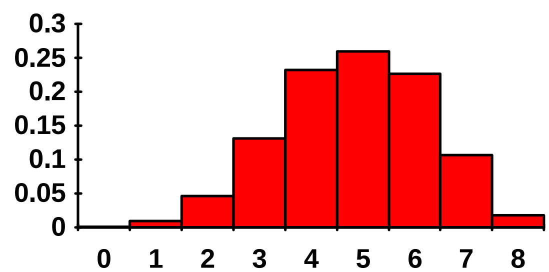


Figure 9
Pork's Test Statistic's Null Distribution

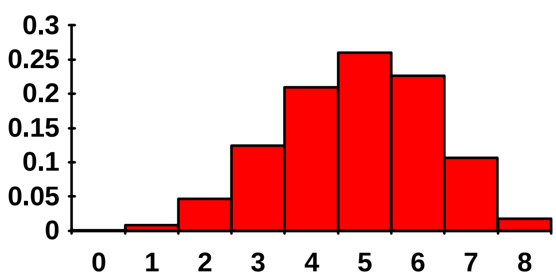


Figure 10
Fish's Test Statistic's Null Distribution

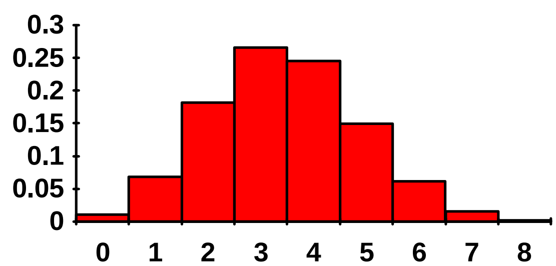


Table 4 shows the p-values for the observed test statistics. For beef, the probability of drawing a eight-pair set that matches the characteristics of the WARP-violating set in which the test statistic is two or less is about 0.46 (Figure x). The probability of the test statistic being two or greater is about 0.83. It turns out that for the case of beef, the pattern of quantity movements observed in the WARP-violating set is not sufficiently unusual to warrant the rejection of the null hypothesis. We cannot rule out the possibility that it was not a taste shift but rather random error, seasonal tastes, or changes in expenditures or relative prices caused the WARP violations. It is also possible that the WARP violations were caused by shifting tastes for goods other than beef in the bundle.

Table 4

Test Statistics and p-values For Each Meat

	Increases	p-value up	Decreases	p-value down
Beef and Veal	2	.83	6	.46
Poultry	7	.12	1	.98
Pork	7	.12	1	.98
Fish and Seafood	4	.47	4	.77

For both poultry and pork, the probability of the quantity increasing in seven of the eight chances was about 0.12 (Figures 8 and 9). For these goods, this is an unusually high test statistic, suggesting there is some evidence of a taste shift. Fish's test statistic is not unusual and thus we cannot reject the null hypothesis (Figure 10).

VII. Implications

There is some evidence for a taste shift in the 1980s toward the "white meats" of poultry and pork. There is no evidence for a taste shift involving the "red meat" of beef nor fish. These shifts have several possible causes:

- Tastes may have shifted in response to increasing health consciousness (Alston and Chalfant, 1991 and 1988; Choi and Sosin; Moschini and Meilke; Chavas, 1988 and 1983). For example, poultry has less saturated fat and cholesterol than beef. This explanation has weaknesses because truly health-conscious consumers would not have shifted toward pork, whose levels of saturated fat and cholesterol are similar to those of beef, but rather toward fish, whose health benefits exceed those of poultry.
- Effective promotion may have increased the consumption of poultry and pork. In particular, it seems the pork industry has successfully piggy-backed on poultry's healthy reputation by advertising pork as the "other white meat."

- As more women join the labor force, the opportunity cost of time spent cooking increases (Chavas, 1988). White meats are often advertised as simple to prepare. For example, the pork industry hands out recipes in grocery stores that emphasize speedy cooking. In addition, poultry retains more of its flavor and texture in the process of pre-cooking, freezing, and reheating than does beef. Finally, cooked chickens are available in grocery stores, but cooked beef is not. The beef industry's new marketing campaign ("Beef. It's what's for dinner") features advertisements which show cooking times for a variety of dishes. The long-run effects of this promotion remain to be seen.
- Fast-food chains, in an effort to vary their limited menus and to respond to health concerns, have started to serve chicken items. Pizza chains now sell chicken wings, and almost every "hamburger" chain also sells at least one chicken sandwich.

VIII. Conclusions

Thsi study uncovers evidence suggesting that tastes probably shifted in the 1980s towards poultry and pork, two "white meats." We found no evidence of shifts involving tastes for beef, a "red meat," nor for fish, a "white meat." Our non-parametric method and our unusual data set avoided the pitfalls of parametric methods and also minimized the weaknesses of the WARP procedure. The taste shift toward poultry can probably be attributed to new information about saturated fat and cholesterol, but the shift toward pork can be rationalized only as the result of promotional efforts.

Appendix. Deriving the Null Distribution

The derivation of the null distribution of the test statistic is described with an example. Suppose the data contained four pairs of observations that violate WARP:

1. (May 1981) with (June 1984); poultry increases.
2. (May 1981) with (July 1989); poultry increases.
3. (June 1982) with (July 1989); poultry decreases.
4. (June 1984) with (July 1989); poultry increases.

There are four important characteristics of this WARP-violating set:

- The budget lines of the observations in any given pair cross. WARP could not be violated otherwise.
- Observations are non-independent across pairs. For example, (May 1981) appears twice, (June 1984) appears twice, and (July 1989) appears three times. This is because if an observation is unusual enough to violate WARP in conjunction with another observation, it is more likely to also violate WARP in conjunction with a third observation.
- Seasonality may exist. Here, all violations involve observations from the late spring to early summer.
- The ordering of the months matters. For example, May appears in the earlier observation in the first pair and June in the later.

The null distribution is derived by finding all combinations of observations in the data set which match the realization of these four features in the WARP-violating set. That is, all the pairs in the set must have crossing budget lines, any non-independence of observations across pairs must be replicate that found in the WARP-violating set, the pattern of months must be matched, and the months must appear in the same early-late order as they do in the WARP-violating set. A sample conforming to the constraints implied by the example WARP-violating set above is:

1. (May 1985) with (June 1987); poultry increases.

2. (May 1985) with (July 1990);   poultry increases.

3. (June 1980) with (July 1990);   poultry decreases.

4. (June 1987) with (July 1990);   poultry decreases.

A GAUSS program exhaustively checks all the possible combinations and accumulatesthe distribution of the test statistic under the null.

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