Alternative output measurement for the U.S. retail trade sector

An experimental alternative estimate of real output in retail trade, based on double deflated margins might be a viable methodology for measuring retail trade output, but important data issues need to be resolved and further research is necessary

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One of the main features of the resurgence in U.S. labor productivity growth after 1995 is the strong contribution by both wholesale and retail trade. In fact, the productivity performance of these sectors is the foremost reason why the American economy grew so much faster than the European economy over the past decade.[1] Naturally, this has attracted attention to the way in which output and productivity in the trade sector is measured in the United States and Europe.[2]

There is no consensus on how to measure output in retail trade for the purpose of productivity measurement. Many productivity studies, including BLS studies in the *Review*, use real sales per hour worked as an indicator of labor productivity growth.[3] Using sales volume as an indicator for real trade output assumes that there is a one-to-one relationship between the number of products sold and the trade services delivered. For example, if an automobile dealership sells twice as many cars, it is assumed to deliver twice as many trade services. This assumption may of course be criticized from a statistical viewpoint. For example, with the more intensive use of quality-adjusted price indexes for the deflation of sales values, the resulting sales volume is not such a correct proxy for trade services anymore. Nowadays, this problem is most visible when one measures computer sales. For example, nominal sales of the electronic and appliance stores (NAICS 4431) grew on average at 5 percent per year during 1995–2002. The prices of these products, about half of which are computers, declined on average at an annual rate of 12 percent due to dramatic technical improvements. As a result, sales volume grew by a phenomenal 17 percent annually. But, as pointed out by Jack E. Triplett and Barry P. Bosworth: “Electronic stores are in the business of selling boxes that they obtain from the manufacturer…An index that combines the improvements within the box with changes in the number of boxes bears little relationship to the actual activities of the retail store.”[4] In the remainder of this article, we call this the “inside-the-box” effect.

An alternative way of measuring retail output, which may circumvent the inside-the-box effect, at least conceptually, is to make a clear distinction between the products sold by a retailer and the retail services delivered. Retailers are seen as supplying services through storing and displaying a selection of goods in convenient locations and making them conveniently available for customers to buy. The goods purchased are not treated as part of the intermediate consumption needed to supply these services, when they are resold with only minimal processing such as grading, cleaning, packaging, and so forth. The difference between the value of the goods sold and the value of the goods that would need to be purchased to replace them is called the margin value. This margin concept of trade output is used in the System of National Accounts which underlies the construction of the national accounts around the world.[5]

To measure productivity growth, the measures of current margins will need to be converted into

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volume measures of margin. The first way to do this is by deflating current margins by a margin price index which is directly observed. Recently, BLS has introduced a new initiative to measure margin prices in its Producer Price Index program by surveying the difference between the sales price of a specific item and its acquisition cost. However, so far, these measures cover only a limited number of trade industries and years.[6] The second way is to apply a double deflation technique, that is, to use sales prices and purchase prices to construct an estimated margin price. Indeed if prices of goods purchased and goods sold are measured separately with indexes that use the same techniques for quality adjustment, double deflated measures of the real margin will not suffer from the inside-the-box problem.

However, although most national statistical offices within the Organisation for Economic Co-operation and Development (OECD) use margin-based output in current prices, as yet, few statistical offices actually deflate margin values to derive margin volumes. Instead they use, as indicated earlier, sales volumes as a proxy for margin volumes. Why do statistical offices not use double-deflated measures of retail trade output in practice? An important practical reason is that price data of purchases of goods for resale is scarce and generally not available at a sufficiently detailed level. Moreover, when purchased goods account for a large share of total sales, and when the reliability of the price indexes for purchased goods is not very high, the estimate of the volume of the margin, which is a residual, can become highly erratic.

In this article, we attempt double deflation of retail output on an experimental basis. Admittedly, data availability is far from perfect and various assumptions need to be made in order to be able to derive double-deflated measures of trade margins. But our results show that the approach should not be ruled out beforehand. The new estimates allow us to assess the difference between the growth in real sales and real margins. We stress that the real margins approach is not the only possible concept of trade output when measuring productivity. As mentioned by Marilyn E. Manser, productivity measurement requires the most general framework of data possible so that various approaches can be tried and compared.[7] But given the increasing questions about the current methodology of using real sales for productivity measurement, it is worthwhile to also pursue research into the alternative of double deflation and indicate areas for further data improvements. Although the double deflation approach may be relevant for the entire trade sector, we focus on the retail trade sector as this sector has attracted the most attention in studies of U.S. economic growth and because data for this sector are more abundant than those for the wholesale sector.

Double deflation

For double deflation of retail margins, two sets of prices are needed: retail sales prices and retail purchase prices. The main problem is the derivation of purchase prices. In exhibit 1, we provide a stylized view of the flow of goods through various purchase channels. Retailers still purchase "goods for resale" mainly through wholesalers (for example, 68 percent of total purchases in the United States in 1997). But increasingly, the wholesale sector is bypassed and goods are acquired directly from domestic and foreign manufacturers.

For each merchandise line, the change in retail purchase prices (p_C^R) can be calculated as a weighted average of changes in wholesaling sales prices (p_S^W), producer prices (p^D), and import prices (p^I) as follows:

$$\dot{p}_C^R = v_R^W \, \dot{p}_S^W + v_R^I \dot{p}^I + v_R^D \dot{p}^D \qquad (1)$$

with $\dot{p}_i$ denoting a price change and v_R the share in total retail purchases of wholesaling, imports, and domestic production respectively. Domestic producer prices can be derived from BLS, *Producer Price Indexes*. Import prices can be derived from BEA, *End Use Import Price Indexes*. Unfortunately, no data are available on wholesale sales prices. But an estimate of wholesale sales prices can be made using the domestic producer and import prices and information on the shares of imports in wholesale purchases. To this end, we need to assume that changes in wholesale sales prices ($\dot{p}_S^W$) are proportional to changes in wholesale purchase prices ($\dot{p}_C^W$). The sensitivity of our results for this assumption is discussed as:

$$\dot{p}_S^W = \dot{p}_C^W = v_W^I \dot{p}^I + v_W^D \dot{p}^D \qquad (2)$$

with v_W^I and v_W^D the share of imports and domestic production in total wholesale purchases. Substituting (2) in (1), we can express the change in the purchase prices of goods for resale faced by the retailers in terms of producer and import prices only as follows:

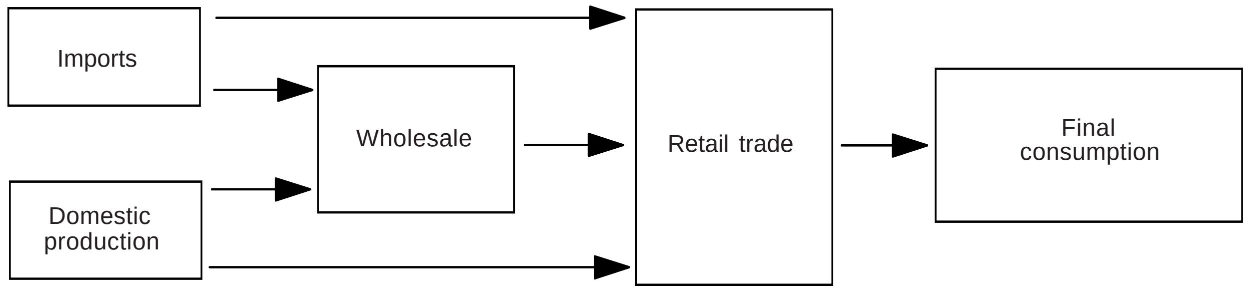
$$\dot{p}_C^R = \left(v_R^I + v_R^W v_W^I\right) \dot{p}^I + \left(v_R^D + v_R^W v_W^D\right) \dot{p}^D \qquad (3)$$

The weights are given by the retail purchase share of the sum of the direct and indirect (though wholesale) purchases of domestic produce and imports. There are no data available on the share of imports in wholesale purchases (v_W^I) or on the share of imports bought directly by retailers in all retail purchases (v^I_R). Therefore, we assume that the share of imports in wholesale purchases and the share of imports in retailers' purchases not made through wholesalers are equal to the total import share in total purchases v^I :

$$v^I = v_W^I = \frac{v_R^I}{1 - v_R^W} \qquad (4)$$

In parallel, a similar assumption is made for domestic production. Substituting (4) in (3) and using the identity that

Exhibit 1. Simplified flow of goods between trade and production sectors



$v^D = (1 - v^I)$, we can derive the change in the retail purchase price as:

$$\dot{p}_C^R = v^I \; \dot{p}^I + (1 - v^I) \; \dot{p}^D \quad (5)$$

The share of imports in total purchases of each type of good is obtained from BEA *1997 import matrix*, under the assumption that the share of each merchandise line in total purchases equals the share of each merchandise line in total consumption. Retail purchase prices are derived for each merchandise line by matching a producer price index and an import price index to each final consumption good category, such as food and clothing. This was done for about 150 products.

Margin prices and volume

Retail purchase prices for merchandise lines given by (5) are aggregated to a retail industry and combined with total margins (*M*) and sales (*S*) to construct retail margin prices ($\dot{p}_M^R$). For a particular retail industry, sales prices are given by:

$$\dot{p}_S^R = \frac{M^R}{S^R} \dot{p}_M^R + \left[1 - \frac{M^R}{S^R}\right] \dot{p}_C^R \quad (6)$$

so that margin prices can be implicitly derived by:

$$\dot{p}_M^R = \frac{S^R}{M^R} \left(\dot{p}_S^R - \left[1 - \frac{M^R}{S^R}\right] \dot{p}_C^R \right) \quad (7)$$

The productivity program derives retail industry sales prices from the detailed price index series of the Consumer Price Index Research Series for the 1987–2002 period. We combine these with data on sales and margins at current prices from the annual *Census of Wholesale Trade* and the *Census of Retail Trade*, covering the 1993–2002 period. The combined data set contains 20 retail industries. In this article, results are given for 12 aggregated three-digit industries using Törnqvist aggregation procedures.

Table 1 compares retail sales prices, purchase prices derived using equation (5), and the implicit margin prices derived using equation (7). Looking first at the purchase prices, one can see that average annual growth in the 1993–2002 period is 0.4 percent at the aggregate retail level. However, purchase prices declined in four retail industries. In sporting goods, hobby, book and music stores (NAICS 451) purchase prices declined by 0.5 percent per year. The major part of purchases by this industry consists of imports, and prices for those goods fell by 0.7 percent. Miscellaneous store retailers (NAICS 453) also benefited from declining purchase prices through imports. Purchase prices of nonstore retailers (NAICS 454) and especially of electronics and appliance stores (NAICS 443) declined at a much faster pace, mainly because of price declines in domestic goods. The price decline in the latter industry was mainly due to declining prices of computers and peripherals, which made up 19 percent and 42 percent of purchases respectively, and for which domestic producer prices declined by 34 percent.

By comparing the sales price in column 1 with the purchase price in column 2, one can also trace whether the final customers benefited from slow growth or declines in purchase prices. At the aggregate level, retail sales prices grew 0.5 percent annually, which was slightly faster than purchase prices. But at the industry level, price changes varied strongly. Sales prices were growing slower than purchase prices for 7 out of 12 industries. In clothing stores (NAICS 448), furniture stores (442), general merchandising (452), and miscellaneous retail stores (453) sales prices grew slower than

Table 1. Sales, purchase, and margin prices growth, U.S. retail industries 1993–2002

NAICS97	Industry	Sales prices	Purchase prices	Purchase price contribution		Share of imports in total purchases (percent)	Implicit margin prices
				Domestic products	Imports		
44–45	Retail trade	0.5	0.4	0.7	–0.3	26	0.6
441	Motor vehicle and parts dealers	.8	.8	.7	.2	24	.4
442	Furniture and home furnishings stores	.1	1.0	1.1	–.2	25	–1.1
443	Electronics and appliance stores	–10.6	–12.7	–8.4	–4.3	51	–4.3
444	Building material and garden equipment and supplies dealers	.0	.3	.4	–.1	59	–.6
445	Food and beverage stores	2.2	1.0	1.0	.0	7	5.5
446	Health and personal care stores	2.3	1.5	1.5	.0	32	4.3
447	Gasoline stations	2.4	2.9	2.6	.3	6	.6
448	Clothing and clothing accessories stores	–1.8	.3	.1	.1	60	–4.7
451	Sporting goods, hobby, book, and music stores	–.9	–.5	.2	–.7	63	–1.5
452	General merchandise stores	–.2	.4	.5	–.1	38	–1.7
453	Miscellaneous store retailers	–1.1	–.6	–.1	–.5	50	–1.8
454	Nonstore retailers	–3.3	–4.4	–2.7	–1.6	36	–2.1

SOURCES: Sales prices are from the BLS, Office of Productivity and Technology; import prices are from the Bureau of Economic Analysis (BEA) Import Price Indexes; domestic prices are from the BLS Producer Price Indexes; import share is from the BEA 1997 import matrix; otherwise authors' own calculations. Sales shares by merchandise line from Census Bureau. Double-deflated margin prices are calculated (using equation 7 in the text) using margin-to-sales ratio from Annual Retail Trade Census, and authors' own calculations.

purchase prices by at least 0.5 percent per year. For example, purchase prices for clothing stores grew by 0.3 percent, whereas sales prices declined by 1.8 percent per year. However, declines in purchase prices of electronic stores were not completely passed on to the customer. In food stores, sales prices increased much faster (2.2 percent) than purchase prices (1.0 percent).

Using equation (7), we can derive margin prices. These prices reflect the implicit price of the trading service, rather than the sales price of the good sold. The last column in table 1 shows that margin prices grew slowly at the aggregate level and in line with sales and purchase prices. But the change in margin prices varies across the various retail industries. Margin prices increased by 4 percent or more in food stores (445) and health and personal care stores (446). But in most retail industries, margin prices declined between 1993 and 2002. In five industries, margin prices declined by a range between 1.1 and 2.1 percent, compared with two industries that experienced price declines of more than 4 percent (clothing stores, NAICS 448 and electronics retailing, NAICS 443).

An appropriate application of the double-deflation method requires that prices for both sales and purchases are corrected for quality changes to the same extent.[8] For most goods, both the CPI, and the PPI and IPP use standard quality adjustment procedures, so one can probably assume that this condition holds. The difference is likely to be greatest where hedonic techniques are used for the index of sales prices, but not for purchase prices. This is currently the case for many clothing types and certain consumer electronics and household appliance products (other than computers and peripherals). For those consumer products, the CPI, not the PPI and IPP, is based on hedonic adjustment methods. One may expect that this should lead to an upward bias in the margin price index, but this is not necessarily the case. For example, for apparel consumer price indexes, a BLS study found no significant bias in the nonhedonic-based sales price series compared with the hedonic ones. Both upward and downward discrepancies were found for various apparel categories, which almost cancelled out at the aggregate.[9] Electronics and appliance stores (NAICS 443) is a special case. For computers and peripherals, the CPI and the PPI and IPP are based on hedonic adjustment techniques. But given the fact that we could only match sales and purchase prices of one merchandise line (computers and peripherals as a whole), the estimate of the margin price in electronics and appliance stores as a whole should still be treated with caution. Further information on the differences in quality-adjustment methods between CPI on the one hand, and PPI and IPP on the other is needed before conclusive remarks on this issue can be made.

Using the margin prices for the deflation of the current margin value, a comparison can now be made between real sales and real margin growth. Although the former measures the volume of sales, the latter measures the changes in the volume of trade services delivered. At the aggregate retail level, we find no substantial difference between the two measures of retail output. During the 1993–2002 period, real margins and real sales in retailing grew at almost 5 percent per year. (See table 2.) But again, differences are substantial for individual retail industries. According to the double-deflated margin concept, output growth in the electronics stores is

Table 2. Growth of real sales and real margins of U.S. retail industries, 1993–2002

NAICS	Industry	Real growth		
		Sales	Margins	Difference
44–45	Retail trade	4.8	4.8	0.0
441	Motor vehicle and parts dealers	5.6	5.9	.3
442	Furniture and home furnishings stores	5.3	6.9	1.6
443	Electronics and appliance stores	17.4	10.7	–6.7
444	Building material and garden equipment and supplies dealers	6.2	7.3	1.2
445	Food and beverage stores	.6	–1.0	–1.6
446	Health and personal care stores	5.0	2.7	–2.3
447	Gasoline stations	2.1	3.1	.9
448	Clothing and clothing accessories stores	5.3	8.8	3.4
451	Sporting goods, hobby, book, and music stores	5.6	6.7	1.1
452	General merchandise stores	6.1	6.2	.2
453	Miscellaneous store retailers	6.8	6.9	.1
454	Nonstore retailers	11.1	9.5	–1.6

NOTE: Real margins are calculated using double-deflated margin prices from table 1.

SOURCE: Table 1, Annual Retail Trade Census, and authors' own calculations.

still high, but much lower than that suggested by sales volumes (10.7 percent instead of 17.4 percent per year). This is because the rapid decline of computer sales prices is partly offset by a similarly rapid decline in prices of the same computers purchased by the electronics stores. Also, in food stores (NAICS 445) and health care stores (NAICS 446), margin-based output grew slower than real sales. But in the other nine retail industries, real margin growth was faster than real sales growth. The difference is biggest in clothing stores (NAICS 448), furniture stores (NAICS 442), building material stores (NAICS 444), and sporting goods, hobby, book, and music stores (NAICS 451). Margin-based output growth in clothing stores is now growing at the highest rate of all retail industries, except for nonstore retailers and electronics retailing, whereas, on basis of sales volume, clothing only ranked eighth out of 12 retail industries.

Caveats

It needs to be stressed that the output estimates based on double-deflated margins presented in this article are of an experimental nature, and require a careful assessment of potential (systematic) errors. One of the reasons for national statistical offices to avoid double deflation in obtaining the volume of the margin for distributive trade industries is that all possible measurement errors in both sales and purchases prices will end up in the margin prices. As a result, double-deflated margin prices are more sensitive to price measurement errors than sales prices. Retail industries can be more susceptible to this problem than other industries as margin-to-sales ratios can be rather low. In table 3, we provide an indication of the severity of this problem by showing the coefficient of variation of the annual growth rates of real sales and real margins over the 1993–2002 period. As was to be expected, the volatility of real margins is higher than the volatility of real sales in all industries, in particular, in food stores and gasoline stations, but only marginally so in furniture stores, clothing stores, and miscellaneous stores. Interestingly, in some industries, the volatility of real margins is actually lower than the volatility of real sales in other industries.

An important potential measurement error in our procedures is that we allocate all the change in margin prices to retailing, thereby ignoring the role of changes in wholesale, transport, and tax margins. The latter two will only have small effects, but ignoring the change in wholesale margins might potentially have a bigger impact.[10] Table 4 indicates the share of retail and wholesale margins in the total trade margins on sales by retail industries. The share of wholesale margins in total margins vary from about one-seventh in the case of clothing stores (NAICS 448), miscellaneous stores (NAICS 453), and nonstore retailers (NAICS 454) to about one-quarter in most other industries. On average, wholesale margins make up less than a quarter (22 percent) of the total margin on consumer goods. As explained earlier, we needed to assume that the change in purchase and sales prices in the wholesale sector were the same. So if, for example, wholesalers have managed to bring down their margin prices more than their purchase price, our estimates of retail margin price changes are upwardly biased. This bias will depend on the share of the wholesale margin in total margin as given in table 4, times the difference in wholesale purchase and margin prices. Without data on wholesale sales prices, this issue cannot be resolved.

Another weakness is the way by which we had to allocate producer and import price indexes to products sold by retail industries. Although indexes are allocated at a relatively detailed level, matching is based on comparatively concise product descriptions, so mismatches cannot be ruled out. We

Table 3. Coefficient of variation of annual growth of real sales in U.S. retail industries, 1993–2002

NAICS97	Industry	Sales	Margins
44–45	Retail trade	0.4	1.0
441	Motor vehicle and parts dealers	.6	2.3
442	Furniture and home furnishings stores	.5	.5
443	Electronics and appliance stores	.3	1.7
444	Building material and garden equipment and supplies dealers	.4	.9
445	Food and beverage stores	2.0	4.3
446	Health and personal care stores	.3	1.5
447	Gasoline stations	1.2	6.8
448	Clothing and clothing accessories stores	.5	.5
451	Sporting goods, hobby, book, and music stores	.5	.7
452	General merchandise stores	.2	.6
453	Miscellaneous store retailers	.7	.8
454	Nonstore retailers	.4	.8

SOURCE: Data from table 2, growth of real sales and real margins, and authors' own calculations.

have not been able to come up with a measure of the potential severity of this problem. More detailed producer price and import price indexes might alleviate this problem.

Other potential measurement errors in our procedures stem from assumptions concerning the shares of goods categories in purchases. Due to data limitations, we assume that the share of imports in purchases of each category in a particular retail industry is equal to the share of imports in total consumer demand for this category. Mismeasurement due to these assumptions about shares will probably only have a modest impact on our results. For example, if the import share for products sold by food stores (NAICS 445) were twice our estimated share (14 percent instead of 7 percent—see table 1), the purchase price would rise by 0.9 percent instead of 1.0 percent. In general, as long as price changes are modest, errors in the measurement of shares will only result in small errors in purchase prices.[11]

Concluding remarks

In this article, we have argued that at times of rapid changes in retail formats, improvements in the quality of distributive services and in the quality of goods sold, conventional measures of trade output using the growth of real sales are

Table 4 Average share of retail and wholesale margins in total retail sales, 1993–2002

NAICS97	Industry	Total trade margin share in retail sales	Total trade: Share of retail margin (in percent)	Total trade: Share of wholesale margin (in percent)
44–45	Retail trade	32.8	78	22
441	Motor vehicle and parts dealers	23.7	74	26
442	Furniture and home furnishings stores	52.9	81	19
443	Electronics and appliance stores	36.0	74	26
444	Building material and garden equipment and supplies dealers	37.0	76	24
445	Food and beverage stores	31.8	82	18
446	Health and personal care stores	40.8	75	25
447	Gasoline stations	28.5	74	26
448	Clothing and clothing accessories stores	48.4	86	14
451	Sporting goods, hobby, book, and music stores	49.7	76	24
452	General merchandise stores	37.0	72	28
453	Miscellaneous store retailers	49.6	86	14
454	Nonstore retailers	50.2	87	13

SOURCES: Wholesale margins are attributed to retail industries based on the product composition of wholesale sales by industry from the 1997 Census, merchant wholesalers margin to sales ratios from the Annual Census of Wholesale Trade, and the share of wholesale sales to retailers from the 1997 census.

becoming increasingly questionable. Sales-based output measures confounds the two types of quality improvements mentioned earlier. Using an experimental approach, we constructed alternative estimates of trade output based on double-deflated margins. This alternative measure suffers less from the inside-the-box effect as long as both sales and purchases prices are corrected for quality changes to the same extent. At the aggregate level of the retail sector and in many specific retail industries, output growth measures based on real margins are not radically different from those based on real sales. But for example, output growth in clothing stores appears to be much higher when measured on the basis of double-deflated margins, whereas output growth in food and beverage stores is much less. Importantly, output growth in electronics and appliance stores based on double-deflated margins was found to be still high, but much lower than growth of real sales.

It should be stressed that the estimates in this article are of an experimental nature. There are important data issues to be resolved before our estimates can be treated as a genuine alternative to the present real sales-based estimates. For example, the increasing complexity of discount practices put a high demand on the data, and may be a reason in favor of a direct measurement of margin prices rather than through our double-deflation approach. Separation of retail and wholesale margins is complicated due to the lack of wholesale sale prices. In addition, none of the current methods discussed here is able to deal directly with the actual improvements in service quality in retail industries.[12] However, this article has shown that double deflation is a viable methodology for measuring retail trade output and deserves further research. □

Notes

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[1] See, for example, Bart van Ark, Robert Inklaar, and R. H. McGuckin, "ICT and productivity in Europe and the United States, Where do the differences come from?" *CESifo Economic Studies*, vol. 49, March 2003, pp. 295–318.

[2] See, for example, *The EU Economy 2004 Review*, European Economy no. 6 (Luxembourg, European Commission, Office for Official Publications, 2004).

[3] See Christopher Kask, David Kiernan, and Brian Friedman, "Labor productivity growth in wholesale trade, 1990–2000," *Monthly Labor Review*, December 2002, pp. 3–14 and Mark Sieling, Brian Friedman, and Mark Dumas, "Labor productivity in the retail trade industry, 1987–99," *Monthly Labor Review*, December 2001, pp. 3–14.

[4] See Jack E. Triplett and Barry P. Bosworth, *Productivity in the U.S. Services Sector. New Sources of Economic Growth*, ch. 8 (Washington, DC, The Brookings Institution, 2004), p. 240.

[5] The Bureau of Economic Analysis (BEA) produces the National Income and Product Accounts (NIPA) for the United States. The BEA uses the margin concept as the concept for retail industry output.

[6] See Triplett and Bosworth *Productivity in the U.S. Services Sector*, 2004 and Marilyn E. Manser, "Productivity measures for retail trade: data and issues," *Monthly Labor Review*, July 2005, pp. 30–38. Some services, such as service shops of automobile dealers, provide directly priced services which can be surveyed as well.

[7] Manser, "Productivity measures for retail trade: data." See also Walter Oi, "Productivity in the Distributive Trades: The Shopper and the Economies of Massed Reserves," in Zvi Griliches, ed., *Output Measurement in the Service Sector* (Chicago, University of Chicago Press, 1992); B. T. Ratchford, "Has the productivity of retail food stores really declined?" *Journal of Retailing*, vol. 79, issue 3, 2003, pp. 171–82; and Triplett and Bosworth, *Productivity in the U.S. Services Sector*, for a discussion about various output and productivity measures in trade industries.

[8] See Jack E. Triplett, "High Tech Industry Productivity and Hedonic Price Indices," in OECD, *Industry Productivity. International Comparison and Measurement Issues*, OECD Proceedings, Paris, 1996, pp. 119–42.

[4] See Paul Liegey, "Apparel price indexes: effects of hedonic adjustments," *Monthly Labor Review*, May 1994, pp. 38–45.

[10] Ignoring transport margins is not a major problem as transport margins only represent a small share of personal consumption expenditure. Not taking taxes into account is potentially more serious: sales and excise taxes have been rising at about 5 percent per year between 1993 and 2002. Still, the potential impact on our results is limited: taxes that represent 7 percent of the total sales value, and increase at about 5 percent per year, add 0.35 percent to sales prices on annual basis.

[11] We also have to assume that shares of product categories in total sales are representative of their shares in total purchases. In the case where margins differ by product within a particular retail industry, the share of a product in purchases will not be equal to its share in total sales. For example, if margins on computers are smaller than on other products sold by electronic and appliances stores, we underestimate the share of computers in the purchases price index. Given the fact that computer prices decline faster than prices of other products sold by this retailing industry, we probably underestimate the price decline of purchases. It is possible to perform some ad hoc sensitivity analysis but, as mentioned before, we have no formal way to evaluate these potential measurement errors.

[12] See, for example, Ratchford, "Has the productivity of retail food stores really declined?"