

Conceptual framework for assessing pricing process initiatives

Prepared by the Electricity Commission

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Glossary of abbreviations and terms

Commission	Electricity Commission.
Final prices	Final prices are calculated the day after physical dispatch and are normally published by 12pm that day. They are used for monthly settlement.
Forecast prices	Prices based on load that bidders provide to the system operator. Forecast prices are published every two hours in the PDS from 1pm the day before trading occurs. The final forecast price for a trading period is provided two hours before the trading period.
Indicator prices	Also called “real time prices”, these prices are based on SCADA measures of load for each 5 minute dispatch period. Each indicator price is an ex post prediction of the 5 minute dispatch period just completed. At the end of each trading period the six 5 minute indicator prices are averaged to produce a 30 minute indicator price (prediction of final price) for the 30 minute trading period just completed. Indicator prices are not currently used for settlement.
Participant	As defined in the Electricity Governance Regulations 2003: (a) means any of the following (within the meaning of section 2(1) of the Electricity Act 1992): (i) an electricity distributor: (ii) an electricity generator: (iii) an electricity retailer: (iv) a line owner (b) includes a person who uses electricity that is conveyed to the person directly from the grid: (c) includes a person who buys electricity from the clearing manager: (d) includes a service provider: (e) includes a metering equipment owner: (f) includes an ancillary service agent: (h) includes an approved test house: (i) does not include the Commission (even to the extent that the Commission is acting as a service provider after an appointment under regulation 35) : (j) does not include the Rulings Panel.

PDS	Pre-Dispatch Schedule – this schedule is produced by the system operator, and includes expected levels of generation, instantaneous reserves, demand and forecast energy and reserve prices.
Provisional prices	Provisional prices are issued if there are unresolved “pricing issues” necessitating a delay in the publication of final prices. Pricing issues arise from SCADA, metering, infeasibility or high spring washer situations. Provisional prices are posted by 10:30am on weekdays and by 9am on weekend days.
Real time prices	See definition for “indicator prices”
SCADA	Supervisory Control and Data Acquisition
SDPQ	Schedule of Dispatch Prices and Quantities
Settlement prices	The prices the clearing manager uses to calculate purchaser and generator payments.
Spot market	The buying and selling of wholesale electricity is done via a ‘pool’, where electricity generators offer electricity to the market and retailers and major users bid to buy the electricity. This market is called the spot or physical wholesale market.

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1. Introduction

- 1.1.1 The purpose of this paper is to set out the conceptual framework for assessing initiatives affecting the pricing process.
- 1.1.2 The Electricity Commission (Commission) first presented the conceptual framework in the consultation paper entitled “Issues and Indicative Options for the Spot Market Pricing Process and UTS Provisions” (Issues and Options Paper), dated 18 November 2008.
- 1.1.3 All parties who submitted on the Issues and Options Paper were in support of the conceptual framework, although there were differing views on the most important attributes. No substantial changes were made to the conceptual framework as a result of submissions on the Issues and Options Paper.

2. Conceptual framework

2.1 Summary

The desirable attributes for any spot market pricing process are certainty, accuracy, robustness, simplicity, and transparency. There are three subcomponents to certainty: timeliness, predictability, and authoritativeness.

In practice, altering the pricing process may improve some attributes and worsen others. For example, initiatives focused on improving the timeliness of spot prices improve certainty but may reduce accuracy. Also, some attributes can be pursued with multiple instruments. For example, greater price certainty can be pursued by improving timeliness, or by improving the accuracy of price forecasting, or by making it easier for participants to hedge their exposure to spot market prices.

2.2 Introduction

2.2.1 For most goods and services, prices are openly displayed or published in some form, or they are negotiated before the goods or services are provided. For some transactions a formula for calculating prices is specified in a sale and purchase contract, such as occurs for the sale and purchase of a company. For more complex goods and services, such as electricity, tightly prescribed processes and complex computer models are used to determine prices, and price projections are provided in the lead up to each trading period.

2.2.2 This section focuses on the economics of market pricing in general, leaving the more complex electricity market to section 3. In particular, this section discusses:

- (a) the desirable attributes of any pricing process;
- (b) an overall framework for making efficient trade-offs among the attributes; and
- (c) key principles for developing pricing processes for any spot market, not just the electricity spot market.

2.3 Desirable attributes of pricing processes

2.3.1 An efficient pricing process is one that facilitates effective decision-making at least cost. In an ideal world a pricing process would provide prices that are:

- Timely;
 - Predictable;¹
 - Authoritative;
- } certain
- Accurate;
 - Robust;
 - Simple and transparent.

2.3.2 As shown above, the timeliness, predictability, and authoritativeness of prices contribute to certainty of prices, which is a key desirable attribute for many market participants. Timeliness and predictability are substitutes in regard to achieving certainty of prices, because reduced timeliness can be offset by higher predictability. Also, prices are rarely 100 per cent certain because prices can sometimes be contested in the courts after the transaction has occurred.

Timely prices

2.3.3 Prices are timely when buyers and sellers know the prices they are transacting at before incurring costs to undertake the transaction. In many cases spot markets do not provide timely prices.

2.3.4 For example, crop farmers make planting and fertiliser decisions months before their goods are ready to supply to the market. Ideally they want to know the prices they will receive for their crops prior to making their planting decisions. In these cases, setting prices after the goods have been supplied to the spot market is much less valuable to the farmer than setting prices prior to the planting season.

2.3.5 In practice, farmers can often achieve timely pricing by negotiating long-term physical supply contracts with buyers, or by obtaining forwards or futures contracts to offset price movements in the spot market for their

¹ Where prices are not provided in a timely manner, the pricing process may provide price predictions ahead of publishing actual prices. In this case accurately predicting actual prices is another desirable attribute of an efficient pricing process.

goods. In the first case farmers are avoiding the spot market altogether, whereas in the second case they are still delivering their output to spot market buyers but they have “contracted out” of spot prices by finding other parties willing to take the price risk for them.

Predictable prices

- 2.3.6 An alternative to using forward contracts or long-term supply contracts is to rely on predictions of the spot price. This happens in dairy farming, for example, as Fonterra issues pay-out predictions to its suppliers months before it announces its actual pay-out. Price predictions also occur in the finance industry, with the large banks forecasting interest rates, inflation rates, exchange rates, and so on.
- 2.3.7 In general, the more accurately prices can be predicted the more parties will rely on the predictions to make commercial decisions rather than use forwards or long-term physical contracts or wait for spot prices to be posted.
- 2.3.8 There are several dimensions to measuring the accuracy of price predictions:
- (a) One dimension refers to the extent the average of the price predictions deviate from the average of actual prices. If the two averages are equal then the predictions are said to be unbiased.
 - (b) Another dimension is the spread of the prediction errors, as the larger the standard deviation of the errors the less efficient the prediction model.
 - (c) The third dimension is value-at-risk, which is relevant when very large errors have the potential to cause irreversible damage. For example, if the forecasting model predicts an \$80 price and the actual price turns out to be \$8,000, then this error may bankrupt the buyer. In this case it makes sense to consider value-at-risk as well as standard deviation as a measure of the accuracy of the prediction model.

Authoritative prices

- 2.3.9 Many people have high “regret values”, in that they dislike executing trades at certain prices only to find out the price changes after the transaction has begun. The more confident parties can be that prices will not be altered, the more they can base decisions on those prices.
- 2.3.10 For building and property work, for example, buyers often obtain price estimates from multiple suppliers before commissioning one of them to undertake the work. However, as the cost of supply depends on the hidden conditions of the customer’s property, the contract normally specifies circumstances in which the actual price can deviate from the estimated price. In these cases, both parties value having authoritative processes for determining the final price.
- 2.3.11 In general, prices are 100 per cent authoritative if the prices paid by buyers and sellers are calculated using pre-specified algorithms and input information that is 100 per cent verifiable.
- 2.3.12 If judgement has to be exercised in determining prices then prices are less than 100 per cent authoritative. Nevertheless, they can be highly authoritative if those judgements are made by independent experts adhering to accepted legal processes and principles. Authoritativeness declines the more often the pricing process relies on special reviews, the more subjective are those reviews, and the less independent and expert are the parties undertaking those reviews.

Accurate prices

- 2.3.13 The accuracy of prices refers to the extent prices deviate from the marginal cost of supply.² This criterion is relevant because inaccurate prices encourage parties to make inefficient consumption and production decisions.

² Economists often distinguish between short run marginal cost (SRMC) and long run marginal cost (LRMC). The appropriate measure to use depends on the time period over which prices are being analysed and the time frame generators need to change their capacity levels. Furthermore the correct benchmark is actually the marginal *social* cost of supply, or MSC, rather than the marginal cost of supply. MSC is the full cost to society of producing and supplying an additional unit of a good to the market. MSC differs from the marginal cost of supply used in the text because of taxes, externalities (such as air pollution), and unresponsive input prices.

- 2.3.14 A common example of an inefficient outcome is a monopoly that charges prices above its marginal cost of supply. In this case consumers are discouraged from purchasing the monopolist's products even though they value the additional consumption more highly than it costs society to produce it.
- 2.3.15 Even in competitive markets most firms do not charge prices equal to their marginal cost of supply because of the transaction and information costs involved in doing so. For example, almost no one sets their prices based on their daily or hourly marginal cost of supply. The fares charged by a taxi company, for example, are typically the same any hour of the day or night. Even over the course of many months, their fares remain the same despite large movements in petrol prices.
- 2.3.16 The main reason for this is that it costs businesses too much to constantly review their marginal cost of supply and change their offerings, and most consumers do not want prices to change every time they consider travelling by taxi. The empirical evidence in the economics literature shows that small "menu" costs and consumer reaction to price changes create "sticky prices" – that is, prices that deviate from marginal costs of supply for long time periods.
- 2.3.17 As for the predictability of prices in paragraph 2.3.8, there are several dimensions to measuring the accuracy of prices with respect to marginal cost.

Robust prices

- 2.3.18 When a pricing process provides multiple prices it creates a risk that parties may find ways to 'game' inconsistencies.
- 2.3.19 A simple example is a firm that manufactures its product in Auckland and sells it in New Zealand and Australia at different prices. If the firm views Australians as wealthier and therefore willing to pay higher prices than New Zealanders, then it may try to set its Sydney price higher than its Auckland price plus the cost of transport from Auckland to Sydney. This pricing regime is not robust because another firm or entrepreneur could discover they could buy the product in Auckland and ship it to Sydney and sell it at a discount. If gaming activity is likely to be significant, firms are forced to adopt robust price structures.

Simple and transparent prices

2.3.20 Simple, clear, and transparent prices are also desirable outcomes of any pricing process. Simple prices make it very easy for buyers and sellers to understand the commercial implications of price changes, whereas more complicated prices (for example, two-part tariffs) can ‘muddy the waters’ for market participants.

2.3.21 Similar comments apply in regard to transparency of prices. For example, hidden add-on fees make it costly for buyers and sellers to calculate the full costs of their transactions.

2.4 Overall economic framework

2.4.1 Provided all attributes can be produced independently of each other, choosing the optimal pricing process is conceptually simple: choose the pricing process in which the marginal benefit of each attribute equals the marginal cost of each attribute.³

2.4.2 For example, suppose we want to consider bringing forward the timing of spot market prices so they are calculated and published when the trade occurs, rather than the following day. This initiative would bring efficiency benefits to the extent it increases price certainty for buyers and sellers, but it would likely involve direct costs in the form of new IT systems.

2.4.3 On the other hand, timelier pricing could bring other benefits by reducing indirect costs – for example, buyers and sellers may invest less in forecasting spot market prices because of the increased certainty they have with spot prices.

2.4.4 Another consideration is whether some of the attributes are conflicting, in that improving one attribute may have a detrimental effect on one, or some, of the other attributes. Choosing an efficient pricing process requires taking into account these interactions or trade-offs in order to determine the best mix of attributes.

³ The marginal benefit of an attribute is the additional benefit market users obtain from a small increase in the attribute. The marginal cost of producing each attribute is the additional costs the market operator incurs to provide more of one attribute whilst producing other attributes at an unchanged level.

2.4.5 From a practical implementation perspective, efficiency is pursued by conducting a cost-benefit assessment of each combination of initiatives and choosing the combination of initiatives that maximises net benefits.

2.4.6 Appendix A provides a more detailed description of the economic framework for assessing pricing process initiatives.

2.5 Key principles for developing pricing processes

2.5.1 The above discussion and framework suggests the following principles for developing a pricing process for any spot market:

- (a) The pricing process should be directed at maximising the overall efficiency of the spot market. In practice this is pursued by choosing initiatives with positive net benefits from a cost-benefit assessment.
- (b) Spot prices should be based on actual demand and supply in the market, or on accurate estimates of actual demand and supply. Basing prices on forecasts of demand and supply is entering into the realm of forward markets.
- (c) The timing of the calculation and publication of spot prices should take into account any trade-offs with other desirable attributes and the availability of alternative instruments for achieving certainty of prices.
- (d) The pricing process should remain credible and sustainable across all possible pricing situations.

3. Overall approach to the spot market electricity pricing process

3.1 Introduction

3.1.1 This section:

- (a) discusses key features of electricity and their implications for the pricing attributes discussed in section 2.3;
- (b) identifies the levers available for improving the pricing process and discusses interrelationships among them; and
- (c) outlines key decision criteria for the pricing process.

3.2 Key features of electricity relevant to the pricing process

Real time balancing of generation and load is critical for grid stability

- 3.2.1 A key feature of electricity is that frequency and voltage on the transmission grid have to be managed within narrow tolerances to maintain system stability and ultimately avoid cascade failure of the grid. As it is too costly to store electricity in commercial quantities, maintaining a stable grid requires closely matching generation to load in real time and having sufficient reserves available to meet generation and transmission contingencies.
- 3.2.2 Generation is dispatched at the start of each 5 minute period⁴ based on forecast demand, the modelled state of the grid, and the anticipated position of generators in regard to previous dispatch instructions.
- 3.2.3 Dispatch inaccuracies and errors are corrected through the actions of frequency-keeping generators and by 'backing off' or 'calling upon' generation during the dispatch period. Material transmission or generation

⁴ Strictly speaking new dispatch instructions are not issued every 5 minutes when the system is very stable, such as in the early hours of the morning. See section **Error! Reference source not found.** for further details on this.

contingencies are managed through the dispatch of instantaneous reserves (reserve generation and interruptible load) and capacity reserves, such as demand inter-trips, generation ramp ups and ramp downs.

- 3.2.4 With decentralised ownership and control of generation it is critical to have robust prices, and prices that incentivise generators and load to act in ways consistent with maintaining grid stability.
- 3.2.5 As any aspect of the system can change quickly, spot market prices need to be based on the conditions of the system close to real time. Grid stability could be undermined, for example, if New Zealand adopted a day-ahead market and relied on day-ahead prices to match generation to load without any balancing market.
- 3.2.6 The need to closely balance generation and load in real time means that “the show must go on” with electricity – there is no stopping the flow of electricity to resolve pricing errors or pricing disputes. This leads spot market participants to place considerable value on having tightly prescribed processes for dealing with pricing issues. Quick and authoritative resolution of pricing issues is necessary because ongoing concerns about prices could undermine incentives for market participants to respond to price signals.

Demand estimates are used to calculate prices

- 3.2.7 In most trading markets actual demand and supply is used to determine prices. This is not the case with electricity, because demand is an estimated quantity. As small variations in demand can cause large price effects, especially when grid constraints are binding, the accuracy of the demand estimates can be very important commercially for spot market buyers and sellers.
- 3.2.8 The accuracy of demand data depends on which data source is used:
 - (a) Prior to each trading period, demand estimates for the pre-dispatch schedule (PDS) are based on demand bids, and for the schedule of dispatch prices and quantities (SDPQ) are based on central demand forecasts and bids submitted by large industrial purchasers;

- (b) Immediately after each dispatch period, demand is estimated using SCADA generation data or back-up systems when SCADA generation data is unavailable; and
- (c) Demand is calculated using data from revenue-grade load meters, supplied from 201 locations around the country. Currently most of these meters can only provide demand data for 30 minute intervals and the information is provided to the pricing manager once a day.

3.2.9 The demand estimate in (a) is the least accurate and the calculation in (c) is the most accurate. Nevertheless they are all estimates of demand, which contrasts with other trading markets where actual demand is used to determine prices.

3.2.10 These conditions mean there is currently a significant trade-off between accuracy and timeliness of spot prices in electricity. The current pricing process assists spot market participants with timeliness by publishing 5 minute indicator prices, while retaining accuracy by basing final prices on metered demand.

Many consumers need 'lead time' to alter demand, while others are unable to alter demand at all

3.2.11 Some consumers need several hours, or even days, to alter their load levels, while others can adjust within seconds and minutes. Large consumers are often contracted to provide interruptible load to the reserves market, but there is no mechanism for them to submit dispatchable load to the energy market and it may be too disruptive for many spot market purchasers to participate in the energy market in that way.⁵

3.2.12 Just as spot markets in other sectors are unable to provide timely prices for all buyers and sellers, the same applies to the electricity spot market. However, the consequences of a lack of timeliness are particularly important in electricity because small changes in load can cause large price changes. Significant welfare gains to the economy may be lost if spot market purchasers are under-reacting to predictions of settlement

⁵ The main exceptions are refrigeration and water heating load, which can be turned-off for short periods with minimal effects on consumer services. Currently, some large industrial consumers actively manage this load based on the price signals provided by 5 minute indicator prices.

prices, but on the other hand if the predictions are wrong then under-reactions avoid welfare losses.

- 3.2.13 It follows that accurately predicting settlement prices is particularly valuable in electricity, which is why the spot market pricing process provides an elaborate set of price forecasts, ranging from a day-ahead to real time.
- 3.2.14 Having said that, most consumers are on fixed retail tariffs that do not vary with spot market prices, and retailers generally have little direct control over their load because load decisions are made by their customers. Hence, as occurs in other sectors with spot markets, only a small portion of consumers receive spot market price signals.

Spot prices for electricity are highly volatile and offsetting them can be problematic

- 3.2.15 The New Zealand electricity spot market is a gross market, as purchasers wanting to buy directly from generators have to do so through the spot market – they are not allowed to enter into long-term physical supply contracts with generators.⁶
- 3.2.16 This leaves hedge contracts as a key instrument for managing spot pricing risks, particularly for non-retailer purchasers.⁷ Electricity retailers manage some of their spot market risks by vertically integrating with generation, which is another form of hedging, but they also use hedge contracts to manage risk.
- 3.2.17 As electricity spot prices in New Zealand are highly volatile – typically five to ten times more volatile than spot prices of other commodities – ready availability of competitively-priced hedge contracts is very important for spot market participants to achieve their desired level of price certainty.
- 3.2.18 On the ‘flip-side’ the higher the level of hedging in the market the more prudently the system tends to be managed and the less volatile are spot prices.

⁶ Rule 6.1 of part H of the Electricity Governance Rules 2003 requires all generators connected to the national grid to sell all of their electricity to the Clearing Manager.

⁷ A common misconception about hedge contracts is that they dilute incentives for hedged parties to respond to spot prices. This occurs for fixed-price variable-volume (FPVV) contracts but not for contracts with specified quantities, such as contracts for differences (CfDs).

- 3.2.19 The Commission understands there is considerable concern among some spot market purchasers about the competitiveness of hedge contracts, and that it is difficult for some spot market purchasers to obtain hedges to cover all of their locational price risk. These issues are being addressed under the Commission's hedge market development initiatives.⁸

3.3 Implications for the electricity spot market pricing process

- 3.3.1 The above discussion suggests some attributes discussed in section 2 are more important in electricity than for other markets.

Robust prices

- 3.3.2 In particular, the robustness of electricity prices is critical in electricity, as the consequences of a flawed pricing regime are particularly severe. An example of this is the debacle in California in 2000 when Enron and other electricity traders gamed the pricing rules, contributing to a period of 'rolling black outs' and leading regulators to adopt an entirely new pricing system.

Authoritative prices

- 3.3.3 Having a highly authoritative pricing process is critical to underpinning the fairness and credibility of the spot market, as participants do not have a choice of real time balancing markets in electricity. If the spot market is not seen as fair and credible, stakeholder support for it will erode and it is likely to be replaced by other trading or regulatory arrangements.

Timely and predictable prices

- 3.3.4 The timeliness and predictability of spot prices is particularly important if purchasers are unable to achieve their desired levels of certainty through hedging activity. Although, even with a well functioning hedge market spot market purchasers will have some exposure to spot prices, but in those cases parties will have made their own trade-offs between certainty and cost.

⁸ For further information on these initiatives see <http://www.electricitycommission.govt.nz/opdev/wholesale/Hedge>.

Accurate prices

- 3.3.5 Accuracy of electricity spot prices is also important, for the same reasons that timeliness is important: small errors in demand estimates can cause large price movements which purchasers may not be adequately hedged against. Accurate prices are crucial for economic efficiency, but they are also important for achieving an accurate allocation of wealth.
- 3.3.6 Accuracy is also important because spot prices are the fulcrum for hedge and retail prices, price forecasting, lowest cost dispatch and demand-side response. If spot prices are on average higher than the accuracy level, then hedge and retail prices may be higher than necessary, and a bias may be introduced to forecast, dispatch, and indicator prices. Achieving accurate spot prices provides a benchmark against which to measure the performance of price forecasts.
- 3.3.7 Even if spot prices are correct on average, they may display larger errors than a pricing process that takes longer to calculate and validate settlement prices.
- 3.3.8 For example, suppose the 5 minute indicator prices contain larger errors than the final prices currently used for settlement. As spot market purchasers already react to the 5 minute indicator prices, the larger errors in the indicator prices already affect purchaser decision-making. In this situation, converting indicator prices to settlement prices could reduce economic welfare because spot market purchasers could react more strongly to the 5 minute price if it was to be settled on rather than if it was only indicative of the final price.

Simple and transparent prices

- 3.3.9 Simplicity and transparency are relatively less important in electricity compared to other markets.

3.4 Key decision criteria

- 3.4.1 In principle, choosing among options for enhancing the pricing process should be based on the present value of estimated net economic benefits over a defined time period, such as 10 years.

- 3.4.2 As it is likely to be difficult to quantify the costs and benefits for all of the options, it may be necessary to undertake a qualitative assessment of each option.
- 3.4.3 This assessment should involve scoring each option in regard to:
- (a) their contribution to achieving the pricing attributes defined in section 2;
 - (b) the costs, practicality, and timeframe for implementing the option; and
 - (c) the level of certainty about the aggregate score of each option.
- 3.4.4 In scoring contributions to the pricing attributes:
- (a) Larger weights should be given to attributes participants are unable to pursue themselves, such as accuracy;
 - (b) The robustness attribute should be treated as a necessary condition, in that options that are not robust are not feasible options and should not be pursued; and
 - (c) Substitutable and complementary attributes should be counted only once. For example, timeliness and predictability are substitutable attributes because poor timeliness can be offset by high predictability levels. They are also complementary attributes because the timelier the spot market price the more accurately it can be predicted.
- 3.4.5 The decision criterion is to choose the option that has the highest score and that satisfies the robustness condition.

Appendix A. Further detail on the conceptual framework

1. This appendix sets out the detailed conceptual framework that forms the basis for the high level analysis in this paper. The framework will also be used for the detailed cost benefit analyses that will be undertaken as the initiatives in this paper are developed further and, ultimately, rule change proposals are consulted upon.
2. The utility of the conceptual framework may also extend beyond the initiatives in this paper, as it is likely to be applicable to other Commissions projects. Any feedback submitters have on the framework is welcome.

A1. The economic role of prices⁹

3. Market prices perform two critical roles in an economy:
 - (a) They provide essential information to buyers and sellers to make trade-offs in their activities. In particular, prices:
 - (i) Inform buyers about the relative costs of the goods and services they would like to consume; and
 - (ii) Inform sellers about the marginal value buyers place on the goods and services offered to them; and
 - (b) They provide incentives for buyers and sellers to coordinate their actions, and to adjust as the economic environment changes.
4. In practice, market prices are often far from perfect, in that often they do not accurately reflect the marginal cost of supply, which means they may encourage inefficient behaviour. However, no better system has been devised for coordinating hundreds of millions of actions in an economy. The experience around the world over the last 80 years is that, even with all of its imperfections, market pricing in many areas of the economy is essential for maximising living standards over the long term.
5. Due to their critical role in market-based economies like New Zealand's, improving the effectiveness of price signals has the potential to bring large efficiency gains for the economy.

⁹ Readers involved in the electricity market will know there are multiple types of prices produced by the spot market pricing process. The "prices" term used in section 2.3 generally refers to the prices that buyers actually pay for their goods and services or to quoted or posted prices. Section 3.3 provides a complete list of prices used in the current spot market pricing process.

A2. The benefits and costs of pricing processes

6. Section 2.3 in the main text introduced the desirable attributes for any pricing process. Although they are desirable, achieving them is costly and it may be impracticable to achieve some attributes because of technology limitations or because of the complexity of the good or service being priced. This section outlines the various costs and benefits of pricing processes.

The direct costs of producing prices

7. The direct cost of a pricing process is the cost the market operator incurs establishing and operating the pricing component of the market, obtaining input data, and calculating and publishing forecasts of prices and publishing final prices. The direct costs also include costs the market operator incurs dealing with any challenges to the pricing methodology and general enquiries about the pricing process.

Direct benefits

8. The direct benefits of any pricing process derive from the attributes discussed above. It is useful to understand the direct marginal benefit of each attribute:¹⁰
 - (a) Increases in the timeliness, predictability, and authoritativeness of prices increases the certainty of prices for market users, which increases the impact that price changes have on buyer and seller decisions. The more they react to price changes the more efficient are consumption and production decisions in the economy;
 - (b) Greater transparency, and simpler prices, also increase the impact prices have on buyer and seller behaviour, leading to more efficient consumption and production decisions; and
 - (c) Greater accuracy improves the efficiency of price signals by aligning consumer and producer decision-making with the true marginal costs of supply.

¹⁰ The direct marginal benefit of an attribute is the additional benefit market users obtain from a small increase in the attribute.

Indirect costs and benefits

9. The indirect costs of a pricing process are the costs that buyers and sellers incur as a result of the process imperfectly meeting their needs. For example, indirect costs include:
 - (a) Costs that buyers and sellers incur making their own price forecasts, or that they incur digesting the forecasts published by the market operator;
 - (b) The transaction costs spot market participants incur hedging against spot market prices or negotiating long-term physical contracts; and
 - (c) Costs that buyers and sellers incur attempting to influence prices after trading has occurred by alleging irregularities or special circumstances that render invalid the normal price calculation.
10. As indirect costs arise from the actions of buyers and sellers, changes in the pricing process can increase or reduce indirect costs. Reductions in indirect costs are treated as indirect benefits in the discussion below.

A3. Overall economic framework

The simple case

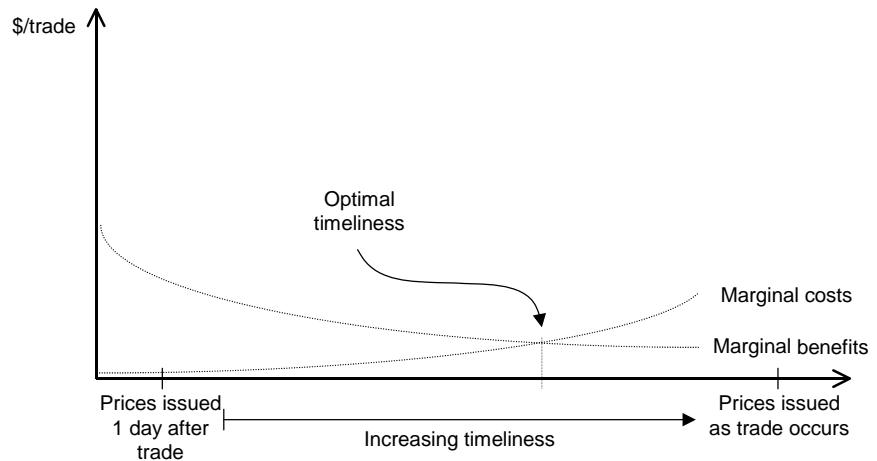
11. Provided all attributes can be produced independently of each other, choosing the optimal pricing process is conceptually simple: choose the pricing process in which the marginal benefit of each attribute equals the marginal cost of each attribute.¹¹
12. For example, suppose we want to consider bringing forward the timing of spot market prices, so they are calculated and published as the trade occurs, rather than “24 hours” afterwards. As discussed in paragraph 8 above, timely pricing brings efficiency benefits to the extent it increases certainty of prices for buyers and sellers.
13. Timely pricing also brings other benefits to the extent it reduces indirect costs – for example, buyers and sellers may invest less in forecasting spot market prices because of the increased certainty they have with spot prices. In other words, the marginal benefit of improving the timeliness of prices includes both direct and indirect benefits.¹²

¹¹ The marginal cost of producing each attribute is the additional costs the market operator incurs to provide more of one attribute whilst producing other attributes at an unchanged level. Letting MB and MC denote the marginal benefit and marginal cost of an attribute, respectively, then optimality requires $MB = MC$ for each attribute.

¹² Letting DMB and IMB denote direct marginal benefits and indirect marginal benefits, the optimality equation becomes $DMB + IMB = MC$ for each attribute.

14. Figure 1 illustrates the optimal timeliness of prices is where the marginal benefit of increasing timeliness equals the marginal costs of that initiative.

Figure 1 **Optimal timeliness in the simple case**

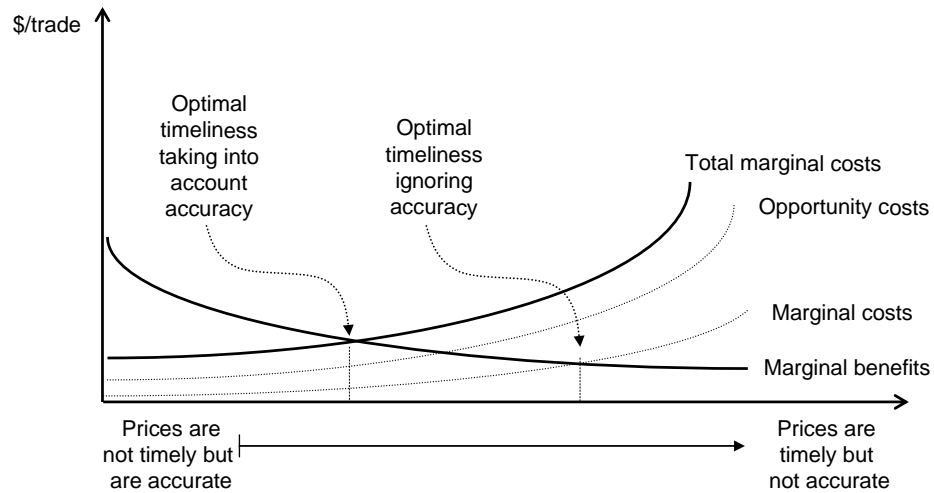


The interaction case

15. In practice some of the attributes may be conflicting, in that achieving more of one involves achieving less of some of the others. In this case choosing an efficient pricing process requires taking into account those interactions or trade-offs when choosing the mix of attributes.
16. For example, consider the initiative to bring forward the timing of spot market prices from “24 hours” after the trade occurs to instantly after the trade occurs. Suppose this initiative would mean spot market prices would reflect the marginal cost of supply less accurately than under the “24 hour” approach. Less accuracy might arise, for example, because the market operator would have no time to check the validity of the demand and supply quantities, leading to more errors than under the “24 hour” approach.
17. The reduction in accuracy reduces the efficiency of the price signal, which may mean buyers buy products when they value them less than the cost of supply (because price is less than marginal cost) or fail to buy products when they value them more than the cost of supply (because price exceeds marginal cost). These mismatches between value and cost are an opportunity cost of improving the timeliness of prices.
18. Taking into account the trade-off between timeliness and accuracy means the efficient pricing process will produce less timely prices compared to the situation when both attributes can be achieved independently of each other.

19. This is illustrated in Figure 2, which has the same marginal benefit and marginal cost curves as Figure 1. Adding the opportunity cost of forgone accuracy to the marginal cost curve gives the total marginal cost curve.

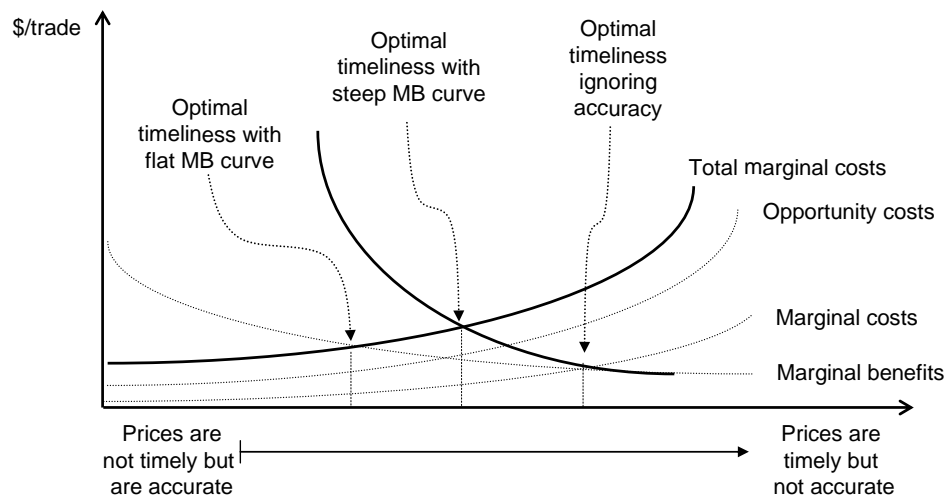
Figure 2 Optimal timeliness of prices when accuracy is affected



20. Figure 2 assumes the opportunity cost of forgone accuracy rises steeply as timeliness increases, which makes the total marginal cost curve rise steeply. As the marginal benefits curve is relatively flat, the optimal timeliness of prices is greatly reduced when the conflict with accuracy is taken into account.¹³
21. The flat marginal benefit curve reflects the case where buyers and sellers have excellent alternatives for achieving certainty of prices. For example, reducing timeliness would have very little impact on marginal benefits if buyers and sellers can readily restore certainty by relying on price forecasts or by hedging their exposure to spot market prices. In this case 'we can have our cake and eat it too' because the pricing process can be targeted to achieve accuracy and price forecasting and hedge market reforms can be targeted to achieve certainty.
22. Figure 3 shows the case when buyers and sellers have little confidence in price forecasts or are unable to easily hedge most of their spot price risks. In this case the marginal benefit curve is much steeper than in Figure 2, and so it is more costly to trade-off timeliness for accuracy. In this case it is optimal to have more timeliness and less accuracy than in Figure 2.

¹³ The optimality equation in this case becomes $DMB + IMB = MC + OC$, where OC is the opportunity cost of achieving less of other attributes that conflict with the timeliness attribute.

Figure 3 Optimal timeliness when price forecasting is inaccurate



23. The above analysis shows the situation where the opportunity cost of timeliness (that is, the forgone net benefits of accuracy) is high relative to the marginal cost of timeliness. If the opposite is the case, then the opportunity cost curve would be close to the horizontal axes and relatively flat. In this case the trade-off between timeliness and accuracy would have little effect on the optimal timeliness of prices.

A4. Concluding comments

24. The above discussion focused on the trade-off between timeliness and accuracy to highlight the conceptual framework. There may well be other trade-offs to consider, such as between timeliness and authoritativeness, or between timeliness and robustness. There may also be other initiatives affecting the spot market, or other closely related markets, that have the potential to alter trade-offs among these attributes (such as the initiatives discussed in section **Error! Reference source not found.**).
25. In developing any pricing process it is important to take into account the magnitude of the trade-off between attributes (for example, how much accuracy is forgone to improve certainty) and the extent to which alternative instruments can be used to ease those trade-offs. The conceptual framework in this section proposes how this should be done.