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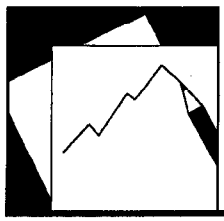

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Domestic Petroleum Price Smoothing in Developing and Transition Countries

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Domestic Petroleum Price Smoothing in Developing and Transition Countries

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Abstract

This paper examines the case for government-led smoothing of domestic petroleum prices in the face of volatile international prices. Governments in most developing and transition countries engage in petroleum price smoothing, as the survey of country practice carried out for this paper shows. This paper reviews the potential welfare implications of petroleum price volatility, and assesses different price smoothing rules on the basis of historical oil prices. These simulations reveal the presence of a sharp trade-off between price smoothing and fiscal stability, suggesting that developing and transition country governments should engage in limited price smoothing and, if possible, rely on hedging instruments to do so.

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Contents

I. INTRODUCTION

This paper examines the case for smoothing retail petroleum prices in the face of volatile international oil prices in developing countries where petroleum prices are regulated by the government. This is an important policy question in many developing countries, given the high volatility of international oil prices, the potentially significant fiscal exposure of many governments to petroleum price changes, and the high political profile of petroleum prices.

In a competitive market economy the case for full and automatic pass-through of international price changes to domestic retail prices is strong, on both economic and institutional grounds. Full pass-through allows for a correct price signal, which enhances efficiency, and does not expose the government to undue fiscal volatility as a result of variable oil prices. However, most of the developing country governments which regulate petroleum prices do not implement automatic and full pass-through mechanisms when setting these prices. A survey of selected developing countries conducted for this paper reveals that most adopt a discretionary approach to changes in petroleum retail prices, which commonly fails to pass-through changes in international prices on a consistent basis. This suggests that, at least from a political economy perspective, full cost pass-through is not a robust policy reform.

This paper seeks to explore whether, and under what conditions, petroleum pricing mechanisms—which provide a degree of insulation to the private sector from international oil price volatility—can offer welfare-enhancing and potentially more politically sustainable alternatives to full cost pass-through mechanisms.

The paper approaches this issue by first considering the consumer welfare implications of volatile oil prices, and the mechanisms which might be available to private sector agents in developing countries to protect themselves against the impact of this volatility. It concludes that retail petroleum price volatility is likely to have a negative welfare impact on consumers, and that while the private sector in developing countries is probably able to manage routine variations in oil prices, there may be scope for efficient government intervention to insulate the private sector from sharp shifts in oil prices.

The paper then explores the case for government-managed retail price smoothing. We first consider a number of potential pricing rules which diverge from full pass-through and provide a degree of price smoothing. The price properties associated with these rules and the fiscal implications of implementing such rules for the government are assessed on the basis of historical oil prices. The paper concludes that there appears to be a sharp trade-off between retail price insurance and government fiscal stability in the face of volatile prices, and that most pricing rules leave the government over-exposed to oil price risk, especially given the institutional difficulties associated with volatile fiscal revenues.

The paper then considers and illustrates a possible hedging strategy, based on futures purchases, for a government wishing to smooth domestic petroleum prices. This has the advantage relative to pricing mechanisms based on spot prices of relying directly on market-based mechanisms for price insurance, and as such it appears potentially able to deliver significant price smoothing with relatively limited fiscal exposure.

The paper concludes that full pass-through of international price changes may be sub-optimal, especially in the face of large shocks. However, governments in developing countries are not well equipped to deal with the significant fiscal risk which can be associated with price smoothing activities. They should, therefore, introduce relatively limited partial pass-through mechanisms (e.g., short moving averages of past prices), or rely on market-based insurance mechanisms to reduce oil price-risk.

II. Background: The Economic Relevance of Petroleum Prices and Current Practice of Petroleum Pricing in Developing Countries

The level of petroleum product retail prices is an important economic variable for both the public and the private sectors in many developing countries, and decisions on the degree of pass-through of changes in international oil prices have significant economic impact on one or both of the sectors.

Domestic taxation of petroleum products is a large source of revenue for many developing countries: it generally accounts for about 7–30 percent of overall revenue, which corresponds to 1–3½ percent of GDP. This is achieved by relatively heavy taxation of petroleum products, which varies by region and petroleum product, reflecting oil availability, and distributional and efficiency considerations. In most countries, and for most petroleum products, there is, therefore, substantial scope for retail price smoothing by varying the level of taxation.

Many developing countries are also significantly exposed to oil prices at a macroeconomic level. This can be illustrated by considering the net oil balance as a percentage of GDP for oil-importing countries. For a sample of 42 developing country net oil importers, most countries' exposure to oil price changes in 1999[2] was in the order of 1–4 percent of GDP.

The substantial economic impact of changes of both international and retail petroleum prices and of taxes on petroleum products implies that the adjustment of domestic prices to international oil prices is an important economic and political issue in many developing countries. If adjustment is complete (full pass-through) the government is relatively insulated

[2] The average crude oil price in 1999 was of $18.1 a barrel, close to the nominal average for the period 1987-2000.

from a fiscal point of view,[3] and the private sector bears the volatility in real income. If adjustment is incomplete, this might be reversed. This trade-off between private and public income volatility poses a difficult policy question because of the high volatility of crude oil prices.[4]

In spite of often substantial policy focus on the issue, reforms of domestic petroleum pricing mechanisms towards systems of automatic and full pass-through have been slow, and frequently reversed in recent years. This can be seen from the survey of current country practice on petroleum pricing, which shows that most of the 45 transition and developing countries in our sample[5] appear to both regulate petroleum pricing, and adopt some form of partial and discretionary pass-through mechanism.

The findings of the survey are summarized in Table 1, which reveals three key stylized facts about current petroleum pricing policies in developing countries:

- *A significant majority of the countries surveyed regulate petroleum prices* (either at the retail or ex-refinery level). Even those governments which have deregulated prices exert pressure on oil companies to moderate their price increases (e.g., as in Thailand and the Philippines during the international price hike of 2000), and still play a role in the price-setting process.

- *Only a minority of countries have an automatic mechanism* for adjusting retail prices to changes in international prices. Of these, the majority currently operate a full pass-through mechanism, even though a number of these mechanisms have stopped being implemented in the course of 2000, due to the pressure from high international prices.

- *Approximately one-quarter of countries which regulate prices run specific stabilization funds* to manage the price smoothing process. Some countries have recently abolished their funds because of their fiscal implications (see below for a discussion of stabilization funds).

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[3] The nature of oil taxes (specific vs. ad valorem) and the price elasticity of demand has a bearing on the degree of insulation. Fiscal stability is enhanced with specific taxation of oil products and low elasticities of demand.

[4] See Wickham (1996) for a detailed discussion of the volatility of oil prices.

[5] The countries surveyed were: (Africa) Côte d'Ivoire, Guinea, Kenya, Mozambique, Nigeria, Senegal, South Africa, Tanzania, Togo, Uganda, and Zambia; (Asia) China, Korea, Mongolia, Philippines, Papua New Guinea, Thailand, and Vietnam; (Europe) Armenia, Azerbaijan, Georgia, Kyrgz Republic, Moldova, Russia, and Ukraine; (Middle East) Algeria, Egypt, Iran, Jordan, Mauritania, Morocco, Pakistan, Sudan, Tunisia, Turkey, and Yemen; and (Western Hemisphere) Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, and Venezuela.

Table 1. Summary of Survey Results

Area	Surveyed	Oil Importers	Regulate Retail Petroleum Prices	Have an Automatic Pass-through Mechanism	Have Full Pass-through	Have a Stabilization Fund
Africa	11	10	8	3	2	1
Asia-Pacific	7	5	4	1	1	1
Europe	7	5	3	0	0	2
Middle East	11	6	11	4	3	1
Western Hemisphere	9	5	7	3	2	3
Total	45	31	33	11	8	8
Percent of total	100	69	73	24	18	18
Percent of countries with regulated prices			100	33	24	24

Source: IMF staff projections and estimates.

III. Oil Price Volatility and its Welfare Implication for Consumers

The economic literature on the welfare implications of price volatility shows that there exist three main drivers of cost and benefits to consumers from price instability: (i) arbitrage and substitution possibilities; (ii) risk-aversion; and (iii) adjustment costs.

Arbitrage and substitution

If consumers are able to vary the level of consumption of a good characterized by unstable prices, substituting away from it in high-price periods and consuming more in low price periods, they may actually benefit from exogenous price instability. This insight is originally due to Waugh (1944), and has subsequently been generalized by others (e.g., Massell, 1969).

Risk-aversion

Risk-averse consumers may prefer stable to unstable prices, given that the marginal utility they gain from high consumption periods (e.g., periods characterized by low petroleum prices), is lower than marginal utility from low consumption periods (Newbery and Stiglitz, 1981). This effect works against the substitution effect highlighted above. Turnovsky, et al. (1980), examine the nature of this trade-off, combining risk-aversion with the "Waugh" effect to show that with a high income share of the good in question, high coefficients of risk-aversion and low elasticities (both income and price elasticity), consumers prefer price stability and reductions in

price volatility.[6] As pointed out by Gilbert (1993), these conditions may yield an ambiguous answer as to whether petroleum price stability is desirable: the demand for petroleum products is relatively price inelastic, and expenditure shares on petroleum tend to be high (both of which point to benefits from price stability) but income elasticities are also high, which suggests price instability may be welfare-improving.

Adjustment costs

Consumers of petroleum products (both households and firms) may face costs of adjusting their economic activities (consumption and/or production) in the face of volatile petroleum prices.[7] These would lead them to prefer stable prices, which do not lead to volatile real incomes (for households) and costs (for firms), and which, therefore, do not require adjustment.

Moreover, depending on the nature of these adjustment costs, consumers will also prefer some unstable price profiles to others. For instance, if adjustment costs are convex (i.e., they display increasing marginal costs), they would prefer gradual price changes to sudden price changes.[8] If adjustment costs are mainly fixed, consumers will tend to react only to large and persistent price changes (adopting *(S,s)* type of rules[9]).

For both types of adjustment technology (convex and concave), the costs of adjusting may often be effectively sunk (i.e., they cannot be recovered once they have been incurred), which would induce "wait and see" behavior by consumers, arising from the option value of deferring adjustment with a volatile price.[10]

A. Optimal Consumption Behavior with Volatile Oil Prices

This brief review of welfare effects shows that consumers' preference for price stability relies crucially on the presence of risk aversion and/or adjustment costs. The high impact of

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[6] Turnovsky, et al. (1980), show that the sign of the benefit (loss) from price stability has the same sign as the following expression: $s(R-\eta)+e$ where s is the budget share of the good in question, R is the coefficient of relative risk aversion, η is the income elasticity of demand, and e is the price elasticity of demand (which is negative).

[7] The precise nature of this effect is likely to differ between households and firms. Households may face costs in changing consumption bundles, and in adapting to a new level of income. These may take place due to "learning-by-doing" effects and sub-optimal changes in expenditure patterns when disposable income varies rapidly (e.g., expenditure-cutting when income falls may hit items which are the easiest, rather than most appropriate, to cut). Firms, on the other hand, may face adjustment costs in the form of the investment required to adapt their production technology to the level of oil prices.

[8] This implies that, if they can, they will only partially adjust when hit by a price shock (see Nickell, 1985).

[9] (S,s) rules describe behavior by which adjustment takes place when the underlying variable that determines the optimality of adjustment is below a given "floor" level (s) or above a "ceiling" level (S).

[10] See, for instance, Dixit (1992).

consumption of petroleum products on households' and firms' budgets, the relatively low price elasticity of demand for these products, and the likely presence of both risk-aversion and adjustment costs all seem to suggest that consumers would prefer to have stable petroleum prices.

In a regime of full spot price pass-through with volatile oil prices, agents can, therefore, be expected to attempt to engage in risk-coping activities, and to try to attain an optimal consumption path.[11] This, in turn, will depend on the nature of the price shocks they face, their attitude to risk, and their adjustment technology.

If a price shock is known to be *temporary,* risk-averse consumers and/or consumers with any kind of adjustment costs will try to *stabilize* consumption and consume at the permanent level of disposable income. Dissavings would, therefore, occur in low income/high oil price periods, and savings would be made in high income/low oil price periods.

If a shock is known to be *permanent* (or very long-lasting), optimal consumption behavior will vary with the characteristics of the consumer:

- a risk averse consumer with no adjustment costs will adjust to it fully and immediately;
- a consumer with convex adjustment costs will adjust to it gradually, smoothing the path of consumption or investment (i.e., behaving as if the price path is smoother than what it actually is); and
- a consumer with fixed adjustment costs would fully adjust if the shock is large enough, and not adjust if it is small, following a *(S,s)* type of rule.

Of course, ex-ante, it is not possible to know whether a given price shock is going to be permanent or temporary,[12] and consumers will have to make adjustment decisions in the context of price uncertainty. In particular, in the case of oil prices, consumers will find it very hard to establish an expected level for spot prices, given that econometric evidence suggests that these are non-stationary, or at least subject to very slow mean reversion.[13] Temporary shocks to oil

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[11] For simplicity, we refer here only to households which consume petroleum products and to consumption-stabilization or smoothing activities. Similar arguments would apply to firms.

[12] Financial markets may help provide this information. We discuss their price-discovery role below.

[13] For instance, Cashin, et al. (1999), find that crude oil prices follow a random walk, characterized by permanent shocks. Engel and Valdes (2000), and Hausmann, et al. (1993), confirm this, with the latter finding that the price process fits a jump-diffusion process (i.e., a random walk with jumps). Other work finds that crude oil prices may be stationary, but that mean-reversion takes a long time and that a significant proportion of shocks is permanent (Mazaheri, 1999). Cashin, et al. (1999) also find that gasoline prices are stationary, but with an autoregressive coefficient which is very close to one, and that price shocks to gasoline are significantly persistent.

prices can, therefore, be very long lasting, and for practical purposes consumers should treat all shocks as potentially permanent, and, therefore, requiring adjustment.[14]

In the presence of adjustment costs, however, partial adjustment to price shocks is justified, even with non stationary-prices (e.g., Hausmann, et al., 1993). As argued above, with convex costs a smooth adjustment is optimal when faced with a permanent shock, and with concave costs no adjustment may also be optimal if the shock is not too large. Moreover, for both types of adjustment technology, the sunk nature of adjustment costs suggests that there is an option value of waiting to adjust, which consumers will try to preserve if prices are non-stationary. Consumers will, therefore, try to optimally delay adjustment, and "wait and see" if a given price shock persists before adjusting to it.

Similarly, risk-averse consumers may wish to attempt to stabilize consumption when hit by a shock of uncertain duration and nature. If this reveals itself to be very long-lasting (or permanent), adjustment to a different consumption level will be required, but at least in the short run a degree of consumption smoothing can be attempted (as long as sufficient risk-coping measures are available) to mitigate the impact of any transitory price changes.

B. Options for Financing Consumption Smoothing Behavior

The previous sub-section has argued that given the nature of oil prices, consumers may wish to engage in partial or delayed adjustment behavior, and attempt to prevent excessive volatility in consumption due to variable oil prices. This kind of consumption behavior needs to be managed and financed by consumers. For instance, if the oil price increases, a consumer attempting to smooth out consumption will have to increase overall expenditure, and will require additional funds to do so. Three options for the management of the consequences of oil price instability are discussed here, arguing that market failure considerations may affect all three, and that consumers may find it hard to finance, and therefore implement, otherwise optimal risk-coping behavior.

Credit markets

Consumers can potentially use credit markets to smooth the path of consumption in the face of volatile oil prices, and spread adjustment over time. That is, when prices rise sharply, agents could borrow to finance a gradual adjustment (in the case of convex costs) or no adjustment (in the case of concave costs and insufficiently large price changes), and gradually repay the debt. Conversely, if prices fall, agents could save, or repay old debts.

Using credit markets may be an effective option to smooth consumption, but it is likely to be of limited availability, especially in developing countries. First, standard asymmetric information and limited commitment arguments imply that many agents are credit-rationed, and, therefore,

[14] This is particularly so for upward movements in oil prices. For downward movements, prudence suggest that consumers should be cautious about treating these as permanent.

cannot access credit markets for consumption smoothing purposes. Second, given the nature of oil prices and the potential duration and magnitude of shocks, credit for consumption smoothing purposes will be particularly hard to obtain in times of high (and rising) prices because of the high risk of default creditors will perceive (see Kletzer, et al., 1991; and Deaton and Miller, 1996, for arguments along these lines).

Self-insurance

Self-insurance can finance sluggish or impartial adjustment of consumption to current oil prices as an alternative to credit markets. Agents can self-insure by accumulating precautionary savings to draw down in times of "high" (or rising) prices and pay into when prices are "low" (or falling). This option essentially corresponds to the creation of a private stabilization fund, and implements an optimal spending-and-saving rule (as derived, for instance, by Hausmann, et al., 1993), in the face of price volatility and adjustment costs.

There is evidence (e.g., Paxson, 1992, on Thai rice farmers; Bevan, et al., 1990, on African coffee producers) that self-insurance is a feasible option for private agents and that, for instance, producers engage in sensible inter-temporal behavior (e.g., they save *temporary* windfalls). For self-insurance to occur it is important, however, that private agents be in a position to accumulate assets which are sufficiently remunerative and liquid.[15] This implies that they need an appropriate macroeconomic environment where the value of liquid assets is not eroded by inflation, and where they have access to adequate saving instruments. In many developing countries, the self-insurance option may, therefore, also be limited (Fafchamps, 1999).

Even if consumers are able to accumulate adequate liquid reserves for the purposes of consumption smoothing, this may be insufficient to achieve full smoothing in the presence of large shocks. When hit by these kinds of shocks, consumers may run out of reserves and be forced into a sub-optimal adjustment of consumption.

Hedging

A direct instrument for the management of oil price risk by consumers is provided by hedging markets. These markets provide contracting tools (such as futures and call options) which buyers can use to lock-in prices and insure against short-run fluctuations.[16]

The main limitation of the use of hedging instruments in developing countries for private consumption smoothing purposes is access. Small consumers do not have access to financial instruments, given the presence of high transaction costs and the absence of intermediation in

[15] Deaton (1991) shows that if the return on the liquid assets is low (i.e., below the consumer's rate of time preference) and the income series is highly auto-correlated (e.g., as in the case of oil), consumers will not find it optimal to accumulate substantial precautionary savings, and their consumption profile will follow net income closely.

[16] This is discussed in more detail in the next section of the paper.

most developing countries. Private sector corporations may have better access to these instruments, even if this may still be limited by considerations of default risk and creditworthiness. Hedging instruments may, therefore, represent a "missing market" for many consumers in developing countries.

IV. The Scope for Government Smoothing of Retail Petroleum Prices

It is useful to start the analysis of the case for government-managed petroleum price smoothing by reviewing the standard case for the full and immediate pass-through of changes in international prices.[17] This is based on two key considerations:

Efficient pricing. If the government engages in price smoothing activities and only partially adjusts domestic oil prices to reflect international spot prices, it creates a wedge between consumer prices and the opportunity cost of oil. This entails a basic efficiency cost, that is a *distorted price signal* which creates a deadweight loss. Given the low price elasticity of demand for petroleum products, this loss may be relatively small. It may, however, be magnified by hoarding and smuggling activities[18] and should, therefore, not be under-estimated.

Institutional considerations.[19] A full pass-through rule in the context of petroleum price regulation has a number of appealing institutional properties, such as its transparency and fiscal insulation properties.[20] Full pass-through minimizes both the government's exposure to fiscal risk due to oil price variability and the risk of political interference in the price determination process, avoiding for instance the emergence of hidden price subsidies when prices rise, or "stealth" taxes when prices fall. Any case for government-run smoothing needs to address these positive efficiency and institutional properties associated with full pass-through, and demonstrate compensating benefits deriving from partial pass-through.

As argued in the previous section, these benefits could derive from the fact that there may be a market failure deriving from the absence of some consumer risk-management instruments in

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[17] Throughout this section, we assume that the government regulates the price level of petroleum products, which is the norm in developing countries. We briefly touch upon the issue of price deregulation and its potential role in allowing for retail price smoothing in Section IV.D of this paper.

[18] The former may result if consumers expect that the government will eventually pass-through a price increase. The latter may occur if price smoothing creates a price difference between petroleum products across neighboring countries, which consumers try to arbitrage. This would have the effect of increasing demand in the country which implements a partial pass-through rule when international prices rise, and depressing demand when they fall.

[19] For a fuller discussion of the political considerations of price subsidy reform, and of the economics of price subsidy reform more generally, see Gupta et al. (2000).

[20] We are assuming here, and throughout the rest of this section, that governments levy specific (rather than ad valorem) excises on petroleum products, which implies that the revenues from these excises are largely independent of the oil price (with an assumption of inelastic demand).

developing countries, which does not allow private agents to smooth their consumption path adequately. Governments may, therefore, have a role in providing a profile of retail prices which allows consumers to smooth consumption more effectively than in a full pass-through environment and which avoids unnecessary fluctuations.

A second argument against a full pass-through rule based on spot prices is that this may be politically difficult in many countries and, therefore, unstable. Petroleum price rises are very visible government interventions, and tend to attract considerable attention. There may, therefore, be "political adjustment costs," which justify price smoothing. This is particularly so at times of sharply rising international prices, when full pass-through rules can break-down, and degenerate into ad-hoc price adjustments by the government. This has taken place during the course of 2000 in a number of countries (e.g., Bolivia and Costa Rica).

Indeed, of the countries in our survey which regulate retail petroleum prices, only 24 percent adopt full pass-through rules for adjusting retail prices in response to changes in international prices. Alternative partial pass-through rules may prove to be more sustainable than full pass-through of spot price changes, and may, therefore, deserve consideration on "political-economy" grounds, even if they may be second-best to full pass-through rules in terms of economic efficiency.

A. The Scope for Partial Pass-through of Spot Prices

Governments can smooth the profile of retail petroleum prices by only partially passing-through changes in international oil price. Governments which smooth retail petroleum prices can adopt a discretionary or rules-based mechanism. The survey results presented in Section II indicate that discretionary price adjustments are the dominant mechanism through which governments adjust petroleum prices.

The theoretical advantage of a discretionary approach to price smoothing is that it allows governments to decide when and how much to adjust domestic petroleum prices, without being constrained by a price formula. This gives government the flexibility to determine the optimal path of retail prices as a function of general market conditions, which may not be fully reflected in the level of spot prices. For instance, if the government is faced with a price spike in the spot market, it can use its discretion to assess whether it should be seen as permanent (or, at least, long-lasting) and thus initiate adjustment in the retail price, or temporary, and, therefore, not requiring retail price adjustment.

In practice, however, governments will find it hard to make these kinds of judgments, thus undermining the benefits which may derive from the discretionary approach.[21] There is also a risk with discretionary price smoothing that this will be used for political purposes, and prevent desirable adjustment to retail prices, both when international prices rise (to avoid the political

[21] To distinguish between temporary and permanent shocks, the governments should rely on financial markets (e.g., futures markets) and could then lock-in prices through this mechanism.

cost associated with high domestic petroleum prices), and when they fall (to allow the government to accumulate additional fiscal resources). As a result, governments implementing discretionary price adjustments may tend to adjust prices rarely, and, when they are forced to do so, by large amounts (e.g., as was the case for the Philippines during the operation of the, now-terminated, Oil Stabilization Fund). This is likely to be particularly harmful from the point of view of consumers, by effectively magnifying both price shocks and price uncertainty.

Automatic price adjustment mechanisms are based on formulae which determine the level of the retail price at regular intervals, on the basis of international prices. The advantage of this approach is that it minimizes political interference in the price setting process, and can shield it from political pressures for low petroleum prices, which at times of rising international prices may have large fiscal implications. On these grounds, price adjustment rules seem superior to a discretionary approach. However, the distinction between the two can become blurred, and automatic mechanisms can collapse into a discretionary approach if they are not always implemented. To avoid this, rules need to be politically robust and, in particular, avoid sharp upwards price adjustments when possible.

Partial pass-through rules

Governments can implement three types of partial pass-through rules to allow for domestic price smoothing:

- *moving average rules*, which base retail prices on a moving average of past spot prices;
- *trigger rules*, by which prices are updated only if spot prices change by more than a pre-determined trigger amount; and
- *max-min rules*, which place a ceiling and a floor on the level of retail petroleum prices.

This paper's assessment of these rules is based on simulations of their impact on retail prices and on the government's fiscal position, using historical prices since 1987. Specifically, partial pass-through rules should:

- complement rather than substitute for feasible private sector adjustment; and
- strike a balance between retail price variability and the fiscal risk.

The first criterion implies that pass-through rules should be designed with the main purpose of facilitating consumers in implementing their optimal partial (or delayed) adjustment behavior. This means that partial pass-through rules should try to smooth large and sharp price shocks and not necessarily prevent small price shocks, which consumers should be able to self-insure against, under most circumstances. By doing so, partial pass-through rules can reduce the negative impact of price volatility for both risk-averse consumers, and consumers with adjustment costs, and, therefore, enhance efficiency. This will also add to the political robustness of a partial pass-through rule, reducing the occurrence of large discrete price changes and potentially preventing the collapse of the price rule at times of rising prices.

Optimal partial pass-through behavior, however, also implies that the rules should not prevent adjustment to permanent (or persistent) price changes, which need to be passed-through to allow consumers to adjust to them. Therefore, any subsidy paid out via the rule at times of high prices needs to be phased out gradually, if the high price situation persists.

To capture the importance of price shocks for consumer welfare, the paper focuses on the short-run changes[22] of the price series simulated with the different partial pass-through rules, measuring both their overall volatility and the frequency of large price jumps relative to a full pass-through rule. This implicitly recognizes that sudden price changes are more costly to consumers than slow and persistent changes (which consumers can gradually adapt to), and should, therefore, be the focus of attention when designing a partial pass-through rule.

The second design criterion recognizes that any price risk which the pass-through rule shields consumers from needs to be borne by the government. As discussed above, this in turn has fiscal implications, and can lead to persistent surpluses or deficits associated with the pass-through mechanism. The simulations produce a measure of the magnitude of both the year-on-year fiscal shocks and the cumulative fiscal implications of the partial pass-through rules. These shocks are scaled in percentage of GDP for a typical net oil importer, based on the 1999 average ratio of net oil balance to GDP (i.e., approximately 3 percent).

The simulations carried out are based on spot crude prices for the period January 1987–June 2000. The price properties and fiscal impact reported for each rule, therefore, abstract from the fact that countries may be importing petroleum products (whose price may be imperfectly correlated with the crude price).[23] This is, however, not unduly restrictive given that crude and petroleum products prices tend to move in line with each other except for short-term changes (which may reflect changes in capacity margins in the refinery industry and seasonal demand effects).

It should also be noted that by basing simulations on historical prices, the paper does not claim to be measuring structural properties of the partial pass-through rules. These simulations serve mainly as an illustration of the kind of retail price smoothing and fiscal risk partial pass-through rules can be expected to yield.

Moving average rules

Under a moving average rule, current retail prices are based on a moving average of past spot prices, starting from the current month and moving backwards. The longer the time horizon of the moving average, the more price smoothing this rule achieves.

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[22] We capture this by examining the first difference of the log of the monthly series.

[23] They also abstract from the presence of fixed margins in the final retail price, which reduce its variability relative to crude. It is, however, straightforward to gross up the price variability measures we report into retail price variability figures by making assumptions on the size of the various fixed margins in the value chain.

The theoretical attractiveness of these price rules is that they "follow the market," and do not impose exogenous targets for the level of retail prices, which may prove to be inappropriate in the face of large and persistent shocks. Moving average rules with long enough time horizons can, therefore, provide substantial price smoothing, shielding consumers from transitory price spikes at the same time as passing through persistent price changes gradually. These rules, however, do not discriminate between large and small price shocks, and do not directly seek to complement private sector self-insurance by focusing on the large shocks.

Simulations show that these rules can achieve substantial price smoothing, both in terms of reduction of the standard deviation of shocks and the frequency of large shocks. The effectiveness of price smoothing rises substantially with the length of the moving average, but even the three-month moving average can achieve a 30 percent reduction in standard deviation and more than half the frequency of monthly shocks in excess of 10 percent relative to spot prices.

The substantial price smoothing the rules can achieve comes with a significant fiscal risk. For instance, the 12-month moving average leads to large fiscal shocks (on average 0.3 percent of GDP per year, for a typical oil importer) and can also bring about large cumulative deficits (0.6 percent of GDP by 2000, assuming the rule started in 1987). Shorter rules are less risky—the three-month moving average is associated with average shocks of less than 0.1 percent of GDP, and its cumulative impact broadly ranges between +/- 0.1 percent of GDP.

Trigger (or (S,s)) Rules

Under trigger rules, a price band is initially determined (e.g., plus or minus 10 percent of the current spot prices), and retail prices are updated to reflect the current spot price, only when spot prices reach a level which is outside the band. When prices are changed, the price band shifts up or down taking the current spot price as the new central point of the band.

The effect of this pricing rule is to avoid minor fluctuation in retail prices, but pass-through relatively large changes in international prices. This rule is, therefore, effective in shielding governments from having to bear large price shocks, but by doing so it exposes the private sector to these shocks. This would be optimal in the presence of fixed adjustment costs, but as argued in Section II, consumers with this type of adjustment costs should be able to autonomously implement their optimal adjustment behavior by self-insuring against small shocks. Trigger rules, therefore, do not appear to complement consumers' risk-coping measures, and can only be justified on grounds which do not relate to price smoothing.[24]

Simulation results show that trigger rules are not effective at providing price smoothing. They actually increase the size and frequency of large price shocks and, in the case of the

[24] Moreover, by reducing the frequency of price adjustments and increasing their magnitude, trigger rules may be politically fragile, and more likely to be violated than rules which allow for continuous adjustment.

+/-30 percent trigger, they can increase overall standard deviation too. This is matched by an overall beneficial fiscal risk profile, but also by large fiscal shocks. Implementing a trigger rule can actually lead to substantial fiscal receipts (as in the case of the +/-30 percent rule). This effect arises from the fact that oil prices are characterized by frequent small price decreases (which are not passed through under this rule, and, therefore, lead to fiscal revenue) and less frequent, but large, price increases (which under a trigger rule are passed through).[25]

Given the poor (or even negative) contribution to retail price smoothing of trigger rules, the main justification for adopting this kind of rule (as opposed to a full pass-through rule) is that it minimizes the transaction costs (i.e., menu costs) of continuously updating domestic price to reflect international spot prices, at the same time as insulating governments from excessive oil-related risk. It, therefore, can represent a convenient way of effectively implementing a full pass-through rule (as long as the width of the price band is not too large).

Both Costa Rica and Bolivia have implemented trigger rules recently. Costa Rica has adopted a +/- 5 percent trigger rule since 1990, even if this has not always been consistently applied. Bolivia also adopted a +/-5 percent trigger mechanism, but this was suspended in July 2000, when retail fuel prices were temporarily frozen, for a period of one year. When the freeze expires, the authorities plan to return to the periodic adjustment mechanism.

Max-min rules

Max-min rules specify a price band around a central price, which defines the maximum and minimum level retail prices can reach. If the cost-plus level of retail price is above the band's ceiling, the government absorbs the difference between two prices, by paying out a subsidy. If the cost-plus retail price is below the minimum price set by the band, the government taxes away the difference, and sets retail prices at the minimum level.

This price rule achieves directly the aim of complementing consumers' risk-coping activities, shielding them from large price shocks, and passing through small shocks. It, however, does not automatically pass-through large price changes if these are persistent and, therefore, require adjustment. For this to occur, and to avoid excessive fiscal risk to the government, a max-min rule needs to be complemented by a mechanism which updates the position of the max-min band or which scales down the additional subsidy (tax) determined by the rule if the cumulative loss (gain) exceeds a given level. Chile has recently adopted both of these measures (see Box 1).

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[25] This is consistent with the findings of Deaton (1992) for non-oil commodities. This effect arises from the asymmetry in storage opportunities, resulting from the fact that negative storage is not possible, so that the constraint on large price increases is weaker than the one on large price falls. Cashin, et al. (1999), find a similar effect for oil.

Box 1. Chile's Price Stabilization Mechanism

Chile has operated a domestic petroleum price stabilization mechanism since January 1991, and has recently reformed it.[1/] The original mechanism was based on a max-min price rule, implemented by a Stabilization Fund (FEPP) initially capitalized with $200 million. Under this mechanism, maximum and minimum prices for each petroleum product were set at +/-12½ percent of a reference price set by the energy authority (CNE) on a discretionary basis, to reflect medium- and long-term market trends. The max-min rule operated asymmetrically: if the (spot) import price was above the ceiling of the band, the fund would pay out a subsidy equal to the difference between the two prices; however, if the import price was below the floor of the band, 60 percent (and not 100 percent) of the difference would be taxed away, and deposited into the Fund.

Until the middle of 1999 this stabilization mechanism worked relatively effectively. The Fund accumulated resources, as import prices were more frequently below the price band than above it. However, the high prices of the second half of 1999 and 2000 have led to financial problems for the Fund,[2/] requiring a total additional injection of $263 million (paid into the Fund in January and July 2000). The difficulties experienced by the Fund have prompted a revision of the rules of the stabilization mechanism, which was passed into law in July 2000.

According to the new Price Stabilization Law, the reference prices which determine the position of the band for each petroleum product are updated weekly, on the basis of a formula, which includes historical prices (a weighted average of prices from the past 2 years), short-term forecasts, and long-term forecasts. The asymmetry in the operation of the price band has been eliminated (so that 100 percent of the difference between the floor of the band and import price is now taxed away), and a contingent tax-subsidy rule has been introduced. According to this rule, prices can rise (fall) above (below) the ceiling (floor) of the price band to prevent excessive depletion (accumulation) of the resources of the Fund. This ensures that the Fund never runs out of resources (i.e., as the fund's resources converge to zero the subsidy paid out to consumers also converges to zero) and never accumulates more than a set maximum amount.

1/ The mechanism includes five petroleum products: gasoline, diesel, LPG, heating oil, and kerosene.

2/ This was exacerbated by the fact that in 1999 the reference prices for the max-min band were lowered (in spite of rising import prices) to avoid an increase in domestic prices.

This paper simulates three kinds of max-min rules, all broadly based on the Chilean mechanism, in place since 1991. These rules have a width of 12½ percent relative to the central price (like the current Chilean rule), and two of these have a fixed central price (at $18.5 and $20 a barrel respectively) while one has a moving band, which is updated in accordance with the recent updating formula adopted by the Chilean energy regulator.[26]

[26] The current Chilean formula updates the max-min price band according to historical prices, short-term projections and long-term forecasts. For the purposes of our simulation, we have assumed that the short-term projection component of the price band formula is equal to the current spot price, and that the long-term forecast is of $20 a barrel.

The simulations show that fixed-band rules are more effective than the moving-band rules in mitigating price volatility, and reducing the impact of large price shocks. This is because the fixed bands, unlike the moving-average band, do not move with current prices, thereby diluting their shock-absorption properties.

The beneficial price smoothing effects of fixed-band rules is however reflected in the higher fiscal risk profile these generate. Both the $18.5 and $20 a barrel rules lead to large absolute fiscal shocks. They differ radically however in their cumulative effect, with the $20 a barrel rule leading to a substantial surplus over the 1987–2000 period, and the $18.5 a barrel rule leading to a deficit. This highlights the main weakness of a fixed-band approach, that is, the need to estimate an expected level for prices (to set the central level of the band), which may prove to be inappropriate, and lead to excess fiscal revenues or losses from price smoothing. The "Chilean" moving–band max-min rule by contrast leads to substantially smaller fiscal shocks, and a limited cumulative impact over the 1987–2000 period.

Summary of assessment of partial pass-through rules

The main differences, summarized in Table 2, between the three types of rules are:

- max-min rules are more effective at complementing private sector risk-coping than both trigger rules (which do not provide price smoothing when the private sector is most likely to need it) and moving average rules (which smooth out all shocks);

- max-min rules need to be complemented by an updating rule for the position of the max-min price band to ensure that persistent shocks are passed-through to the private sector; and

- the trade-off between retail price insurance and fiscal risk, as measured by historical simulations of the rules, appears sharp.

Given the findings from the simulations, it appears that the most effective partial pass-through rules and those that strike an appropriate balance between retail price smoothing and fiscal shocks, are short moving-average rules (3-month and, possibly, 6-month) and/or a max-min rule with an automatic updating of the max-min price band.[27]

More ambitious price smoothing rules appear to leave the government over-exposed to oil price-related fiscal risk, especially given the limited availability of effective risk-coping instruments for most developing country governments, as discussed in the next sub-section. Therefore, while there is a case for government-led petroleum price smoothing (as discussed in Section III), governments should not attempt to provide excessive price insurance to the private sector, given its fiscal implications. Governments may, on the other hand, find it relatively effective to rely

[27] A hybrid of these two rules (i.e., a max-min rule where the position of the band is updated according to a relatively short moving average of past prices) may also be appropriate.

on market-based insurance instruments to implement some retail price smoothing, as we illustrate below.

Table 2. Summary of Properties of Partial Pass-through Rules

	Price Smoothing Properties		Simulation Results	
	Temporary Shocks	Persistent Shocks	Reduction in Standard Deviation [1/]	Average Annual Fiscal Shock (In percent of GDP) [2/]
Moving Average	Smoothes out all shocks	Full pass-through (with a lag)	30 to 70 percent	0.07 to 0.3 percent
Trigger	Smoothes out only small shocks	Full pass-through (if large enough)	2 to 8 percent	0.05 to 0.26 percent
Max-Min	Smoothes out only large shocks	No pass-through (unless there is an updating rule)	27 to 45 percent	0.08 to 0.17 percent

Source: IMF.

[1/] Relative to spot prices, based on first difference of the logs of the monthly price series, January 1987 to June 2000.

[2/] Based on 1999 typical oil importer.

B. Managing the Fiscal Risk Deriving from Partial Pass-through

It is clear from the historical simulations of the partial pass-through rules that implementing a system of partial pass-through of oil price changes automatically transfers some financial risk onto the government. The government faces a number of options to manage this risk.

The most immediate option for managing the risk associated with volatile oil-revenues is for governments to use their budgets to absorb the shock, either adjusting expenditure or raising additional revenue. This is unlikely to be an efficient option however. Changing expenditure with oil prices is likely to entail fiscal adjustment costs, which imply that governments should attempt to smooth expenditure over time. Adjusting non-oil taxes is also likely to be inefficient, for tax-smoothing considerations.

As in the case of the private sector, governments should try to smooth the budgetary shocks due to the partial pass-through of volatile oil prices. They can potentially do so by making use of credit markets. However, many governments are externally credit-constrained and may not be able to issue domestic debt because of the absence of developed domestic financial markets. Moreover, governments are most likely to be credit constrained when they most need to borrow (i.e., when hit by a negative terms of trade shock).

The most accessible risk-coping option for governments is to self-insure by engaging in precautionary saving behavior (as in the private sector case, discussed in Section III). The option of self-insurance is, however, not costless. Simulation results for partial pass-through

rules presented above show that such saving or dissaving may well be large and very long-lived. Deficit situations, in particular, will need to be financed with up-front liquidity, which will have a cost. As shown by Deaton (1991), excessive price (or consumption) smoothing should not be attempted when faced by the combination of liquidity costs and persistent price shocks. Our simulations support this theoretical result. Saving or dissaving for long periods may also be hard to sustain politically.

One option to implement a self-insurance mechanism in the face of oil-related fiscal risk is to set up a separate oil price stabilization fund.[28] This has been a relatively popular option among oil importers. Of the countries which regulate prices in our survey, 24 percent currently run such funds, and a few have had funds for a number of years, and only recently abolished them (e.g., Mauritania and the Philippines). In 2000, most of these funds were negatively hit by high oil prices, and have needed extra resources (Chile) or lost significant sums (Brazil).

Governments in developing countries, like private sector agents, do not seem to be suited to handle large fiscal variability due to oil price risk, given the lack of effective risk-coping instruments. Coupled with the high frequency and persistence of oil price shocks, this implies that any smoothing of spot price variability carried out by government needs to be limited, and designed to minimize the fiscal shocks it implies for the public sector, as illustrated by the historical simulations presented above.

C. Hedging

Governments, which wish to shield consumers from excessive petroleum price volatility, can use financial hedging instruments to reduce oil price risk.[29] This has the advantage relative to partial pass-through rules of affecting the nature of the price process faced by the country's consumers directly, potentially removing or mitigating undesirable time-series properties of oil and, therefore, reducing the fiscal risk associated with partial pass-through of spot price changes. It also addresses more directly one of the market failures identified in Section III, namely the lack of access to hedging instruments for most consumers in developing countries.

Financial markets for oil products are very well developed and used extensively by producers and consumers in industrialized countries. Crude oil and petroleum products financial contracts are heavily traded (both in New York, on NYMEX, and in London, on the IPE), especially for short maturities (up to 6-12 months).[30] This potentially offers substantial scope for risk-management activities by oil consuming countries, especially if they are relatively small oil purchasers.

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[28] For a full discussion of oil savings and stabilization funds, see IMF Occasional Paper 205.

[29] See IMF Occasional Paper 205 for a more extensive discussion of the potential for government use of hedging instruments.

[30] For instance, NYMEX crude oil open interest (the number of outstanding contracts which have not been closed yet) averages about 1,000 million barrels a day, which is equivalent to 27 of global crude exports. Of this open interest, 75 percent is for six months or less forward, and about 5-10 percent for 24 months and beyond.

We review here two basic instruments which oil purchasers could use to limit their exposure to spot price volatility—futures and options—assessing their potential benefits and limitations.[31]

Futures contracts

Futures are exchange-based contracts which allow buyers to purchase oil for future delivery at a pre-determined price. Through these contracts buyers can lock-in a price in advance, and avoid having to bear risk due to short-term fluctuations in spot markets. Futures can also serve a price-discovery role, allowing the buyer to distinguish between movements in the spot price which are perceived to be permanent (and would, therefore, affect futures' prices too) and those which are seen as temporary (and, therefore, are not fully reflected in futures' prices). This can help governments and consumers to avoid unnecessary adjustments. A government trying to hedge spot price risk and smooth the profile of retail prices can purchase futures on a roll-over basis (e.g., purchasing contracts six-months ahead on a monthly basis), and fully pass-through the cost of these purchases into retail prices. This can potentially achieve substantial price smoothing, given that the profile of futures' prices is smoother than that of spot prices.[32]

Futures' purchases can also be combined with a partial pass-through rule, to increase the smoothing of retail prices. For instance, retail prices could be based on the average of the contract prices held by the government for future months (e.g., the retail prices for March could be based on the March 3-month future contract prices, as purchased in January, and on the April and May 3-month futures, as purchased in February and March). Simulation results show that this pricing strategy can achieve a substantial reduction in overall variance and in the frequency of large price changes relative to both spot purchases and the corresponding moving average rules based on spot prices.

A moving average rule based on futures' prices would have to be financed by the government (in a similar fashion to a partial pass-through rule). The associated financial impact on government finances for a three and six-month moving average rule based on roll-over future contracting shows that the fiscal shocks associated with futures-based moving average rules are of a similar order of magnitude to the ones found for the spot-based moving average rules, suggesting that futures purchasing combined with partial pass-through may offer a particularly favorable price insurance-fiscal risk trade-off.

There are, however, constraints for developing country governments in the purchase of futures contracts. In particular, developing countries may face high liquidity costs when purchasing oil futures. These may arise because of low creditworthiness and the presence of sovereign risk,

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[31] More complex instruments, such as swaps, could also be used, but for the purposes of exposition, this paper focuses on more basic instruments.

[32] Claessens and Varangis (1993) simulate a six-monthly hedging strategy using crude futures markets for a Costa Rican oil company, for the period July 1986 to January 1990, finding that following such a strategy would have reduced risk by 69 percent relative to spot purchases.

which would lead to high deposits being required by brokers, and because of margin calls, which would need to be financed if the spot price moves against the contract's position. A country with a low credit rating may not even be allowed to purchase futures.

Purchasing futures may also have an associated political cost. By locking-in prices in advance governments may miss out on price falls, and, therefore, be unable to lower retail prices without incurring a fiscal loss. This may be politically costly, and discourage governments from entering into futures purchases.

Options

Call options are an alternative to futures for the risk-management of oil purchases. These contracts give buyers the option to purchase oil at a pre-defined price (the strike price), over a given time period (American-style options) or at a pre-defined date (European-style options). A call option, therefore, guarantees a maximum price to the buyer. It also allows the buyer to fully benefit when prices are below the exercise price, unlike a futures contract, where the price is fixed. To purchase call options buyers need to pay a premium, which depends on the exercise price and the (expected) price volatility of the underlying commodity.

Options are an effective way of limiting exposure to price spikes and can be signed on a roll-over basis, and for relatively long-time periods (e.g., 6 months) to allow for consumption smoothing. Compared to futures, options are however more expensive, especially for long expiry periods. This cost can however be mitigated by selling put options, at an exercise price below that of the call, thus creating a price band (collar) within which the effective purchase price is guaranteed to lie. This can effectively mimic a moving-band max-min rule (as discussed above), where the position of the band is determined endogenously by market conditions.

Given that call options limit only the downside associated with high oil prices, they may be politically more attractive than futures contracts. Also, given that options are paid for upfront, and do not require deposits or margin calls, they do not suffer from the credit constraints which may be imposed on future purchases. This however has a cost, as reflected in the option's price, which is not insignificant.[33]

For pricing purposes call options deliver less price predictability than futures, since a government which holds options would not know ex-ante if the price in any given month would be at the strike price (in which case the option is exercised) or below the strike price. The simplest pass-through rule to adopt in this context would be to fully pass-through the spot price if the option is not exercised, and base retail prices on the option's strike price if it is exercised. This rule would not impose any oil-risk onto the government, as long as the cost of purchasing the options is passed-through into the retail prices.

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[33] For instance, on August 8, 2000, to purchase a call option for expiry in October with a strike price equal to the October futures price (i.e., $28.65 a barrel) would have cost approximately 4½ percent of the futures price.

D. The Scope for Private Sector Involvement in Petroleum Price Smoothing

Private oil companies may have an important role to play in facilitating or implementing a retail price smoothing mechanism. The role of the private sector in relation to petroleum price smoothing is not the focus of this paper, but it is briefly treated here to provide a more comprehensive discussion of the subject, and to highlight the implications of our analysis of the potential for government-led price smoothing for private sector involvement in this area.

In a regime of price regulation (e.g., where the government sets a maximum price for petroleum products), the government may be able to delegate to private oil companies risk-management activities relating to oil price variability, and avoid bearing fiscal risk from price smoothing. It could do so in one of two ways:

- it could set retail prices according to a partial pass-through rule, and fix petroleum excises. This would imply that domestic industry margins would fluctuate with international oil prices; or

- it could set retail prices on the basis of a "hedging" rule, whereby it pre-supposes that a given share of oil demand is purchased using financial instruments (e.g., traded futures), and fully passes-through the notional purchase cost.

Under both mechanisms, private oil companies will seek to hedge or manage the oil-price risk they face, using the range of instruments described above (e.g., financial instruments; credit markets; etc.). This may be superior to the government handling of oil price risk, given the political difficulties which may be associated with stabilization funds and the restricted access to financial and hedging markets governments may face. Private companies (especially if they are part of larger international groups) may have better access than the authorities to effective risk-coping measures.

These delegation mechanisms may, however, suffer from some limitations. In particular,

- They would render the price regulation of petroleum products harder to manage, and require retail prices to take into account the higher cost of capital faced by private companies due to oil-price risk;

- They may lead to sub-optimal hedging behavior by the private sector if the government hedging rule is too rigid (or mis-specified);

- Governments may be unable to credibly commit to the price-stabilization formulae agreed with private companies. For instance, in a situation of rising international prices, they may fail to raise retail prices to compensate private companies even if the pass-through rule allows for a price increase; and

- Given the nature of oil prices and the potential for chronic deficits or gains emerging from a partial pass-through rule, it is likely that there will be a need to renegotiate the risk-transfer arrangements between the government and the oil companies, and political

pressure may build up not to compensate companies for low retail prices, or to extract the rents from high retail prices. This political risk may, in turn, imply that private companies may be unwilling to manage the risk due partial pass-through.

A contractually more straightforward alternative to the delegation of risk-management activities to private oil companies would be to deregulate prices altogether. This has the advantage of letting market forces determine the appropriate level of retail price smoothing,[34] and of being a more structural pricing reform than the introduction of partial pass-through rules, and, therefore, less liable to be reversed or not adhered to. A number of countries in our survey have opted for deregulating petroleum pricing (27 percent of the countries in the survey).

Under some circumstances, price deregulation may not be a viable strategy however. If domestic market conditions are not sufficiently competitive (e.g., the market is too small to allow effective competition to emerge) price regulation may be necessary, which implies that the government needs to assume responsibility for price smoothing decisions. If this is the case, governments should still consider the option of involving the private sector in managing price smoothing activities.

V. Conclusion

The level of retail petroleum prices is an important economic variable in many developing countries, affecting both governments' fiscal revenues and consumers' disposable income. This paper has made the case that consumers may suffer from petroleum price instability, due to risk-aversion and adjustment costs considerations. Further, they may not be able to adequately mitigate the negative welfare impact of oil price volatility because of the absence of risk-coping instruments and limited self-insurance possibilities.

There appears, therefore, to be a case for government-led petroleum retail price smoothing, in an environment where these prices are regulated. However, given the properties of international oil prices and, in particular, the persistence and high frequency of large price changes, petroleum price smoothing has significant fiscal implications for governments. The simulations of partial pass-through rules based on past international spot prices in this paper suggest that there is a sharp trade-off between price insurance and fiscal stability, and that only limited price smoothing (e.g., in the form of a short moving-average rule, or a moving max-min price band) is likely to be fiscally sustainable. Market-based price insurance appears to represent a superior alternative for smoothing retail prices; an alternative governments of oil-dependent countries should consider.

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[34] In countries where petroleum pricing is deregulated, private oil companies engage in some price smoothing. In the US for instance, the Department of Energy estimates that average gasoline retail prices reflect the variation in spot prices fully after three months, with 50 percent of the change passing-through within four weeks (US Department of Energy, 1998).

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