"INTERTEMPORAL PRICES AND THE US TRADE BALANCE"

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Abstract

The deterioration of the US merchandise trade deficit since 1982 has fallen mostly on durable goods. Using a representative agent model, we show that the key distinction between the trade balance in nondurables and durables is the role of intertemporal prices in the latter. A decrease in intertemporal prices associated, for example, with an exchange rate overvaluation should therefore be expected to worsen the trade balance in durables more than in nondurables. This interpretation of the compositional changes of the US trade balance is supported by our econometric findings.

1. Introduction

It is widely recognized that conventionally estimated aggregate US merchandise trade balance equations have performed poorly in recent years. In particular, they have consistently underpredicted the US trade deficit since 1982. This apparent breakdown of traditional relationships has motivated several new approaches to the trade balance determination based, among other things, on monopolistic competition and fixed costs (Krugman and Baldwin 1987 or Baldwin 1988), voluntary import restrictions (Bhagwati 1988), or import spillovers in a disequilibrium model (Bean, Drèze, and Layard 1990).

This paper proposes an alternative explanation for the behavior of the US trade deficit in the 1980s, and at the same time isolates an important aspect of the US trade deficit which has received relatively little attention in the literature. Since 1982, virtually all of the deterioration of the US merchandise trade balance is accounted for by the trade balance in durable goods, defined as capital goods, automobiles, consumer durables, and durable industrial supplies. Furthermore, at least half of the US durables trade deficit in the early 1980s can be explained by a large increase in imports of capital goods since 1982. While other components of the durable trade balance -- automobiles, consumer and industrial durables -- also deteriorated, these components are dwarfed by the capital goods component.

The very different behavior of durable and nondurable goods is interesting for several reasons. First, it is somewhat inconsistent with the "consumption-binge" explanation of the US merchandise trade deficit. If the deficit were primarily due to a consumption boom fueled by high aggregate demand, the trade balance should presumably worsen predominantly in the consumption goods sector. In fact, the worsening of the trade balance in consumer durables is much less pronounced than in capital goods, whereas the worsening in consumer nondurables is unremarkable compared with previous expansions. Second, import-reducing policies are presumably a more appropriate policy response to a trade deficit if it is due to imports of nondurable consumption goods rather than firms' purchases of investment goods. Third, the distinction between durable and nondurable goods is of economic significance. When goods are durable, the relevant price is the user cost, not the purchase price. We show below that a temporary reduction in the price of durable goods -- associated for example with an exchange rate overvaluation -- should have a larger effect on the trade balance on durables than on nondurables.[1] Compositional changes in the US trade balance should thus be related to the durability of the goods imported, which implies that the aggregation of nondurables and durables generally found in the literature is probably ill-advised.

The rest of the paper is organized as follows. Section 2 shows that the deterioration of the US trade balance in the 1980s is attributable to durable goods, especially capital goods. One explanation of this phenomenon is changes in the tax treatment of investment spending during this period. In Section 3 we explore

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[1] For a general discussion of the trade balance and intertemporal price changes following a devaluation, see Gerlach (1989) and Bacchetta and Gerlach (1990). For an empirical reference to this phenomenon in Latin American countries, see Dornbusch (1988).

this possibility, but find little empirical support for an overall US investment boom, nor evidence that the US tax changes favored foreign suppliers of capital goods. In Section 4, we consider an optimizing model of the trade balance that highlights the difference between durable and nondurable goods. We study the responses of the trade balances in durables and nondurables to changes in wealth, current relative prices, and the path of future prices. While the trade balances in both durable and nondurable goods depend on all these variables, the model predicts that the durable trade balance will respond more strongly to changes in intertemporal prices. In Section 5 we examine the econometric evidence. Our estimates support the hypothesis that intertemporal price movements are indeed an important determinant of both the trade balance in durable goods and real durable imports. Moreover, this effect is absent for nondurables. Finally, Section 6 contains our conclusions.

2. Durables vs. Non-Durables

To illustrate the strikingly different roles of durable and nondurable goods in the US trade deficit, Figure 1 disaggregates the US merchandise trade account as a percentage of GNP into three components: (1) oil and petroleum products; (2) nonoil industrial and consumer nondurable goods; and (3) durable goods as defined by the US Commerce Department, including industrial durables, capital goods, and consumer durables.[2] The figure reveals several

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[2]Nondurables include food, foodstuffs, grains, feeds, beverages, textiles, paper and paper-based products, chemicals, nonmetal industrial supplies (nonoil imports and exports in 1989 were 120.3 and $128.8 billions respectively). Durables include metal-related

interesting facts. While imports of petroleum products increased from about 1.5% of GNP in 1970 to as much as 4% of GNP in 1977, they have stabilized at about 2% of GNP during the 1982-88 period. It is evident that the deterioration of the trade balance beginning in 1982 can be attributed to durable goods; from a surplus of roughly 1% of GNP in 1980, the durables trade balance deteriorated rapidly after 1982 with the deficit eventually reaching 2.5% of GNP in 1986. In contrast, the decline of the nonoil nondurable goods trade balance of about 0.5% of GNP since 1982 is not remarkable given the historical experience. The worsening in the durables deficit is associated with a surge of imports between 1982-84 (cumulatively 60.1% in real terms), and a collapse of exports in 1982. While both balances have improved in the second half of the past decade, the improvement is again concentrated in durable goods, with almost all coming from export growth rather than import reduction.[3]

Disaggregation of the durables account reveals further surprises. Figure 2 plots the four most important components of durable merchandise trade as a fraction of real GNP: industrial durables, capital goods, automobiles, and consumer durables. At least half of the behavior of US durables trade deficit in the

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industrial supplies; electrical and electronic, industrial, construction and textile machinery; business and office machines; computers and related equipment; scientific and professional equipment; telecommunications equipment; transportation equipment, automotive vehicles including engines, parts and accessories; aircraft and parts; radios, televisions, and other household appliances (imports and exports in 1989 equalled $311.0 and $240.7 billions respectively). See US Survey of Current Business.

[3] It is unlikely that problems in the measurement of durable goods volumes can account for much of this variability, as the ratios of Figures 1 and 2 are similar to those measured in nominal values.

early 1980s can be explained by the substantial worsening in the trade balance on capital goods, historically a surplus account. In general, the extent of deterioration appears to be inversely proportional to durability; the most significant movements are in the capital goods sector, followed by automobiles, other consumer durables, and industrial durables.

The dominant role of capital goods is poorly accounted for by the standard view associating the deterioration of US trade deficit with a consumption binge. In this view, expansionary fiscal policy combined with myopic or liquidity-constrained consumers induced rapid growth and a rise in imports.[4] One weakness of this argument is that implausibly high income elasticities of durables goods demand are required to account for the large increase in imports: from 1982:1-1989:3, real GNP grew by 31.0% while real durable imports grew by 138%. Moreover, other recent large swings in fiscal policy -- such that associated with the 1975 Tax Reduction Act when the cyclically adjusted federal deficit rose by roughly 2% of GNP -- were not associated with a deterioration of the trade account.

3. Taxes and the Trade Balance[5]

Changes in tax policy in the 1980s represent a potential alternative explanation for the worsening of the US trade balance in durable goods.[6] More precisely, it is possible that provisions

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[4] See the textbook discussions of Dornbusch and Fischer (1987) or Krugman and Obstfeld (1988). One exception is Barro (1990).

[5] This section was added at the suggestion of an anonymous referee

[6] There are two different questions regarding the relationship

of the Economic Recovery Tax Act of 1981 increased firms' overall investment demand, part of which was met by a deterioration of the trade balance in capital goods. However, there are several reasons to doubt the hypothesis that tax changes played a major role in the sectoral behavior of the trade balance.

First, while investment in producers' durable equipment was strong in the first half of the 1980s, the results in Bosworth (1985) suggest that overall behavior of investment spending in the early 1980s was not unusual for a business expansion. This conclusion is supported in later work by Corker et. al. (1989), who find that about three-quarters of the investment upswing is attributable to the business cycle expansion that started in 1983. Among the remaining variables, the fall in real interest rates appears most important, with the tax cuts playing a minor role. They conclude that the notion that the investment expansion was due to the tax cuts is not supported by the evidence.

Second, the timing of the events provides a reason to doubt the role of the tax cuts as a major factor in the evolution of the durable goods trade balance. Although the trade balance started to deteriorate already in 1981, investment spending in real terms were essentially flat in the 1980-3 period, and did not start to increase rapidly until 1984.[7]

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between tax changes and the trade deficit. The first question, which is discussed elsewhere in the literature (e.g. Sinn 1985, 1988) and not addressed here, asks whether the aggregate current account deficit was caused by the reduction in public saving associated with the tax cuts. The second and more relevant question for this paper asks whether the tax changes caused the different behavior of the trade balance in durables and non-durables.

[7] See, e.g., Table C2 in Economic Report of the President 1990, p.

Finally, little correlation has been demonstrated at a disaggregated level between tax-induced changes in the cost-of-capital and the investment behavior. Bosworth (1985) found that while over 90 percent of the growth of equipment spending fell on office equipment (computers) and automobiles, the tax rate on computers increased and the tax treatment of automobiles was unaffected by the change in the tax code. Bosworth concludes that the investment boom in automobiles and office equipment was due to a sharp drop in the user cost of capital for these assets, which he associates with a significant reduction in purchase prices.[8]

One plausible interpretation of the investment boom in office equipment and automobiles is that the appreciation of the dollar reduced their acquisition prices, and that firms responded by increasing their purchases. That firms acted on the belief that the reduction in the purchases prices was temporary and likely to be reversed is the hypothesis we develop in following section.

4. An Intertemporal Model of the Trade Balance

In this section we develop a simple intertemporal model of the current account, incorporating both durable and non-durable goods in the analysis. While earlier theoretical work has stressed either intertemporal aspects of current account deficits in open economies or the effects of durability on consumer

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[8]See Table 3 and the discussion on pages 16-17 in Bosworth (1985).

expenditure behavior in closed economies, the implications of durable goods for the trade balance has not been discussed in the literature.[9] Sachs (1982) showed that a small open economy can smooth consumption relative to permanent income via its current account. In addition to intertemporal smoothing motives, Obstfeld (1983), extending ideas of Dornbusch (1983) and Svensson and Razin (1983), demonstrated that a temporary terms-of-trade deterioration induces agents to increase consumption of the imported goods in response to a lower real interest rate. This intertemporal speculation effect will depend on the elasticity of intertemporal substitution of consumption.

In a different literature, Mankiw (1985, 1987) emphasized durability in modelling consumption expenditures. Since the real interest rate enters the user cost of consumer durables, it should have a larger effect on consumption expenditure than usually predicted by intertemporal substitution and wealth effects. On the other hand, Mankiw's (1987) setup does not allow variation of the purchase price of durable goods, so that the user cost depends only on the interest rate and the depreciation rate. Furthermore the production side is ignored and consumer income is taken as given. The large movements in the US capital goods trade balance thus remain a key fact to be explained in a model.

We analyze the central aspects of the merchandise trade balance in the context of a infinitely lived representative producer-consumer who takes domestic currency prices as given. The

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[9] An exception is Leiderman and Razin (1988), who model durable consumption in a single good, open economy model. However, they ignore the supply side and address a different set of issues than those discussed here.

small country assumption ignores general equilibrium in the world economy as well as the pricing decisions of traders, but frees us to focus on the response of trade accounts to changes in the paths of local prices. Although the model can easily be extended to stochastic environments, for simplicity uncertainty is ignored.

We assume that there are two tradable goods in this economy, nondurables and durables. While nondurable goods may be consumed only, durables can be used in either consumption or production activities. If used in production, they depreciate at the rate δ^K, and their installation requires one period. If used for consumption, they depreciate at rate δ^D but their services can be enjoyed immediately. There are no costs of adjustment, nor are costs incurred for "unbolting" durable goods from one application to another, or for selling them on the world market.

4.1. Preferences

The representative agent's preferences are defined over nondurable consumption C and the flow of services of durable goods, which is normalized to equal the stock D. These preferences are summarized by the utility function

$$\sum_{t=0}^{\infty} \beta^t \sigma^{-1} [C_t^{\theta} D_t^{1-\theta}]^{\sigma} \qquad (1)$$

where $0<\beta<1$ and $\sigma<1$. The logarithmic form is assumed for $\sigma=0$. The elasticity of intertemporal substitution is given by $1/(1-\sigma)$. These preferences impose a unit elasticity of intratemporal substitution between durable and nondurable consumer goods, an assumption that finds empirical support in Mankiw (1987).

4.2. Technology

As in Sachs (1982), the production possibilities frontier available to the representative agent is convex and given by

$$(Z_t K_t^{\alpha} - Q_t^D)^{\gamma} - Q_t^C = 0 \tag{2}$$

with $0<\alpha,\gamma<1$, where Q^C and Q^D are nonnegative quantities produced of the durable and nondurable goods, K is the economy-wide capital stock assumed to be perfectly fungible in production, and Z is an economy-wide shift term to the production function, which may represent technical progress but could also capture the effects of taxes.[10]

4.3. Evolution of consumer durable and capital stocks

Durables are used either in the production of goods or durable consumption services. In period t, the inherited stock of consumer durables D_{t-1} can be augmented with purchases of durable goods at the beginning of the period, I_t^D. On the other hand, there is a time-to-build aspect of investment in productive capacity, so K_t is given. Investment undertaken in period t will affect the capital stock in the following period. Thus the capital and consumer durable good stocks obey transition equations

$$K_t = I_{t-1}^K + (1-\delta^K)K_{t-1} \tag{3}$$

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[10] This frontier can be derived from a two-sector model with perfect capital mobility and fixed labor supply.

$$D_t = I_t^D + (1-\delta^D)D_{t-1}. \tag{4}$$

4.4. The Intertemporal Budget Constraint

The representative agent can trade on a world market at domestic currency prices p_t^C and p_t^D and can freely borrow from and lend to the rest of the world at nominal interest rate i, which is fixed for simplicity. The stock of nominal financial wealth at the end of period t is denoted by B_t. If the durable stocks have zero present discounted salvage value ($\lim_{t\to\infty} (1+i)^{-t}p_t^D(K_t+D_t)=0$) and if Ponzi schemes are excluded ($\lim_{t\to\infty} (1+i)^{-t}B_t \geq 0$), we can write the *intertemporal* budget constraint as

$$B_{-1} + \sum_{t=0}^{\infty} (1+i)^{-t}[p_t^C(Q_t^C-C_t) + p_t^D(Q_t^D-I_t^K-I_t^D)] \geq 0 \tag{5}$$

The existence of a perfect resale market in durable goods is assumed, so any loss of economic value not summarized in the market price is captured by δ.[11]

It will be convenient to rewrite the budget constraint as

$$\sum_{t=0}^{\infty} (1+i)^{-t}(p_t^C C_t + u_t^D D_t) = \tag{6}$$
$$B_{-1} + p_0[(1-\delta^D)D_{-1} + (1-\delta^K)K_0] + \sum_{t=0}^{\infty} (1+i)^{-t}(p_t^C Q_t^C + p_t^D Q_t^D - u_t^K K_{t+1})$$

where $u_t^K \equiv p_t^D - (1-\delta^K)(1+i)^{-1}p_{t+1}^D$ and $u_t^D \equiv p_t^D - (1-\delta^D)(1+i)^{-1}p_{t+1}^D$ are the

[11]Investment in capital or consumer durables can be negative but must exceed $-(1-\delta^K)K_t$ and $-(1-\delta^D)D_t$ respectively; put differently, the representative agent cannot short sell durable goods in either of their uses.

user costs of capital and consumer durables, respectively. Equation (6) has the usual interpretation that the present value of expenditures cannot exceed available resources. To a first approximation, $u_t^K \cong (i+\delta^K-\pi_t)p_t^D$ and $u_t^D \cong (i+\delta^D-\pi_t)p_t^D$ where π_t is the rate of increase of durable prices, p_{t+1}^D/p_t^D-1. The user costs of durable goods in production and consumption are thus closely linked to the intertemporal price of these goods: a reduction of current prices or increase in future prices reduces the current user cost of these goods; furthermore, this effect is larger, the lower the depreciation rate.

4.5. The Problem

The representative producer-consumer chooses sequences of nondurable consumption $\{C_t\}$, investment in consumer durables $\{I_t^D\}$ and producer durables $\{I_t^K\}$, and production of consumption $\{Q_t^C\}$ and durable goods $\{Q_t^D\}$ to maximize (1) subject to (2), (3), (4), and (6), given initial conditions on D_{-1} and K_0, and the no-short sale restriction on both durable stocks. Assuming incomplete specialization in production, the problem can be expressed as:

$$\max_{\substack{\{C_t\}\\ \{Q_t^D\}\\ \{D_t\}\\ \{K_{t+1}\}\\ \lambda}} \left[\sum_{t=0}^{\infty} \beta^t \sigma^{-1} [C_t^{\theta} D_t^{1-\theta}]^{\sigma}\right] + \lambda \Bigg[B_{-1} + p_0[(1-\delta^D)D_{-1} + (1-\delta^K)K_0 + \sum_{t=0}^{\infty} (1+i)^{-t} (p_t^C (Z_t K_t^{\alpha} - Q_t^D)^{\gamma} + p_t^D Q_t^D - u_t^D K_{t+1}) - \sum_{t=0}^{\infty} (1+i)^{-t} (p_t^C C_t + u_t^D D_t)\Bigg]$$

where λ is the Lagrangian multiplier on the intertemporal budget constraint, interpreted here as the marginal utility of nominal wealth.

The first order conditions are

$$Q_t^D: \quad \gamma(Z_t K_t^{\alpha} - Q_t^D)^{\gamma-1} = p_t^D / p_t^C \tag{7a}$$

$$K_{t+1}: \quad (1+i)^{-1} p_{t+1}^D \alpha Z_{t+1} K_{t+1}^{\alpha-1} = u_t^K \tag{7b}$$

$$C_t: \quad \theta\beta^t [C_t^{\theta} D_t^{1-\theta}]^{\sigma-1} (D/C)_t^{1-\theta} = \lambda(1+i)^{-t} p_t^C \tag{7c}$$

$$D_t: \quad (1-\theta)\beta^t [C_t^{\theta} D_t^{1-\theta}]^{\sigma-1} (D/C)_t^{-\theta} = \lambda(1+i)^{-t} u_t^D \tag{7d}$$

λ: (6) holds with equality (7e)

Equations (7a-e) have the following interpretations: (7a) stipulates that the economy operate on the production possibilities frontier (intratemporal productive efficiency), (7b) enforces intertemporal efficiency in production with respect to capital in adjoining periods, (7c) and (7d) balance marginal utility from additional units of nondurable and durable consumption goods with their respective prices in utility units, and (7e) indicates that as long as the marginal utility of nominal wealth λ is positive, the budget constraint will hold with equality.

4.6. Solution and Interpretation

The model considered above yields a convenient separation of production and consumption decisions. Optimal production plans may be solved independent of consumption as a function of the initial capital stock, $\{Z_t\}$, relative current and future prices. Conversely, consumption demands can be solved conditional on total wealth. Define nominal wealth W_t as the discounted value of resources available in period t when economic opportunities are efficiently exploited, or the right hand side of equation (6) when the representative agent behaves according to equations (7):

$$W_0 \equiv B_{-1} + p_0[(1-\delta^D)D_{-1}+(1-\delta^K)K_0] + p_0^C Q_0^{C*} + p_0^D Q_0^{D*} \tag{8}$$

$$+ \sum_{t=1}^{\infty} (1+i)^{-t}[p_t^C Q_t^{C*} + p_t^D Q_t^{D*}] - \sum_{t=0}^{\infty} (1+i)^{-t} u_t^K K_{t+1}^*$$

where

$$Q_t^{D*} = Z_t K_t^{\alpha} - (p_t^C \gamma / p_t^D)^{1/(1-\gamma)}$$
$$Q_t^{C*} = (p_t^C \gamma / p_t^D)^{\gamma/(1-\gamma)}$$
$$K_{t+1}^* = [\alpha(1+i)^{-1} p_{t+1}^D Z_{t+1} / u_t^K]^{1/(1-\alpha)}$$

It is possible to solve (7c) and (7d) for $\{C_t\}$ and $\{D_t\}$ as functions of current and future prices and λ:[12]

$$C_t = \left[\theta[\beta(1+i)]^t[(1-\theta)p_t^C/\theta u_t^D]^{\sigma(1-\theta)}/\lambda p_t^C\right]^{1/(1-\sigma)} \tag{9}$$

$$D_t = \left[\theta[\beta(1+i)]^t[(1-\theta)p_t^C/\theta u_t^D]^{1-\theta\sigma}/\lambda p_t^C\right]^{1/(1-\sigma)} \tag{10}$$

Substituting (9) and (10) into (8) above and solving for λ yields:

$$\lambda = \left[\left[\sum_{\tau=0}^{\infty} \beta^{\tau}[\beta^{\tau}(1+i)^{\tau}(\theta/p_{\tau}^C)^{\theta}((1-\theta)/u_{\tau}^D)^{(1-\theta)}]^{\sigma/(1-\sigma)}\right]/W_0\right]^{(1-\sigma)} \tag{11}$$

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[12] Similar results can be found in Frenkel and Razin (1987), Ch. 10.

Note that in the case of log utility ($\sigma \to 0$), the marginal utility of nominal wealth λ is independent of the path of current and future prices and is equal to $[(1-\beta)W_0]^{-1}$; income and substitution effects of price changes in any period exactly cancel. We thus have for t=0:

$$C_0 = \theta(1-s_0)W_0/p_0^C \tag{12}$$

$$D_0 = (1-\theta)(1-s_0)W_0/u_0^D \tag{13}$$

where $(1-s_0)$ is the marginal propensity to spend in the current period out of current wealth, given by the expression

$$(1-s_0) = \left[\sum_{\tau=0}^{\infty} \beta^{\tau}[\beta^{\tau}(1+i)^{\tau}(p_0^C/p_\tau^C)^{\theta}(u_0^D/u_\tau^D)^{1-\theta}]^{\sigma/(1-\sigma)}\right]^{-1}. \tag{14}$$

In the log utility case ($\sigma=0$), $s_0=\beta$.

The real trade balances in nondurables $(Q_t^C-C_t)$ and durables $(Q_t^D-(D_t-(1-\delta^D)D_{t-1})-(K_{t+1}-(1-\delta^K)K_t)$ can now be written as

$$TB_t^C = (p_t^C\gamma/p_t^D)^{1/(1-\gamma)} - \theta(1-s_t)W_t/p_t^C \tag{15}$$

$$\begin{aligned} TB_t^D = {} & Z_tK_t^{\alpha}-(p_t^C\gamma/p_t^D)^{1/(1-\gamma)} \\ & - (1-\theta)(1-s_t)W_t/u_t^D + (1-\delta^D)D_{t-1} \\ & - [\alpha(1+i)^{-1}p_{t+1}^D Z_{t+1}/u_t^K]^{1/(1-\alpha)} + (1-\delta^K)K_t \,. \end{aligned} \tag{16}$$

The interpretation of equations (15) and (16) is straightforward. First, optimal intratemporal resource allocation induces dependence of both trade balances on the current relative price of durables. For constant wealth, an increase in p_t^D/p_t^C improves the durable good trade balance, and worsens the trade balance on nondurables. Second, both trade balances depend negatively on (real) wealth, which is determined by both "observables" (current prices, stocks of capital, consumer durables, and bonds) and "unobservables" (future prices and Z_t). Since wealth is defined by the representative agent's optimal behavior, the effect of changes in these variables can be assessed by applying the envelope theorem to (8). While the stocks of durable consumption goods, capital, and financial assets all have clear effects on total wealth, the effect of current or future prices is generally ambiguous. In addition, the marginal propensity to consume out of current wealth, $(1-s_t)$, depends on current and future prices as long as the elasticity of intertemporal substitution differs from unity.[13] Intuitively, when $\sigma>0$ ($\sigma<0$), an increase in future prices of either good reduces the real interest rate, leading to an increase (decrease) in current consumption of both goods.

The key difference between the two trade balances lies in the role of intertemporal prices. Even if the elasticity of intertemporal substitution is unity, changes in the price path of durable goods will exert a powerful effect on their demand in a way that is absent from nondurables. Note that durability increases the sensitivity of the user cost to changes in current

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[13]Even in the log utility case, future prices can influence nondurable consumption via wealth; however, as in the case of nonunitary elasticity of substitution, consumption of both goods will move in the same direction.

and future prices. To a first approximation, the elasticities of user cost with respect to p_t^D and p_{t+1}^D are $(i+\delta^i-\pi_t)^{-1}$ and $-(i+\delta^i-\pi_t)^{-1}$ for i=D,K, both of which are significantly greater than unity, the "user cost" of the nondurable good.[14]

Overall, these results imply that a temporary reduction in current prices relative to future prices -- caused for example by a temporary exchange rate appreciation or an expected future devaluation -- should have a larger effect on the durable goods trade balance than on the trade balance on nondurables. Mankiw (1987) has confirmed the importance of this intertemporal effect in US consumption expenditure data. However, he treats the supply side as perfectly elastic. If one considers supply explicitly, increased demand may be met through imports. In the next section we turn to the data for evidence of this effect.

5. Econometric Evidence

The transition from our theoretical model to an econometric analysis requires several steps. First, in our model, foreign and domestic goods are perfect substitutes so that there is a single price of durables and nondurables. Since in reality the composition of US imports and exports differ, this assumption is inappropriate for empirical analysis. We therefore define the price of two goods as equally-weighted averages of import and export prices. Second, according to our theoretical model, consumption of durables and nondurables are linear in wealth or

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[14]The exact elasticities are $(\partial u_t^i/\partial p_t^D)(p_t^D/u_t^i)=[1-(1-\delta^i)(1+\pi_t)/(1+i)]^{-1}$ and $(\partial u_t^i/\partial p_{t+1}^D)(p_{t+1}^D/u_t^i) = -[(1+i)/[(1+\pi_t)(1-\delta^i)]-1]^{-1}$for i=D,K.

permanent income, its annuity value. Since permanent income is unobservable, we follow the econometric literature initiated by Hall (1978) -- which argues that current consumption is approximately linear in permanent income -- and proxy y_t^p by nondurable domestic consumption.

The third set of issues that arises concerns the appropriate estimation strategy when the data are non-stationary, since standard errors of the parameters estimated in level equations are biased in this case.[15] Simple linear deterministic trends are likely to be spurious, while first differencing disregards any information present in the trends themselves.[16] Provided that the different time series are trending jointly, more efficient estimates of the model can be obtained by including "error-correction" terms among the regressors, as suggested in Stock (1987) and Engle and Granger (1987).

Finally, we require construction of an adequate measure of a user cost or intertemporal price variable. The theoretical model in Section 3 suggests $p_t^D-(1-\delta)(1+i)^{-1}p_{t+1}^D$ or its approximation $(i+\delta-\pi_t)p_t^D$. Since the durable trade balance consists of goods with widely differing rates of depreciation, the choice of δ for the empirical work is not obvious. In addition, some goods classified as nondurable may be storable for some time. For the

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[15] See Engle and Granger (1987) and Stock (1987).

[16] The first difference filter removes power at the zero frequency and reduces the power at low frequencies (see Baxter 1988). Since macroeconomic time series appear to be most strongly associated in the low frequency portion of the spectrum (Stultz and Wasserfallen 1985), the use of first differenced data is likely to underestimate long-run relationships among time series.

analysis that follows we simply assume zero depreciation.[17]

A second difficulty arises in the choice of appropriate time horizon for constructing the intertemporal price variable. In the theoretical model, the user cost of durable goods incorporates the rate of change of the purchase price over adjacent periods. With quarterly data, however, such a series tends to be dominated by high frequency movements which will attenuate our ability to detect the effects we describe. On the other hand, choosing a longer forecast horizon implies the loss of data at the end of the sample. The researcher must thus trade off power against sample size. Somewhat arbitrarily, we chose 4 quarters as the appropriate horizon and consequently used the rate of price increase between time periods t and t+4 in the computations of q_t. Figures 3 and 4 plot the intertemporal price variable $q_t \equiv p_t(i_t - \pi_t)$ for durables and nondurables, as well as the respective two trade balances, for the period 1970:1-1988:3. An increase in this variable should be associated with an increase in the user cost of durable goods, a postponement of goods purchases, and an improvement in the trade balance.

5.1. The Empirical Model

Suppressing constants, we estimate models of the form

$$A(L)\Delta X_t^i = B(L)\Delta\ln(p_t^C/p_t^D) + C(L)\Delta\ln y_t^P + D(L)E_t q_t^i + \gamma\theta_{t-1}^i + \varepsilon_t \qquad (17a)$$

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[17]We have estimated the equations assuming a variety of depreciation rates in the user cost formula. The results are robust with respect to the depreciation rate chosen.

where

$$\theta_t^i = X_t^i - \alpha \ln(p_t^C/p_t^D) - \beta \ln y_t^P - \rho q_t^i \tag{17b}$$

where the superscript i=C,D denotes nondurables and durables, and where X_t denotes, depending on the regression, either the log of real imports or the real trade balance.[18] The variable y_t^P stands for (real) permanent income.

This two-equation model can be interpreted heuristically as follows. Equation (17b) defines a long-run equilibrium relationship between the variables, that is, the trade balance evolves over time so as to satisfy (17b). The deviation from this equilibrium, θ_t^i, affects the short-run dynamics of X_t specified in (17a), and γ should be estimated negative. Technically, the model is of the error-correction form (see Salmon 1982 or Engle and Granger 1987).[19]

A standard problem encountered when estimating models like (17) is the fact that agents' decisions depend on an expected intertemporal price variable, $E_t q_t^i$, which is not observed by the econometrician. However, under rational expectations, $q_t \equiv E_t q_t + \xi_t$, where ξ_t is orthogonal to any information available in time period t. Following standard procedure, we estimate (17a), replacing $E_t q_t$ with its actual value q_t and instrumenting it with variables

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[18]The log of the real trade balance is computed as the log of the ratio of real exports to real imports.

[19]Rose and Yellen (1989) have applied this methodology to investigating the aggregate US trade balance.

observed in time period t. An implication of this procedure is that the equation errors will be MA(3) processes, and that the covariance matrix used to compute test statistics must be corrected for MA-errors.

5.2. Results

Equations (17a) and (17b) were estimated using data described in the Appendix. Augmented Dickey-Fuller (ADF) tests indicated that all variables were non-stationary, with the possible exception of relative prices.[20] Following Stock (1987), we estimated (17b) by OLS, and tested for stationarity of the θ_t^i-errors. While we could not reject at the five percent level the hypothesis that the θ_t^i were non-stationary at the five percent level (and thus not valid regressors in equation (17a)), tests against nonstationarity have very little power against borderline-stationary alternatives. Poterba and Summers (1988) have argued that testing at conventional significance levels in such a case implies a statistical loss function with extremely low weight on Type II errors. In their example, the appropriate significance level implying equal weighting of Type I and II errors is roughly 40%. Unfortunately, critical values of the ADF statistic are not readily available at such significance levels. An alternative approach is simply to compare the autocorrelations functions for θ_t^i with those for variables generally considered nonstationary, for example, the logarithm of real GNP or real consumption expenditure. Since the θ_t^i dampen quickly compared to

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[20]We also estimated the equations assuming that relative prices were stationary, with similar results.

these variables, we proceeded on the assumption that the error-correction variables were stationary.[21]

Next, we estimated equation (17a) by instrumental variables.[22] Four sets of typical results are presented for the trade balance in durables (Table 1) and nondurables (Table 2), as well as real durable (Table 3) and nondurable (Table 4) imports. The most striking finding is that in all regressions involving durable goods, the intertemporal price variable has the sign suggested by the model and is statistically significant. This suggests that intertemporal considerations of the type discussed above are empirically relevant. Second, the intertemporal price variables are insignificant in the nondurables equations. This result lends support to the hypothesis that intertemporal speculation arises more strongly when goods are durable. Third, the relative price variable $\ln(p_t^D/p_t^C)$ is generally significant in the trade balance equations, but less so in the import equations. The variable has

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[21]The ADF test statistics are as follows: 2.36 (X defined as the durable trade balance), 1.78 (nondurable trade balance), 2.17 (durable imports) and 2.44 (nondurable imports). The critical value calculated by Engle and Yoo (1987) for a 4-variable system with 100 observations is 3.89 at the 10 percent significance level. The autocorrelations at lags 1/4/8/12 are: .90/.46/.16/.10 (durable trade balance), .87/.51/.28/.10 (nondurable trade balance), .87/.39/.24/.26 (durable imports) and .66/.28/.17/.21 (nondurable imports). For comparison, the autocorrelations for the logs of real GNP and total nondurable consumption are .95/.78/.61/.45 and .96/.82/.64/.48, respectively.

[22]As instruments we used a constant, four lagged values of the dependent variables, the current plus four lagged values of (our proxy for) the change in permanent income, the current plus three lagged values of the change in relative prices, the lagged error correction term, the current and lagged four-quarter change the price of (depending on the independent variable) durables or nondurables, and the current and lagged change in the t-bill rate. The R-squareds in the first-stage regressions were typically in the 0.5 - 0.65 range.

a counterintuitive sign in the durable goods equations, which is somewhat difficult to explain. Fourth, the error correction term enters significantly in the durable goods equations but not in the nondurable goods equations. Dropping the error correction terms from the latter equations, however, yields no significant differences in the results.

In sum, our empirical results support the hypothesis that intertemporal prices matter for the determination of the trade balance in durables.

6. Concluding Comments

This paper demonstrates that the deterioration of the US trade balance since the early 1980s is strongly concentrated in durable goods, in particular capital goods. A simple theoretical model indicates that the main analytical difference between the determination of the durable and nondurable goods trade balance is that the former depends more strongly on intertemporal prices. This opens up the interesting possibility that the behavior of the trade balances in durables stems from intertemporal substitution by consumers and firms. The increasing volatility of local prices since the demise of fixed exchange rates may thus account for the increase in trade balance swings evident in Figures 1 and 2.

There are many directions for future research in this area. We suspect that the disaggregation of the merchandise trade into finer categories will result in sharper estimates of intertemporal price effects, which in theory should be increasing in durability. Second, the model has interesting implications for the behavior of the trade balance when misalignments occur under fixed exchange rate regimes. Third, joint modelling of the pricing behavior of US importers' reactions to exchange rate changes might yield insights into the interaction of markup and consumer behavior. Finally, international comparisons would allow testing for the effects we discuss in other countries and historical episodes.

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TABLE 1

Trade balance in durables, 1970:1-1988:3.

$$A(L)\Delta\phi_t^i = B(L)\Delta\ln(p_t^C/p_t^D) + C(L)\Delta\ln y_t^p + D(L)E_t q_t^i + \gamma\theta_{t-1}^i + \varepsilon_t$$

Variable	A(L)	B(L)	C(L)	D(L)	γ
Lags	1, 2	0, 1	0, 1	0, 1, 2	
Sum of coefficients	.503	-.553	.930	1.54	-.095
t-Statistics for sum	4.12	-3.92	1.49	2.27	-3.20
MSL for exclusion restriction	.000	.000	.211	.023	
MSL for Q-statistic	.235				
Adj. R^2	.342				

Estimated cointegrating vector of $[\ln X_t^i \; 1 \; \ln(p_t^C/p_t^D) \; \ln y_t^p \; q_t^i]$:

[1 9.391681 -1.100195 -1.447495 0.4371522]

Notes:

All test-statistics are heteroscedasticity consistent. The constant has been suppressed.

TABLE 2

Trade balance in nondurables, 1970:1-1988:3.

$$A(L)\Delta X_t^i = B(L)\Delta \ln(p_t^C/p_t^D) + C(L)\Delta \ln y_t^P + D(L)E_t q_t^i + \gamma\theta_{t-1}^i + \varepsilon_t$$

Variable	A(L)	B(L)	C(L)	D(L)	γ
Lags	1, 2	0, 1	0, 1	0, 1, 2	
Sum of coefficients	-.127	-.695	-2.41	-.084	-.037
t-Statistics for sum	-.688	-2.16	-1.89	-.211	-.632
MSL for exclusion restriction	.786	.051	.108	.364	
MSL for Q-statistic	.544				
Adj. R^2	.113				

Estimated cointegrating vector of $[\ln X_t^i \; 1 \; \ln(p_t^C/p_t^D) \; \ln y_t^P \; q_t^i]$:
[1 1.358064 -.7715472 -.1978929 .8984732]

Notes:

All test-statistics are heteroscedasticity consistent. The constant has been suppressed.

TABLE 3

Import demand for durables, 1970:1-1988:3.

$$A(L)\Delta X_t^i = B(L)\Delta\ln(p_t^C/p_t^D) + C(L)\Delta\ln y_t^P + D(L)E_t q_t^i + \gamma\theta_{t-1}^i + \varepsilon_t$$

Variable	A(L)	B(L)	C(L)	D(L)	γ
Lags	1, 2	0, 1	0, 1	0, 1, 2	
Sum of coefficients	.293	.341	.341	-1.65	-.134
t-Statistics for sum	1.68	.384	.384	-2.25	-3.30
MSL for exclusion restriction	.158	.178	.611	.030	
MSL for Q-statistic	.390				
Adj. R^2	.216				

Estimated cointegrating vector of $[\ln X_t^i \; 1 \; \ln(p_t^C/p_t^D) \; \ln y_t^P \; q_t^i]$:
[1 -20.65213 .2191396 3.852322 -.1242980].

Notes:

All test-statistics are heteroscedasticity consistent. The constant has been suppressed.

TABLE 4

Import Demand for nondurables, 1970:1-1988:3.

$$A(L)\Delta X_t^i = B(L)\Delta \ln(p_t^C/p_t^D) + C(L)\Delta \ln y_t^P + D(L)E_t q_t^i + \gamma\theta_{t-1}^i + \varepsilon_t$$

Variable	A(L)	B(L)	C(L)	D(L)	γ
Lags	0, 1, 2	0, 1	0, 1	0, 1, 2	
Sum of coefficients	-.391	.596	1.53	-.741	-.109
t-Statistics for sum	-1.28	1.925	1.20	-1.36	-1.29
MSL for exclusion restriction	.171	.044	.053	.044	
MSL for Q-statistic	.911				
Adj. R^2	.042				

Estimated cointegrating vector of $[\ln X_t^i \; 1 \; \ln(p_t^C/p_t^D) \; \ln y_t^P \; q_t^i]$:
[1 -11.92521 2.432696 .4216211 -.2628907].

Notes:

All test-statistics are heteroscedasticity consistent. The constant has been suppressed.

Appendix

All data were obtained from the Data Resources US Central databank, and are in quarterly, seasonally adjusted form for the period 1967:1 to 1989:3. Durable imports and exports, both in both current and constant dollar values, are taken directly from the Commerce Department, with the divisions detailed in footnote 2. Current and constant dollar values of nondurable exports are the reported values, whereas current and constant dollar imports are calculated as the difference between total nondurable imports and petroleum product imports. As described in the text, p_t^c and p_t^D are unweighted averages of implicit price deflators for exports and imports of nondurable and durable goods, respectively. y_t^p was proxied by nondurable real consumption. The nominal interest rate used was the twelve month treasury bill yield.

Figure 1. The US Merchandise Trade Balance, 1967:1-1989:3

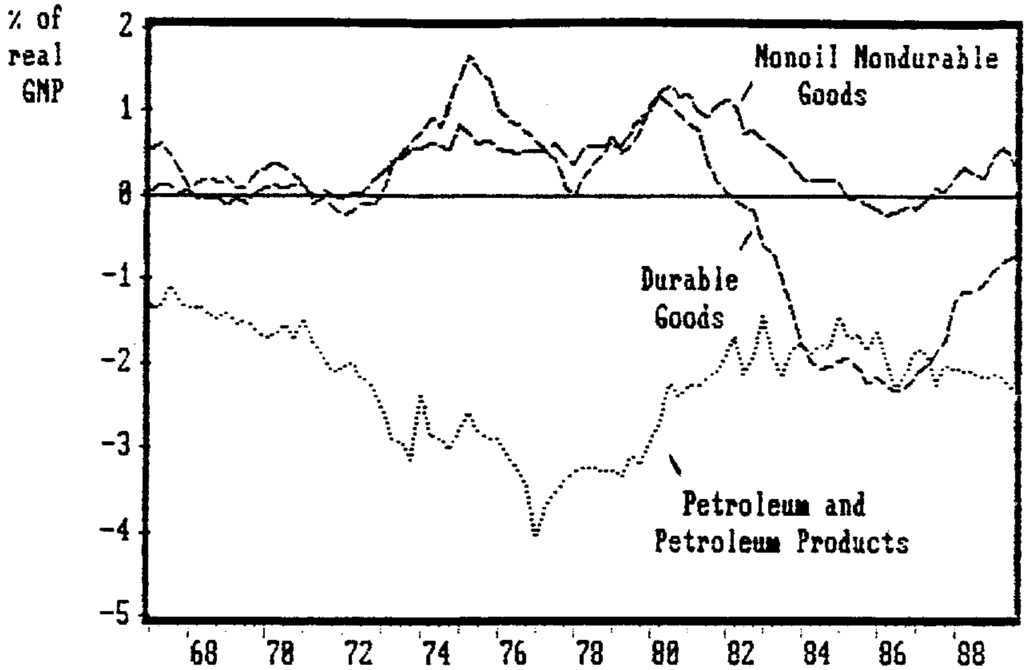


Figure 2: Components of the US Durable Merchandise Trade Balance, 1967:1-1989:3

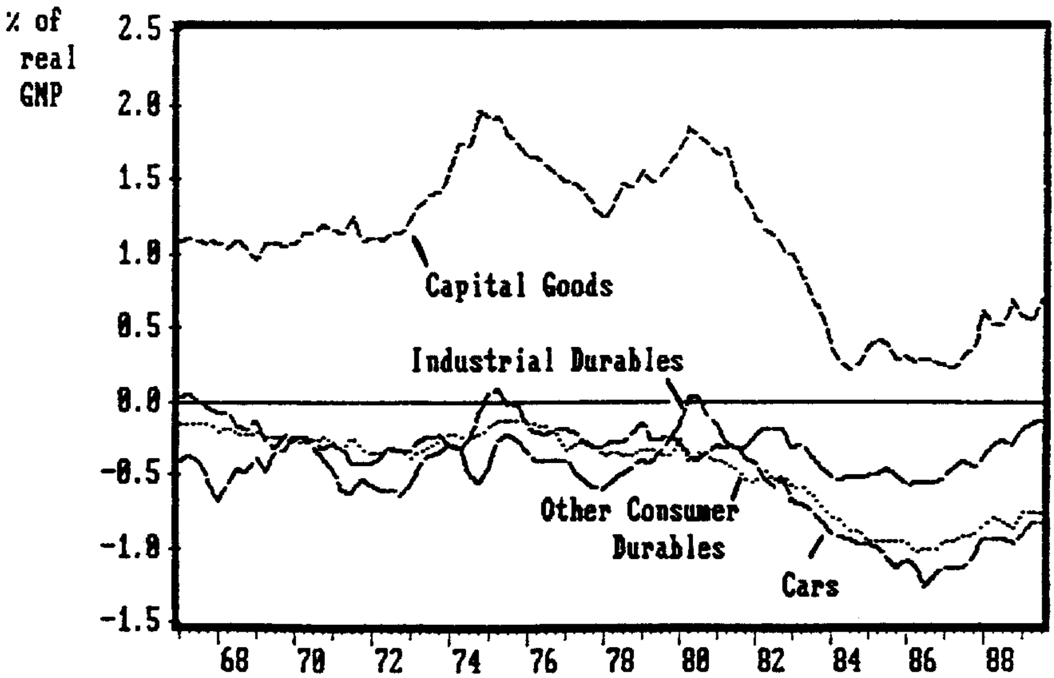


Figure 3. Intertemporal Prices and the US Durable Merchandise Trade Balance, 1970:1-1988:3

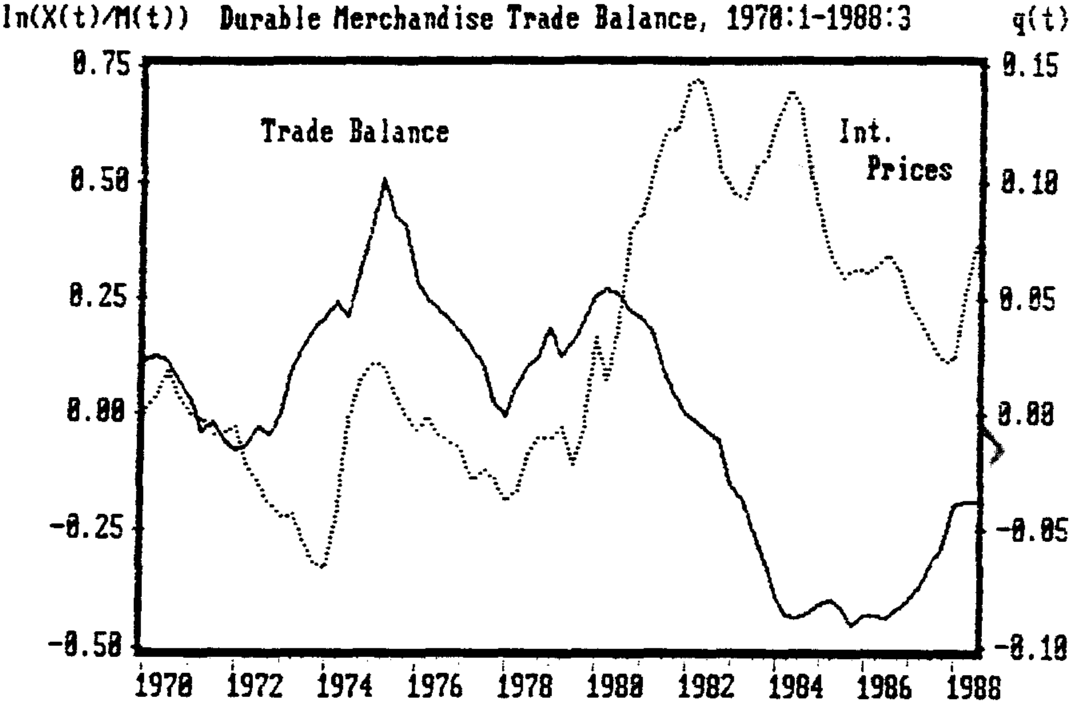
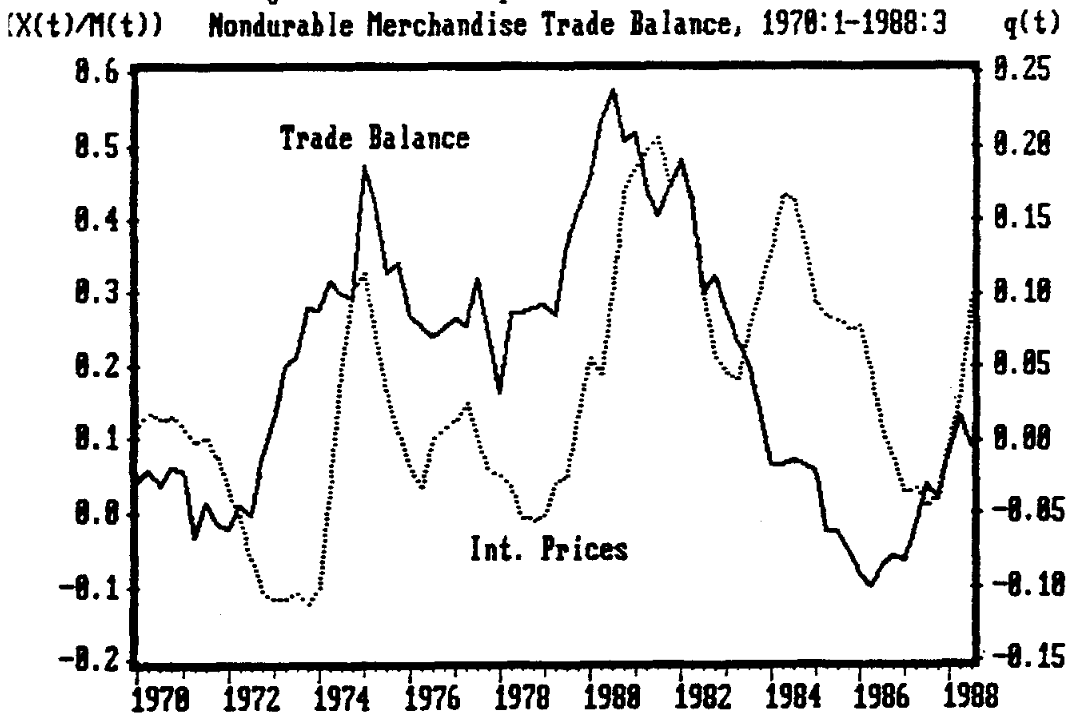


Figure 4. Intertemporal Prices and the US Nonoil Nondurable Merchandise Trade Balance, 1970:1-1988:3



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