NEW MEASURES OF PRICES AND PRODUCTIVITY FOR TRADABLE AND NONTRADABLE GOODS*

BY MORRIS GOLDSTEIN
International Monetary Fund

AND

LAWRENCE H. OFFICER
Michigan State University

Empirical work on the division of real output and prices into tradable and nontradable components has not kept pace with theoretical developments. The conventional proxies of prices and productivity by tradable and nontradable sector are examined and found deficient in several important respects. It is demonstrated that an approach that relies on the long-standing data on gross domestic product by industry of origin can overcome some of these deficiencies. These data are used to construct new annual measures of prices and productivity for tradable and nontradable output for 12 industrial countries over the period 1950–73. While far from precise, the new measures are consistent with the following criteria for distinguishing between tradables and nontradables: the degree of foreign trade participation should be higher for tradables than for nontradables; the degree of international commodity arbitrage, as measured by cross-country correlations of price changes, should be higher for tradables than nontradables; and tradables should be closer substitutes than nontradables for traded goods from other countries (imports).

Despite the considerable conceptual advantages of the new measures of prices and productivity over the conventional proxies, correlation analysis indicates that the new and old measures usually move together rather closely in our 12 subject countries. The correlations are higher across the alternative relative productivity measures than for the alternative relative price measures.

1. INTRODUCTION

The distinction between the tradable and nontradable sectors of the economy has become an increasingly important element in many branches of international economics, with special relevance for, inter alia, the effects of devaluation, the purchasing-power-parity theory of exchange rates, the determination of inflation in open economies, and the specification and estimation of international trade flows.[1] At the same time, empirical work in the tradable/nontradable sphere has always lagged behind theoretical developments, due in large part to the difficulty of obtaining data along tradable/nontradable lines. The primary purpose of this

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[1]The literature involving the tradable/nontradable dichotomy is clearly too vast even to partially survey here. Briefly, one may mention the use of this dichotomy in the work of Salter (1959), Swan (1963), Mundell (1971), Dornbusch (1973), and Kravis and Lipsey (1978) on the effects of exchange-rate changes; of Balassa (1964), McKinnon (1971), and Officer (1976) on productivity bias in the purchasing-power-parity theory of exchange rates; of Aukrust (1970), Edgren and others (1969, 1973), and Cross and Laidler (1976) on the determination of inflation in open economies; and of Murray and Ginman (1976), Clements (1977), and Goldstein and others (1979) on the estimation of trade flows.

paper is to help alleviate this data problem by introducing new measures of prices, real output, and (labor) productivity for tradable and nontradable goods. Our measures cover 12 industrial countries, are annual in frequency, and relate to the period 1950–73.[2]

The paper is organized into six sections. We begin in section II by considering the issue of defining tradable and nontradable goods or sectors. In section III we discuss the proxy variables that have been in previous empirical studies for the price of tradables, the price of nontradables, and the relative productivity of tradables with respect to nontradables. In section IV we suggest what we regard as better-quality measures and explain their construction for 12 industrial countries. Section V employs simple correlation analysis to compare the time-series behavior of our tradable/nontradable variables with that of the conventional proxies. Some concluding comments are offered in section VI. The data series of principal interest are displayed in the Appendix.

II. Defining Tradables Versus Nontradables

At the outset, we must face the fundamental issue of how to define a "tradable good" or "tradable sector" in relation to a "nontradable" good or sector. One approach relies exclusively on international-trade statistics. Specifically, the aggregate "gross domestic product (GDP) plus imports of goods and services" is divided into goods and services actually traded (exports plus imports, "traded goods") and goods and services absorbed in the domestic economy ("nontraded goods').

A second approach considers tradable goods as having a wider scope than commodities actually traded. While there is no consensus on the appropriate dividing line in the literature,[3] perhaps the most appealing criterion is the one which would call an industry tradable if its pricing behavior followed the "law of one price." This law requires that, for a given product, the elasticity of the domestic price with respect to both the exchange rate and foreign prices of the same product be unity, i.e., that the sole determinant of the rate of change of the domestic price of product i be the exchange-rate-adjusted foreign price of product i.[4] Several recent studies have shown, however, that if this criterion is used, then few industries indeed, even at very fine levels of disaggregation (four-digit and beyond), would qualify as tradables (despite the fact that some of

[2]Although we have not done so in this paper, release of the most recent OECD data on gross domestic product by industry of origin now makes it possible to extend our measures through 1975.

[3]A discussion of the existing "state of the art" in empirically distinguishing tradables from nontradables is found in Kravis and Lipsey (1978, pp. 202–203).

[4]Richardson (1978) suggests that the presence or absence of perfect commodity arbitrage (i.e., the law of one price) be used as the indicator of the tradability of a product. Specifically, consider the following relationship:

$$P_d = B_0 E^{B_1} P_f^{B_2} T^{B_3} R^{B_4}$$

where: P_d is the domestic price of the product, E represents the exchange rate (units of domestic currency per unit of foreign currency), P_f is the foreign price (in foreign currency units) of the product, T is a measure of transfer costs (tariffs, transport, insurance, etc), and R represents all other factors affecting domestic price. Perfect commodity arbitrage coupled with perfect substitutability (i.e., a tradable) would then be indicated by the conditions: B_0, B_1, B_2, $B_3 = 1$, and $B_4 = 0$; similarly, a nontradable would be indicated by B_1, B_2, $B_3 = 0$.

these industry groups are heavily engaged in foreign trade).[5] At the other end of the spectrum, if one classifies as tradable any good that either is internationally traded or could be traded at some plausible range of variation in relative prices, then the tradable category becomes very broad indeed.

As a balanced viewpoint, we suggest the use of both trade flows and market behavior—particularly the degree of independence between domestic and foreign prices—in identifying tradable and nontradable commodities or industries. Specifically, we employ three complementary criteria to distinguish between tradables and nontradables: (a) the degree of foreign-trade participation should be substantially higher for tradables than nontradables; (b) cross-country correlations of price changes should be much higher for tradables than nontradables; (c) tradables should be closer substitutes for traded goods from other countries (imports) than are nontradables. These criteria are employed in section IV; but first we turn to a review of conventional measures of tradable/nontradable variables.

III. Conventional Proxies for Prices and Productivity by Tradable/Nontradable Sector

Three alternative price indices have been employed in the empirical literature to measure the price of tradable goods (hereafter PT), namely: the export price index (EPI), the import price index (IPI), and the wholesale price index (WPI).[6]

The EPI and IPI measure the price movement of tradables by the price movement of goods actually traded. Also, since the EPI and IPI are invariably used as alternative proxies for PT (rather than as components of a proxy for PT), each purports to represent the price of all tradables, both importables and exportables, whereas the EPI can logically represent only the price of exportables and the IPI that of importables.

The implicit assumption behind the use of these two proxies is that commodity arbitrage and substitution possiblities in consumption and production are sufficiently powerful to ensure that export and domestic prices of the same product in a given country and the export prices of the same product from different countries will both be closely aligned. Whatever the reason, however, be it trade barriers, transport costs, price-discriminating monopolists, different commodity composition of the price indices, etc., the available empirical studies, taken as a whole, suggest that departures from the "law of one price" are far from unusual, both within and across countries; and this is so even at fairly fine levels of disaggregation.[7] For example, Kravis and Lipsey (1977, p. 155) sum up their study

[5]See Bordo and Choudri (1977), Isard (1977), Kravis and Lipsey (1977), and Richardson (1978).

[6]In principle, a purchasing-power-parity approach may be used to obtain price *levels* (i.e., weighted averages of *absolute* prices) of the tradable and nontradable outputs of a country *relative to those of a standard country*. In practice, data limitations generally prevent the construction of such inter-country relative price levels of tradables and nontradables. An exception is the impressive study by Kravis and others (1975, p. 193), who compute price levels of tradables and nontradables for nine countries relative to the United States for the year 1970. In view of these data limitations, we confine our discussion here to measurement of PT and PNT by price indices relative to a base period.

[7]See, for example, Bordo and Choudri (1977), Isard (1977), Kravis and Lipsey (1977), Ripley (1974), Richardson (1978), and Kreinin and Officer (1978).

of export and domestic price movements in the United States, United Kingdom, Germany, and Japan, as follows:

> We find that there are sometimes substantial and prolonged divergences between the export price movements of different countries for the same or closely related products and notable differences within countries between export and domestic price changes.

Thus, proxying the price of tradables by the price of goods traded can be a dangerous procedure. In addition, the quality of the EPI (IPI) as a price measure even of exported (imported) goods alone is often suspect, as the component price indices are generally unit-value indices (rather than true price measures), and these have well-known deficiencies as measures of the prices of heterogeneous or nonstandard commodity groups.[8]

Use of the IPI is rare compared to that of the EPI for the purpose at hand. The presumed explanation is that to proxy PT by the EPI requires only the assumption that export and domestic prices move closely together, while to proxy PT by the IPI involves both this and the further assumption that export prices from various countries are closely aligned. For this reason, we too deem the EPI as the superior proxy variable compared to the IPI.

What then about the WPI? Because it is heavily weighted with traded goods and does not include services (which are generally considered to lie within the nontradable sector), the WPI is often regarded as a logical proxy for PT. Unfortunately, like both the EPI and the IPI, the WPI has its own deficiencies. Its component price indices measure prices of commodities at varying stages of production (generally below the retail level), thus leading to the possiblity of double-counting. The fact that the quantitative importance of this double-counting is difficult to assess renders this defect all the more troublesome. The tradable output of the economy is (at least conceptually) a distinct part of GDP; yet the WPI cannot be construed as measuring the price of value-added output of *any* well-defined sector or sectors of the economy. A further defect is that the WPI purports to measure the price of not domestic tradable production alone but rather this production plus imports—and the latter should normally be excluded from PT.

Turning to the conventional proxies for the price of nontradable goods (PNT), the leading candidates are the consumer price index (CPI) and the price deflator for either gross domestic product (PGDP) or gross national product (PGNP). Since the CPI includes price movements of consumer services, it is clearly a better measure of PNT than is, say, the WPI. However, not all nontradable output is covered by the CPI. Services not purchased by households (e.g., business services and public administration) are excluded, as are nontradable goods not so purchased (e.g., nonresidential construction). In addition, the goods (as distinct from services) components of the CPI (aside from housing) are generally construed as tradables, and this, of course, is inappropriate for an index that seeks to proxy PNT. Furthermore, because its orientation is to domestic consumption rather than production, the CPI incorporates the price movements not just of importables and exportables, but also of imports of consumer goods.

[8]See Allen (1975, pp. 95, 116, 252–253) and Leamer and Stern (1970, p. 15).

For the above reasons, the CPI cannot be considered as a satisfactory representation of PNT as such. Rather, the CPI should be viewed as measuring PNT *relative* to the WPI (or, alternatively, EPI) measuring PT. In other words, the relative price of nontradables with respect to tradables, PNT/PT, may be proxied by CPI/WPI or CPI/EPI.

The GDP (or GNP) price deflator, PGDP (or PGNP), measures the price movement of *all* domestic (or national) production, i.e., the aggregate of tradable and nontradable output. Therefore, like the CPI, these deflator indices are appropriately used not to represent PNT independently but rather to contrast the behavior of PNT in relation to PT in conjunction with a proxy measure of the latter variable. The advantage of PGDP (or PGNP) over the CPI for this purpose is that the national-accounts deflators measure the price movement of all domestic (or national) production on a value-added basis, not just that part of production purchased by households. As a general price index, PGDP (or PGNP) is a precise representation of a weighted average of price-index equivalents of PT and PNT, where the weights are proportional to domestic (or national) production of tradables and nontradables, respectively.

Is there any reason to choose one of the national-accounts deflators over the other for the purpose at hand? From an empirical standpoint, the quantitative difference between PGDP and PGNP would be insignificant. Nevertheless, because most hypotheses involving PT and PNT concern prices and production within the boundaries of a country, a domestic rather than national concept of the price deflator is superior from a theoretical standpoint. Therefore PGDP is to be preferred to PGNP.

In summary, the behavior of PNT in relationship to PT can be measured by the behavior of PNT *cum* PT in relationship to PT, with PGDP representing PNT *cum* PT. The relative price of nontradables, PNT/PT, can thus also be proxied by PGDP/WPI or, alternatively, PGDP/EPI.

Now let us consider the conventional proxy measures that have been used for productivity in the tradable and nontradable industries (hereafter PRODT and PRODNT, respectively). These variables have been subject to proxy measure only in ratio form, that is, the proxies have been developed for the *relative* productivity of tradables with respect to nontradables (PRODT/PRODNT). Also, the productivity concept has been limited to *labor* productivity with a homogeneous labor input assumed. The data limitations and conceptual difficulties in (a) measuring capital and other non-labor factors of production, (b) distinguishing varying qualities of labor input, and (c) combining non-homogeneous factors of production into a single input measure are impressive indeed for the total economy; they are overwhelming for separate consideration of the tradable and nontradable sectors. Therefore PRODT and PRODNT will themselves be interpreted as labor-productivity variables with labor taken as a homogeneous input.

As a rule, the proxy variables for PRODT/PRODNT have been based on the hypothesis that *general* productivity growth is manifested largely in the tradable sector of the economy. A good proxy variable in this light would be an economy-wide productivity measure that is highly correlated with PRODT/PRODNT. One proxy variable that has been used is *per capita* output, defined alternatively as *per capita* GNP (GNP/POP) or *per capita* GDP (GDP/POP), where GNP and GDP

are expressed in real terms. The same reason that induces one to prefer PGDP over PGNP as a proxy for PNT leads one to select GPD/POP over GNP/POP as the preferred productivity measure here.

A measure of overall productivity with greater precision, and therefore presumably a superior proxy variable, is the ratio of GDP to total *employment* in the economy (GDP/EMP) as distinct from total population in the country. GDP/EMP has greater accuracy than GDP/POP as a productivity variable because its (labor) input measure excludes both that part of the population not in the labor force and that part of the labor force not currently employed.

Still greater precision could be obtained if the labor input measure were denominated in man-hours instead of number of workers, because the former (unlike the latter) takes account of changes in the utilization rate of labor as well as changes in the stock of this factor of production. Unfortunately, the information required is generally unavailable for the total economy and therefore for a tradable/nontradable sectoral breakdown.[9]

IV. New Measures of Prices and Productivity by Tradable/Nontradable Sector

The preceding discussion on the relative merits of alternative proxies for PT, PNT, and PRODT/PRODNT is suggestive of a methodology that should produce better measures of these variables. Such an approach begins with the recognition that the GDP price deflator, PGDP, can be interpreted as a weighted average of PT and PNT (where both variables are price indices) because tradable and nontradable output are, by definition, exhaustive components of GDP. This suggests, in turn, that price-index equivalents of PT and PNT can be constructed in the same manner that PGDP is constructed once total production is allocated as between tradables and nontradables. Specifically, consider the following identities:

$$GDPC \equiv GDPCT + GDPCNT$$

$$GDPK \equiv GDPKT + GDPKNT$$

where

GDPC = GDP at current prices

GDPCT = output of tradables at current prices

GDPCNT = output of nontradables at current prices

GDPK = GDP at constant prices

GDPKT = output of tradables at constant prices

GDPKNT = output of nontradables at constant prices

[9]An hourly input measure can usually be obtained for manufacturing, which is generally recognized as a sub-sector of the tradable part of the economy. However, proxying PRODT/PRODNT by manufacturing output per man-hour has the double deficiency that productivity of only a part of the tradable sector is covered and that productivity in the nontradable sector is assumed to be unvarying; the other measures exhibit only the second deficiency.

Now recall that PGDP is an implicit price index that is defined as the ratio of output at current prices to output at constant prices, i.e., PGDP = GDPC/GDPK. If the output of tradables (nontradables) can then be defined as that part of GDP originating in the tradable (nontradable) sector of the economy, we can obtain new measures of proxies for PT and PNT (call them $\hat{P}T$ and $P\hat{N}T$) as:

$$\hat{P}T = GDPCT/GDPKT$$

$$P\hat{N}T = GDPCNT/GDPKNT$$

In a similar fashion, it is possible to construct new proxies for PRODT and PRODNT (call them $PR\hat{O}DT$ and $PR\hat{O}DNT$) by allocating both GDP and employment to the tradable and nontradable sectors. (The implicit assumption here is that the ratio of real GDP to employment is better than the alternative productivity measure.) Specifically, consider the following additional identity:

$$EMP \equiv EMPT + EMPNT$$

where EMP denotes total employment, and EMPT and EMPNT denote employment in the tradable and nontradable sectors of the economy, respectively. Just as GDPK/EMP serves as a measure of productivity for the whole economy, productivity in the tradable and nontradable sectors can be defined as:

$$PR\hat{O}DT = GDPKT/EMPT$$

$$PR\hat{O}DNT = GDPKNT/EMPNT$$

The productivity of tradables with respect to nontradables is then simply

$$PR\hat{O}DT/PR\hat{O}DNT = (GDPKT/EMPT)/(GDPKNT/EMPNT)$$

In order to make the above described procedures operational, it is, of course, necessary to specify which industries are assigned to the tradable and which to the nontradable sector. For each of 12 industrial countries, we allocated the following industries to the tradable sector: (i) agriculture and related activities, (ii) mining and quarrying, and (iii) manufacturing. The nontradable sector encompasses all other industries in which GDP originates—or, specifically in terms of industry groupings: electricity, gas, and water; construction; wholesale and retail trade; transport, storage and communication; financial, insurance, and real-estate services; consumer services; business services; and government services.

The basic source of data to divide GDP into tradable and nontradable categories is OECD, *National Accounts of OECD Countries* (tables on GDP by industry of origin in both current and constant prices). A secondary source is United Nations, *Yearbook of National Accounts Statistics.* As regards data on employment by tradable/nontradable sector, the primary source is OECD, *Labor Force Statistics*, with ILO, *Yearbook of Labor Statistics* acting as a secondary source. For $\hat{P}T$ and $P\hat{N}T$, it is possible to construct an annual time series for 1950–73 for Austria, Belgium, Canada, Denmark, Finland, Germany, Italy, Norway, Sweden, the United Kingdom, and the United States; for France, however, the series runs only to 1971. In the case of the relative-productivity variable (i.e., $PR\hat{O}DT/PR\hat{O}DNT$), data limitations reduce the sample size to ten countries (the above 12 countries less Denmark and Finland) and the time period to less than 1950–73 for four of the ten countries (Austria, France, Italy, and

Sweden).[10] Our constructed series for $\hat{P}T$, $P\hat{N}T$, and ($PR\hat{O}DT/PRO\hat{D}NT$) are given in the Appendix[11].

To our knowledge, there have been no previous applications of the long-standing data on GDP by industry of origin to construct price indices for tradable and nontradable goods. There have, however, been earlier attempts both to use other data sources to construct tradable and nontradable goods prices, albeit for fewer countries (e.g., see Cross and Laidler (1976), Murray and Ginman (1975), and Clements (1977)), and to use the GDP data to construct the relative-productivity variable (see Maynard and von Ryckeghem (1976)).[12] By and large,

[10]Denmark and Finland are eliminated from the sample (for purposes of constructing ($PR\hat{O}DT/PR\hat{O}DNT$)) due to unavailability of data on employment by tradable/nontradable sector. Similarly, the same data deficiency reduces the sample period to 1953–73 for Austria, 1954–73 for Italy, and 1964–73 for Sweden. In the case of France, unavailability of data on GDP at constant prices by tradable/nontradable sector of origin for 1972 and 1973, and on employment by tradable/nontradable sector for 1950–53 combined to reduce the productivity sample to 1954–71.

[11]Tables 4 and 5 in the Appendix present the data only in ratio form, i.e., ($P\hat{N}T/\hat{P}T$) and ($PR\hat{O}DT/PRO\hat{D}NT$). The separate series on the variables in non-ratio form are available from the authors upon request.

[12]Cross and Laidler (1976, pp. 252–53) generate variants of PNT and PT for the United Kingdom by partitioning components of the CPI (rather than GDP) into tradables and nontradables. The price-level concept is consistent with their use of the CPI as the general price index for their models not involving the tradable/nontradable distinction. Their tradable/nontradable delineation is consistent with our own; but ours includes output purchased not only by the consumer sector but also by the business, government, and export sectors.

Murray and Ginman (1976, p. 79) suggest an allocation of industries to the tradable/nontradable sectors consistent with our own, except for exclusion of the government sector—a reasonable exclusion in view of the fact that, for Murray and Ginman, PT and PNT are to be used as explanatory variables in an import demand equation. However, they do not strictly follow their tradable/nontradable delineation in selecting measures of PT and PNT; for PT is proxied by the WPI and PNT is constructed as "a weighted index of services and construction." The data source is cited as the *Survey of Current Business*, but no details are provided.

While we develop our tradable/nontradable variables using the production side of the national accounts, Clements (1977) considers the expenditure side to divide GNP into importables, exportables, and nontradables. Categories of consumption and investment are allocated to the three commodity groups on the basis of trade data, although arbitrary decisions are also made (e.g., the change in business inventories is allocated half to importables, half to exportables). All government expenditure on goods and services is considered nontradable. The EPI and IPI are used as price indices for exportables and importables, respectively. This procedure is valid under the assumption of perfect substitutability between exports (imports) and exportables (importables). The price measure for nontradables is obtained residually from the GNP deflator, EPI, and IPI, using current-period output weights. One advantage of using the expenditure approach is that price indices for final expenditure do not require double deflation and therefore could be more accurate.

Our composition of the tradable and nontradable sectors is the same as that of Maynard and van Ryckeghem (1975), who generate variants of $PR\hat{O}DT$ and $PR\hat{O}DNT$ in a manner similar to our construction of these variables. They calculate annual growth rates of productivity in the tradable and nontradable sectors for 13 OECD countries over the time period 1954–68, except for Ireland (1958–68) and Sweden (1956–68). Their list of countries differs from our own by including Ireland, Japan, and the Netherlands, and by excluding Austria. Stated data sources are the OECD national accounts and the International Labor Office (for employment data). We cannot understand why Austria was excluded from their sample, as information is readily available to construct $PR\hat{O}DT$ and $PR\hat{O}DNT$ for 1954–68. We are also surprised that Maynard and van Ryckeghem were able to include Denmark, Sweden, Japan, Ireland, and the Netherlands in their sample for the time periods stated. In each of these cases, we found one or more data series necessary for constructing $PR\hat{O}DT$ or $PR\hat{O}DNT$ to be either unavailable for at least part of the period or insufficiently disaggregated to permit the desired sectoral breakdown.

There is some indication that Edgren and others (1969, 1973) *might* have used a method similar to our own to construct tradable/nontradable variables. However, their description is vague, and their labor input measure is man-hours rather than number of workers. The data used emanate from the Swedish Central Bureau of Statistics.

our industry composition of the tradable and nontradable sectors is similar to that of the other studies.[13]

In our view, these new measures of PT, PNT, and PRODT/PRODNT are an improvement over the conventional proxy variables, because the new measures alone possess a solid conceptual foundation. This does not mean, however, that our proxies themselves do not have limitations. At least three of these limitations or weaknesses deserve explicit mention. First, since our measures derive directly from data on GDP by industry of origin and since these data are available over a reasonably long time period only on an annual basis for most countries, it is generally not feasible to generate quarterly or monthly observations (unlike the cases of the CPI and WPI). This, in turn, may inhibit precise estimates of the timing of various economic relationships. Second, as implicit price deflators, $\hat{P}T$ and $\hat{PN}T$ are current-weighted indices, just as PGDP is a current-weighted price index. For use in analysis of price movements as distinct from the deflation of variables at current prices, a base-weighted index is generally preferred to a current-weighted one. Because, however, $\hat{P}T$ and $\hat{PN}T$ can be constructed only as the ratio of output at current prices to output at constant prices, these measures are inherently current weighted and no equivalent base-weighted price index can be obtained.

The third limitation, and probably the most important one, concerns the classification of industries into tradable and nontradable sectors.[14] The problem is that the level of aggregation of the existing data on GDP by industry of origin is so high (the one-digit level) that it is difficult to get a clear classification of industries into one sector or the other. Under these circumstances, an industry must be allocated to the sector in which the preponderance of its sub-industries (weighted, of course, by their output, i.e., value added) would be assigned given a greater degree of disaggregation. The result is that some tradable (nontradable) output and employment will undoubtedly be included in the nontradable (tradable) sector.

Since we have allocated the same industries into the tradable and nontradable categories across all countries, and given the data limitations described above, it would be difficult to argue convincingly that we have identified tradable and nontradable goods with a good deal of precision. We do think, however, that our tradable/nontradable breakdown and the series derived from it are reasonable in terms of the criteria established in Section II. To begin with, even a cursory examination of input/output data for the countries included in our sample reveals that the degree of foreign-trade participation (e.g., the ratio of imports or exports to total domestic sales) is substantially higher for our tradable sector than for the nontradable sector.[15] Second, in accord with *a priori* expectations about goods

[13]A more precise comparison of the delineation of the tradable/nontradable sectors in the various studies is presented in the Appendix, Table 6.

[14]Of course, it could be argued that the very idea of allocating industries to either a tradable or nontradable category makes less sense than viewing products and industries as lying on a spectrum between the two, and switching over time from one category to another in response to changes in international comparative advantage. For an exposition of this view, see Dornbusch and others (1977).

[15]See Goldstein and others (1979) for the individual country figures. The only exception to this rule was the United Kingdom, where such normally nontradables as banking services and insurance traditionally have played an important role in the balance of payments.

arbitrage across national borders, we find that cross-country correlations of inflation rates for $\hat{P}T$ are generally much higher than those for $P\hat{N}T$, that is, the prices of tradables seem to be more closely connected across countries than the prices of nontradables.[16] Finally, there is some evidence that what we call tradable goods are closer substitutes for traded goods from other countries (imports) than are nontradables. More specifically, estimates of aggregate import demand equations for our sample of countries indicate that the elasticity of import volume with respect to the price of tradables is higher than that for either the price of nontradables or the price of all domestic goods (PGDP).[17] Similarly, within each country, import prices are more highly correlated with $\hat{P}T$ than with either $P\hat{N}T$ or PGDP.[18]

V. Correlation Analysis

In section III, we concluded that among the various proxies that have been used for the relative price of nontradables with respect to tradables, the leading candidates were CPI/WPI, CPI/EPI, PGDP/WPI, and PGDP/EPI. As regards the productivity of tradables with respect to nontradables, the best of the conventional proxies seemed to be GDP/POP and GDP/EMP. In this section, we report on how closely these proxy variables are related to (correlated with) the new proxies introduced in this paper, namely $P\hat{N}T/\hat{P}T$ and $PR\hat{O}DT/PRO\hat{D}NT$, respectively. The correlations for relative prices appear in Table 1, while those for relative productivity are shown in Table 2.

The relative-price correlations are generally high. In fact, they are below 0.8 only for Finland (one proxy variable) and for Norway (all proxy variables). The result for Norway clearly represents a data peculiarity, for which we have no good explanation. In the case of the relative-productivity variables, the correlations between our measures and the proxy variables are even higher, with fully 75 percent of them above 0.98.

The tale told by Tables 1 and 2 is that the (better) conventional proxy variables, taken as a whole, are good empirical representations of our specially constructed measures of relative price and relative productivity of tradables. This should be of some comfort to those researchers who have used these proxy variables because of their easy availability.

Having said this, what can one conclude about the *relative* quality of the conventional proxy variables vis-à-vis one another? Recall that in section III we argued that PGDP/WPI and PGDP/EPI were better proxies on *a priori* grounds than either CPI/WPI or CPI/EPI. This can be tested empirically if we are willing to assume that $P\hat{N}T/P\hat{T}$ is the best available representation of the true

[16]The cross-country correlations of inflation rates for $\hat{P}T$ and $P\hat{N}T$ were performed on a year-to-year basis for each country against nine other countries (France was excluded for data reasons and Norway was excluded because of the implausible correlation results discussed in Section V of this paper). The yearly correlations were then averaged for the 1951–73 period. In 8 of the 10 countries (Belgium and Denmark were the exceptions), the correlations for $\hat{P}T$ were higher than those for $P\hat{N}T$. The differences would no doubt be larger if the correlations were done only for periods of fixed exchange rates.

[17]The specific country results are given in Goldstein and others (1979).

[18]See Goldstein and others (1979).

TABLE 1

CORRELATIONS OF PROXY VARIABLES WITH NEW RELATIVE-PRICE MEASURE ($\hat{PNT}/\hat{PT}$)

Country	Time Period	CPI/WPI	CPI/EPI	PGDP/WPI	PGDP/EPI
Austria	1950–73	0.961	0.974	0.969	0.976
Belgium	1950–73	0.948	0.952	0.956	0.957
Canada	1950–73	0.837	0.974	0.911	0.987
Denmark	1950–73	0.975	0.989	0.974	0.988
Finland	1950–73	0.824	0.691	0.948	0.840
France	1950–71	0.950	0.925	0.974	0.975
Germany	1950–73	0.961	0.803	0.991	0.944
Italy	1950–73	0.931	0.973	0.995	0.991
Norway	1950–73	0.238	0.281	0.259	0.291
Sweden	1950–73	0.935	0.948	0.965	0.965
United Kingdom	1950–73	0.914	0.891	0.936	0.913
United States	1950–73	0.936	0.837	0.906	0.824

TABLE 2

CORRELATIONS OF PROXY VARIABLES WITH NEW RELATIVE-PRODUCTIVITY MEASURE ($\hat{PRODT}/\hat{PRODNT}$)

Country	Time Period	GDP/POP	GDP/EMP
Austria	1953–73	0.984	0.989
Belgium	1950–73	0.993	0.992
Canada	1950–73	0.948	0.988
France	1954–71	0.996	0.996
Germany	1950–73	0.996	0.990
Italy	1954–73	0.991	0.985
Norway	1950–73	0.959	0.938
Sweden	1964–73	0.982	0.979
United Kingdom	1950–73	0.969	0.985
United States	1950–73	0.982	0.983

unobservable ratio of tradable to nontradable prices. Taking this as a maintained hypothesis, there are 11 countries for which comparisons can be made (we exclude Norway because of the unexplained peculiar behavior of $\hat{PNT}/\hat{PT}$ there). We find that one or the other of the (relative price) proxy variables involving PGDP has the highest correlation with $\hat{PNT}/\hat{PT}$ in 9 of the 11 cases, and has the second highest correlation in 7 of 11 cases. Therefore, the *a priori* superior proxy variables for relative prices do tend to perform better empirically than do the *a priori* inferior ones.

However, the same result does not hold for the *a priori* superior proxy (GDP/EMP) for relative productivity. Reference to Table 2 reveals that the correlation of GDP/EMP with $\hat{PRODT}/\hat{PRODNT}$ exceeds that of GDP/POP with $\hat{PRODT}/\hat{PRODNT}$ in four cases, falls below it in four cases, and is equal to it (to the third significant digit) in one case. In short, there is not much to choose between GDP/EMP and GDP/POP on empirical grounds.

As a final comparison of our measures with the more traditional proxies, it is useful this time to look at the price variables separately, to concentrate on

cross-country averages rather than on country-by-country results, and to examine price changes rather than price levels. As a yardstick for comparison of $\hat{P}T$ and $\hat{PN}T$, we use the EPI and WPI for the price of tradables, and the CPI and PGDP for the price of nontradables. The numbers are expressed as annual percentage changes averaged across the 12 industrial countries in our sample. The calculations are made for 1951, for the periods 1952–59 and 1960–69, and for the individual years 1970–73. The results are presented in Table 3. Without going

TABLE 3

ANNUAL PERCENTAGE CHANGES IN THE PRICE OF TRADABLES AND NONTRADABLES: CROSS-COUNTRY AVERAGES

	1951	1952–59	1960–69	1970	1971	1972	1973
			Price of Tradables				
EPI	25.9	−0.1	1.3	5.7	2.8	2.6	10.8
WPI	22.0	0.5	2.0	5.3	3.5	4.5	11.7
$\hat{P}T$	12.6	1.3	2.0	4.8	3.8	5.7[a]	8.9[a]
			Price of Nontradables				
CPI	9.1	2.6	3.1	5.1	5.3	5.6	7.7
PGDP	12.6	3.1	3.4	5.7	6.0	5.8	7.5
$\hat{PN}T$	11.1	4.7	4.7	6.3	7.7	6.7[a]	7.4[a]

[a]Excludes France for reasons of data availability.

into great detail, the figures suggest that apart from the years of very high inflation (1971 and 1973), the conventional proxy variables exhibit increases that are reasonable reflections of the movements in $\hat{P}T$ and $\hat{PN}T$ across countries. As such, there does not seem to be violent error in using these proxies for rough "back-of-the-envelope" estimates of relative price trends as among tradables and nontradables.

VI. CONCLUDING REMARKS

In this paper we have demonstrated how a rather long standing set of national accounts data, namely that of gross domestic product by industry of origin, could be used to generate a consistent time series on prices and productivity of tradable and nontradable goods for each of 12 industrial countries over the period 1950–73. The resulting measures have both advantages and disadvantages relative to other available proxies, and we have tried to spell out just what these are. We also compared, via correlation analysis and simple cross-country averages, increases of prices and productivity according to the new measures with those of the other leading proxy variables and found that in general they moved together rather closely.

If the various theoretical propositions regarding the tradable/nontradable dichotomy are to be subjected to empirical testing similar to that used in other areas of international economics, data will have to be developed along tradable/nontradable lines. The data presented here on tradable and nontradable prices and productivity are put forward in that spirit.

APPENDIX

TABLE 4

RATIO OF PRICE INDEX OF NONTRADABLES TO PRICE INDEX OF TRADABLES ($\hat{PN}T/\hat{P}T$), 1970 = 100

Year	Austria	Belgium	Canada	France	Germany	Italy	Sweden	U.K.	U.S.
1950	60.58	65.43	59.23	61.18	61.27	54.06	53.03	69.74	72.11
1951	62.95	66.29	55.83	59.80	61.17	53.54	47.94	70.67	70.25
1952	66.02	68.56	60.21	65.78	65.34	57.78	51.35	69.29	73.08
1953	68.15	73.83	64.63	70.68	66.13	60.32	55.86	69.19	76.67
1954	68.71	78.17	68.12	73.40	68.30	63.52	54.93	70.74	76.08
1955	70.01	82.35	68.61	74.95	70.54	66.54	55.69	72.95	76.98
1956	73.18	80.90	69.38	74.97	71.81	70.15	55.87	73.48	76.07
1957	75.75	79.26	73.50	76.38	73.61	72.81	59.38	73.49	76.99
1958	78.04	84.51	76.66	76.18	75.63	74.02	60.72	73.71	77.20
1959	80.40	86.76	77.89	80.49	77.68	78.83	61.34	76.11	79.33
1960	79.70	87.05	78.77	81.25	79.96	80.88	63.10	79.08	80.16
1961	82.94	86.56	82.76	82.35	81.17	80.34	64.65	80.59	81.81
1962	84.57	88.13	82.43	83.57	83.32	82.72	66.15	83.46	82.70
1963	87.05	87.24	83.31	85.87	86.25	85.11	79.46	86.56	84.64
1964	87.56	87.83	84.17	88.96	89.06	88.68	80.41	88.88	86.24
1965	89.64	89.72	86.54	91.26	90.19	92.75	82.81	89.68	87.05
1966	91.61	92.03	87.34	92.98	92.34	95.45	88.38	91.85	87.74
1967	96.24	95.46	91.28	95.51	93.34	97.47	93.76	95.52	90.07
1968	98.66	96.47	92.72	99.95	96.49	101.32	97.34	99.61	91.71
1969	100.03	95.81	96.96	98.92	98.54	100.42	100.55	101.80	97.61
1970	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1971	99.73	109.72	104.75	101.45	104.72	102.48	101.83	102.37	104.47
1972	101.77	110.86	105.69		107.65	102.48	102.59	100.31	106.55
1973	103.70	113.76	98.60		111.22	100.40	98.14	95.62	106.01

TABLE 5

RATIO OF PRODUCTIVITY IN TRADABLE SECTOR TO PRODUCTIVITY IN NONTRADABLE SECTOR (PRÔDT/PRÔDNT)

Year	Austria	Belgium	Canada	France	Germany	Italy	Sweden	U.K.	U.S.
1950		0.5359	0.4909		0.4821			0.6962	0.7114
1951		0.5711	0.5439		0.5033			0.7117	0.7156
1952		0.5954	0.5876		0.5431			0.7015	0.7199
1953	0.5194	0.6057	0.5946		0.5644			0.7076	0.7484
1954	0.5146	0.6266	0.5753	0.6252	0.5937	0.3126		0.7208	0.7346
1955	0.5301	0.6615	0.6085	0.6389	0.6110	0.3327		0.7311	0.7566
1956	0.5234	0.6475	0.6462	0.6696	0.6116	0.3631		0.7277	0.7451
1957	0.5471	0.6575	0.6584	0.6961	0.6339	0.3751		0.7352	0.7514
1958	0.5585	0.6502	0.6865	0.7142	0.6460	0.3920		0.7168	0.7552
1959	0.5660	0.6701	0.7289	0.7114	0.6731	0.4034		0.7490	0.7887
1960	0.5943	0.7150	0.7689	0.7538	0.7174	0.4129		0.7625	0.7992
1961	0.6153	0.7171	0.7728	0.7767	0.7224	0.4470		0.7520	0.8169
1962	0.6093	0.7362	0.8393	0.7993	0.7331	0.4679		0.7702	0.8470
1963	0.6170	0.7467	0.8651	0.8206	0.7559	0.4878		0.7919	0.8796
1964	0.6403	0.7645	0.8582	0.8400	0.7944	0.5235	0.5805	0.8253	0.9021
1965	0.6347	0.7679	0.9171	0.8702	0.8076	0.5208	0.6012	0.8282	0.9258
1966	0.6399	0.7995	0.9510	0.9092	0.8077	0.5527	0.6630	0.8338	0.9271
1967	0.6713	0.8309	0.9374	0.9418	0.8179	0.5829	0.6952	0.8495	0.9277
1968	0.6882	0.8815	0.9834	1.0034	0.8741	0.6005	0.7347	0.8793	0.9462
1969	0.7622	0.9273	1.0041	1.0202	0.8951	0.6043	0.7683	0.8865	0.9895
1970	0.7422	0.9680	1.0236	1.0514	0.8979	0.6364	0.8844	0.8731	0.9952
1971	0.7879	0.9959	1.0622	1.0701	0.9135	0.6186	0.9328	0.9433	1.0500
1972	0.7880	1.0447	1.0848		0.9333	0.6290	0.9421	0.9709	1.0818
1973	0.8182	1.0611	1.1164		0.9669	0.6668	0.9684	0.9311	1.1228

TABLE 6

DELINEATION OF TRADABLE AND NONTRADABLE SECTORS

	Tradables	Nontradables
Current Study: *List of Component Industries*	Agriculture, hunting, forestry and fishing Mining and quarrying Manufacturing	Electricity, gas and water Construction Wholesale and retail trade Transport, storage and communication Finance, insurance and real estate Consumer services Business services Government
Other Studies: *Divergences from Current study*		
Aukrust (1970)	Shipping (ocean and coastal transport) Air transport	Agriculture Sheltered manufacturing
Edgren, Faxen and Odhner (1969; 1973)	Foreign transport	Agriculture Sheltered food manufacturing
Maynard and van Ryckeghem (1975)	—	—
Cross and Laidler (1976)	Excludes output not purchased by consumers	Excludes output not purchased by consumers
Murray and Ginman (1976)	—	Excludes government

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