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An Introduction to Currency Boards

by Owen F. Humpage and Jean M. McIntire

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Introduction

The usefulness of money lies in its ability to reduce transaction costs. This depends, in turn, on public confidence in the stability of money's purchasing power. In acquiring the requisite monetary credibility, governments face a trade-off between 1) creating institutions that limit their ability to generate inflation, and 2) relying on an established record for actually achieving and maintaining stable prices. Those governments lacking an established reputation for price stability must adopt stronger institutions to foster confidence in the purchasing power of their money.

The recent peso crisis is a good example of this trade-off. Mexico granted its central bank greater autonomy and made commendable improvements in its monetary policy prior to 1994. Money growth and inflation slowed dramatically after 1992. Nevertheless, these gains were not typical of Mexico's broader experience and were too recent to constitute a credible monetary policy reputation. Following political turmoil in 1994, capital flows into Mexico began to recede, and the country lost official reserves. A marked rate differential between Mexico's peso-denominated and dollar-indexed debts prior to last December's devaluation indicated that investors were becoming increasingly worried about holding pesos. They feared that Mexico would once again resort to inflationary finance and devaluation. Without a well-established track record for price stability, the Bank of Mexico's newfound autonomy could not endow it with credibility.

Events in Mexico, coupled with more market-based development strategies in Eastern Europe, Latin America, and Asia, have kindled an interest in currency boards as an institution for providing monetary credibility in developing countries (see Hanke and Schuler [1994] and Hanke, Jonung, and Schuler [1993]). A currency board offers to exchange domestic currency for foreign exchange at a fixed rate, on demand, and under all circumstances. It insures this offer by fully backing the domestic monetary base with a foreign-reserve currency and by setting the exchange rate as a matter of public law.

This currency-board primer begins by describing those salient features of the arrangement that secure its monetary credibility.[1] As

■ 1 Fieleke (1992) and Walters and Hanke (1993) also cover the basics of currency boards.

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we discuss in section I, full convertibility at a fixed exchange rate ties money growth and inflation in a developing country to those measures in the reserve-currency country, independent of whether a central bank or a currency board manages the exchange-rate peg. In striking contrast to a central bank, however, an orthodox currency board never acquires domestic assets, and this prevents it from financing fiscal policies, sterilizing reserve flows, or otherwise engaging in discretionary monetary policies.

In the second section, we consider three important criticisms of currency boards. The first suggests that fully backing a currency with foreign-exchange reserves is needlessly costly, especially when domestic assets might offer a higher return. The second criticism questions the appropriateness of fixed exchange rates, because movements in nominal exchange rates can promote needed changes in a country's terms of trade. The third criticism faults currency boards for not acting as the lender of last resort, a function that may be especially important to developing countries. All things considered, currency boards' major advantage over central banks is that for developing countries willing to accept a diminution of monetary sovereignty and some lessening in the responsiveness of their terms of trade, a currency board provides a stronger arrangement for acquiring a credible commitment to price stability.

I. Securing Price Stability

Currency Boards and the Monetary Adjustment Mechanism

In large part, currency boards boost monetary credibility because they link money growth in a currency-board country to that in a reserve-currency country. Reserve currencies, like the U.S. dollar and the German mark, function as money beyond their national borders. The countries that issue them have relatively well-developed financial sectors as well as reputations for comparatively low inflation rates. Because they are widely accepted, reserve currencies provide good collateral against the currency board's promise of full convertibility. Today, currency boards in Argentina, Hong Kong, and Latvia utilize the U.S. dollar as their reserve currency, while Estonia relies on the German mark. Although we assume that currency boards hold only a single reserve currency, they have often held multiple currencies as well as reserves of gold and silver. Estonia, for example, initially considered linking to the European Currency Unit — a composite currency — and started its operations with gold reserves (see Bennett [1993]).

Because a currency board issues only domestic notes against foreign exchange at a fixed exchange rate, the money stock in a currency-board country is related to the nation's overall balance-of-payments position.[2] To illustrate this relationship, we assume that commercial banks in the currency-board country operate on a fractional-reserve basis, holding currency-board notes (N_B) in reserve against domestic deposits.[3] In the absence of legal reserve requirements, as is often the case under currency boards, banks determine the amount and composition of their reserves based on four factors: 1) the size and turnover of deposits, 2) clearing obligations, 3) the public's relative demand for notes, and 4) the opportunity cost of holding reserves. The public holds currency-board notes (N_P) and commercial bank deposits for transaction purposes.

Currency boards have often appeared in countries that experience widespread currency substitution. We assume, however, that only currency-board notes and bank deposits serve as money in the currency-board country. This simplifies the analysis without altering any fundamental conclusions. By improving confidence in the domestic monetary unit, a currency board might greatly reduce currency substitution. On the other hand, allowing individuals to hold foreign currency and foreign currency deposits, as in Argentina, might further constrain a currency board's ability to renege on the arrangement and might heighten its monetary credibility.

Under these circumstances, the monetary base consists of currency-board notes held by both commercial banks and individuals. The money supply (M), which consists of currency-board notes held by the public and commercial bank deposits, is a multiple of the monetary base:

$$(1) \quad M = \left[\frac{1+c}{r+c} \right] (N_B + N_P),$$

2 Currency boards may also provide coin, a subject we ignore in this article.

3 Some currency boards have offered reserve deposit accounts to commercial banks.

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BOX 1

Balance Sheets for a Currency Board and a Central Bank

Currency Board

Assets	Liabilities
Foreign currency reserves (R_O)	Notes ($N_P + N_B$)
Liquid reserve account	
Investment reserve account	
Surplus reserve account	Net worth

Central Bank

Assets	Liabilities
Foreign exchange (R_O)	Reserves and clearing accounts
Domestic assets (D)	Currency held by the public
Securities	
Loans	Net worth

NOTE: We assume a fixed exchange rate equal to one.
SOURCE: Authors.

where r is the average reserves-to-deposit ratio, and c is the average ratio of notes to deposits held by individuals.[4]

As the currency board's balance sheet illustrates (see box 1), notes issued to the public and to the banking sector cannot exceed the currency board's receipts of foreign-exchange reserves (R_O).[5] The currency board's holdings of foreign-exchange reserves are, in turn, directly related to the balance of payments (see appendix). According to the balance-of-payments identity,

$$(2) \qquad C + \Delta K = \Delta R_O ,$$

where C is the current-account surplus, ΔK represents net private capital inflows, and $\Delta R_O > 0$ refers to an official acquisition of foreign exchange.

When the home country runs an overall balance-of-payments surplus ($C + \Delta K > 0$), the currency board acquires foreign exchange. Other things equal, the monetary base and money stock expand. Similarly, when the home country runs an overall balance-of-payments deficit ($C + \Delta K < 0$), its monetary base and money supply shrink, other things equal. Contrary to common perception, a currency-board country need not maintain a current-account surplus to expand its monetary base. Developing countries, which rely on foreign capital for growth, may experience current-account deficits and larger net-capital-account inflows, resulting in an overall balance-of-payments surplus.

In summary, we can state the money stock in a currency-board country at any time, T, as a multiple of the monetary base, which in turn reflects the foreign-exchange holdings of the currency board (equal to the cumulation of all past balance-of-payments surpluses and deficits):

$$(3) \qquad M_T = \left[\frac{1+c}{r+c}\right](N_B + N_P)_T = \left[\frac{1+c}{r+c}\right](R_O)_T = \left[\frac{1+c}{r+c}\right]\sum_{t=-\infty}^{T}(C_t + \Delta K_t).$$

Equation (3) is an identity. Changes in the money stock result from developments that simultaneously affect the overall balance of payments or the money multiplier. If, for example, investors in the currency-board country decide to shift wealth out of deposits in that country and into deposits in the reserve-currency country, they would first exchange domestic deposits for currency-board notes through their commercial banks, and then exchange currency-board notes for the reserve currency with the currency board.[6] The domestic money supply would fall and the overall balance of payments would shift into deficit as investors deposited funds abroad. Interest rates in the currency-board country might rise, partially counteracting the desire to invest in the reserve-currency country and reducing the demand for currency-board notes in line with the now-smaller supply. Prices might also fall, encouraging exports.

All of these adjustments follow automatically without government intervention. Unfortunately, they may take time, especially if wages and prices are inflexible, and they may result in some temporary dislocations in the currency-board country (as, for example, resources shift from the production of investment-related goods to the provision of export goods).

Equation (3) indicates that the money stock in the currency-board country will increase as

4 See Brunner (1973) for a general discussion of money multipliers in an open economy. See also Osband and Villanueva (1993).

5 We assume throughout this paper that the exchange rate is fixed and equal to one.

6 Most currency boards have dealt only with commercial banks, which supply foreign exchange to their customers at competitive rates.

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long as that country runs a balance-of-payments surplus. For the currency-board country to acquire reserves, the reserve-currency country must supply more money than its own public wishes to hold. As the reserve-currency country increases its money supply, short-term interest rates might fall and domestic prices might rise, creating arbitrage opportunities relative to the developing country and a balance-of-payments deficit in the reserve-currency country. As persons in the currency-board country exchange newly acquired foreign exchange for currency-board notes, the money stock in the currency-board country increases.[7]

In the long run, this process should ensure that money growth in the currency-board country approximates that in the reserve-currency country.[8] The currency-board country acquires credibility at the expense of losing monetary sovereignty to the reserve-currency country.

The key aspect of the adjustment process outlined above is that it is automatic; no discretionary policy changes took place. Under fixed exchange rates, a central bank would face similar automatic adjustments, but unlike a currency board, a central bank can offset — or sterilize — the contractionary monetary effects of the capital outflow. In contrast to a currency board, the money stock for a central bank is determined according to

$$(4) \qquad M = \left[\frac{1+c}{r+c}\right](R_O + D)\,,$$

where D is domestic assets, typically government securities and loans to depository institutions (see box 1). When a change in its foreign-exchange reserves occurs, a central bank can sterilize the effects on its domestic money supply through offsetting operations with its domestic assets:

$$(5) \qquad -(\Delta R_O) = \Delta D.$$

The size of the central bank's portfolio of foreign-exchange reserves limits its ability to sustain a reserve loss associated with a balance-of-payments deficit. This highlights a key insight of the monetary approach to the balance of payments: Central banks maintain balance-of-payments deficits (surpluses) by supplying more (less) money than their citizens desire.

If a central bank accurately identifies as temporary the underlying problem causing a balance-of-payments deficit or surplus, sterilization might be beneficial for avoiding interim economic adjustments and dislocations. If, however, the underlying problem is long term or is related to uncertainty about government or central bank policies, sterilization can actually worsen the capital outflow. Speculators realize that the probability of a devaluation increases as a central bank's reserves dwindle. They are likely to move funds out of the country, thereby aggravating the situation. Consequently, while central banks may avoid adjustment to temporary balance-of-payments disequilibria, they have no advantage over currency boards when the underlying problem is persistent.

No Domestic Assets

Unlike a central bank, an orthodox currency board never acquires domestic assets. Among other things, this precludes the currency board from buying home-government debt obligations, from lending to state-run industries, or from making loans to local banks. This crucial prohibition separates the currency board from the government's fiscal activities and prevents it from engaging in discretionary monetary policy.

As Ow (1986) and Schuler (1992) both point out, the decision to abandon currency boards in the 1950s did not stem from their failure to provide stable money. Instead, these newly independent developing countries believed that an inability to conduct discretionary monetary policy would hamper their development efforts (see Schwartz [1993]). Consequently, they established central banks.[9] In actuality, most developing countries have relied on their central banks to undertake a myriad of fiscal operations, including monetizing government activities (see Fry [1993] and Calvo and Végh [1992]).

In addition to preventing currency boards from acquiring government-debt instruments, the prohibition against holding domestic assets appears to constrain deficit spending. Absent inflationary finance, governments seem more concerned about fiscal competition with private borrowers for available credit (see Osband and Villanueva [1993]). Ow (1986, pp. 47–48) shows that under currency boards, Singapore and

■ 7 On the connection between monetary disequilibria and the balance of payments, see Frenkel and Mussa (1985). Price increases following a one-time rise in the reserve-currency country's money supply will eventually restore monetary equilibrium and eliminate the balance-of-payments deficit.

■ 8 The measured inflation rate may diverge because of nontradable-goods prices, but should remain cointegrated. See discussions about Hong Kong in Schwartz (1993) and Ow (1986).

■ 9 Ironically, the success of currency boards in stabilizing the currency often facilitated the move to a central bank.

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Hong Kong typically operated with government budget surpluses, while other former British colonies that abandoned their currency boards persistently maintained large deficits.

The prohibition on holding domestic assets prevents the currency board from engaging in monetary policy, but as Ow (1986, pp. 71–75) argues, the government retains a limited ability to influence the domestic money stock. Governments in currency-board countries typically hold portfolios of assets denominated in the foreign-reserve currency. These portfolios are independent of the currency board and, as we discuss below, often result from currency-board profits. By converting the foreign exchange acquired from the sale of these assets into currency-board notes, the government can alter the domestic money supply. Hence, the government might finance a fiscal expenditure or respond to an exogenous increase in money demand (see section II, "Lender of Last Resort").[10] A government's ability to undertake such a policy depends on its holdings of foreign-currency assets (or on its ability to borrow abroad). Unlike discretionary central-bank actions, however, this policy cannot undermine the currency's reserve backing or the currency board's credibility.

II. Criticism of Currency Boards

100 Percent Reserve Backing in Foreign Exchange

As Schuler's (1992) historical survey indicates, currency boards typically apportioned their foreign exchange among three accounts. They held approximately 30 to 50 percent of the assets backing their notes in a *liquid reserve,* consisting of high-quality, marketable securities of the reserve-currency country that mature in less than one year. They maintained 50 to 70 percent of the assets backing their notes in an investment reserve that comprised higher-yielding securities with a longer maturity and somewhat greater risk. This split between liquid and investment reserves was possible because the public used a relatively fixed proportion of notes and coin in circulation to finance day-to-day transactions and, under normal circumstances, would not redeem this amount for reserve assets. The investment reserve was an important source of profit for the currency board.

Besides the 100 percent reserve backing apportioned to the liquid and investment reserves, Schuler found that currency boards usually held an additional amount of foreign exchange, equal to approximately 5 to 10 percent of their note issuance, in a *surplus reserve.* This surplus ensured that possible capital losses on the investment reserves would never pull the total amount of foreign-exchange backing below the 100 percent necessary to fully guarantee all notes in circulation.[11] The surplus reserve grew from profits generated on currency-board investments.

Schuler (1992, p. 188) found that the costs of operating currency boards were typically very small and that only two were unprofitable. Even currency boards that started operations holding less than 100 percent in reserve backing were able to build their foreign-exchange portfolios to the required level through earnings on their investments. Typically, any profits in excess of approximately 110 percent of the currency board's notes in circulation were remitted to the local government, enabling the government to acquire the aforementioned portfolio of reserve-currency assets.

By issuing its own currency in exchange for the reserve currency and by investing its reserves in earning assets, governments in currency-board countries garnered seigniorage (profits associated with the issuance of base money) that they otherwise would have lost because of currency substitution. Unlike central banks, which earn seigniorage primarily from inflation, currency boards gain seigniorage only as interest from assets denominated in the reserve currency. Historically, capturing seigniorage has been an important reason for establishing currency boards.

Critics of currency boards have argued that backing 100 percent of the monetary base with foreign-reserve assets when domestic assets yield more is needlessly costly. In their view, the currency board could place its *investment reserve* in higher-yielding domestic assets without unduly weakening itself. Argentina currently allows up to one-third of its reserves to be held in domestic instruments (see Bennett

■ **10** Following the monetary approach to the balance of payments, an exogenous increase in the money supply, other things equal, will eventually dissipate through a balance-of-payments deficit. Hence, the discretionary actions of the government must simultaneously increase the demand for money. See Frenkel and Mussa (1985).

■ **11** Osband and Villanueva (1993, pp. 206–07) argue that with reserves large enough to cover a likely valuation change, a currency board could exist with a flexible exchange rate. Although Singapore is a prime example (see Ow [1986, pp. 87–88]), a floating exchange rate greatly reduces the credibility of the system. Thus, many analysts no longer consider Singapore to have a currency board (see Schwartz [1993]).

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[1994, p. 6]). Some colonial currency boards did invest reserves in domestic assets and thereby evolved into central banks capable of discretionary policies.[12]

The opportunity cost of holding foreign reserves, however, actually reflects country risk and exchange-rate risk and is not a cost of operating a currency board. If capital markets are efficient, if capital is perfectly mobile, and if domestic and foreign assets are perfect substitutes, arbitrage will equate real returns across countries. The higher interest rates that investors require of developing countries offset the risks of currency devaluation, confiscatory taxes, and capital restrictions. A currency board, by providing a stable currency at a fixed exchange rate and by constraining fiscal policy, may reduce these risks, thereby encouraging domestic investment and equating returns. For a currency board to hold higher-yielding, but riskier, domestic assets may impinge on its ability to instill confidence. As individuals substitute foreign for domestic currencies, they incur higher transaction costs, and the currency-board government loses seigniorage.

Fixed Exchange Rates

Confidence in a currency-board system results because it guarantees complete convertibility at an absolutely fixed exchange rate.[13] In addition to promoting monetary credibility, fixed exchange rates reduce the transaction costs associated with exchange-rate volatility that is unrelated to fundamentals. These transaction costs could be substantial for small economies that are heavily dependent on international trade and investment. On the other hand, currency-board systems prevent exchange-rate changes from helping an economy adjust to economic shocks. Consequently, any cost–benefit analysis of currency boards must consider the possible trade-off between monetary policy credibility and smoother economic adjustments.[14]

When domestic wages and prices are inflexible or when international arbitrage is otherwise slow, flexible exchange rates can hasten a country's adjustment to idiosyncratic economic disturbances by facilitating rapid changes in the terms of trade.[15] As one might expect, if the currency-board country and the reserve-currency country experience similar economic shocks, the bilateral terms-of-trade changes will not aid adjustment. Fixed exchange rates would then seem optimal. Countries with comparable economic makeups are likely to experience similar and coincidental economic shocks.

When shocks are dissimilar, fixed exchange rates can be feasible if other variables facilitate adjustment. If, for example, the currency-board country has a sufficiently well-diversified economy (in the sense that shocks are negatively correlated across its producing sectors), changes in the international terms of trade may not be necessary in the adjustment process, since unemployed resources in one sector will migrate to other sectors. Similarly, adjustment in the terms of trade will prove unnecessary if factors of production are highly mobile across international borders. Then, arbitrage quickly eliminates even small differences in prices or interest rates. Closely integrated financial markets or fiscal transfers across countries could also ease transitions to temporary shocks without recourse to exchange-rate changes. Finally, when prices and wages are highly flexible, the terms of trade can adjust quickly without a change in the nominal exchange rate. The appropriateness of a fixed exchange rate involves a country-by-country analysis.

In addition, Schwartz (1993, pp. 179–82) argues that the choice of an exchange-rate peg is complicated because the reserve-currency country might not be one of the currency-board country's closest trading partners. A change in the reserve-currency country's exchange rate might alter the currency-board country's competitive position relative to its major trading partners. A currency board pegged to the German mark, for example, would have experienced an 11 percent appreciation relative to the dollar (and to countries pegged to the dollar) in 1994. Schwartz argues that this was not as much of a problem for currency boards operating under the gold standard as it might be today under more generalized floating.

■ 12 The Southern Rhodesia Currency Board and the East African Currency Board evolved in this manner (see Schuler [1992, pp. 106–08]). See also Schwartz (1993) and Hanke and Schuler (1991).

■ 13 Strictly speaking, the currency board does not peg the exchange rate, but fixes the rate at which currency-board notes trade for the currency of the reserve country. An exchange rate at which bank deposits trade for foreign exchange will deviate within small arbitration points from the currency board's rate (see Bennett [1993, pp. 18–20]).

■ 14 Ishiyama (1975) provides a survey of the optimal-currency-area literature, engaging in a cost–benefit analysis of fixed and flexible exchange rates and discussing the examples that follow in more detail.

■ 15 The terms of trade are the price of a country's exports relative to the price of its imports, expressed in a common currency.

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Lender of Last Resort

Currency boards enhance monetary credibility by eliminating the opportunities for discretionary monetary policies and by guaranteeing the convertibility of domestic currency at a fixed exchange rate. They do not, however, guarantee the convertibility of bank deposits, even though banking sectors in small, open, developing countries may be particularly susceptible to macroeconomic shocks. The chief criticism of currency boards, therefore, has been that, unlike central banks, they do not serve as a lender of last resort (LLR).

In periods of economic or financial crises, uncertainty about banks' solvency often causes individuals to shift their monetary wealth from bank liabilities to currency. With runs impending, banks also attempt to shore up their credibility by holding more reserves. As the public increases its cash-to-deposit ratio and as banks increase their reserve-to-deposit ratio, the money supply contracts, leading to a general deflation (see equation [3]). A traditional LLR can avoid a contraction in the money supply and prevent a collapse of temporarily illiquid, but solvent, commercial banks by accommodating the increased demand for high-powered money.[16] Usually, the LLR fulfills this function through discount-window operations, but a central bank can also undertake open-market operations. Since an orthodox currency board neither holds reserves against commercial bank deposits nor undertakes discretionary monetary policy, it is unable to perform LLR operations. Recent problems with bank liquidity in Argentina illustrate the vulnerability of currency boards to banking crises.

Proponents of currency boards note that banks in currency-board countries have often been branches of large, global banks headquartered in the reserve-currency country. They believe that currency-board arrangements — domestic notes backed with foreign-exchange reserves at a fixed exchange rate — eliminate exchange risk and thereby encourage branch banking. Borrowing from a foreign parent then affords the domestic branch bank an elastic supply of reserve currency.[17] Selgin (1989) argues that the ability of commercial banks to branch reduces the likelihood of banking crises, since branching effectively enables commercial banks to diversify. A currency-board country, despite an undiversified economic base, could effectively diversify its financial system through an unregulated (or minimally regulated) branch banking network.

Schwartz (1993) disputes the contention that currency boards encourage branch banking. She suggests that the extensive branch banking found in British colonial currency-board countries stemmed from their colonial status, not from their having currency boards. Many developing countries that today might benefit from a currency board, such as Mexico, have not heretofore encouraged the entry of foreign banks and do not have extensive branch banking networks. Whether sufficient branch banking would follow the establishment of a currency board remains uncertain.[18]

Many currency-board countries appoint a wholly separate monetary authority to regulate commercial banks (by setting capital requirements and reserve requirements) and to provide LLR functions through a discount-window facility. The Bank of Estonia, for example, established an Issuing Department, which is a currency board, and a Banking Department, which regulates banks and acts as the LLR (see Bennett [1993]).[19] Under such an arrangement, the independent monetary authority would need to hold either currency-board notes or foreign-reserve currency. As long as the LLR finances its operations out of the currency board's surplus reserves (as in Estonia) and avoids holding obligations of the fiscal authorities, it will not necessarily undermine the credibility of currency-board notes. The monetary authority might also lower reserve requirements during banking crises, thereby encouraging liquid banks to lend temporarily to illiquid institutions.[20]

As noted above, governments in currency-board countries often acquire foreign assets, because the currency boards remit excess reserves to them. The fiscal authority of a currency-board country can also inject liquidity into the banking

16 Humphrey (1993) views bank runs as primarily disrupting the payments system, while Goodhart (1987) views them as primarily affecting banks' ability to intermediate between borrowers and lenders.

17 This argument applies to bank borrowing in general.

18 Ow (1986) argues that a developed branch banking network retards the development of other financial institutions.

19 Schuler (1992) suggests that the original model for currency boards was the Bank of England, which under the Bank Charter Act of 1844 split into separate Banking and Issuing Departments. Schwartz (1993) disputes this, arguing that British authorities often attempted to suppress the development of currency boards.

20 Argentina's currency board, which sets reserve requirements, has lowered these requirements selectively in response to the current banking crisis. Argentine banking authorities have actively encouraged insolvent banks to merge with healthy institutions.

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TABLE A-1

A Balance-of-Payments Example

	Credits	Debits	Net
Current Account			
Trade in goods and services		–$15,000	–$15,000
Interest/dividends			
Unilateral transfers			
Capital Account			
Direct investments	$10,000		$10,000
Portfolio investments			
Change in bank liabilities	$15,000	–$15,000	
Change in bank assets			
Official Reserves			
Change in foreign-exchange reserves	$ 5,000		$ 5,000
Change in other reserve assets			

NOTE: We assume a fixed exchange rate equal to one.
SOURCE: Authors.

system by selling foreign assets or by borrowing abroad. The Monetary Authority of Singapore has done this (see Ow [1986]), and Argentina has recently borrowed from the International Monetary Fund and from private sources to help ease the restructuring of its banking system.

Although a Banking Department or the government might operate as a LLR, its portfolio of foreign assets and its ability to borrow abroad limit its capacity to create notes within the currency-board framework and to fend off a banking crisis. In contrast, a central bank that issues fiat money does not face limitations on its ability to create reserves during a banking crisis. Consequently, one cost of operating a currency-board system, particularly in relatively undiversified developing economies, may be a greater susceptibility to banking crises.

III. Conclusion

Because governments can generate revenue from monetary expansions, no institutional arrangement for stabilizing the value of money is fully credible. A reputation for achieving and maintaining a low inflation rate is necessary.

After a country has acquired a credible reputation for maintaining reasonably stable prices, many different institutional arrangements may be capable of sustaining it. In the interim, however, a trade-off exists between strong institutional constraints and an established reputation. Developing countries with histories of inflation and devaluation must adopt much stronger institutional constraints on their ability to inflate than developed countries have done if they are to achieve even moderately comparable levels of credibility. Currency boards offer an approach whose costs and benefits deserve closer consideration.

Appendix

Balance-of-Payments Accounting

A nation's balance of payments is a comprehensive accounting record of all transactions between its residents and the rest of the world. Although they are typically published only on a net basis, balance-of-payments statistics incorporate double-entry-accounting techniques. Any transaction that creates a receipt (such as an export) is a credit, and any transaction that creates a payment (such as an import) is a debit.

Economists often group accounts into three categories. The current account includes trade in goods and services, receipts or payments of interest and dividends, and unilateral transfer payments to, or from, foreigners. The capital account includes long-term capital flows, such as direct investments and long-term portfolio investments, and short-term capital flows, such as investments in short-term money market instruments or acquisitions of bank deposits. It also includes private and government capital flows other than the government's "official" capital flows. Official reserves include official transactions in various reserve assets, such as foreign exchange. Under floating exchange rates, governments use these assets to influence their exchange rates. Under fixed exchange rates, governments use these transactions to offset net overall debits or credits in the other accounts, since exchange rates would otherwise move to balance these accounts. Acquisition or losses of official reserves affect the balance sheet of a nation's central bank or currency board, as we described in the text.

Since every international transaction creates both a debit and a credit in the balance of payments, the ledger always balances. If, for example, a country imports a $15,000 foreign car and

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pays for it with a check drawn against a domestic bank, the balance of payments records the imported car as a debit and lists the foreign claim on a domestic bank as a credit (see table A–1). Essentially, the country exports ownership of a bank deposit in order to import the car. If the foreigner decides to acquire something else with the bank account, like stocks, bonds, land, or computers, additional offsetting debits and credits will enter the account. With fixed exchange rates, if the foreigner elects to exchange the bank account back into his own currency, a debit appears under bank-related capital flows, and a corresponding credit appears under official reserves, as the central bank pays out foreign exchange from its official holdings.

Table A–1 assumes that the foreigner purchases $10,000 of stock and repatriates $5,000 of his bank claim. Should the monetary authority not make this exchange, the foreigner's sales of domestic currency will cause that currency to depreciate. This in turn affects private decisions about exports, imports, and capital transactions in such ways as to restore balance to the current and capital accounts.

Because of the double-entry nature of the accounts, a surplus or deficit can exist only in a subset of the accounts. How one defines a balance-of-payments deficit or surplus largely depends on which accounts one finds interesting or useful to isolate. In our case, we define the overall balance as consisting of items in the current and capital accounts. Our example records a $5 billion overall balance-of-payments deficit. (Note that the balance of payments records the loss of foreign-exchange reserves as a credit. We import a foreign car, a debit, and pay for it by exporting stock and foreign reserves, both credits.)

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The Seasonality of Consumer Prices

by Michael F. Bryan and Stephen G. Cecchetti

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Introduction

Early in 1993, the Consumer Price Index (CPI) reversed course and increased at an annualized rate of roughly 4⅓ percent—about 1½ percentage points above its average growth rate during the previous six-month period. The prospect of rising inflation sent shock waves through capital markets and attracted the attention of monetary policymakers. The minutes of the Federal Open Market Committee (FOMC) meeting of May 18, 1993 document a commitment to shift the stance of monetary policy if the inflation statistics continued their ascent:

> In the view of a majority of the members, wage and price developments over recent months were sufficiently worrisome to warrant positioning policy for a move toward restraint should signs of intensifying inflation continue to multiply.

But in the months immediately following the FOMC's "asymmetric directive," the growth rate of the CPI moderated sharply, averaging less than 2½ percent per annum in the final six months of 1993. For the year as a whole, the CPI rose only about 2¾ percent, approximately ¼ percentage point *below* 1992's rate.

A popular interpretation of these events is that the inflationary scare of 1993 was a result of "seasonal" price increases that were not part of a more persistent inflationary process. In fact, several studies have identified a pattern of large price increases during the first several months of every year followed by a more moderate inflation performance over the balance of the year.[1] Indeed, prior to this recent experience, economists generally presumed that, relative to the real economy, prices contained little seasonal variation.

These observations raise an important question. Has the seasonality in prices changed substantially over the past quarter century? Perhaps seasonal variability was obscured by a dominant cyclical variability in prices over much of the post–World War II period. We do, in fact, find that seasonal price movements have become more prominent in the relatively stable inflation environment that has prevailed since 1982. Furthermore, we find that a substantial share of price seasonality is idiosyncratic in nature, which implies that seasonal patterns in

1 See, for example, Biehl and Judd (1993).

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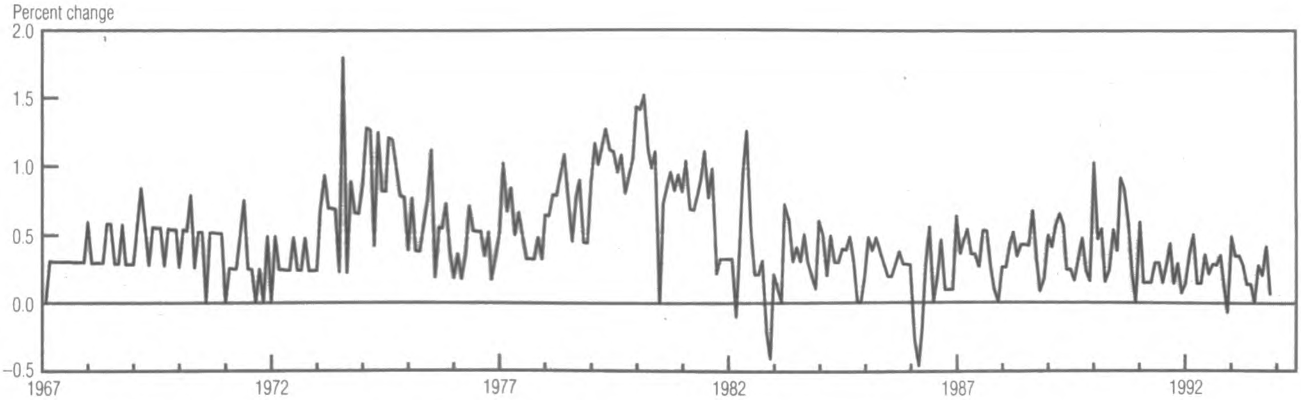
FIGURE 1

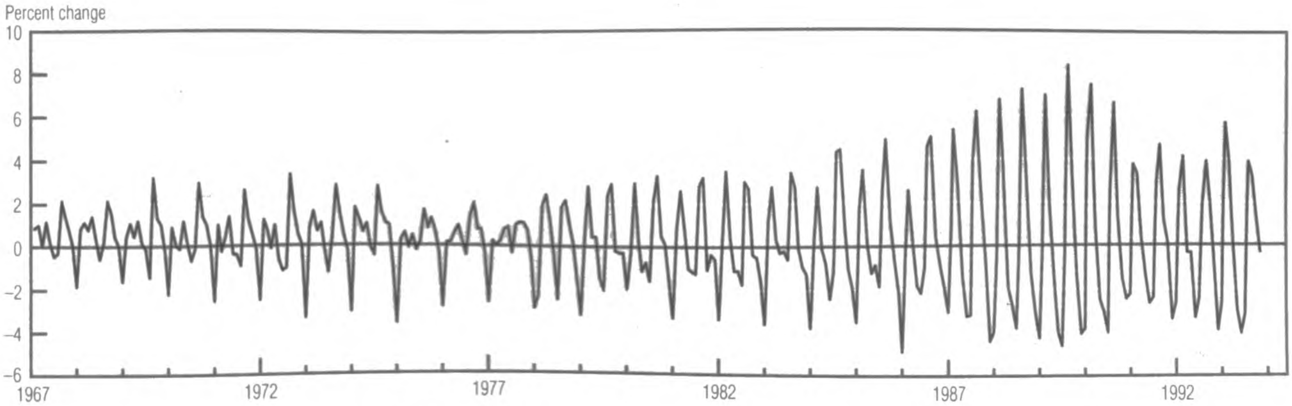
CPI, All Items (not seasonally adjusted)



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

FIGURE 2

Women's Apparel Prices (not seasonally adjusted)



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

individual price series are partially negated in the process of aggregation.

Figure 1 shows monthly movements for the CPI without seasonal adjustment. Though monthly consumer prices are certainly volatile, there is little obvious seasonal movement in the aggregate data. However, prices of most components display a distinct seasonal pattern, and for some, such as women's apparel (figure 2), the seasonal pattern is a prominent feature of the data.

In this paper, we reevaluate the evidence of seasonality in consumer prices in light of the relatively stable inflation seen in the United States during the past 10 years. In section I, we describe and catalog deterministic seasonality in individual consumer prices. Section II considers seasonality in aggregate prices and the procedure used by the U.S. Labor Department's Bureau of Labor Statistics (BLS) for adjusting individual price data to eliminate seasonal variation. We show that this procedure allows idiosyncratic noise to become incorporated into the price data. We consider the use of a limited-influence estimator, the median CPI, as a method of reducing seasonal noise.[2] We then briefly describe the case of stochastic seasonality in consumer prices before concluding in section III.

2 See also Bryan and Cecchetti (1994).

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TABLE 1

Deterministic Seasonality in the CPI, 1967–1993 (using Newey–West correction)

	Jan. 1967–Nov. 1993		Jan. 1967–Dec. 1981		Jan. 1982–Nov. 1993	
Months	α_s	t-stat	α_s	t-stat	α_s	t-stat
Jan.	0.054	1.50	−0.009	−0.27	0.139	2.80
Feb.	0.002	0.09	0.011	0.29	−0.007	−0.25
Mar.	0.102	0.27	0.019	0.39	0.000	0.01
April	0.029	0.88	0.014	0.33	0.050	0.92
May	0.018	0.56	0.014	0.38	0.024	0.47
June	0.067	2.53	0.077	3.21	0.055	1.12
July	−0.053	−1.46	−0.052	−0.89	−0.054	−1.83
Aug.	−0.006	−0.19	−0.058	−1.31	0.059	1.75
Sept.	0.121	3.00	0.074	1.34	0.181	4.21
Oct.	0.024	0.80	0.039	0.76	0.007	0.29
Nov.	−0.100	−3.09	−0.038	−1.09	−0.176	−4.53
Dec.	−0.165	−4.00	−0.091	−1.98	−0.278	−6.53
R^2	0.068		0.032		0.320	
Wald	88.040		44.650		330.600	
p-value	0.000		0.000		0.000	

SOURCE: Authors' calculations.

I. The Deterministic Seasonality of Prices

Miron (1990) identifies broad classifications of seasonal variation for a variable x_t, the most common being deterministic seasonality, specified as

$$(1) \quad x_t = \sum_{s=1}^{S} \alpha_s \, d_t^s + \varepsilon_t,$$

where d_t^s is a dummy for season s ($d_t^s = 1$ in season s of period t, 0 otherwise), α_s is the mean of x_t in season s, S is the number of seasons per year (four for quarterly data and 12 for monthly data), and ε_t is a stationary stochastic process.[3]

Although data on real output and nominal money exhibit substantial deterministic seasonal variation, it is curious to note the absence of a deterministic seasonal pattern in aggregate prices. For example, Barsky and Miron (1989) find that seasonal dummies explain nearly 88 percent of the quarterly variation in U.S. real GDP, more than 92 percent of real final sales, and more than 50 percent of the nominal money stock during the postwar period. Beaulieu and Miron (1990) obtain similar results at a monthly frequency for retail sales, industrial production, and money growth for a broad cross-section of countries.

However, seasonal variation has accounted for only a small share of the variation in aggregate prices in the postwar period (for example, less than 4 percent of the monthly variation in the CPI). Perhaps exogenous seasonal increases in aggregate supply fortuitously coincide with increases in seasonal demand, resulting in the substantial seasonality of real spending and output while virtually eliminating the seasonal behavior of prices. This explanation has been dismissed as implausible by Barsky and Miron (1989) and Mankiw and Miron (1990).[4] Alternatively, it may be that aggregate supply is perfectly elastic. By extension, then, interest-rate targeting policies that do not adjust for fluctuations in the real rate of interest at a seasonal frequency may have real effects that are manifested in exaggerated seasonal output and employment fluctuations (Mankiw and Miron [1990]).

But the observed lack of seasonality in prices has been influenced by the predominant cyclical pattern of inflation during the 1970s and early 1980s, a pattern that has since been dramatically reduced. And as U.S. inflation has settled into a more stable pattern, seasonal variation has become a relatively more important and more obvious source of monthly price fluctuations. That is, there is certainly less appearance of price stickiness at a seasonal frequency since 1982.

We use equation (1) to estimate the deterministic seasonal pattern in the monthly CPI over the 1967 to 1993 period and over two subperiods: 1967 to 1981, and 1982 to 1993 (table 1). For the full period, we find that deterministic seasonality accounts for about 7 percent of the monthly variation in the CPI—similar to the results found by Beaulieu and

3 Throughout the paper, we examine seasonality in the log difference of prices. In contrast, the BLS applies a two-sided ARIMA X-11 filter to the level of prices that includes both past and future data. In limited instances where a trend shift in the data is suspected, the BLS seasonally adjusts using intervention analysis (see Buszuwski and Scott [1988]). We chose our method for two reasons: First, since our major interest is inflation, our goal is to seasonally adjust the growth rate of prices, not their levels. Second, we wish to model seasonality as either a deterministic or a simple stochastic process, in order to preserve the timing patterns in the data.

4 This explanation may not be as implausible as it initially seems. We find substantially more seasonality in energy prices after the collapse of OPEC price controls. It may well have been that OPEC price targets, which were managed by production quotas, operated at a seasonal frequency to maintain a constant price of oil. This accentuated seasonal behavior in energy prices may be an important seasonal cost fluctuation for a broad range of commodities in the post–1981 period.

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TABLE 2

Deterministic Seasonality in 36 CPI Components, 1982–1993 (using Newey–West correction)[a]

	Variances		
	Seasonal	Unconditional	R^2
CPI—all items	**0.01406**	**0.04394**	**0.32**
Food away from home	0.00165	0.01868	0.09
Auto repair	0.00616	0.04310	0.14
Apparel services	0.00773	0.06910	0.11
Personal services	0.00952	0.06754	0.14
Housekeeping services	0.01233	0.14055	0.09
Medical commodities	0.01643	0.06702	0.25
Entertainment commodities	0.02178	0.10541	0.21
Housekeeping supplies	0.02290	0.13655	0.17
Toilet goods	0.02549	0.19028	0.13
Cereals	0.02692	0.09709	0.28
Shelter	0.02785	0.12018	0.23
Entertainment services	0.02902	0.09736	0.30
Other transp. commodities	0.03478	0.28866	0.12
Medical services	0.03849	0.06792	0.57
Dairy	0.03989	0.28452	0.14
Other utilities	0.04266	0.26639	0.16
Household furnishings	0.04366	0.16937	0.26
Alcoholic beverages	0.06237	0.30373	0.21
Other food	0.12482	0.20477	0.61
Public transportation	0.12575	1.12806	0.11
Meats	0.12898	0.76826	0.17
Other transp. services	0.13856	0.27041	0.51
New vehicles	0.16027	0.24708	0.65
Used vehicles	0.27306	0.87139	0.31
Tobacco	0.32535	1.27310	0.26
Other apparel	0.47608	1.79247	0.27
Infants' apparel	0.68437	2.94988	0.23
Books and supplies	0.76361	1.01300	0.75
Footwear	0.83807	1.22939	0.68
Educational services	1.08842	1.37163	0.79
Men's apparel	1.30880	1.58662	0.82
Motor fuel	1.78895	10.13414	0.18
Fruits	1.79705	6.02819	0.30
Gas and electricity	2.15611	2.78571	0.77
Fuel oil	2.71104	14.95497	0.18
Women's apparel	7.70884	9.40582	0.82

a. Variances reported are scaled by 10,000.
SOURCE: Authors' calculations.

Miron (1990). In the earlier, volatile inflation subperiod, deterministic seasonality represents about 3 percent of the monthly variation in consumer prices. Since 1982, however, seasonality accounts for approximately 32 percent of the monthly price movement.

Estimated over the 1982 to 1993 subperiod, the amount of deterministic seasonality in prices, as measured by the seasonal variance, $\sum_{s=1}^{S} (\alpha_s^2)$, differs greatly by item, making it difficult to generalize about seasonal price movements from the 36 consumer items considered here (table 2). For example, the largest seasonal variation in prices occurs in women's apparel (last row), where seasonal fluctuations also represent 82 percent of the total price variation. At the other extreme, food away from home (first row) exhibits a very small amount of seasonal variation. Furthermore, these variations account for only about 9 percent of the total price variation in this category.

In some cases, seasonal variation is relatively large, yet still amounts to a small share of the total variation in the individual price series. For example, fuel oil and motor fuel prices each rank high in terms of deterministic seasonal variation, but in both cases such seasonality accounts for only 18 percent of their total price variation. However, while the seasonal variation in medical services prices is rather small, seasonality contributed to a relatively high proportion of the category's total price variation (57 percent).

A casual reading of the seasonal patterns fails to reveal an easily identifiable origin of the seasonal variation of prices (table 3). Supply fluctuations may explain much of the seasonal behavior in food prices. Specifically, cereal and fruit prices show repeating price declines in the fall, when harvests are generally great, but large positive seasonals in January, when harvests are small. Public transportation prices show a single, large positive seasonal variation in January, and natural gas and electricity prices are generally adjusted upward in early summer (May and June), perhaps a reflection of their regulated environment.

A large share of the price movements, however, is hard to ascribe to obvious patterns in the weather or to the timing of holidays. For example, private education costs exhibit a single large seasonal increase in September, the beginning of the school year, which is offset by generally small and negative seasonals over the remaining 11 calendar months. Prices of books and supplies show large positive seasonal

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TABLE 3

Deterministic Seasonality in Individual CPI Components, 1982–1993 (using Newey–West correction)[a]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	R^2
CPI—all items	**0.14**	−0.01	0.00	0.05	0.02	0.05	−0.05	0.06	**0.18**	0.01	**−0.18**	**−0.28**	0.32
	0.05	0.03	0.05	0.05	0.05	0.05	0.03	0.03	0.04	0.03	0.04	0.04	
Cereals	**0.36**	0.02	**−0.16**	0.13	−0.02	0.04	0.06	0.11	**−0.27**	**−0.15**	**−0.17**	0.07	0.28
	0.09	0.07	0.05	0.07	0.05	0.06	0.06	0.07	0.05	0.03	0.06	0.06	
Meats	**0.79**	−0.38	0.05	−0.36	−0.40	0.25	0.38	0.14	0.01	**−0.46**	−0.11	0.09	0.17
	0.29	0.31	0.23	0.20	0.22	0.24	0.28	0.24	0.09	0.16	0.20	0.26	
Dairy	0.29	−0.03	**−0.30**	−0.34	−0.24	−0.12	0.07	0.15	0.16	0.23	0.06	0.08	0.14
	0.13	0.08	0.06	0.17	0.11	0.18	0.06	0.11	0.11	0.13	0.09	0.12	
Fruits	**3.90**	0.51	−0.59	0.71	0.00	−0.82	−1.13	−0.87	−0.79	**−0.92**	−0.62	0.61	0.30
	0.78	0.46	0.53	0.48	0.48	0.74	0.49	0.60	0.50	0.19	0.56	0.43	
Other food	**0.90**	**0.46**	−0.12	**−0.14**	−0.15	**−0.19**	−0.14	0.03	−0.13	**0.19**	**−0.48**	**−0.24**	0.61
	0.09	0.15	0.06	0.05	0.07	0.05	0.06	0.05	0.06	0.05	0.07	0.07	
Food away from home	0.07	0.02	**0.05**	0.05	0.01	0.00	−0.01	−0.02	−0.01	**−0.06**	−0.05	−0.04	0.09
	0.06	0.02	0.02	0.02	0.02	0.03	0.04	0.02	0.03	0.02	0.02	0.02	
Alcoholic beverages	0.48	**0.46**	0.12	0.01	−0.10	−0.09	−0.09	**−0.15**	−0.07	−0.11	**−0.34**	**−0.33**	0.21
	0.30	0.15	0.07	0.06	0.06	0.06	0.05	0.04	0.05	0.23	0.07	0.05	
Shelter	0.17	0.00	0.01	0.02	0.02	0.13	**0.28**	**0.14**	−0.22	−0.02	**−0.23**	−0.30	0.23
	0.09	0.04	0.10	0.14	0.13	0.10	0.07	0.04	0.09	0.04	0.06	0.13	
Fuel oil	2.55	−1.83	**−2.51**	**−1.56**	−0.87	−0.80	**−1.37**	0.27	1.53	2.27	**1.39**	0.93	0.18
	1.82	1.72	0.63	0.48	0.51	0.54	0.43	0.78	0.92	0.98	0.44	0.55	
Gas and electricity	**0.58**	−0.24	−0.04	−0.38	**1.46**	**3.30**	0.09	−0.06	0.11	**−2.76**	**−2.08**	0.03	0.77
	0.19	0.23	0.18	0.17	0.15	0.49	0.17	0.18	0.14	0.40	0.24	0.18	
Other utilities	0.56	0.08	−0.02	0.02	−0.05	0.05	0.03	0.06	**−0.17**	−0.06	−0.15	**−0.36**	0.16
	0.27	0.09	0.10	0.10	0.06	0.18	0.11	0.09	0.06	0.09	0.08	0.12	
Household furnishings	0.00	**0.32**	0.23	0.17	−0.20	−0.20	−0.01	−0.27	**0.25**	0.15	−0.17	**−0.26**	0.26
	0.12	0.11	0.10	0.13	0.08	0.09	0.12	0.12	0.10	0.08	0.09	0.10	
Housekeeping supplies	0.09	0.09	−0.22	**0.22**	0.08	0.03	−0.20	**−0.28**	0.03	−0.05	0.02	0.18	0.17
	0.10	0.08	0.11	0.08	0.12	0.03	0.11	0.06	0.08	0.10	0.06	0.10	
Housekeeping services	−0.05	0.28	0.03	0.15	−0.07	−0.04	−0.04	−0.05	0.05	−0.08	**−0.13**	−0.06	0.09
	0.06	0.21	0.08	0.20	0.05	0.09	0.04	0.06	0.05	0.04	0.03	0.03	
Men's apparel	**−1.89**	−0.01	**1.29**	**0.70**	0.16	**−1.21**	**−1.26**	0.49	**1.90**	**1.02**	0.18	**−1.37**	0.83
	0.11	0.31	0.12	0.13	0.10	0.20	0.21	0.21	0.17	0.17	0.07	0.13	
Women's apparel	**−3.71**	1.45	**4.20**	0.64	**−1.67**	**−2.71**	**−2.72**	**2.54**	**4.78**	**1.18**	**−1.02**	**−2.97**	0.82
	0.23	0.68	0.59	0.42	0.24	0.43	0.48	0.48	0.62	0.39	0.17	0.39	
Infants' apparel	−0.91	1.14	1.01	0.97	−0.31	−0.60	**−1.48**	0.60	0.57	0.06	−0.23	**−0.83**	0.23
	0.46	0.82	0.40	0.54	0.29	0.29	0.47	0.35	0.26	0.31	0.28	0.21	
Other apparel	1.06	**0.79**	−0.09	0.13	**−0.45**	−0.51	0.48	0.24	0.24	0.27	−0.40	−1.75	0.27
	0.55	0.25	0.12	0.20	0.13	0.39	0.26	0.15	0.21	0.37	0.21	0.72	
Footwear	**−1.27**	0.24	**1.24**	**0.64**	0.04	**−0.82**	**−1.12**	−0.19	**1.43**	**1.10**	−0.26	**−1.05**	0.68
	0.18	0.15	0.17	0.14	0.12	0.18	0.13	0.16	0.23	0.31	0.25	0.13	
Apparel services	0.10	0.10	0.03	0.00	0.09	−0.06	−0.14	−0.07	−0.06	0.14	0.00	**−0.12**	0.11
	0.08	0.07	0.03	0.06	0.07	0.12	0.07	0.07	0.05	0.06	0.06	0.02	
New vehicles	0.09	−0.27	**−0.36**	−0.13	−0.01	−0.18	**−0.27**	**−0.36**	**−0.36**	**0.60**	**0.91**	**0.36**	0.65
	0.06	0.12	0.07	0.10	0.08	0.08	0.07	0.09	0.06	0.11	0.10	0.12	
Used vehicles	**−0.92**	**−0.79**	−0.20	**0.54**	**0.82**	**0.65**	0.27	0.00	0.03	0.13	0.00	**−0.52**	0.31
	0.26	0.26	0.17	0.16	0.21	0.24	0.21	0.14	0.11	0.08	0.10	0.17	
Motor fuel	−1.07	−1.67	−1.89	1.70	**2.57**	1.61	−0.62	0.19	0.36	0.08	−0.26	−1.02	0.18
	0.88	0.69	0.74	1.14	0.37	0.64	0.49	0.71	0.65	0.63	0.37	0.45	
Auto repair	0.00	**0.13**	0.05	0.00	−0.05	−0.04	−0.03	−0.04	**0.17**	0.01	−0.07	−0.13	0.14
	0.04	0.04	0.07	0.06	0.05	0.04	0.04	0.03	0.05	0.04	0.05	0.08	

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TABLE 3 (cont.)

Deterministic Seasonality in Individual CPI Components, 1982–1993 (using Newey–West correction)[a]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	R^2
Other transp. commodities	0.10	–0.07	–0.29	–0.10	0.11	0.02	–0.29	0.19	0.05	–0.20	0.30	**0.19**	0.12
	0.23	0.10	0.13	0.14	0.14	0.13	0.13	0.12	0.09	0.11	0.16	0.07	
Other transp. services	**0.30**	**–0.19**	**–0.30**	**–0.30**	–0.16	0.01	0.03	–0.13	**–0.45**	**0.93**	**0.44**	–0.17	0.51
	0.06	0.07	0.07	0.04	0.10	0.09	0.10	0.11	0.14	0.10	0.14	0.08	
Public transportation	**0.57**	–0.16	–0.24	–0.34	–0.38	–0.42	0.22	–0.21	–0.14	0.21	0.67	0.23	0.11
	0.18	0.18	0.14	0.35	0.18	0.43	0.22	0.15	0.19	0.28	0.34	0.31	
Medical commodities	–0.01	**0.21**	**0.26**	0.16	0.01	–0.09	–0.04	**–0.13**	–0.09	–0.09	–0.12	–0.05	0.25
	0.04	0.07	0.02	0.07	0.07	0.04	0.06	0.03	0.05	0.05	0.05	0.05	
Medical services	**0.38**	**0.31**	–0.05	**–0.17**	**–0.19**	**–0.12**	**0.19**	0.05	**–0.16**	0.00	0.03	**–0.26**	0.57
	0.03	0.03	0.06	0.04	0.04	0.03	0.03	0.04	0.03	0.03	0.05	0.03	
Entertainment commodities	**0.21**	0.10	0.16	0.14	**–0.21**	–0.11	0.04	–0.10	–0.03	0.16	–0.11	**–0.25**	0.21
	0.07	0.11	0.09	0.07	0.07	0.04	0.04	0.08	0.07	0.07	0.13	0.06	
Entertainment services	0.23	0.04	–0.14	**0.15**	**–0.27**	0.08	–0.04	–0.06	0.26	0.14	–0.17	**–0.22**	0.30
	0.10	0.05	0.06	0.05	0.06	0.08	0.07	0.06	0.11	0.07	0.07	0.07	
Tobacco	**1.34**	0.05	**–0.34**	**–0.37**	–0.20	–0.07	**0.89**	–0.53	–0.72	–0.14	–0.24	0.33	0.26
	0.30	0.13	0.13	0.14	0.20	0.26	0.27	0.23	0.41	0.25	0.17	0.28	
Toilet goods	0.18	0.15	0.04	0.24	**–0.26**	–0.14	0.16	–0.16	–0.12	0.00	0.08	–0.18	0.13
	0.09	0.10	0.11	0.12	0.07	0.13	0.15	0.08	0.13	0.08	0.10	0.11	
Personal services	**0.17**	0.10	–0.18	0.03	0.04	–0.06	**–0.17**	0.01	0.07	–0.04	0.01	0.01	0.14
	0.06	0.05	0.09	0.05	0.08	0.05	0.07	0.05	0.06	0.04	0.07	0.05	
Books and supplies	**1.02**	**0.26**	**–0.53**	**–0.50**	**–0.53**	**–0.37**	**–0.48**	–0.21	**2.48**	–0.04	**–0.56**	**–0.54**	0.75
	0.11	0.07	0.06	0.05	0.05	0.10	0.06	0.17	0.46	0.04	0.05	0.06	
Educational services	–0.21	**–0.37**	**–0.37**	**–0.39**	**–0.42**	**–0.42**	**–0.31**	0.15	**3.38**	–0.02	**–0.52**	**–0.50**	0.79
	0.09	0.07	0.05	0.04	0.07	0.07	0.05	0.22	0.58	0.11	0.04	0.05	
Number of significant (+)	12	7	5	4	3	2	3	2	7	6	3	2	
Number of significant (–)	4	3	8	7	8	7	9	4	5	5	9	15	
Total	16	10	13	11	11	9	12	6	12	11	12	17	

a. Standard errors appear below numbers. Bold type indicates statistical confidence at the 99 percent level.

SOURCE: Authors' calculations.

adjustments in September and January, coinciding with the start of each school term. New car models and their attendant price adjustments are generally introduced in the fall, and in fact, new car price seasonals are positive and large in the fourth quarter of the year. Shelter prices post large positive seasonal adjustments in July and August, when household migrations are prominent. And apparel prices show pronounced seasonal price fluctuations that coincide with the fashion seasons—large positive adjustments in March/April and September/October, and large negative adjustments during "off-season" periods.

In general, though, there is little commonality in seasonal price movements—the aggregate CPI exhibits small seasonal variation relative to the seasonals in individual component prices; only food away from home prices demonstrated less seasonal movement than did the aggregate CPI from 1982 to 1993.[5] In no month was there a statistically significant deterministic seasonal for a majority of prices (table 3). The most common, statistically significant seasonal price variations occurred in December, when 15 of the 36 components had significant, negative seasonals, against only two significant, positive seasonals. In January, 12 statistically significant, positive seasonals were detected against only four significant, negative seasonals.

5 The aggregate CPI in this study has been constructed using the 36 components and applying 1985 weights, such as in Bryan and Cecchetti (1994).

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TABLE 4

Idiosyncratic Seasonality in 36 CPI Components, 1982–1993

	Ratio[a]
Auto repair	0.59917
Food away from home	0.76243
Entertainment services	1.02518
Apparel services	1.11776
Personal services	1.19945
Housekeeping services	1.36387
Entertainment commodities	1.41811
Shelter	1.75476
Other utilities	2.01226
Medical commodities	2.02691
Cereals	2.62600
Toilet goods	2.64553
Household furnishings	2.69258
Housekeeping supplies	2.89405
Medical services	3.06386
Alcoholic beverages	3.22595
Dairy	3.65126
Other transportation commodities	4.12955
Other food	7.05639
Meats	9.20606
Other transportation services	11.97717
Public transportation	12.26934
New vehicles	16.25136
Used vehicles	19.42488
Tobacco	25.24895
Other apparel	26.94287
Infants' apparel	45.54596
Books and supplies	45.94267
Footwear	55.30488
Educational services	69.04402
Men's apparel	88.35469
Motor fuel	122.08662
Fruits	124.72690
Gas and electricity	146.80739
Fuel oil	192.29498
Women's apparel	532.12456

a. Ratio of idiosyncratic seasonal variance to common seasonal variance.
SOURCE: Authors' calculations.

Moreover, the items that showed negative seasonal price adjustments during the final two months of the year were generally *not* the same items that tended to rise in price during the first few months of the following year.

The proportion of the monthly aggregate price variation accounted for by seasonality was similar to that of a large number of its components, which directly implies that the unconditional variation in the CPI is also quite small relative to its components. That is, individual goods prices have negative unconditional and seasonal covariances. These results contrast with a number of recent observations on the seasonality of industrial production, shipments, retail sales, and other real magnitudes as documented by Barsky and Miron (1989), Beaulieu and Miron (1990), and Miron (1990). Those variables show a positive correlation in seasonality across sectors and countries, parallel to the comovement in data that is generally presumed to characterize the business cycle.

We can examine the idiosyncratic nature of seasonal price movements directly using the linear decomposition of an individual price movement, p_{it}.

$$(2) \quad p_{it} = P_t^a + S_t + s_{it} + \varepsilon_{it},$$

where P_t^a is the average seasonally adjusted price change, S_t is the average seasonal price movement, and s_{it} and ε_{it} are mean zero, idiosyncratic seasonality and noise, respectively. That is, aggregate seasonally *unadjusted* price movements can be defined as

$$(3) \quad P_t^u = \Sigma w_i p_{it} = P_t^a + S_t,$$

where the w_i's are base-period weights that sum to unity over all goods n. We can estimate S_t directly in the aggregate unadjusted index and subtract it from the deterministic seasonal in the individual components to obtain an estimate of the idiosyncratic seasonals. Table 4 reports the ratio of the idiosyncratic seasonality to the common seasonal variance for each of the 36 components (var $[s_{it}]$ / var $[S_t]$). In only two of the 36 cases—auto repair and food away from home—was the common price seasonal variance larger than the idiosyncratic seasonal variance. In half of the cases, we find that the idiosyncratic seasonality has more than five times the variance of the common seasonal.

Our finding that deterministic seasonality in prices is largely idiosyncratic in nature may be one reason why studies that have used aggregate price statistics have tended to dismiss the amount of seasonality in price movement. Further, the idiosyncratic tendencies of seasonal price movements have important ramifications for the adjustment of such data.

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TABLE 5

Deterministic Seasonality in the Seasonally Adjusted CPI, 1982–1993 (using Newey–West correction)

	Pre-1994 Procedure		Post-1993 Procedure	
	α_s	t-stat	α_s	t-stat
Jan.	0.0016	3.21	0.0008	1.71
Feb.	–0.0003	–0.88	–0.0005	–1.28
Mar.	–0.0011	–1.93	–0.0008	–1.31
April	0.0004	0.60	0.0002	0.32
May	0.0001	0.21	0.0002	0.39
June	0.0003	0.41	0.0007	1.10
July	0.0001	0.30	0.0001	0.26
Aug.	–0.0003	–0.88	–0.0002	–0.50
Sept.	–0.0003	–0.77	–0.0002	–0.53
Oct.	0.0008	2.35	0.0005	1.73
Nov.	–0.0005	–1.15	–0.0002	–0.54
Dec.	–0.0009	–1.43	–0.0006	–1.00
R^2	0.101		0.053	
Wald	44.470		30.590	
p-value	0.0000		0.0012	

SOURCE: Authors' calculations.

II. Aggregate Deterministic Seasonality

The BLS seasonally adjusts the CPI indirectly—by first filtering the disaggregated components, then aggregating upward to arrive at the seasonally adjusted price index. Seasonal adjustment at the component level allows the BLS to capture the wide range of seasonal patterns that exist in the price data. Moreover, seasonally adjusting the index in this way ensures that seasonally adjusted subindexes will aggregate to the seasonally adjusted aggregate index. However, not all components are adjusted, as they must first pass certain statistical criteria; otherwise, they are introduced into the "seasonally adjusted" aggregate index on an unadjusted basis.[6]

Because of the BLS's selective approach to seasonal adjustment, 26 of the 60 CPI subindexes (roughly 20 percent of the weighted index) were left unadjusted prior to January 1994. Yet, because not all of the components were seasonally adjusted, the BLS may have inadvertently introduced a seasonal pattern into the aggregate price series by eliminating only large seasonal price fluctuations, while allowing the small, otherwise offsetting seasonal price adjustments to pass into the index unadjusted. The net result may have been a residual seasonal variation in the price data that became conspicuous when the cyclical variation in prices subsided.

Indeed, over the 1982 to 1993 subperiod, deterministic seasonality can be detected in the *seasonally adjusted* CPI (table 5). Specifically, seasonally adjusted consumer prices tended to rise about 2 percentage points (annualized), or about 50 percent more, during January and tended to decline by a cumulatively similar amount during November and December. Such seasonality accounts for more than 10 percent of the variation in the *seasonally adjusted* CPI over the period.

In an effort to reduce the amount of deterministic seasonality in aggregate consumer prices, the BLS broadened its seasonal adjustment procedure in 1994 to allow the seasonal adjustment of a price series, even if it fails to meet the statistical criteria, if the index at the next higher level of aggregation meets the criteria for seasonal adjustment.[7] As a result of the new procedure, only 10 of the 60 major subindexes, or about 5 percent of the weighted CPI, were unadjusted in the seasonally adjusted CPI in 1994. This procedural change reduced but did not eliminate the residual, deterministic seasonality in the adjusted CPI. While no single month reveals a statistically significant seasonal at the 5 percent level of significance, Wald tests of the joint significance of the deterministic seasonals showed seasonality at the 99 percent confidence level. Moreover, deterministic seasonality still accounts for slightly more than 5 percent of the variation in the seasonally adjusted CPI using the new BLS procedures.[8]

6 Specifically, the BLS seasonally adjusts a series if seasonality is demonstrated by an F statistic greater than 7. While this may seem an unusually rigorous criterion (the unconditional probability of which is roughly 10^{-6}), the BLS notes that the F statistic is biased in autocorrelated data such as these. The BLS further notes that this criterion is commonly used by other statistical organizations, such as Statistics Canada.

7 In addition, the BLS dropped a rule prohibiting the seasonal adjustment of a series if it failed the statistical criteria in either of the prior two years.

8 Buszuwski and Gallagher (1995) note that residual seasonality in the seasonally adjusted CPI appears to originate in the energy components of the index, specifically fuel oil and natural gas. Moreover, the authors claim that these price movements are the result of interventions (or trend adjustments) in the data. Our specification for deterministic seasonality makes no distinction between different "types" of price movements as long as they can be observed at the seasonal frequency.

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TABLE 6

Deterministic Seasonality in the Seasonally Adjusted CPI and the Seasonally Adjusted Median CPI, 1967–1993 (using Newey–West correction, new procedure)

	1967-1993				1982-1993			
	CPI		Median CPI		CPI		Median CPI	
	α_s	t-stat	α_s	t-stat	α_s	t-stat	α_s	t-stat
Jan.	0.0005	1.46	0.0003	1.27	0.0008	1.71	0.0004	1.45
Feb.	–0.0001	–0.38	–0.0002	–0.86	–0.0005	–1.28	–0.0001	–0.30
Mar.	–0.0004	–0.88	–0.0005	–1.72	–0.0008	–1.31	0.0001	0.22
April	–0.0002	–0.48	0.0001	0.43	0.0002	0.32	0.0005	1.00
May	–0.0003	–0.70	–0.0002	–0.56	0.0002	0.39	–0.0003	–0.64
June	0.0008	2.12	0.0004	1.26	0.0007	1.10	0.0004	1.07
July	–0.0003	–0.71	0.0000	0.02	0.0001	0.26	0.0001	0.23
Aug.	0.0000	0.00	0.0004	1.45	–0.0002	–0.50	0.0000	0.28
Sept.	0.0001	0.40	–0.0002	–0.66	–0.0002	–0.53	–0.0006	–1.59
Oct.	0.0002	1.08	0.0002	0.49	0.0005	1.73	0.0000	–0.02
Nov.	0.0000	0.02	0.0000	–0.17	–0.0002	–0.54	–0.0002	–0.48
Dec.	–0.0003	–0.81	0.0000	–0.53	–0.0006	–1.00	–0.0004	–1.45
R^2	0.010		0.01		0.05		0.05	
Wald	24.820		15.18		30.58		31.97	
p-value	0.0090		0.174		0.0013		0.0008	

SOURCE: Authors' calculations.

Bryan and Cecchetti (1994) demonstrate how the median in the cross section of consumer price changes reduces idiosyncratic noise in individual prices and improves the inflation signal in the aggregate price change statistic.[9] Here, we consider residual seasonality in the aggregate price index as a special case of idiosyncratic noise. We test for the existence of deterministic seasonality in the weighted median price change calculated from a cross section of seasonally adjusted data from 36 inclusive components in the CPI. We then compare the results to those of the CPI, similarly constructed (table 6).

Over the full sample, deterministic seasonality was found in the seasonally adjusted CPI at more than a 99 percent confidence level, but at only an 82.6 percent level of confidence for the seasonally adjusted median CPI. However, in the post–1982 subperiod, deterministic seasonality can be observed in both the CPI and the median CPI at the 99 percent confidence level.

We tentatively conclude that due to the predominantly idiosyncratic nature of the deterministic seasonality we observe in consumer price data, the median price change estimate may reduce the influence of such seasonal noise in the aggregate monthly price statistics. These results also have implications for the seasonal adjustment procedures currently employed by the BLS. By selectively seasonally adjusting the component data before constructing the seasonally adjusted index, the BLS risks inadvertently introducing idiosyncratic noise into the aggregate index at a seasonal frequency. This potential problem could be addressed by adjusting the index after aggregation.

An obvious difficulty that arises from this approach is that aggregation anomalies can occur. That is, the weighted sum of the seasonally adjusted index is unlikely to match the seasonally adjusted aggregate index exactly. Such

9 That paper shows how idiosyncratic price disturbances that are manifest as an asymmetric distribution of price changes can be reduced by limited-influence estimators. In that class of estimators, the median has the highest correlation with past money growth and improves CPI forecasts.

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BOX 1

The Case of Stochastic Seasonality

As noted by Miron (1990), stochastic seasonality is not qualitatively different or logically separable from stochastic variation at a nonseasonal frequency.[a] Nevertheless, we consider seasonality of the form

$$(4) \qquad x_t = \epsilon + \Theta\epsilon_{t-s.}$$

Seasonality of this type might occur when there is a strong seasonal price pattern with large adjustment costs. This might generate intermittent price changes at a seasonal frequency that persist over a period of a few years. An example might be adjustments to school tuition that occur in the fall and are spread out over several school years. Another potential source of stochastic seasonality is when the seasonal cycle and the business cycle interact, such that the degree of seasonality depends on the irregular stage of the business cycle. Such interactions have been demonstrated by Cecchetti, Kashyap, and Wilcox (1994).

We test for the existence of stochastic seasonality both independently and jointly with deterministic seasonality for the unadjusted CPI. In no case, and in neither of the two subperiods, were we able to identify a stochastic seasonal process in the aggregate index. However, several individual components exhibit stochastic seasonal variation at the 95 percent confidence level, and a few do so at the 99 percent level (table 7), including educational services, books and supplies, entertainment commodities, motor fuel, apparel services, housekeeping supplies, and gas and electricity.

Although we fail to find a significant, stochastic seasonal process in aggregate prices (a result that has been found elsewhere and for other macroeconomic data), we note that some of the component data exhibit significant stochastic variation at a seasonal frequency. This result may reveal those areas where the interaction between the seasonal and cyclical variation in prices is greatest. Obviously, more work in this potentially important area is advisable.

a. A third source of seasonal variation, the seasonal unit root, commonly specified as $x_t = x_{t-s} + e_t$, was not considered here and has little apparent standing in the theory or evidence of seasonal processes. An example of a seasonal unit root is a calendar effect, such as the number of "paydays" varying irregularly from month to month depending on the rotation of the seven-day week around the calendar.

anomalies may be a problem for those agencies, like the BLS, that intend the CPI as a cost-of-living statistic and, therefore, where consistent component estimates are an important consideration. Consequently, this is not a criticism of the BLS approach per se, but a recommendation for economists who use the CPI as a monthly inflation guide. As a high-frequency estimate of inflation, the potential for aggregation anomalies would seem to be of secondary importance to the elimination of transitory noise from the statistic.[10]

III. Conclusion

In this paper, we reevaluate the evidence of seasonality in prices in light of the significant reduction in cyclical price movements that has allowed the seasonal patterns to become evident. We find the existence of seasonality to be substantially greater than previous research has indicated.

One central conclusion is drawn from this analysis. Seasonality in consumer prices is predominantly, although certainly not entirely, idiosyncratic in nature. This result stands in contrast to studies that demonstrate a common seasonal cycle in real economic variables, such as industrial production and retail sales. Furthermore, given the statistical criteria that the BLS uses to seasonally adjust component data, the existence of unadjusted data in the index may inadvertently allow noise into the price index at a seasonal frequency. For economists who are interested in using the index as a high-frequency inflation estimate, this implication argues in favor of seasonally adjusting the index after aggregation.

10 See Buszuwski and Gallagher (1995). An alternative approach is to seasonally adjust all of the subindexes. This is likely to be inferior as a noise-reduction technique, however, because seasonal adjustment coefficients cannot be estimated without error and thus are unlikely to completely eliminate seasonal noise from the aggregate index.

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TABLE 7

Stochastic Seasonality in the CPI and Components, 1982–1993 (using Newey–West correction)

	Without deterministic		With deterministic	
	Wald	p-value	Wald	p-value
CPI—all items	**0.4121**	**0.8138**	**7.4942**	**0.0236**
Cereals	19.6336	0.0001	5.6420	0.0595
Meats	12.8219	0.0016	5.4446	0.0657
Dairy	1.5522	0.4602	1.5523	0.4602
Fruits	8.9438	0.0114	1.8708	0.3924
Other food	43.4812	0.0000	1.9228	0.3824
Food away from home	2.1967	0.3334	0.5165	0.7724
Alcoholic beverages	7.0808	0.0290	3.7931	0.1501
Shelter	49.0183	0.0000	5.2125	0.0738
Fuel oil	2.2181	0.3299	7.1812	0.0276
Gas and electricity	313.7587	0.0000	9.6267	0.0081
Other utilities	2.8059	0.2459	7.0030	0.0302
Household furnishings	4.7049	0.0951	3.9263	0.1404
Housekeeping supplies	28.1663	0.0000	10.8060	0.0045
Housekeeping services	3.4370	0.1793	6.0842	0.0477
Men's apparel	23.0618	0.0000	7.7959	0.0203
Women's apparel	13.5094	0.0012	6.3310	0.0422
Infants' apparel	0.0967	0.9528	1.4833	0.4763
Other apparel	26.0616	0.0000	4.1555	0.1252
Footwear	3.0012	0.2230	1.2125	0.5454
Apparel services	10.9630	0.0042	23.3470	0.0000
New vehicles	7.6641	0.0217	6.2327	0.0443
Used vehicles	4.6747	0.0966	8.9065	0.0116
Motor fuel	1.0181	0.6011	9.8272	0.0073
Auto repair	4.3387	0.1142	2.0889	0.3519
Other transp. commodities	3.6178	0.1638	2.4884	0.2882
Other transp. services	20.7485	0.0000	6.1998	0.0451
Public transp.	1.4668	0.4803	2.5277	0.2826
Medical commodities	1.6251	0.4437	8.2525	0.0161
Medical services	123.7170	0.0000	2.1021	0.3496
Entertainment commodities	4.4067	0.1104	24.3490	0.0000
Entertainment services	12.4474	0.0020	3.6727	0.1594
Tobacco	0.2201	0.8958	9.4616	0.0088
Toilet goods	2.8849	0.2364	5.8198	0.0545
Personal services	2.6919	0.2603	4.5603	0.1023
Books and supplies	293.4063	0.0000	20.9720	0.0000
Educational services	100.6680	0.0000	23.6430	0.0000

SOURCES: Authors' calculations.

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