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How weak are the signals? International price indices and multinational enterprises

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Abstract
International price indices (IPIs) provide the most timely and comprehensive market information available to international business. How do multinational enterprises (MNEs) affect the validity of IPIs? We review the earlier debate over methods for calculating IPIs, which concluded that unit values were inferior to specification prices, although most governments produce only unit value indexes. We explore three ways in which MNEs can affect the validity of IPIs: determining the 'representative' transfer price, excluding intrafirm transactions from the index, and choosing the 'right' transfer price along the transportation chain. We argue that MNE activities strengthen the case for specification prices; although still uncommon, they are the stronger signal of international markets. Our empirical analysis supports this hypothesis, finding that a 10% increase in the intrafirm trade share of US imports widens the gap between specification price and unit value by 1.3%, with transfer price manipulation further increasing the gap.
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Since they were first constructed in the late 1960s, international price indices (IPIs) have provided the most timely and comprehensive information available about international markets. Used initially by government statisticians to deflate the foreign trade component of national income accounts, IPIs are now critical tools for international business, used for predicting exchange rates, calculating escalator clauses in long-term contracts, conducting strategic market analyses, and assessing international competition. Ironically, the quality of IPIs may be falling just as this information is becoming indispensable in an increasingly global environment. We argue that both phenomena – lower quality and greater need – stem from the growing role of multinational enterprises (MNEs) in international markets.

MNEs have come to dominate manufacturing industries characterized by R&D intensity, economies of scale, scope, and learning (Caves, 1996). In turn, these industries have claimed larger and larger shares of world trade. In 1999, trade among units of MNEs in such industries accounted for 47% of US merchandise imports and 32% of merchandise exports, by value (US Census, 2000). However, the transfer prices that accompany intrafirm trade (IFT) often do not reflect market forces, either because external markets do not exist or are imperfect, or because transfer prices are manipulated for income-shifting purposes (Eden, 1998). Transfer price manipula-

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tion (TPM) poses clear problems for IPIs because it reflects efforts to reduce income taxes, the burdens of customs duties or exchange controls, and thus may be far removed from any reflection of marginal costs and changes in supply and demand.

Conceptually, IPIs allow for the accurate measurement of private sector production and economy-wide growth by accounting for price changes in exports and imports (BLS, 1999, Chapter 2: 12). If transfer prices are not prices in the classical sense – that is, they do not represent market-clearing forces evidenced through the actions of unrelated parties – then the link between prices and production is broken, and our best estimates of changes in international markets are unreliable. By failing to account for the problems posed by MNEs, IPIs may offer at best an incomplete signal of changing competitiveness and opportunities in international markets.

The purpose of this paper is to answer the following question: How do multinational enterprises affect the validity of international price indexes? We address this question in three steps. First, we briefly review the earlier debate over the choice of IPI methodology – that is, between the unit value index (UVI) and specification price index (SPI). Second, we expound three ways in which MNEs can affect the validity of IPIs: by determining the 'representative' transfer price, by excluding some or all intrafirm transactions from the index, and by choosing amongst alternative 'right' transfer prices along the transportation chain. Third, we argue that IFT actually strengthens the case for using SPIs. We estimate the impacts of IFT and transfer pricing on the gap between US import prices and unit values, using monthly US import data for January–June 1999. We find that a 10% increase in the share of IFT causes the logged price gap to rise by 1.3%; government trade barriers that provide transfer pricing arbitrage opportunities widen the SPI–UVI gap. We conclude that MNE activities strengthen the case for SPIs; although still uncommon, they are a stronger signal of international market forces than UVIs.

The old debate: which index – SPI or UVI?

There are two different approaches to constructing IPIs: unit values and specification prices. A UVI simply divides the value of international trade (either exports or imports or both) by some measure of the volume of international trade. The UVI is, by an overwhelming margin, the most common approach used by national statistical agencies (Lipsey, 1994; OECD, 1999a, b). However, the problems with UVIs are well known (Alterman, 1991; Kravis and Lipsey, 1971; Lipsey, 1994). Changes in value occur for many reasons, not just changes in price. Changes in quantity shares, holding prices constant, can cause UVIs to overestimate or underestimate actual prices (Feenstra and Shiells, 1997). Even if quantity is fixed, changes in quality, terms of payment, product mix, and exchange rates imply that dividing value by quantity will not yield a well-defined price. Moreover, where quantity figures are unavailable, unit values cannot be computed, causing a high dropout rate from the index. These problems are particularly acute for manufactured goods where quality changes are frequent and the rate of new product development is high (Lipsey *et al.*, 1991).

The main alternative to the UVI, first developed by Kravis and Lipsey (1971), is the SPI, in which the government, on a monthly basis, collects individual export and import prices for a huge list of products representative of the composition of a country's international trade flows. Prices are collected from customs declarations, shipping invoices and surveys of individual businesses. The advantages of such a detailed, hands-on approach are clear: the index takes product specifications into account when price changes are measured. By keeping product selection constant and making adjustments for quality changes, the SPI guarantees pure price comparisons.

Because the high cost of producing SPIs, only a few countries have developed and disseminate SPIs; all are OECD members (OECD, 2001: Table 3). The US Bureau of Labor Statistics (BLS) (1997: 158) has the most sophisticated program.[1]

Despite their many advantages, SPIs are not problem free. A key decision is who and what to sample, as the reliability of an SPI depends on the selected items being representative of all trade flows. As specification data are collected from voluntary surveys of firms, non-response bias is also a problem. Moreover, the statistical agency must decide how to handle new and obsolete goods, whether to ignore seasonal variations, and how to deal with rapid technological change (Diewert and Feenstra, 2001; EUROSTAT, 2001; Feenstra and Shiells, 1997; Lipsey *et al.*, 1991). Still, after comparing the benefits and costs of UVIs *vs* SPIs, it seems clear that only SPIs provide reasonable measures of international market conditions. EUROSTAT (2001: 60–61) concluded as much, arguing that UVIs were inappropriate for 'products of a unique nature' and were, at best, poor indexes for capital goods. EUROSTAT gave an A (best) rating to SPIs and a B (acceptable) rating to UVIs for homogeneous products, but UVIs for products where quality changes were frequent received a C (unacceptable) rating.

The current debate over international price indexes, therefore, focuses less on *which method* to use for calculating IPIs (where SPI is the clear winner) and more on how to improve the quality of price indexes. Our paper contributes to the new debate by analyzing how MNEs affect the validity of IPIs.

The new debate: how do MNEs affect IPIs?

The growing importance of IFT challenges the creation of international price indexes. An IPI must include MNE transactions to be reasonably representative, and yet it cannot fulfill its purposes if biased by prices that do not reflect market conditions. Consequently, we confront the problem of excluding some or all intrafirm prices, and thus discarding the heavy influence of MNEs on world trade, or including all intrafirm prices and potentially biasing the IPIs in ways we do not fully appreciate. Indeed, we know very little about how IFT and transfer pricing affect international price indexes, either theoretically or in practice.

One insight is provided by Alterman (1997a, b), who compared the US export price index with the producer price index for semiconductors. Transfer pricing was an important factor explaining price differences. Producer prices for semiconductors were generally arm's length (and falling) market prices, whereas export prices were cost plus (and flat) transfer prices. A second insight is provided by Feenstra and Shiells (1997), who hypothesized that products with rising (falling) import shares should downward (upward) bias the US import price index because import expenditure shares for the sampled firms were held constant during the sample timeframe. The authors argued that IFT should reduce this bias because transfer prices were less likely than arm's length prices to reflect economic values. Their empirical work confirmed these hypotheses: the US import price index appeared to be upward biased by about 1.5% annually as compared with an exact price index, and the bias was smaller for industries with below-average shares of IFT. The problem of rising/falling expenditure shares should plague UVIs even more than SPIs because movements in import quantities are reflected in UVIs even when prices are constant (EUROSTAT, 2001: 30–31).

In this section, we explore three issues that IFT and transfer pricing pose for the validity of IPIs:

(1) What is the 'basic' or 'representative' price for intrafirm transactions? Should IPIs use reported transfer prices or alternative pricing methods?
(2) Should IPIs exclude IFT when transfer prices do not reflect market prices?
(3) What point along the transportation chain should be the basic transfer price for calculating IPIs?

What is the 'basic' price for intrafirm transactions?

International price indexes are based on the idea that 'index numbers should relate directly to the optimizing problems of the agents engaging in the activity being measured' (Diewert, 1993: 43). Firms are assumed to be price takers, maximizing profits under perfect competition and constant returns to scale (Alterman *et al.*, 1999: 10–16). Index numbers are drawn from 'representative' or 'basic' prices for arm's length transactions in competitive markets. The basic export price is the actual price receivable by the exporter; the basic import price is the actual price payable by the importer (IMF, 2001b, Chapter 10: 7). International price indexes are therefore built on the assumption that market prices are arm's length prices reflecting marginal costs in competitive markets. This is clearly not the case where MNEs are concerned.

Because the inherent difficulties of incorporating transfer prices into IPIs, no such index has been developed. However, we can draw inferences from the microeconomic theory of transfer pricing (Diewert, 1985; Eden, 1998), which theorizes that the welfare-maximizing transfer price is the economically efficient (shadow) transfer price. In the absence of an external market for the product, the efficient transfer price is the marginal cost of the exporting affiliate or the net marginal revenue of the importing affiliate. (These are opposite sides of the same transaction.) When an external market exists for this product, the market price and the efficient transfer price are one and the same (Hirshleifer, 1956).

This analysis holds, however, only in the absence of trade barriers and interdependencies among the MNE's affiliates. Ghemawat (2003) provides empirical evidence that international product and factor markets are semiglobalized, and argues that arbitrage is a key strategy that MNEs use to take advantage of semiglobalization. Where trade barriers and income tax differentials exist, the MNE can increase its after-tax global profit through arbitrage, trading the income gains from TPM against the resource allocation costs of moving away from the efficient transfer price (Horst, 1971). Income shifting through TPM has been well documented in the literature (Eden, 1998). In addition, with interdependencies among affiliates, non-market-based prices may also be more efficient than market prices. For example, Colbert and Spicer (1995) show that, when asset specificity is high, MNEs prefer cost-based transfer prices and discourage their affiliates from using external markets. When income-shifting incentives are high, actual transfer prices may bear little relation either to market prices (if they exist) or to the 'representative' price on which the economic approach to index number theory is built.

How, then, should transfer prices be included in IPIs? We argue that transfer prices should not be taken at face value by statistical agencies and included directly in IPIs, because these prices are likely to be distorted, particularly in markets where trade barriers are high. A parallel caution is evidenced in the practices of both tax and customs authorities that require MNEs to set transfer prices following the arm's length standard, the price that two unrelated parties would have negotiated for the same product under the same circumstances (Eden, 1998). Where comparable external market prices exist, current regulations in all OECD countries require MNEs to use market-based prices. Where market prices are not available, transfer prices based on manufacturing mark-ups or distribution margins are normally acceptable under OECD transfer pricing guidelines (OECD, 1995).

As both customs and income tax authorities follow the arm's length standard, this suggests that the statistical agencies responsible for calculating IPIs should use the same approach. Where external markets exist, the *representative* or *basic* transfer price should be the arm's length price in the international market of a *product comparable*, with adjustments made if necessary to ensure comparability. There is some support for this in the IPI literature. Kravis and Lipsey (1971: 79) recommend replacing the transfer price with the *price at the first sale to an independent foreign producer* for intrafirm exports from a US parent to its foreign affiliates. However, if the MNE centralized exports in a trading company that charged one arm's length price worldwide, they recommend using upstream transfer prices (or production costs) instead of the arm's length price because they better reflect trade movements (Kravis and Lipsey, 1971: 313).

Where product comparables are not available, customs and tax authorities require MNEs to use *gross margin* methods to value intrafirm transfers. For example, in knowledge-intensive industries where organized exchanges or reference prices are typically unavailable (Buckley and Casson, 1976; Caves, 1996; Rauch, 1999), gross margin methods such as arm's length manufacturing mark-ups (cost plus) or distribution margins (resale minus) drawn from comparable firms are used to 'back into' the transfer price. This suggests that IPIs could be constructed in a similar manner, using gross margins, as a secondary method when international arm's length prices do not exist.

Should 'wrong' transfer prices be excluded?

Given the theoretical problems that TPM raises for the optimal construction of IPIs, perhaps it would be simpler to exclude IFT from the indexes. The argument for doing this is that transfer prices are not prices in the classical sense: they do not represent market-clearing forces. However, excluding IFT means that arm's length transactions must represent all international transactions, even those within MNEs. Excluding MNE activities from IPIs would also bias IPIs towards small, purely domestic firms and thereby eliminate any information about MNE behaviors in the markets they dominate.

To appreciate the extent to which the exclusion of intrafirm trade (IFT) can limit the usefulness of IPIs, consider the following statistics from the US Census (2000). In 1999, related party trade accounted for 47% of US merchandise imports and 32% of merchandise exports, by value. The average intrafirm trade share of US exports ranged from a high of 44% with Mexico to a low of 6% with the former USSR. The average intrafirm trade share of US imports was considerably higher in two large trading partners, Japan (74%) and Mexico (66%). IFT shares also varied enormously by commodity and were particularly high for motor vehicles, electrical products, computers, and machinery (US Census, 2000).

A second alternative would be to include only transactions where the transfer price was based on an arm's length price. The BLS did this until recently. Before February 1998, the US export and import price indexes included intrafirm transactions only when the transfer price trended with market prices; all other transfer prices were excluded from the indexes. These exclusions exerted a cost in the applicability and reliability of the US export and import price indexes and led to significant under-reporting of trade with particular countries and in particular commodities. Simple counts of the numbers of items in the BLS price surveys between January 1997 and June 2000 show that approximately 25% of export items and 40% of import items were omitted because the transfer prices did not trend with market prices.

What is the 'right' transfer price along the transportation chain?

Once we conclude that it is best to incorporate all intrafirm transactions in the calculation of IPIs, there remains the equally critical issue of the stage at which the transfer price should be measured. The sequence of prices can be thought of as an international transportation chain – the chain of prices that emerges as a product moves from production in the origin country to final sales in the destination country. Measurement at different points in this chain leads to different reported prices. We argue that the 'right' stage depends on the purpose for which the IPI is to be used. Consider these alternative pricing points.

From the exporter's perspective, we start with the factory gate price, which offers the nearest approximation to producer costs. The pre-tax export price is the private sector product price (factory gate plus inland transport, insurance, and fees), which measures the economic cost to the firm of producing this product for export rather than for local sale. Increased production costs raise the pre-tax export price, but higher export taxes do not affect this price. The post-tax or water's edge export price measures the price as the product moves offshore: that is, the price includes export taxes/subsidies and value added taxes.

From the importer's perspective, the pre-tariff or water's edge import price (CIF) is the price for delivering a product to the importing country's point of entry or water's edge, including international freight and insurance but excluding tariffs and value added taxes. Because international transport costs vary with location and method of transport, this price can move separately from the pre-tax export price. From the perspective of the exporting country, this is the price for moving the exported product to the importing country's border. The post-*tariff* import price is the price of delivering a product to the importer, inclusive of the customs duty. As duties vary across countries, this price provides a measure of the cost of getting the product 'on the ground' ('over the tariff wall') in the importing country. The BLS calls this the import-for-consumption price, and uses it to calculate the impact of imports on domestic inflation and short/long-term price trends. Once onshore, the product may move through several more stages before it is sold to final consumers.[2]

The transportation chain illustrates the variety of prices that could be tracked by an IPI program. Current UVI and SPI programs track only two, one each for exports and imports. The water's edge export price is the export price used by OECD countries. The BLS calls this price the *general export* or *free-alongside-ship* (FAS) price; other governments call it the *export price (FOB)*. The BLS also collects the same price, from the importing country's perspective, as the *general import price (FOB)*. The US is alone in this regard, however; other OECD governments use the *water's edge import price (CIF)* to measure UVIs for imports (OECD, 1999a, b, 2000).

We argue that the 'right' transfer price for IPIs depends on the purpose of the index. As IPIs are used for multiple purposes, multiple transfer prices need to be tracked.[3] However, we recognize that the administrative cost associated with collecting and generating price indexes is an important constraint. SPIs are already expensive, as witnessed by the small numbers of countries that produce these indexes relative to the numbers producing UVIs. Still, it is important from theoretical and policy perspectives to assess what the appropriate transfer price should be, even if few statistical agencies at present can afford to generate multiple indexes.

For example, if the goal is to deflate balance of payments statistics for international trade – the original purpose of IPIs – the general export price (FAS) and general import price (FOB) are the correct ones as they measure the terms of trade facing a country in international markets. However, if the purpose of the IPI is to assess export competitiveness for a particular product or market, the right price depends on whether one takes an export neutrality or import neutrality perspective.[4] In assessing their competitiveness, producers need to compare the real resource costs of two alternatives – exports *vs* domestic sales – as the opportunity cost of exports to the firm is forgone domestic sales. This suggests that the appropriate price is the pre-tax export price, not the general export price. For competitive assessments between exporters from different countries in terms of sales into the same foreign market, the appropriate *import neutrality* price index should be based on the water's edge import price. The water's edge price is better for this purpose because it is unaffected by tariffs, which change over time and differ by exporting country. On the other hand, for competitiveness assessments between exporters and domestic suppliers, the appropriate import neutrality price index should go even further downstream to the ''distributor's price'' or the retail sales price. The objective in this case is to compare likely retail prices facing consumers in the importing country.

The choice among prices has another implication that arises when MNEs are vertically integrated across the transportation chain. In these instances, the MNE can manipulate transfer prices so as to realize profits at any point along the chain (Eden, 1998; Horst, 1971). Thus the choice of valuation point can significantly affect the IPI when IFT is included. The same problems arise with horizontally integrated intrafirm transactions, particularly in knowledge-intensive industries when arm's length prices are not available (Buckley and Casson, 1976; Caves, 1996; Rauch, 1999).

How weak are the signals?

We conclude that the appropriate treatment of intrafirm trade and transfer pricing is critical for ensuring that IPIs are representative and useful signals of changing conditions in global markets. But, how critical? How weak are the signals? In this section, we make a first attempt to show empirically how the intrafirm transactions of MNEs can and do affect international price indexes.

The old literature comparing SPIs with UVIs, which we reviewed above, argued that the SPI–UVI price gap depended on differences in quantities and qualities of the traded product, exchange rates, terms of payment, and the product mix (Alterman, 1991; EUROSTAT, 2001; Feenstra and Shiells, 1997; Kravis and Lipsey, 1971; Lipsey, 1994; Lipsey *et al.*, 1991). The literature also expected the price gap to be especially pronounced for knowledge-based intermediate and capital goods. As our interest lies in understanding how MNE activities affect the SPI–UVI gap, we control for the variables discussed in this earlier literature.

Our variables of interest relate to MNE activities. We hypothesize that the SPI–UVI gap will be affected by the type of trade (intrafirm *vs* arm's length), the MNE's transfer pricing method, and government policies that induce income shifting. We argue that TPM should increase with the presence of corporate income tax differentials, bilateral tax treaties, tariffs, political risk, and foreign exchange controls – the traditional policies that cause income shifting. TPM, on the other hand, should be reduced where arm's length prices are readily available, because in these cases government authorities will use the arm's length standard to constrain transfer prices, and MNEs themselves will take market prices into account when setting their transfer prices (Eden, 1998; Horst, 1971). Our model is represented by equation (1), in which IFT is a dummy variable (0=arm's length trade, 1=intrafirm trade)[5]

$$\text{PXGAP} = \alpha\text{CONTROLS} + \beta\text{IFT} + \theta\text{POLICY} + \phi\text{IFT}\times\text{POLICY} + \varepsilon \qquad (1)$$

Data and variables

Dependent variable

Our dependent variable is the SPI–UVI gap. Because international price indexes are based on month-over-month changes in prices, we do not use the simple difference between the specification price (*PX*) and unit value (*UV*), but rather the difference between *percentage changes* in *PX* and *UV*. That is, our dependent variable is *LNPXGAP*=*LN*(*PX*/*UV*)=*LNPX*−*LXUV*. We compared unit values with specification prices for US monthly import transactions at the six-digit HSCODE level, for January–June 1999. Unit values were calculated as value/volume, using the US Census's monthly CD-ROMs for US merchandise imports (US Census, 1999).[6] The specification prices come from a confidential BLS data set of monthly US import prices based on a voluntary survey of approximately 8000 companies engaged in US trade (Alterman *et al.*, 1999; BLS, 1997). We developed a concordance between the two sets at the six-digit HSCODE so our prices and unit values are HSCODE averages by country and month.

Control variables

Our control variables were selected from the earlier literature on SPIs *vs* UVIs. First, quantity changes have been used as a rationale for *LNPXGAP* as quantity changes, even with fixed prices, cause movement in UVIs. Feenstra and Shiells (1997) argued that SPIs would be less responsive to changes in intrafirm as compared with arm's length trade. We include the natural log of import quantity (*LNQ*) from the US Census CD-ROMs as a control variable.[7] If importers switch quantities to cheaper inputs in response to cost-cutting pressures, holding prices constant, UVI would fall whereas SPI would be unchanged. We therefore expect *LNQ* to be positively correlated with *LNPXGAP*.

Second, perhaps the most important factor influencing *LNPXGAP*, according to the literature, is changes in quality and product features. UVIs ignore these changes; however, the BLS takes them into account through the creation of a link price to the transaction price. Using this information in the BLS data set, we include a dummy-variable *LINK* (0=no link; 1=link) for quality changes; we expect its sign to be positively related to *LNPXGAP*. As a second proxy for product characteristics, we use the ABSORB routine and AREG ROBUST in STATA 6.0 to include dummy variables for each of the 1641 HSCODEs in our sample.

Third, a key difference between UVIs and SPIs is that UVIs include all international transactions, whereas the IPIs are derived from a volunteer survey of a relatively small number of items, with a high non-response rate (in any given month, 30% of BLS import items do not have reported prices). To handle this problem, we first group our observations by $HSCODE \times COUNTRY \times MONTH$, and discard all grouped observations that do not appear in both data sets. Our final data set consists of 19,635 observations, based on 1641 HSCODEs and imports from 103 countries.[8] Second, where a monthly observation is missing, the BLS imputes a price based on the average price movement of other transactions in the same group. We use *PXFLAG* as a dummy variable to take account of imputed prices by the BLS (0=no imput, 1=imput) and expect *PXFLAG* to be positively related to *LNPXGAP*.

Fourth, exchange rates have been hypothesized as an explanation for differences between UVIs and SPIs. We control for this possibility using *LNEXRATE*, the natural log of the US dollar equivalent exchange rate on a monthly basis; our data are from IMF (2001a). Clausing (2001) found that movements in the US dollar equivalent were positively related to US export and import prices. To the extent that specification prices more accurately reflect exchange rate changes (pass through) compared with unit values, we expect *LNEXRATE* to be positive.

We also control for dollar-invoiced imports. Almost 90% of imports in the BLS data set are invoiced in US dollars, the rest almost entirely in the exporter's home currency. We expect dollar-invoiced imports to be less sensitive to exchange rates and therefore predict a negative sign on the dummy-variable *INVOICE* (1=invoiced in US currency; 0=all others).

Fifth, we include four control measures related to the transportation chain. Although both US Census and the BLS price data should be in FOB terms, in practice the BLS takes both FOB and CIF prices. Each item in the BLS data set has a tag for the type of price basis. We used these tags to generate a dummy-variable *FOBCIF* (0=FOB, 1=CIF) to test whether differences in the point at which prices are measured along the transportation chain affect *LNPXGAP*. To the extent that BLS prices are CIF based, we expect a positive sign on *FOBCIF* because specification prices should be higher than unit values.

As an additional control for transport costs, we used Feenstra's (1996) CD-ROM for US trade flows, which reports FOB and CIF import prices, to calculate average insurance and freight rates as a percent of the CIF import price, by three-digit SITC and by country. *LNCIF* is the natural log of 1 minus this variable as a proxy for CIF rates.[9] Again, to the extent that specification prices are CIF while unit values are FOB, we expect higher freight and insurance costs to be positively related to *LNPXGAP* so the sign on *LNCIF* should be negative. We also include *LNDIST*, the natural log of the great circle distance between capital cities, as a proxy for the length of the transportation chain; again, expecting *LNPXGAP* to be positively related to this distance measure. For example, Parsley and Wei (2000) found that great circle distance had a positive impact on price differentials between paired cities in the United States and Japan. Great circle distance data were provided to us by John Byers. Last, we include dummy variables for items that were imported from the US's largest trading partners (Mexico, China, Japan, UK); the largest (Canada) was dropped due to multicollinearity with *LNDIST* (US Census, 2000). *A priori*, we have no expectation as to the signs on these country dummies.

Our final control variable provides a link between traditional explanations for *LNPXGAP* and our MNE-related explanations. Quality and product characteristic changes should be greatest for differentiated products where organized exchanges and/or reference prices do not exist (Rauch, 1999). Thus *LNPXGAP* should be positively related to highly differentiated products and negatively related to commodities traded on organized exchanges (e.g., London Metal Exchange). In addition, TPM should be highest for differentiated products where arm's length prices do not exist. To test these hypotheses, we adopted Rauch's (1999) five-digit SITC Revision 2 classification of product markets as 0 (organized exchange), 1 (reference prices), or 2 (differentiated products). We developed a concordance between Rauch's scales and our six-digit HSCODE and generated the variable *RAUCH*, ranging from 0 to 2, to proxy for the increased probability that external market prices exist. From this variable we created *RAUCHOE* (organized exchange), *RAUCHREF* (referenced prices), and *RAUCHDIF* (differentiated products).[10] We include *RAUCHOE* and *RAUCHDIF* as control variables, expecting a negative sign on *RAUCHOE* and a positive sign on *RAUCHDIF*.

Independent variables

IFT is our key variable in Eq. (1), and we focus on both its direct and indirect (through the *POLICY* variables) impacts on *LNPXGAP*. The IFT dummy variable is coded, by import item, in the BLS data set.[11] As SPI is a direct measure of prices whereas UVI is (at best) an indirect measure, we expect the sign on *IFT* to be positive. That is, as the share of IFT rises within an HSCODE group, the logged gap between specification prices and unit values should increase. We also include dummy variables for the MNE's transfer pricing method. The BLS data distinguish between three methods (price based, cost based, and other). We include dummy variables for market-based transfer prices (*TPCUP*) and cost-based transfer prices (*TPCOST*). Following Alterman (1997a), we expect the sign on *TPCOST* to be negatively related to *LNPXGAP*. To the extent that arm's length prices exist, we also expect *TPCUP* to be negatively related to *LNPXGAP*.

We include six policy variables that the literature predicts will induce income shifting through TPM. We do not have any *a priori* predictions about the direct relationship between *LNPXGAP* and these policy variables (with two exceptions, see below); our predictions concern their indirect relationships through *IFT*.

Our first three policy variables are tax related; these data were hand collected, for each country in 1999, from various accounting, tax, and legal sources. *LNTXMIN* is the natural log of 1 minus the minimum statutory corporate tax rate (CIT) in the exporting country, $\ln(1-t_x)$. We expect MNEs to overinvoice US intrafirm imports from low-tax countries in order to shift profits to the low-tax location. Therefore, *LNPXGAP* should be positively related to the interaction term $IFT \times LNTXMIN$. Our second tax variable, *LNTXGAP*, measures the degree of *ring fencing* in the foreign country: that is, the gap between the minimum and maximum CIT rates, $\ln(t_x^{\max}-t_x^{\min})$, where the maximum rate includes the withholding rate on repatriated dividends. As we treat minimum CIT as the host CIT rate, our ring fencing variable measures the likelihood that the MNE will have to pay a foreign tax rate that is higher than the minimum rate. The greater that likelihood, the less should be the MNE's incentive to engage in TPM. We therefore expect a negative sign on the interaction $IFT \times LNTXGAP$.

We also include a dummy variable identifying whether the foreign country had a double tax treaty with the United States in 1999, *TREATY* (1=yes, 0=no), using the US Treasury's website list of US tax treaties. As tax treaties provide MNEs with 'stability, transparency, and certainty of treatment' (UNCTAD 2000, 2002: 81), we hypothesize that TPM should be more likely where a treaty is in force. We therefore expect a positive sign on the interaction between *IFT* and *TREATY*.

Our fourth policy variable is the US tariff rate. Using Feenstra's (1996) CD-ROM, we created average US tariff rates by six-digit HSCODE and country.[12] Our *LNTARIFF* variable is $\ln(1-\tau)$, where τ is the tariff rate. Both SP and UV prices are measured on a pre-tariff basis; however, if the US is a price maker in world markets (which we assume it is), the incidence of the US tariff will fall at least partly on foreign exporters, depressing their FOB export prices. Thus higher US tariff rates should be associated with lower specification prices, and the direct relationship between *TARIFF* and *LNPXGAP* should be positive. From an IFT perspective, higher US tariffs should encourage underinvoicing. Therefore the indirect effect of the tariff, measured by the interaction term $IFT \times LNTARIFF$, should also be positive.

As a general measure of policy instability, we include political risk. Using the monthly composite risk rating from the International Country Risk Guide (ICRG), we construct *LNPOLRSK*, the natural log of the ICRG ratings (our data are reversed as ICRG gives a high rating to a low-risk country). We expect underinvoicing from high-risk countries, so the interaction term between *IFT* and *LNPOLRSK* should be negative.

Lastly, we include a dummy-variable *EXCNTRL* for countries with foreign exchange controls in 1999; the data were hand collected from various tax, accounting, and legal sources. We used a three-level format (0=no controls, 1=minimal controls, 2=high controls). To the extent that foreign exchange controls act as a tax on foreign exports, the direct impact of *EXCNTRL* on *LNPXGAP* should be positive. We expect MNEs to underinvoice US intrafirm imports to avoid these controls, so the indirect effect *IFT* × *EXCNTRL* should be negative.

Empirical results

Table 1 provides descriptive statistics for our variables. We include pairwise correlations with *LNPX*, *LNUV*, and *LNPXGAP*. In general, the signs for *LNPX* and *LNUV* are in the same direction, with the correlations being larger for *LNUV*. *IFT* is positively related to both price measures. *LNPXGAP* is most strongly correlated with *LNQ* (0.31), *FOBCIF* (0.14), *RAUCHDIF* (−0.18), and *LNTARIFF* (0.17).

Because we have cross-section, time-series data with a large dummy-variable set, we use the AREG ROBUST regression technique with White-corrected standard errors in STATA 6.0. All variables, other than dummy variables, are measured in natural logs. Our results are reported in Table 2. The regressions include 1641 absorbed dummy variables for HSCODE and five dummy variables for months 2–6, which are not reported. We follow a hierarchical approach, first regressing the dependent variable *LNPXGAP* against the control variables (stage 1), next adding the IFT variables (stage 2), then adding the *POLICY* variables (stage 3), and finally including interaction terms between *IFT* and the *POLICY* variables (stage 4). We adopt the conservative two-tailed *t*-test for significance, and report the change in F distribution as we add new variables. Column 5 reports the predicted signs for each variable.

The adjusted R^2 squared ranges from 0.6781 to 0.6818 across the four regressions. The change in F is significant as we move from one regression to the next, showing that our model in Eq. (1) has good explanatory power. In regression 4, where interaction terms with *IFT* are included, the Chow test result is 13.61 and also strongly significant, implying that *IFT* is a moderator of the relationship between *POLICY* variables and *LNPXGAP*.

The signs on most of the control variables are as predicted, with the exception of *LNEXRATE*. The most representative regression is Stage 3, where all the variables are included. As hypothesized, both *RAUCH* variables have the predicted signs. As our regression is in logs, the coefficient on each variable measures the responsiveness of the price gap to a change in an independent variable, *Ceteris paribus*. Thus a 10% increase in the quantity purchased of product at the six-digit HSCODE level causes a 2% increase in the gap between specification prices and unit values, *Ceteris paribus*.

The sign on the IFT variable is positive and significant. It suggests that a 10% increase in the share of IFT, within a six-digit HSCODE, causes *LNPXGAP* to rise by 1.3%. The transfer pricing method, however, can offset this tendency, as market- and cost-based transfer prices tend to reduce the price differential (although only market-based prices are statistically significant).

The two direct effects of government policies (the tariff and foreign exchange controls) on *LNPXGAP* are both significant and have the expected signs. Interestingly, *POLRSK* is also significant and positive. In stage 4, the *POLICY* × *IFT* interaction terms are significant and large, with the exception of *LNPOLRSK*. *IFT* retains its significance, implying that IFT has both direct and indirect impacts on *LNPXGAP*. All the interaction signs have the predicted signs with the exception of *TARIFF*. Although the sign on *TARIFF* × *IFT* is negative, contrary to our prediction, the direct impact increases from 2.735 to 3.336 percentage points as hypothesized. When US imports are sourced from low-tax countries through IFT, *LNPXGAP* increases by 2.466 percentage points. Ring fencing also significantly contributes to the logged price gap, in the presence of IFT. Lastly, foreign exchange controls encourage MNEs to underinvoice US intrafirm imports, dampening *LNPXGAP*, as expected.

Discussion and conclusions

The National Academy of Sciences, in its report *Behind the Numbers* (Kester, 1992: 16), recommended that US government agencies develop better statistical measures for 'capturing in more detail the rapidly growing intracompany trade and trade in intermediate inputs'. The report argued that US businesses were facing increasingly complex issues due to globalized markets, such as weighing opportunities to sell at home *vs* abroad, to produce for export or undertake FDI, and to import components or source locally. At the same time, governments needed better data in order to coordinate macroeconomic policies, negotiate improved access to foreign markets, and assess the macroeconomic effects of international transactions on the domestic economy. A key recommendation in *Behind the Numbers* was the development of an ownership-based balance of payments that would better measure the activities of US multi-

Table 1 Descriptive statistics and pairwise correlations

Variable	*Mean*	*s.d.*	*Min*	*Max*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*
1 *LNPXGAP*	-0.082	2.502	-22.01	11.74																													
2 *LNPX*	3.193	3.269	-13.82	17.70	0.52																												
3 *LNUV*	3.275	2.901	-5.79	17.72	-0.27	0.68																											
4 *LNQ*	8.854	3.146	0	18.65	0.31	-0.52	-0.85																										
5 *LINK*	0.003	0.046	0	1	0.02	0.01	-0.01	0.01																									
6 *PXFLAG*	0.674	0.807	0	2	0.01	-0.03	-0.05	0.02	-0.04																								
7 *FOBCIF*	0.335	0.452	0	1	0.14	-0.12	-0.25	0.25	0.01	-0.01																							
8 *LNCIF*	0.472	0.033	-0.49	0.50	-0.07	0.14	0.23	-0.16	0.00	-0.02	-0.15																						
9 *INVOICE*	0.904	0.278	0	1	0.03	-0.10	-0.15	0.15	0.01	0.09	0.11	-0.09																					
10 *LNEXRATE*	-2.836	2.398	-12.72	1.20	0.03	0.08	0.07	-0.02	-0.01	-0.01	-0.01	0.08	-0.12																				
11 *LNDIST*	8.885	0.746	6.61	9.70	-0.05	-0.08	-0.05	-0.10	-0.01	0.00	-0.02	-0.10	0.04	-0.36																			
12 *CANADA*	0.066	0.249	0	1	0.03	0.03	0.01	0.10	0.00	-0.01	-0.01	0.08	0.00	0.27	-0.81																		
13 *MEXICO*	0.048	0.214	0	1	0.01	-0.05	-0.07	0.15	0.00	0.04	-0.01	0.11	0.08	0.05	-0.26	-0.06																	
14 *CHINA*	0.087	0.282	0	1	0.01	-0.09	-0.11	0.07	0.01	0.03	-0.02	-0.09	0.10	0.09	0.18	-0.08	-0.07																
15 *JAPAN*	0.120	0.325	0	1	-0.04	0.08	0.13	-0.09	0.00	-0.05	0.04	0.12	-0.09	-0.30	0.20	-0.10	-0.08	-0.11															
16 *UK*	0.047	0.212	0	1	0.04	0.12	0.11	-0.10	-0.01	0.00	-0.01	0.05	-0.08	0.31	-0.06	-0.06	-0.05	-0.07	-0.08														
17 *RAUCHOE*	0.054	0.226	0	1	0.10	-0.08	-0.18	0.21	0.00	0.00	0.18	-0.05	0.04	0.04	-0.09	0.07	0.01	-0.04	-0.05	0.00													
18 *RAUCHDIF*	0.746	0.435	0	1	-0.18	0.15	0.33	-0.37	-0.01	0.01	-0.47	0.24	-0.06	-0.05	0.17	-0.11	-0.02	0.10	0.05	0.01	-0.41												
19 *PRIMARY*	0.149	0.357	0	1	0.15	-0.15	-0.30	0.31	-0.01	0.00	0.28	-0.33	0.06	0.02	-0.16	0.12	0.04	-0.07	-0.12	-0.02	0.34	-0.54											
20 *MFGMLT*	0.065	0.247	0	1	-0.09	0.06	0.15	-0.15	-0.02	0.00	-0.09	0.05	-0.04	-0.04	0.05	-0.05	-0.01	0.00	0.03	-0.01	-0.06	0.15	-0.11										
21 *MFGHT*	0.785	0.410	0	1	-0.07	0.10	0.17	-0.17	0.02	0.00	-0.18	0.26	-0.03	0.01	0.11	0.08	-0.03	0.05	0.08	0.02	-0.25	0.37	-0.80	-0.50									
22 *IFT*	0.359	0.457	0	1	-0.01	0.16	0.19	-0.10	0.01	-0.01	-0.01	0.14	-0.08	0.13	-0.12	0.02	0.06	-0.19	0.18	0.09	-0.05	0.05	-0.16	-0.02	0.15								
23 *TPCUP*	0.056	0.212	0	1	0.02	0.04	0.03	0.03	0.01	0.00	0.04	0.00	0.00	0.00	-0.02	0.00	0.01	-0.06	0.06	0.02	0.04	-0.04	-0.03	-0.02	0.04	0.33							
24 *TPCOST*	0.024	0.141	0	1	-0.02	-0.02	0.00	0.03	0.01	-0.02	-0.04	0.01	-0.01	0.05	-0.12	0.07	0.10	-0.05	0.01	0.01	-0.02	0.01	0.04	-0.03	-0.01	0.22	-0.03						
25 *LNTXMIN*	-0.446	0.179	-0.80	0.00	0.01	-0.10	-0.12	0.08	0.00	0.03	-0.07	-0.10	0.14	0.20	0.07	-0.07	0.02	0.31	-0.27	0.11	-0.01	0.05	0.01	-0.01	0.00	-0.09	-0.01	-0.02					
26 *LNTXGAP*	0.048	0.042	0	0.27	-0.02	-0.11	-0.12	0.06	0.01	0.02	-0.03	-0.13	0.08	0.01	0.09	0.07	-0.25	0.46	-0.14	-0.25	-0.05	0.05	-0.01	0.03	-0.01	-0.15	-0.05	-0.03	0.54				
27 *TREATY*	0.790	0.407	0	1	0.03	0.14	0.14	-0.09	0.00	-0.01	0.09	0.12	-0.14	-0.03	-0.18	0.14	0.12	0.16	0.19	0.11	-0.04	-0.03	-0.04	-0.05	0.06	0.18	0.07	0.04	-0.40	-0.17			
28 *LNTARIFF*	-0.049	0.052	-0.59	0	0.17	0.10	-0.04	0.16	0.00	-0.06	0.21	-0.06	-0.02	0.17	-0.29	0.22	0.11	-0.09	0.03	0.06	0.16	-0.21	0.26	-0.17	-0.12	0.14	0.04	0.05	-0.06	-0.10	0.13		
29 *LNPOLRSK*	3.089	0.338	2.26	4.00	0.04	-0.16	-0.22	0.21	0.00	0.08	0.03	-0.20	0.26	-0.32	0.15	-0.18	0.28	0.13	-0.26	-0.10	0.07	-0.04	0.14	-0.01	-0.11	-0.25	-0.08	-0.02	0.17	0.03	-0.16	-0.07	
30 *EXCNTRL*	0.751	0.801	0	2	0.00	-0.11	-0.13	0.07	0.01	0.03	0.01	-0.12	0.16	-0.22	0.41	-0.25	-0.21	0.48	0.11	-0.21	-0.01	0.08	-0.06	0.03	0.03	-0.24	-0.06	-0.09	-0.02	0.26	-0.24	-0.15	0.29

Note: Pairwise correlations greater than 0.015 are significant at the 5% level.

Table 2 *LNPXGAP*

LNPXGAP	*Stage 1*	*Stage 2*	*Stage 3*	*Stage 4*	*Predicted*
CONSTANT	−1.645**	−1.751**	−2.073**	−2.479***	
LNQ	0.211***	0.216***	0.204***	0.203***	+
LINK	0.248	0.236	0.209	0.180	+
PXFLAG	0.057**	0.055**	0.052**	0.053**	+
LNEXRATE	−0.021**	−0.022**	−0.018*	−0.010	+
INVOICE	−0.195**	−0.194**	−0.260***	−0.256***	−
FOBCIF	0.120*	0.120*	0.106†	0.098†	+
LNCIF	−3.478***	−3.387***	−2.944***	−3.179***	−
LNDIST	0.055*	0.057*	0.055†	0.038	+
MEXICO	−0.054	−0.071	−0.083	−0.184*	
CHINA	0.046	0.046	−0.045	0.055	
JAPAN	−0.408***	−0.410***	−0.374***	−0.257***	
UK	0.551***	0.543***	0.616***	0.437***	
RAUCHOE	−4.087***	−4.082***	−3.982***	−3.909***	−
RAUCHDIF	1.527**	1.506**	1.484**	1.561**	+
IFT		0.114*	0.133**	1.289**	+
TPCUP		−0.478***	−0.447***	−0.484***	−
TPCOST		−0.149	−0.168	−0.136	−
LNTXMIN			0.011	−0.506***	
LNTXGAP			0.389	0.987†	
TREATY			−0.055	−0.179**	
LNTARIFF			2.735**	3.336**	+
LNPOLRSK			0.135*	0.300***	
EXCNTRL			0.087**	0.071*	+
IFT × LNTXMIN				2.466***	+
IFT × LNTXGAP				−6.080***	−
IFT × TREATY				0.405***	+
IFT × LNTARIFF				−4.816***	+
IFT × LNPOLRSK				−0.133	−
IFT × EXCNTRL				−0.182**	−
No. of obs.	19,635	19,635	19,635	19,635	
Adjusted R^2	0.6781	0.6788	0.6799	0.6818	
F	35.2***	31.48***	26.96***	24.10***	
ΔF		6.02***	9.17***	15.00***	
Chow test				13.61***	

Note: Two-tailed *t*-test levels: ***$P<0.001$, **$P<0.01$, *$P<0.05$, †$P<0.10$.

nationals by including their foreign affiliates and by highlighting the importance of intrafirm transactions in US trade flows.[13]

The same issue raised in *Behind the Numbers* – IFT – is the key problem for international price indexes. In this paper we have explored the question: What impacts do MNEs have on the validity of international price indexes? First, we reviewed the earlier debate over unit values *vs* specification prices. Second, we explored three ways in which MNEs affect the validity of IPIs: determining the 'representative' transfer price, excluding some or all intrafirm transactions from the index, and choosing the 'right' transfer price along the transportation chain. Third, we argued that IFT strengthens the case for using SPIs instead of UVIs. We empirically tested this hypothesis by regressing the logged gap between US specification prices and unit values against MNE activities and their interaction with government policies. Our results suggest that MNEs have pervasive impacts that are reflected in large differentials between logged specification prices and unit values.

Our conclusions support the superiority of specification prices on the grounds that SPIs are better able than UVIs to handle the activities of MNEs. UVIs, by deflating value by volume, simply ignore the problems caused by IFT and transfer pricing. As the share of IFT rises, these problems are exacerbated. Our results show that the gap between specification prices and unit values widens by 1.3% for every 10% increase in the share of IFT. These results are even stronger where government policies encourage TPM. Given that IFT accounts for nearly half of US imports and three-quarters of US trade with Japan, it is clear that the problems of IFT can be critical to the assessment of conditions and changes in important markets.

To our knowledge, this paper is the first empirical attempt to measure the factors – both traditional explanations and MNE activities – that can drive a wedge between specification prices and unit values. Our empirical test could be extended in several ways, for example by lengthening the time period and testing US exports in addition to US imports. Our analysis could also be tested in other countries, such as Germany and Sweden, which also produce SPIs. For smaller countries, where MNEs may bulk even larger as a share of exports and imports, we anticipate that our results would be even more dramatic.

We conclude that the case against the UVI is far stronger than first supposed. If international price indexes are the single most important data signal of trade and competitiveness in international markets, the only strong signal is the still uncommon SPI.

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Notes

[1]The BLS started producing annual US export and import price indexes in 1968 using unit values (Alterman, 1988: 36). The first BLS specification price indexes were published in 1973; SPIs for all US exports and imports were available by the mid-1980s. The US Census Bureau continued to produce UVIs until the BLS assumed full responsibility for all international price indexes and discontinued UVIs in 1989. US export and import price indexes are now calculated monthly, using collected prices for 20,000–25,000 goods and 1500–2000 service items (BLS, 1997: 154–157), covering 90–95% of US trade (Alterman, 1991: 113).

[2]For example, assume a product (e.g., a computer keyboard) moves from a Taiwanese manufacturer (e.g., Acer) to a US distributor (e.g., Wal-Mart) for US retail sale. Acer's price consists of standard cost ($55) plus a gross profit mark-up of 20%. There are inland transport costs (freight, insurance, fees) in each country ($14 Taiwan, $10 US), along with international transport costs ($15). Assume Taiwan levies a 25% export tax and the US government a 10% tariff. Assume Wal-Mart's gross profit margin is 10% of the US retail price. From the exporter's perspective, the factory gate price is $66, the pre-tax export price is $80, and the general export price (FAS) is $100. From the importer's perspective, the general import (FOB) price is $100, the pre-tariff import price (CIF) is $115, the post-tariff import price is $125, the price inclusive of inland freight and insurance is $135, and the retail price is $150.

[3]This is a variation of the well-known policy prescription that the number of policy tools must be at least as large as the number of policy goals.

[4]The analogy is from the international tax literature, which distinguishes between capital export neutrality (exporters of capital should earn the same after-tax return abroad as at home) and capital import neutrality (investments in the host country should earn the same after-tax return regardless of ownership). See Eden (1998: 73–79).

[5]BLS data are measured at the individual item level, whereas our dataset concordance is at the six-digit HSCODE. As a result, our IFT measure is an average for each HSCODE classification.

[6]We divided general imports customs value (*GEN_VAL_MO*) by general imports 1st unit of quantity (*GEN_QY1_MO*), and dropped observations when either quantity or value was missing.

[7]As specification prices are normally in terms of a unit quantity, one can interpret *LNQ* as $\ln[Q(PX)]-\ln[Q(UV)]=\ln(1)-\ln[Q(UV)]=-\ln[Q(UV)]$. We use monthly QY1, from the US Census CD-ROMs, to calculate *LNQ*.

[8]The overlap is small, about 10%. We could have increased the overlap, in theory, by extending the number of months, aggregating products (e.g., to the three-digit HS code), or matching only by $HSCODE \times COUNTRY$. Each alternative has its own costs.

[9]There are holes in the data, most notably that FOB prices are often absent for former USSR countries. For missing data, we imputed transport costs by three-digit SITC based on the nearest country. In some cases, only country averages could be calculated.

[10]Using a concordance from five- to three-digit codes meant that our scales vary from 0 to 2. Products with Rauch numbers between 0 and 0.667 were classified as organized exchanges, between 0.667 and 1.34 as referenced markets, and over 1.34 as differentiated markets.

[11]The BLS data set is the only data set available that codes each international transaction as intrafirm or interfirm trade. For example, although confidential US Census tapes contain the IFT identifier, it is widely recognized to be inaccurate. Publicly available data do not even contain this field, although some authors (Pak and Zadanowicz, 1994) have incorrectly used the Census data to claim transfer price manipulation.

[12]We also created monthly duty rates from the US Census CD-ROMs, but these performed less well than annual rates from the Feenstra CD-ROM.

[13]Landefeld *et al*. (1993) subsequently developed and compared the NAS proposal with two other ownership-based approaches. In all three proposals, the valuation of intrafirm transfers was a critical component in measuring MNE activities.

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