United States Department of Agriculture

A Process to Establish and Use Base Period Prices for National Forest System Transaction Evidence Timber Appraisal

Richard W. Haynes
Kenneth E. Skog
Richard Aubuchon

Forest Service | Forest Products Laboratory | General Technical Report FPL–GTR–242 | December 2016

Abstract

The USDA Forest Service is required to appraise timber prior to it being offered for sale. Currently the Forest Service uses a transaction evidence based approach, but concerns have been raised about availability—both in number and applicability—of timber sales used as the basis of this approach. In addition to the problem of few sales, in certain situations a notable fraction of the sales may be made at the minimum rate. This transaction evidence system and the application of a rollback factor in setting a minimum bid rate can result in appraised prices declining over time in areas with low competition, even though primary product prices are increasing. This study evaluates several changes that may be needed to address these concerns. The changes should be able to provide a base period price (BPP) that does not rely on local transactions. The estimated BPP could rapidly respond to change in timber and product market conditions and after local cost adjustments would provide an estimated fair market value for sales with mixes of sawtimber and nonsawtimber products. We propose use of price mark-up rules to estimate BPPs for various timber product classes. These price mark-up rules could be estimated for various geographic zones and would predict quarterly average stumpage prices for recent sales based on primary product price indexes. The mark-up equation estimates of average base period stumpage price are compared to actual high bid values for 810 recent Forest Service timber sales. The comparisons highlight a number of issues that need to be addressed and require decisions by forest management decision makers as part of implementation. These issues include selection of geographic zones where mark-up equations may be needed to estimate BPP, appropriate size of timber appraisal zones when mark-up equations are used, assignment of sawtimber and nonsawtimber volumes to appraisal groups, structure and extent of uniformity of cost adjustments, treatment of high- and low-value hardwoods, adjustments for bid premiums, and selection of rollback factors.

Keywords: timber appraisal, mark-up equations, base period price, bid rate, advertised rate

December 2016

Haynes, Richard W.; Skog, Kenneth E.; Aubuchon, Richard. 2016. A process to establish and use base period prices for National Forest System transaction evidence timber appraisal. General Technical Report FPL-GTR-242. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 43 p.

A limited number of free copies of this publication are available to the public from the Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53726–2398. This publication is also available online at www.fpl.fs.fed.us. Laboratory publications are sent to hundreds of libraries in the United States and elsewhere.

The Forest Products Laboratory is maintained in cooperation with the University of Wisconsin.

Contents

Preface

This report is part of an effort to examine and potentially address various issues involved in appraising USDA Forest Service timber sales. This study provides information that will help in further discussions among timber purchasers and Forest Service timber appraisers to address selected issues. The intent of this report is to review a number of contemporary issues and suggest ideas that would address those issues and provide an appraisal process that is transparent, consistent across Regions, and more specific to the mix of products being sold by the Forest Service.

This report was prepared by a small group of individuals that have been involved in the appraisal process. This group selected a number of issues to discuss and address. The Forest Service and timber purchasers will need to further consider the extent to which individual issues will be addressed in any revision to appraisal methods. Extensive review comments from a variety of individuals and organizations have greatly influenced the development of the final report.

A Process to Establish and Use Base Period Prices for National Forest System Transaction Evidence Timber Appraisal

Richard W. Haynes, Natural Resource Economist
Kenneth E. Skog, Research Forester Emeritus
USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin

Richard Aubuchon, Forester
USDA Forest Service, Sale Administration & Appraisals, Fort Collins, Colorado

Introduction

The USDA Forest Service is required to appraise timber prior to it being offered for sale. The objectives of timber appraisal (see section 2420.2 of the Forest Service Manual) are to

1. estimate fair market value for National Forest timber offered for sale,
2. set an advertised rate that encourages sufficient competition for National Forest System (NFS) timber that results in values that are fair to both the Government and purchaser,
3. bring advertised values close to bid values,
4. ensure that appraisals are sensitive to changes in the market for forest products, and
5. redetermine stumpage values to ensure fair market value received for timber under contracts of more than seven years duration.

Although appraisal methods have changed over time, transaction evidence methods are currently used in Regions 1–9 and the residual value method is used in Region 10. In the past several years, there has been growing concern about availability—both in number and applicability—of timber sales used as the basis of transaction evidence methods in certain Regions. In addition to the problem of few sales, in certain situations a notable fraction of the sales may be made at the minimum rate. With this transaction evidence system and the application of a rollback factor in setting an advertised rate, Base Period Prices (BPPs) can decline over time even though primary product prices are increasing. This study is intended to address this concern by suggesting use of price mark-up equations to estimate BPPs, where Forest Service managers decide they are needed, as a substitute for existing transaction evidence prices. The proposed price mark-up equations should have the following features:

- Be available nationwide
- Work with current or revised system of local cost adjustments
- Rely on data readily available in the public sector
- Be easy to understand and operate, using variables that have a "real world" basis
- Rapidly adjust BPPs in response to change in timber and product market conditions
- Predict BPP that can be used in combination with cost and sale adjustments to set a fair market value for sales with mixes of sawtimber and nonsawtimber products
- Evaluate predicted average BPPs for appraisal zones by comparing them to bid rates for recent historic sales (such as prior 2–3 years)
- Can eventually be implemented using the Timber Information Manager (TIM) program

A successful method is one that meets these objectives and could be effectively implemented by a diminishing timber sales staff. The intent would be to have a tool that could periodically estimate equations that would be used by staff in each appraisal zone to estimate BPPs. Use of systematically developed BPPs could increase societal confidence that the agency is estimating "fair market values" and may also increase financial returns to the treasury (and payments to the States) by reducing the number of situations where timber is sold at appraised prices that do not reflect current market prices.

We define BPP per unit of timber volume for a given appraisal group and appraisal zone as the estimated value from the high bid price for a sale in the current calendar quarter where the sale has volume-weighted average characteristics. These average characteristics include average costs (including stump to landing, haul) and average market demand conditions. Average market demand conditions are determined by an estimated primary product price and the average conversion efficiency of mills in the zone. These average market conditions will determine the average price mills can pay for stumpage. The BPP implicitly includes any average bid premium that the winning bidders have paid above the recent average appraised prices.

This definition (label as A) differs to a degree from the definition used in various Forest Service Regions (label as B). In definition B, BPP is generally defined as representing

the appraisal group's volume-weighted average winning bid price of the competitively sold timber sales in the base period, with the exceptions of Regions 1, 8, and 9 and Regions 5 and 6 biomass. For Region 1, it is the average of the winning bid price plus road maintenance costs, environmental costs, temporary development costs and specified road costs and is called the "actual past average value." For Regions 8 and 9, it includes the application of a rollback factor. For Region 5 biomass, it is an estimated value. For Region 6 biomass, it is the delivered chip price converted per hundred cubic feet (CCF). In general the BPP reflects average sale characteristics of the base period sales.

In definition A, BPP is the estimated average high bid price for a sale *in the current quarter* where the sales characteristics are average for a recent period. In definition B, BBP is the average high bid price for a sale of average characteristics *over a historic period as close to the present as possible and extending back a number of quarters*.

The Transaction Evidence Appraisal (TEA) system has been used by the Forest Service (except in Region 10) for the past 25 years. It was intended to reduce appraisal costs (by reducing the need for cost collection) and to reduce the difference (bid premium) between appraised and high bid prices. To function as intended, TEA depends on a number of transactions (sales) in competitive markets (that is, with multiple bidders). The downturn in the Forest Service timber sales program starting in the mid-1990s has led to fewer sales in the time periods that comprise the various transactions data bases and, in many areas, fewer bidders. The great recession of 2008–2009 further reduced the basis for transaction evidence, raising questions about whether timber sale appraisals reflect fair market value, especially in declining or rapidly changing markets. (The Forest Service is required by 36 CFR 223.60 to sell timber at "fair market value." From an economics perspective, this value is like a reserve price that represents the agency's view of a sufficient price, taking into account local cost adjustments and the average mix of bidders.) Specific problems are the drop in competition, inadequate number of transactions, outdated appraisal zones, lack of transparency in regional cost adjustments, increased use of stewardship contracting, and the tendency to lag market price changes. The primary objective of the study is to provide a method to estimate BPP (that is, stumpage prices, or net returns to the landowner from selling timber, generally expressed as dollars per CCF in Forest Service sales) that may be used when transaction evidence data are limited and to provide a preliminary evaluation of their use. These average base period stumpage prices are estimated for a given timber appraisal group (such as softwood sawtimber) as a function of primary product (such as softwood lumber) price in a given appraisal zone. Depending on decisions of Forest Service managers, this method might be used to estimate BPPs in a limited set of Regions with minimal alterations to the current appraisal system or for all BPPs with more extensive system alterations. The implementation section discusses options for managers. This study suggests that BPPs be estimated for six appraisal groups—for each of two species groups (softwoods and hardwoods) there are three product groups (sawtimber, nonsawtimber, and fuelwood). These groups are flexible and could be divided into low- and high-value subgroups. The BPPs are estimated for the current quarter for a given appraisal group in a given appraisal zone. For an individual sale, a BPP for an appraisal group is further adjusted by local cost adjustments and potentially by a rollback factor to provide an indicated advertised rate (before base rate adjustment).

The Problem

Figure 1 shows variations in primary wood product prices that drive what wood product mills can pay for Forest Service stumpage. These lumber and wood pulp prices drive prices that can be paid for logs at mills and the stumpage price that can be paid for offered timber. (We implicitly assume that given longer Forest Service timber sale contracts, bidders base their bids on expectations for future product values, which may or may not be reflective of current product values.) A problem for the timber appraisal system is how to account for this known influence of primary product price on appraised price. Our proposed solution to this problem is to select and use primary product prices (such as lumber prices) familiar to bidders to estimate current stumpage prices (discussed in a later section).

For lumber prices, the market swings are notable. These are commodity markets that reflect key movements in overall economic conditions. Also notable are differences between softwood species (the lower group of lines) and hardwood (HWD) species, reflecting differences in end uses and markets of these species groups.

Figure 1b shows one of the price series for wood pulp. Although showing less volatility than for lumber, it still reflects general market cycles. Lumber prices were more volatile than pulp prices because of greater volatility in housing construction markets over this period than in paper end-use markets. Both charts illustrate the dilemma facing agencies when market conditions are relatively uncertain and additional known variables (such as sale volumes, species, product groups, logging system requirements, haul distances, slash and road maintenance adjustments, and other local sale adjustments) influence sale value.

Although strong economic theory indicates that primary product prices will influence what mills pay for stumpage, our ability to detect the degree of influence using data series will depend on variation in primary product prices, variation in other factors that influence stumpage prices, and the length of the data series. While Figure 1 shows notable variation in primary product prices over 13 years, we use data from a shorter time, since 2009, to estimate the relationships between primary product prices and stumpage prices.

The intent of an appraisal system is to provide an advertised value as the starting point for a bidding process. This starting point needs to represent a "fair market value" in the sense that such a value is one that both willing buyers and sellers would agree on. For most sales of public timber in the United States, the final market price is set by public auction, where bidders bid based on their perceptions of the value of timber being offered and future market conditions. (In the United States, public agencies selling timber use various ways to develop appraised prices, but most include some form of product prices.) Most agencies do not attempt to estimate a final price, because it is not possible to do so without knowing who the purchaser will be or what economic conditions will be at time of harvest, which is often two or more years after a sale. (USDA Forest Service timber sale contacts can range in length from less than 1 year to 10 years; most sales are in the 2–4 year range.) Often the goal of the appraisal process is to attract multiple bidders and have a high likelihood of successfully selling the sale at initial offering. The issue in developing an appraisal process

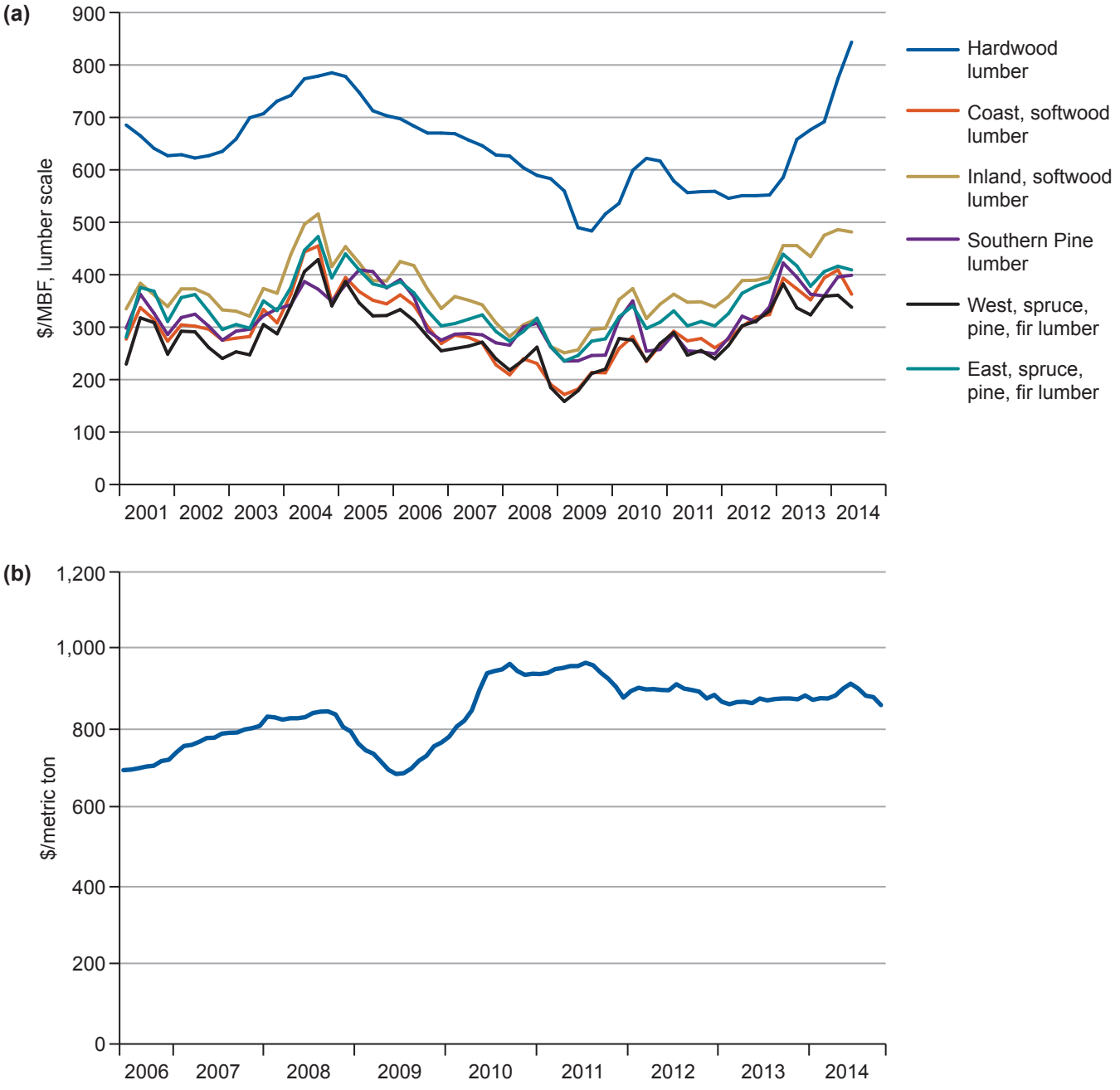

Figure 1—U.S. prices for (a) lumber, by region, and (b) wood pulp. (Lumber prices from Random Lengths (2014), Luppold (2015), and WWPA (2011); June 2006 world wood pulp price from World Bank (2015), U.S. wood pulp price index from USBLS (2015a).)

is how to include expectations of lumber market conditions. TEA systems were intended to provide a minimum advertised value that reflects current market conditions; but as Figure 1a illustrates, market conditions can change rapidly and TEA systems typically use data from a number of quarters in the past. Given how forest product markets, including stumpage, can be characterized as experiencing relentless change (Haynes 2008), can we develop an appraisal method that ties changes in stumpage prices to product prices, and how would that method work?

A Revised Method to Calculate Base Period Prices for a Timber Sale

In this section we discuss three key parts of the appraisal method and possible revisions to those parts. We first give an overview of appraisal calculations then review the model that will be used to estimate the BPP. Next we review spatial aggregations for which we develop relationships between product prices and Forest Service sold prices. We call the spatial aggregations "appraisal zones," but unlike the former use of appraisal zones for appraising timber, which tended to be small (often subparts of a Forest Service Region), these are larger, follow broad timber market areas, and combine several National Forests and, in some cases, parts of more than one Forest Service Region. In most cases, these larger appraisal zones follow the various regional definitions used in some of the spatial timber market models from various Resources Planning Act (RPA) timber assessments (see Adams and Haynes 1980). Then discuss the timber product (appraisal group) framework for this study.

Overview of Timber Appraisal Calculations

An initial objective for the appraisal system is to calculate a predicted bid rate, $\mathrm{PBR}^{\mathrm{s}}_{igz}$. This value is for a particular sale (i), for volumes in each of several timber appraisal groups (g), in a given appraisal zone (z). For simplicity, we drop the g and z notation for appraisal group and appraisal zone.

The PBR for a sale, i, is calculated based on (1) an expected average current price for stumpage in the appraisal zone and (2) an adjustment to that expected average price (and average sale conditions) to account for the difference between average costs to get stumpage to a mill and specific sale i costs to get stumpage to a mill:

$$\mathrm{PBR}^{\mathrm{s}}_{i} = \mathrm{BP}^{\mathrm{s}} + \sum\nolimits_{j=1}^{n} \left(\overline{C}_j - C_{ji}\right) \qquad (1)$$

where BP^{s} is the estimated current average stumpage price for stumpage in appraisal group g for the stumpage market in appraisal zone z. In the TEA system, this is called the BPP. $\overline{C}_j$ is the estimated current average cost for cost center j in a given appraisal zone. Cost centers include felling/bucking/yarding, hauling, and road maintenance; include routine adjustment for quality or risk or for any unusual adjustment; and include any deposits required by the purchaser. They include any cost to a purchaser that would cause them to adjust their bid. C_{ji} is the estimated cost for cost center j or adjustment for quality or risk or unusual circumstance specifically for sale i.

In some ways, Equation (1) follows the process a bidder uses to develop site-specific prices (called site prices; for a discussion, see Haynes (2008)) that recognize local differences in operations and costs compared to regional averages. The adjustments $\overline{C}_j - C_{ji}$ are not increased or decreased by a multiplier, on the assumption that these differences accurately indicate the adjustments to average costs that bidders effectively would use when calculating a bid price. We assume that bidders do not modify these estimated costs, by increasing or decreasing them, when including them in a bid calculation.

The appraisal system begins with a BPP and volume for each appraisal group (an aggregation of species, such as lodgepole pine and grand fir) in a sale. Several adjustments are applied to each BPP, including market adjustments and local cost adjustments from recent average costs (such as haul cost). Adjustments may also be made for quality, risk, and a catch-all—"unusual adjustment." The result is the PBR for each appraisal group, which is adjusted by a competition or "rollback" factor and any property value added to the sale. The result is the *indicated advertised rate* for the appraisal group. This value is compared to a *base rate* for each appraisal group in the sale. The base rate is calculated by selecting, for each appraisal group, the higher of a *minimum rate* or a minimum deposit to the National Forest Fund ($0.25/CCF), plus the cost of reforestation on regeneration acres and any timber property value over the amount used to offset deficit values (FSH2409.18,45.42). If this base rate is higher than indicated advertised rate (a deficit appraisal group), it is used as the value for the appraisal group. The indicated advertised rates of other appraisal groups are adjusted downward in proportion to their positive (nondeficit) value to recover the upward price adjustment in the deficit appraisal group(s). The current minimum rates are $1/CCF for a low-value appraisal group, $3/CCF for a medium-value group, and $5/CCF for a high-value group (FSM2431.31b). The result after any substituting and adjusting due to base rates is the *advertised rate* for each appraisal group, which is intended to be a fair market value. There are some differences among Forest Service Regions; for example, in Regions 8 and 9, a rollback factor is used in calculating the BPP, whereas other Regions apply the factor to the PBR.

Model for Estimating Base Period Price

We propose a method to estimate $\mathrm{BPP}^{\mathrm{s}}_{t}$, which is average stumpage price in the current quarter t as a function of price in the current quarter of the product that is made from the timber, P^{p}_{t}:

$$\mathrm{BPP}^{\mathrm{s}}_{t} = c_1 + c_2 P^{\mathrm{p}}_{t} \qquad (2)$$

This approach for estimating a raw material price is common in agricultural markets (Wohlgenant 2001). The price change for the factor of production (raw material such as stumpage) is estimated as a function of price change in product markets. Discussion of the link between factor and product markets is a common aspect of production economics. In the case of timber, stumpage markets are considered to be derived from product markets where stumpage is one factor in the production of lumber or wood pulp (other factors are typically labor and capital). Economic theory and empirical evidence indicate that as product prices increase, the ability of mills to pay higher prices for stumpage increases as well. Conversely, as product prices decrease, the ability of mills to pay for stumpage decreases. Finally, we are proposing not that the price mark-up rule could predict the high bid for a specific sale but rather that it estimates the high bid if a sale has average costs and average bid premium. Models for predicting the specific high bid would be more complex and would include sale characteristics, market condition expectations, number of bidders, and other factors. Our goal is to estimate the BPP, the starting point for timber sale appraisal, which would then be modified by local cost adjustments and potentially a rollback factor and then compared to the legal minimums to determine the advertised rate.

We estimate current quarterly average stumpage prices (by product class) as a function of current quarterly primary product price (for lumber or wood pulp). The data are quarterly, and past studies suggest that lumber and stumpage prices adjust to changes in either market within a month (Haynes 2008). We use nominal price data (inflation is not removed) for both stumpage and primary products. This implies that any adjustment in product price within a quarter will be reflected in an adjustment to stumpage price within the same quarter. For our method, we assume that we can use the latest reported product price to estimate current average stumpage price.

In Equation (2), BPP^s is the price in the stumpage market and P^p is the price in, say, the lumber market. Coefficients c_1 and c_2 are estimated from historic price data for the two markets. In agricultural literature, this is called a marketing margin or sometimes a price mark-up rule and used to relate farm level prices to wholesale product prices. (George and King (1971) summarize this use and discuss how marketing margins can be used to develop derived demand functions.) In forestry, this relation has been used to understand how changes in the product market are transmitted to the stumpage market (Haynes 1977, Spelter 2005).

Depending on estimates for c_1 and c_2, there are three possible types of relations between the factor (stumpage) and the product (such as lumber, wood pulp, biomass): The contribution of factor cost to product cost is fixed if c_1 is significant and c_2 is zero, is proportional to the product price if c_1 is zero, or is mixed if both are significant.

A caution to be aware of in interpreting the coefficients is that measurement scales are different between volumes in product markets and volumes in stumpage markets. For example, lumber prices are dollars per thousand board feet lumber tally, whereas Forest Service stumpage prices are in dollars per hundred cubic feet ($/CCF). This means that the estimated coefficients will include implicit conversions between measurement scales and cannot be used to estimate price elasticity of stumpage prices with respect to product prices. In past studies, price mark-up rules have been used to estimate elasticity of price transmission, which can be used to estimate elasticity in the stumpage market from elasticity in the product market. This is useful in determining how price changes in one market are transmitted to the other market (Haynes 1977).

For the case where only c_2 is used, the actual calculation of aggregate BPP for all appraisal groups in a sale is a volume-weighted average price across the product groups calculated as

$$\begin{aligned} \text{BPP} = {} & w_1 C_2^1 P_s^p + w_2 C_2^2 P^{wp} + w_3 F + y_1 D_2^1 P_h^p \\ & + y_2 D_2^2 P^{wp} + y_3 F \end{aligned} \tag{3}$$

where w_1, w_2, and w_3 are proportions of softwood sawtimber, softwood nonsawtimber, and softwood fuelwood, respectively; P_s^p is price of softwood lumber; and C_2^1 and C_2^2 are softwood sawtimber and nonsawtimber coefficients, respectively; P^{wp} is wood pulp price; F is firewood permit fee for the appraisal zone (a proxy for fuelwood prices because of a lack of reported prices); y_1, y_2, and y_3 are proportions of hardwood sawtimber, hardwood nonsawtimber, and hardwood fuelwood, respectively; P_h^p is price of hardwood lumber; and D_2^1 and D_2^2 are hardwood sawtimber and nonsawtimber coefficients, respectively. (Prices of softwood lumber, wood pulp, and hardwood lumber are from the primary product data set shown in Table 3; hardwood sawtimber and nonsawtimber coefficients are estimated for a single-coefficient equation in Table 6.)

In actual application, Equation (3) will be modified for species and product groupings in the various appraisal zones.

Appraisal Zones

Forest Service timber appraisals have long depended on using appraisal zones to represent similar timber market, timber production, and milling cost conditions. Traditionally these have been relatively small geographic areas reflecting timbersheds or working circles for clusters of forest product manufacturing facilities. The number of these zones varies by Forest Service Region, but they are geographically specific. The past three decades have seen steady consolidation of the forest products industry, where there are now fewer but larger facilities drawing timber from broader areas. During this same period, the Forest Service shifted its timber appraisal processes away from residual value to transaction

evidence (TEA) processes, reducing the need for local manufacturing cost collection used for the residual value method. (Region 10 is the one exception, where the residual value approach is stilled used.) With the TEA method, the role of appraisal zones, while still being based on log flows to a milling center, changed to being areas used to make cost adjustments to the average transaction evidence price to reflect sale-specific conditions. At the same time, western products markets for Forest Service timber have become less diverse as panel markets have changed and softwood lumber and associated residue (including biofuels) markets have increased (see the discussion in Haynes (2008) for an explanation). Coinciding with the diminishing diversity of products markets is the increase in bidders for Forest Service timber that operate in multiple Forests and/or Forest Service Regions. Some of these bidders question the differences between Forest Service Regions in appraisal and sale practices. Another component of this evolution has been changes in lumber market price reporting. There are now broad composite indexes for regional species (and grade) groupings that are reported monthly. These broad price composite indexes are a key component in the method we propose to estimate BPP. The relationship between stumpage and lumber prices is used to estimate average stumpage price for each product appraisal group used in each zone. These lumber prices are broad regional aggregates including a range of species available in the region.

After considering the availability of stumpage price data for National Forest locations and appropriate matching to markets and lumber price index data, we propose nine appraisal zones for the country, not counting Alaska (see Appendix 1 for assignment of National Forests to each appraisal zone):

1. Coast—Western Oregon, Washington and northern California (15 National Forests)
2. Inland, North—eastern Oregon, Washington, all of Region 1 plus Boise, Payette, and Salmon–Challis National Forests in Idaho, Montana (30 National Forests)
3. Inland, Central—Idaho/Nevada border National Forests, Nevada, Utah, Colorado, Wyoming, South Dakota (20 National Forests), most of Regions 2 and 4 (minus the Idaho Forests of Region 4 north of the Snake River) (31 National Forests)
4. Inland, South—All of Region 3, southern California (16 National Forests)
5. Sierra—middle forests in California (9 National Forests)
6. Southeast—National Forests in Region 8 east of Texas (26 National Forests)
7. Mid-South—Texas, Arkansas, Missouri (8 National Forests)
8. Lake States—Minnesota, Wisconsin, Michigan (8 National Forests)
9. Northeast—Region 9 without the Lake states (8 National Forests)

Why these nine appraisal zones? They each correspond to a broad lumber market. The coast appraisal zone is roughly the same as the Western Wood Products Association's (WWPA's) coast region and the area covered by the Northwest Forest Plan (NWFP), and contains two traditional lumber markets (Douglas-fir and redwood markets). The three inland appraisal zones (North, Central, and South) correspond roughly to the WWPA's Inland region. The North Inland appraisal zone is roughly the old inland empire timber market that has pine and Douglas-fir markets. The Central Inland appraisal zone is an area where production is scattered but mostly in the eastern part focusing on mixed softwood species. The South Inland appraisal zone includes National Forests where there is little product production and the Forest Service has had difficulty in sustaining a sales program; there are some local markets for pine lumber. The Sierra appraisal zone includes National Forests in eastern California where there are active markets for lumber production in the Sierra Mountains; this zone has a mix of species including pine and true firs. The Southeast appraisal zone includes both the product-diverse southern pine markets and Appalachian hardwood markets in several of the states associated with the furniture industry. The Mid-South appraisal zone (mid-south west of Mississippi) contains traditional pine sawtimber and hardwood markets of the Ozarks. The Lake States appraisal zone includes the three lake states with a mix of hardwood and softwood markets. The Northeast appraisal zone includes both the northeast States and Ohio valleys with primarily Appalachian hardwood markets.

Product Codes and Appraisal Groups

The Forest Service has an extensive list of timber product codes (Appendix 2). Thirteen product codes (shown in bold in App. 2) are included in the Forest Service Timber Cut and Sold reports (one of the basic data sets used in this study). A combination of a product code and one or more species codes are used to define an appraisal group for which cost adjustments are made for individual timber sales. For example, sale number 11054 (FY2014) in Region 9 has a total volume 1,894 CCF divided among four species and two product codes (saw timber and pulpwood), for a potential total of eight appraisal groups. In the case of sale number 11054, volumes are identified for each of four species codes and two product codes; cost adjustments are applied separately for each. There are no limits to the number of possible combinations of species and product codes for each sale. Each combination is treated as a possible appraisal group requiring cost adjustments to an average base period appraised price for volume in each group. Cost adjustments are made for logging costs (felling, bucking; skidding, loading) and for hauling, road maintenance, contracting costs (such as lopping and scattering vegetation along roads or away from leave trees), temporary development costs, unusual sale-related costs, specified road costs, and for other risks to arrive at an advertised rate. (Temporary development costs vary among regions. Most would include temporary bridges and

Table 1—Assignment of FS products into product groups used in the revised appraisal method

Product group	FS products, names	FS products, numbers
Sawtimber	Sawtimber, Poles, Pilings, Ties	01, 03, 04, 09
Nonsawtimber	Pulpwood, Posts, Nonsawtimber	02, 06, 08
Fuelwood	Fuelwood, Miscellaneous Convertible, Cull Logs, Small Roundwood, Green biomass Convertible, Dry biomass Convertible	07, 14, 18, 19, 20, 21

landings and their decommissioning. Some regions include seed and fertilizer costs in this category, whereas others list it separately, called in these cases "seed and fertilizer" or "erosion control.") In our approach to form appraisal groups, we have grouped species into two broad groups (hardwoods and softwoods) and grouped timber products into three product groups (sawtimber, nonsawtimber, and fuelwood) resulting in a maximum of six possible appraisal groups (Table 1). These groupings represent actively functioning stumpage markets within the appraisal zones. The most widespread markets for National Forest timber are for softwood sawtimber; in the east, there are also markets for hardwood sawtimber. In the east and especially the South, there are also functioning markets for nonsawtimber that include both traditional pulpwood and chip or fiber input for other engineered products. Although characterized by less formal markets, there are various markets and permit systems for fuelwood or biomass used for energy applications.

Data Sets

Three data sets are constructed for this study. The first two (Forest Service data on timber sold volume and price, and data on primary product prices) give averages by quarter. The third data set contains 810 Forest Service timber sale records. (These sales represent the variety of timber sales offered over the past several years, including regular, thinning and salvage sales. Each sale reflects unique circumstances that may lead to out of the ordinary bidding as illustrated in various figures later.) For a selection of sales, these records include sale dates, sale volume, species and product groups, cost data, and appraised and high bid prices. The third data set includes all sales for several fiscal years for some regions and all sales in fiscal year 2014 for other regions. The first data set includes timber volume sold and volume-weighted average price by quarter and covers the period fiscal year 2009 to the third quarter of fiscal year 2014. The second data set, which includes quarterly price for lumber and wood pulp, covers the fourth quarter of 2008 to the second quarter of 2014 (a total of 23 quarters). This period was chosen because it includes the most recent 20 quarters available at the start of this project (which was assumed to be the minimum sample size for estimation and to represent recent supply and demand trends that set prices). Generally this is a period where timber markets reflected both the full effect of the great recession of the 2000s and the beginning of the economic recovery.

Forest Service Timber Sold Data

All the Forest Service sold data for fiscal years 2009 to 2014.3 were entered in two Excel spreadsheets. These data cover the calendar year period of 2008.4 to 2014.2. Each row contains the sold volume and bid prices for up to 13 products included in the sold data for that period. Aggregate volumes of sawtimber, nonsawtimber, and fuelwood sold by quarter are shown in Figure 2. Of the total 2.55 billion cubic feet of timber sold over this period, 86.4% was softwoods and 13.6% hardwoods. For the three product groups, 57.8% was sawtimber, 24.3% was nonsawtimber, and 17.9% was fuelwood. These proportions varied among regions,

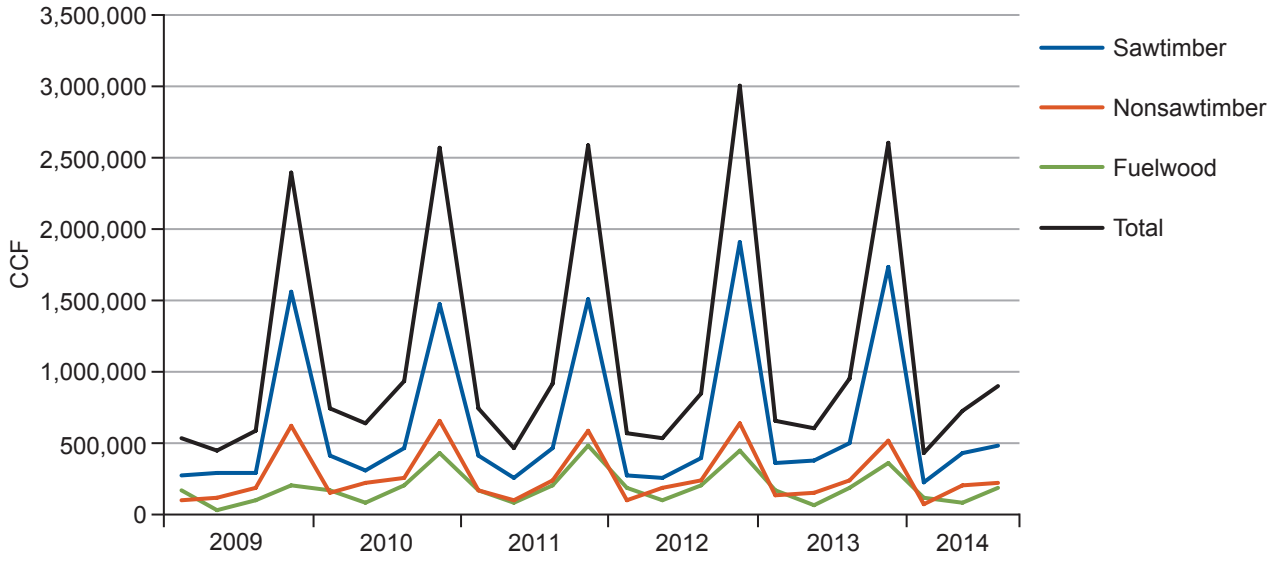

Figure 2—Volumes sold by the Forest Service Timber Sales Program, FY2009–2014 (USDA Forest Service 2014).

Table 2—Total volume and value of Forest Service timber sales, FY2009–2014

	Volume ($\times 10^6$ CCF)	Value ($)	Volume (%)	Value (%)
Coast	3.64	137.74	14.24	18.13
Inland North	5.86	148.88	22.95	19.60
Inland Central	3.26	32.09	12.77	4.22
Inland South	1.39	9.44	5.46	1.24
Sierra	2.43	44.00	9.53	5.79
Southeast	3.40	130.10	13.29	17.12
Mid-South	2.30	90.57	9.00	11.92
Lake States	2.67	110.47	10.44	14.54
Northeast	.60	56.44	2.32	7.43
Total	25.55	759.73	100.00	100.00

with higher proportions of sawtimber sold in the western National Forests. (Proportions among the three product groups were 66.5%, 8.9%, and 24.5% for western appraisal zones and 41.7%, 52.9%, and 5.4% for the eastern appraisal zones.) Spikes in the sales program in Figure 2 reflect a consistently higher number of sales, and corresponding volume, sold in the fourth quarter of each fiscal year (third quarter of each calendar year).

The total value of all timber sold during this period was $759.7 million. Table 2 shows total timber volume and value for each of the new appraisal zones. It shows that there are differences between the volume and value proportions by appraisal zone. An important difference is that all eastern zones have higher value proportions than volume proportions, reflecting higher competition, more active markets for nonsawtimber material, and higher value species than western zones (except for the Coast zone).

Primary Product Price Data

Primary product prices are shown in Table 3 and Figure 1. These are presented in their nominal dollar form and reflect both long-term market trends and short-term market adjustments, such as the drop in prices in 2008–2009 accompanying the great recession.

Softwood and hardwood lumber prices. The product prices are market price proxies that bidders for Forest Service sawtimber are reacting too as they bid for Forest Service sawtimber. To serve this purpose for our appraisal method and for bidders, they need to be widely available (reported) and representative of demand for timber provided by Forest Service sales.

In this section, we describe the sources, data compilation issues, and various propositions about the price series. The lumber price series represent the product markets for sawtimber sold by the Forest Service. A secondary purpose is to discuss the relation between the lumber price indexes collected by the Bureau of Labor Statistics and stumpage prices, to provide background to discussions of how they can be used to adjust stumpage prices to actually be paid after timber is sold. Some of the price series and indexes are periodically published in two Forest Service publications (Howard and Westby 2013, Zhou 2013). The sources we use for softwood and hardwood lumber prices are Random Lengths, the Hardwood Market Report, and the Western Wood Products Association (WWPA). See the series and their sources in Table 3.

Various lumber price indexes are published by the Bureau of Labor Statistics (BLS) and in Howard and Westby (2013). BLS lumber price indexes have been simplified in recent years, but they still report a national price for all lumber, softwood lumber, and hardwood lumber. These are the lumber price index (WPU081 1982=100), the softwood lumber index (WPU0811), and the hardwood lumber index (WPU0812). These changes have made them useful for illustrating broad trends but less useful for developing base prices that need to reflect regional differences in species mixes.

Some of the most widely used softwood lumber price series in the West are the WWPA Coast and Inland lumber price series. Summaries of the WWPA price data are published by Zhou (2013). Random Lengths ("the weekly report on North American forest products markets," which uses the rule that monthly prices are averages of weekly prices starting with the week that has the first Thursday of the month) collects and publishes nearly 300 lumber species and grade prices, but most useful for our estimation methods are 6 of their 11 lumber composite prices: Coast Dry Random and Stud, Inland, Southern Pine, Western SPF, Eastern SPF, and Green Douglas Fir (Random Lengths 2014). These lumber composite prices are collected and published weekly by Random Lengths, intended to enable readers to quickly grasp price comparisons among different species, end uses, and regions. The weekly prices are also compiled into monthly averages and published as part of their monthly market overviews and annual yearbooks. For our purposes we compute a price series equivalent to the WWPA coast price series using two Random Lengths composite series. This price series is formed as the weighted average of the Coast Dry Random and Stud and green Douglas Fir composite prices using the proportions of kiln dried and green lumber for the coast and inland regions published by WWPA in their annual yearbooks (for example, WWPA (2011)). The various softwood lumber price series we use are shown in Figure 1a.

Hardwood lumber prices. We use an unpublished composite series developed by Bill Luppold (USFS, Northern Research Station). He developed a weighted price for Number 1 Common grade of hardwood lumber that uses 1C lumber prices by species weighted by the volume that each particular species is in the forest inventory for the Appalachian and northern area. (The species and weights are Ash, 0.04; Basswood, 0.01; Beech, 0.01; Birch, 0.01; Cherry, 0.04; Hickory, 0.03; Hard maple, 0.09; Soft maple, 0.06; Red oak, 0.36; White

Table 3—Primary wood product price data

Year	Qtr	Inland West softwood lumber ($/MBF)	Southern Pine lumber ($/MBF)	West spruce, pine, and fir lumber ($/MBF)	East spruce, pine and fir lumber ($/MBF)	West Coast softwood lumber ($/MBF)	Hardwood lumber ($/MBF)	Wood pulp ($/t)
2008	4	263.00	262.33	185.00	263.33	191.03	583.10	813.78
2009	1	251.00	235.33	158.33	235.33	171.64	559.60	750.56
	2	256.67	236.00	178.67	245.67	181.88	489.90	701.51
	3	295.67	246.00	211.67	273.33	213.69	483.10	704.07
	4	298.33	246.67	220.00	277.67	212.81	515.90	753.12
2010	1	352.33	314.67	278.67	319.33	259.50	536.10	804.49
	2	373.67	350.33	275.33	340.67	282.21	598.90	897.93
	3	316.67	254.33	235.67	297.33	234.38	621.65	956.50
	4	343.67	257.33	268.67	309.33	264.95	616.90	943.49
2011	1	363.00	287.33	289.67	331.00	292.45	578.80	946.51
	2	347.33	254.67	246.67	302.67	273.77	556.70	959.99
	3	348.33	252.67	255.33	311.00	278.60	558.10	959.53
	4	338.67	249.33	239.33	302.33	260.68	558.70	906.76
2012	1	358.33	279.67	265.33	326.00	277.33	545.65	902.35
	2	388.67	321.00	302.33	365.00	301.26	550.55	901.42
	3	389.67	310.00	311.33	378.00	318.67	550.85	906.99
	4	395.00	338.67	331.33	387.00	324.27	551.85	888.17
2013	1	455.33	422.67	382.33	439.00	393.50	585.75	868.64
	2	455.33	395.33	336.67	416.67	372.87	657.75	872.59
	3	434.33	363.00	323.33	378.00	351.98	676.70	877.24
	4	475.33	359.33	359.00	406.00	394.21	691.80	881.19
2014	1	485.67	395.67	361.00	416.00	409.32	772.50	878.40
	2	481.33	399.00	338.33	409.00	362.60	843.25	902.81

Data sources: All softwood lumber series, Random Lengths (2014); Hardwood lumber, Hardwood Lumber Market Report as compiled by Luppold (2015); Wood pulp, USBLS (2015a) and World Bank (2015) for the June 2006 dollar value per metric ton. Data from Random Lengths and the Hardwood Market Report are used with permission of the publishers.

oak, 0.18; Yellow poplar, 0.16; and Walnut, 0.01.) Common grade is often referred to as Cabinet grade because of its adaptability to the standard sizes of kitchen cabinet doors and is also used in the manufacture of furniture parts. Lumber prices by species are published in the Hardwood Market Report (various years). (The Hardwood Market report is published weekly and provides benchmark pricing and market commentary on North American lumber and hardwood products industry.) To represent quarterly prices, he uses prices reported for the first of the month for January, April, July, and October. Although hardwood lumber prices appear in Figure 1a to have risen sharply, the deflated recent prices are below levels reached in the mid-2000s. The one exception is black walnut, which enjoys strong export markets.

Wood pulp prices. Nonsawtimber can include small logs that can be sold to make several types of products that can vary by appraisal zone. Traditionally, nonsawtimber has been sold as pulpwood to make pulp and composite panel products (Table 1). More recently, some small logs could be used by small log sawmills to make lumber. These markets are predominantly in the eastern United States and are emerging in the West, where sellers are considered to arbitrage small logs between pulp, panel, and lumber markets. A stumpage owner will sell stumpage in the market with the highest return. Because the pulpwood markets will have to match prices for other small log uses, we use pulp prices to predict the nonsawtimber stumpage markets in the Eastern United States.

There is no single market pulp price for the United States, but there is a BLS national wood pulp price index ((WPU09110501) 2006 (June) = 100) (USBLS 2015a) that we use to construct a price series for wood pulp. A wood pulp price specific to the United States can be constructed by taking the June 2006 world wood pulp price ($697.3/mt or $632.6/t) and multiplying it by the U.S. wood pulp index in 2006 and thereafter. (The world wood pulp price is the price ($/mt) for Swedish wood pulp, especially softwood sulphate bleached, air-dry weight pulp at North Sea Ports (World Bank 2015).) The resulting price is shown in Figure 1b and Table 3.

Timber Sales Data for Individual Sales

The third data set is a collection of individual sales data sets from each Forest Service Region except for Region 10. We use these data sets to compare BPP estimates to final sales prices and show local sales costs.

Table 4—Time periods and number of sales for individual timber sales data by Region and zone

Region and new zone	Time period	Number of sales
Region 1 (Inland North)	FY2010.3–FY2015.1	64
Region 2 (Inland Central)	FY2010–FY2014	171
Region 3 (Inland South	FY2010–FY2014	62
Region 4 (Inland Central)	FY2010–FY2014	142
Region 5 (Coast)	FY2007.4–FY2014	10
Region 5 (Sierra)	FY2007.4–FY2014	40
Region 5 (Inland South)		0
Region 6 (Coast)	FY2014	41
Region 6 (Inland North)	FY2014	19
Region 8 (Mid-South)	FY2014	24
Region 8 (Southeast)	FY2014	76
Region 9 (Mid-South)	FY2014	26
Region 9 (Lake States)	FY2014	103
Region 9 (Northeast)	FY2014	32

These data were compiled in Excel spreadsheets from appraisal information on FS-2400-17 forms kept for each timber sale. The data include sales of timber from final harvest, intermediate treatments, and salvage treatments but do not include timber removed as part of stewardship contracts where timber goods are traded for ecosystem restoration treatments. All the sales were sold using sealed or oral auction procedures. These data sets include sale identifiers, administrative variables, general sale information, and cost center and other adjustments. For details on data they usually contain, see Appendix 4. The data sets vary among Regions in the variables they include and the number of sales. There are at least 50 sales for each Region, and several Regions sent data for the FY2010–2014 period or for all sales in a fiscal year (most frequently FY2014) (Table 4).

We added several summary variables to each sale. Depending on the variables in the regional data sets, these include (1) fractions of volume that are in certain categories (such as, percentage sawtimber, percentage softwoods) (2) volume-weighted average costs (logging, haul costs, slash disposal, temporary roads, sale contact costs, specified road costs), (3) advertised bid price (after local cost adjustments), (4) high bid price, and (5) bid premium (difference between the advertised rate and high bid price). The actual data sets contain more detail for each product and species combination. For example, the Region 9 data set has 14 possible appraisal groups that are subject to cost adjustments for each sale.

Matching Appraisal Zones and Product Prices

Table 5 indicates the primary product prices that are used in each appraisal zone. Assignment of primary product prices was guided by the need to estimate stumpage prices for species groups that are sold in each zone. Differences between eastern and western regions in the primary product price series used for hardwood species and nonsawtimber products will be explained in the next section.

Table 5—Match up among appraisal zones stumpage prices and primary product price series

	Softwood		Hardwood	
Appraisal zone	Saw-timber	Non-sawtimber	Saw-timber	Non-sawtimber
Coast	Coast	Coast	N/A	N/A
Inland North	Inland	Inland	N/A	N/A
Inland Central	West SPF[a]	West SPF	N/A	N/A
Inland South	West SPF	West SPF	N/A	N/A
Sierra	Inland	Inland	N/A	N/A
Southeast	Southern Pine	Wood pulp	Hlum[b]	Wood pulp
Mid-South	Southern Pine	Wood pulp	Hlum	Wood pulp
Lake States	East SPF	Wood pulp	Hlum	Wood pulp
Northeast	East SPF	Wood pulp	Hlum	Wood pulp

[a]Spruce–pine–fir lumber.
[b]Hardwood lumber.

Results

First, we present estimated price mark-up rules for each appraisal group in each appraisal zone. This includes discussion of caveats for using the equations. Second, using data on individual sales, we compare our estimates of stumpage price from the mark-up equations to high bid prices for individual sales. In addition to the obvious goal of learning if our estimates are above or below actual high bid, this comparison provides a basis for subsequent discussions about local cost adjustments and possible requirements for rollback factors that would need to be applied to initial appraised price.

Estimates of Price Mark-Up Equations

Price mark-up rules, in the form of linear equations, were estimated for the four groups, hardwoods and softwoods, sawtimber and nonsawtimber, for all appraisal zones. Regressions were made first using two coefficients (c_1, c_2) in the form shown in Equation (2), second with a constant term only (c_1), and third with a coefficient for primary product price only (c_2). We evaluated the predictive ability of the equations by estimating root mean square error (rmse) comparing predicted quarterly average stumpage price to actual quarterly average stumpage price and r^2 values for the equations. Equations with a single coefficient for primary product price did not have strong predictive power for stumpage price (low r^2), but the predictions were always better than using the previous quarter's stumpage price as a prediction of the current quarter's price. Use of a recent period's local stumpage price to estimate current BPP is the current

Table 6—Estimated coefficients for stumpage price equations[a]

	Sawtimber	RSQ	Non-sawtimber	RSQ
East equations—softwood				
Lake States	0.22360	0.417	0.048832	–0.119
Northeast	0.12757	0.960	0.048832	–0.026
Southeast	0.21052	0.775	0.026354	–0.327
Mid-South	0.14644	0.911	0.014885	–0.253
East equations—hardwood				
Lake States	0.11845	0.102	0.03136	0.155
Northeast	0.41791	0.146	0.00419	–0.095
Southeast	0.08085	0.260	0.00919	–0.085
Mid-South	0.11690	0.260	0.00961	0.004
West equations				
Coast	0.14916	0.298	0.02514	–0.043
Inland North	0.10203	0.910	0.03515	0.484
Inland Central	0.04000	0.726	0.04967	0.395
Inland South	0.02448	0.843	0.00513	0.556
Sierra	0.08599	0.626	0.03888	0.258

[a]Coefficients are for the equation $y = ax$, where y is stumpage price in $/CCF and x is product price for lumber in $/MBF or pulp in $/ton. The R^2 (RSQ) values are computed as [1 – (residual sum of squares)/(centered sum of squares)]. The value is negative in cases where a constant value has a lower error of estimate for stumpage values than the equation estimate.

transaction evidence appraisal method. The regression with a constant term gave lower rmse than the equation with a single coefficient on primary product price for 18 of 26 appraisal groups. The two-coefficient regressions gave somewhat lower rmse and higher r^2 values, but coefficients were often not statistically significant. We use single-coefficient equations to estimate stumpage price (Eq. (4)) because, with competition among mills for stumpage, the stumpage price would consistently increase with primary product price (coefficients are shown in Table 6):

$$\mathrm{BPP}_t^{\mathrm{s}} = c_2 P_t^{\mathrm{p}} \qquad (4)$$

We made preliminary tests to determine if the data could be transformed to improve the predictive equation (for example, by testing for stationarity of prices series and adjustments to attain stationary series for prediction equations). Initial tests did not suggest predictions would be altered notably. Appendix 5 discusses possible ways to improve BPP predictions.

Certain modifications were made in forming the equations. In the western appraisal zones, hardwood volume was a small part (1.1% of the total sales program, and 84.3% of hardwood volume was sold as fuelwood) of the total Forest Service timber sales program. Consequently the mark-up equations for sawtimber and nonsawtimber stumpage price were estimated using the price for total (both softwood and hardwood) volumes sold. Also, in the West, few timber sales are sold solely containing nonsawtimber. These relatively small volumes of nonsawtimber leads to greater price volatility in the nonsawtimber markets, as shown in Figure 3 for two example western regions.

Because the volume and value of western sales are predominantly for sawtimber, western bidders likely develop their bid price for sawtimber volumes while considering the value they can obtain from the associated nonsawtimber volumes. (This same type of behavior has been observed in the South, where the issue is hardwood volumes in softwood stands. The hardwoods are referred to as the "come along volumes," and it may be that some hardwood value is assigned by bidders to the softwood bid price and would be one explanation for lower hardwood pulpwood prices relative to softwood.) In cases where nonsawtimber is a biddable product, bidders may bid higher on nonsawtimber to keep sawtimber bids lower. The higher the potential bid for sawtimber (as influenced by lumber price), the higher the possible bid for nonsawtimber. For the few sales with significant nonsawtimber volumes, bidders still adjust bid price in accordance with current lumber prices if they think they can sell some nonsawtimber logs for sawtimber prices; the price for the portion of nonsawtimber not suitable for sawtimber uses would be influenced by chip prices. Another explanation for high overbids is that Forest Service cruising procedures are incorrectly calling logs nonsaw when they actually contain a sawlog. The purchaser reveals this information via their bid prices. There is also the case where the nonsaw product class consists of very different product types that have very different prices. For example, the nonsaw product class in Region 1 consists mostly of pulp and post and pole materials. Pulp logs typically sell for $25 to $30 per ton in specific areas in Region 1. Post and pole material ranges in value from $50 to $65 per ton, which at the upper end of the range rivals sawtimber prices. This highlights the issue of creating product classes ignoring the values of the material and "not appraising" the nonsaw material and advertising the material at $1/CCF.

Western chip prices are mostly proprietary except for chip export prices (see table 49 in Zhou (2013)), which are shown in Figure 3a and are generally for mill residues. (Chip export prices, which are arbitraged against other products for stumpage, can be used as a proxy for the driver of domestic nonsawtimber stumpage prices (Haynes 1999, Busby 2006).) Export prices are not immediately available to use in predictions. Both parts of Figure 3 indicate that western nonsawtimber prices are more volatile than chip export prices. It seems likely that this volatility is due to the influence of volatile lumber prices in the bidding process. The volatility of nonsawtimber prices may result from the bidding process where their price is established in joint bids with sawtimber. It seems likely that both chip prices

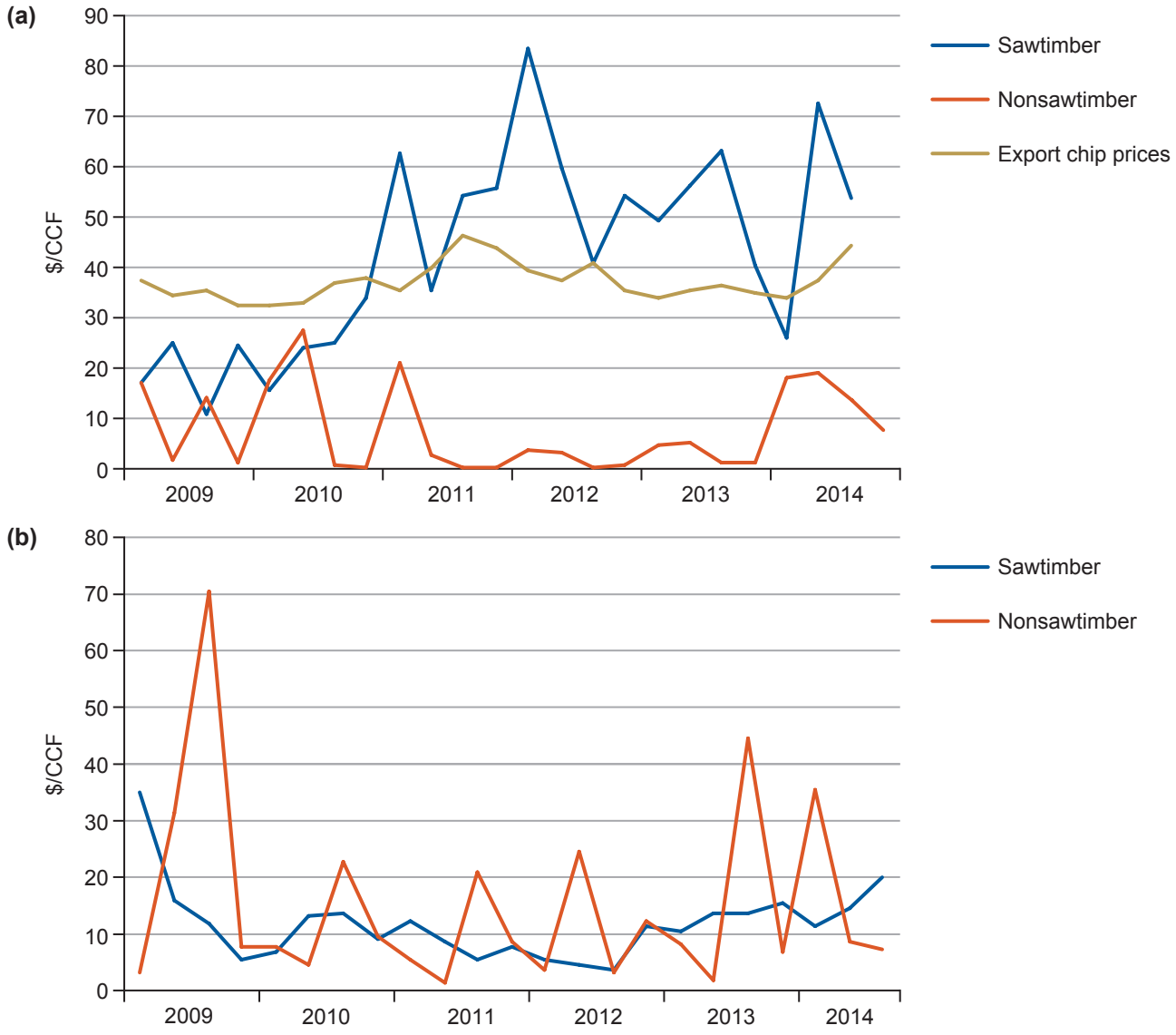

Figure 3—(a) Softwood sawtimber, nonsawtimber, and chip export prices for the Coast Appraisal Zone (sawtimber and nonsawtimber, USDA Forest Service (2014); Chip export price, Zhou (2013)) and (b) softwood sawtimber and nonsawtimber prices for the Inland Central Appraisal Zone (USFS 2014).

and sawtimber/ lumber prices influence the movement of nonsawtimber prices. As a first approximation to track the volatility of nonsawtimber prices, we use lumber prices to estimate nonsawtimber prices. If chip price data can be found that are available in the current period to make predictions, then they may be used to improve predictions of nonsawtimber price.

In the four eastern appraisal zones, there are clear differences between sawtimber and nonsawtimber markets. These differences are illustrated in Figure 4 from the southeast appraisal zone. Prices in both sawtimber and nonsawtimber markets vary in broadly similar ways, unlike those shown in Figure 3.

Estimated coefficients are shown in Table 6. For the eastern appraisal zones, equations for softwoods and hardwoods (four equations for each appraisal zone) follow a general format:

1. Sawtimber stumpage price is a function of lumber price.
2. Nonsawtimber stumpage price is a function of wood pulp price.

For the west, equations for total volumes only (two equations for each appraisal zone) follow a general format:

1. Sawtimber stumpage price is a function of lumber prices.
2. Nonsawtimber stumpage price is a function of lumber prices.

Model Tests by Forest Service Region

The new method for calculating BPPs can be evaluated using data on individual sales by Region. Our equation estimates an initial stumpage price, which is the estimated

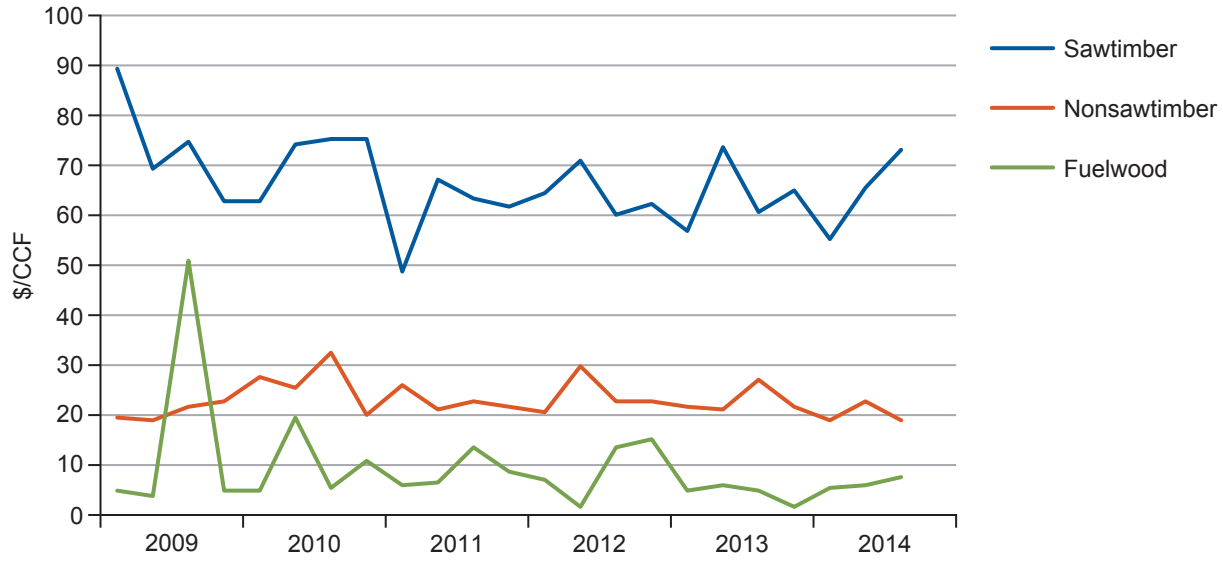

Figure 4—Forest Service sold prices for softwood sawtimber, nonsawtimber, and fuelwood for the Southeast Appraisal Zone (USDA Forest Service 2014).

price for an average cost sale, before individual sale cost corrections and application of rollback factors, and with an average bid premium. In the simplest form, we can compare a new estimate of the BPP using prices from our mark-up equations to the high bid price for the individual sales. Results of interest include

1. the number of sales where BPP is higher than the high bid price (if the new BPP was used without cost corrections, these sales would likely have resulted in no bid sales) and
2. the number of sales where an adjusted BPP is higher than the high bid price where the BPP for each is adjusted for some local costs.

These results will indicate (1) the need for cost adjustments in the development of the initial appraised price, (2) modifications that may be needed in how nonsawtimber volumes are valued, and (3) how haul cost differences impact local sale prices in spatially diverse regions (such as Region 3).

Common influences over time on timber sales used include shifts in Forest Service management and shifts in market conditions. Since the mid-1990s, the Forest Service has shifted management objectives from harvesting certain areas for volumes of timber to objectives to treat forest land to attain certain ecosystem outcomes. The consequences include more volume from thinning treatments, limited harvest of large trees (over 22 in. (56 cm) in the west), lower volumes per acre harvested, shifts to logging systems that result in higher costs, and increasing harvest volumes of difficult-to-utilize timber (such as more dead or small-diameter timber). In addition to various cost impacts, if Forest Service utilization definitions lag industry utilization practices, we could find that appraised prices are less than high bid prices as bidders achieve greater product recovery from material that the agency might have considered unmerchantable. (This is not a new phenomenon; it was observed in the late 1970s in the disposition of yarded unmerchantable material (YUM) in Region 6.) As has been noted in discussion of Figure 1a, sales data sets generally cover the end of the period associated with the "great recession" and most of the figures for the test results, if they include multiple years, demonstrate the downward price trends in 2008–2010 and recovery afterwards. The sale data sets do not include stewardship sales or in many cases direct sales. (The Region 4 dataset is an exception and has some direct sales.)

Forest Service Region 1. Region 1 is part of the proposed Inland North Appraisal Zone. Results comparing BPP to high bid for individual sales in Region 1 are shown for sales ordered chronologically in Figure 5a. There were 64 sales from the period FY2010 to FY2015. The BPP does not include cost corrections for individual sales, and its values for nonsawtimber are higher than their assumed price in the appraisals (which values all nonsawtimber at $1/CCF). Figure 5b shows BPP values for two different values assigned to nonsawtimber. The line BPP-R1 indicates the appraised price using Region 1 default appraisal values, and the BPP line indicates the BPP with the new (higher) appraised price for nonsawtimber. There are no cost adjustments for prices in Figure 5. BPP is computed using Equation (3) modified to include just softwood species. In these examples we assigned a value of $6.25/CCF for fuelwood, hardwood, and softwood (based on converting a $5/cord fuelwood collection permit fee from cords to CCF by the ratio 1.25 CCF/cord).

Individual sales are shown on the x axis, with the oldest sale (FY2010.3) on the left and the newest (FY2015.1) on the right. In this simplest approach to sale appraisal, BPP

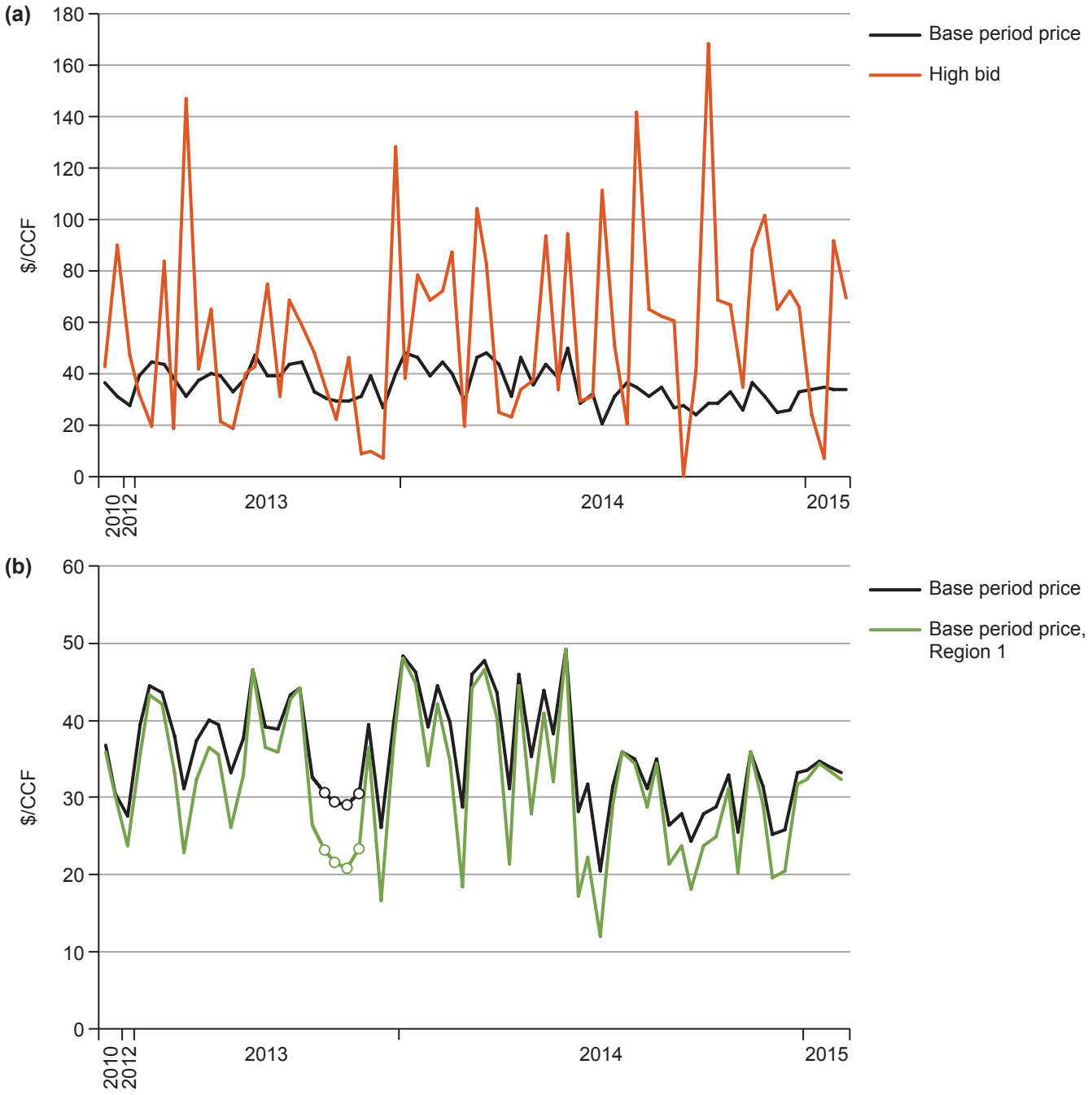

Figure 5—Region 1 (a) BPPs and actual high bid price for sales from 2010 to 2015 and (b) BPPs using two nonsawtimber value assumptions. (BPP from mark-up equations and Table 6 applied to appraisal group volumes from USDA Forest Service Region 1 (2014); high bid from USDA Forest Service Region 1 (2014); BPP-R1 is the same as BPP except R1 minimum bid prices are used for nonsawtimber volumes.)

is higher than high bid price for 34% of all sales. Figure 5b shows BPP with and without use of the default R1 price of $1/CCF for nonsawtimber. Using the R1 price for nonsawtimber, we overestimate high bid price for 26% of sales.

These results suggest that further thought needs to be given to how to appraise sales in a time of changing sawtimber/nonsawtimber definitions. Figure 5b reveals that groups of sales (for example, sales 20–23, the four sales from the Flathead National Forest offered in FY2013 that are plotted as circles) have sufficient nonsawtimber volumes (48% in these sales) to reduce appraised prices and consequently lower the high bid to levels less than might have been expected.

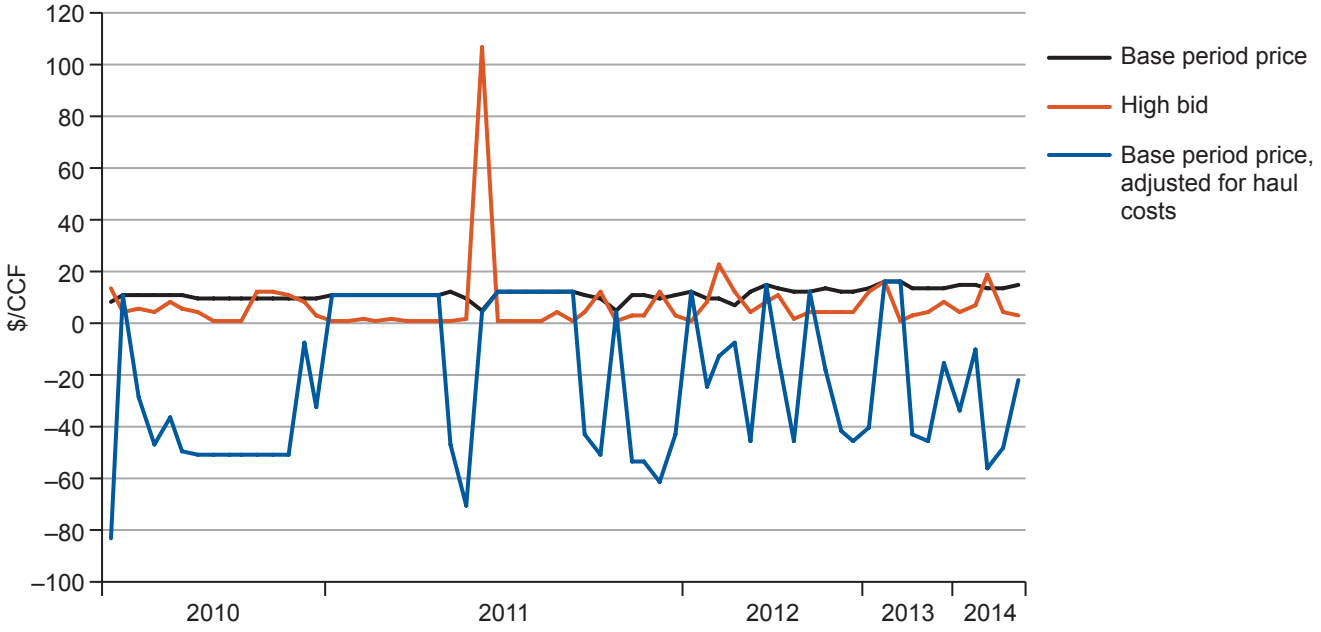

Figure 6—Region 3 BPP, actual high bid price, and adjusted BPP for sales from 2010 to 2014. (BPP from mark-up equations and Table 6 applied to appraisal group volumes from USDA Forest Service Region 3 (2014); high bid from USDA Forest Service Region 3 (2014); adjusted haul costs from BPP minus the difference between average haul cost and haul cost for each sale.)

Forest Service Region 3. Region 3 is part of the proposed Inland South appraisal zone. Results comparing BPP to high bid prices for Region 3 are shown in Figure 6. This Region provided a data set that had 62 sales covering fiscal years 2010–2014. The chart is plotted chronologically, with earliest sales on the left and latest sales on the right. There are three prices plotted in Figure 6: BPP, high bid prices, and BPP adjusted for differences in haul costs. BPP was less than high bid price on 18% of these sales. In an attempt to improve its performance, we adjusted the BPP by the difference from the average of haul costs, after which the adjusted price was less than the high bid price for 68% of the sales. This is "better" performance in that the adjusted price overestimates the high bid 32% of the time. However, the fact that the adjustment reduced estimated prices on average indicates that the adjustments were for a set of sales with costs that were, on average, greater than the longer-term average.

Our comparison of estimated BPPs (and adjusted BPPs) to high bid prices is imperfect to the degree that the time period of sales used to estimate the BPP equations (20+ months), the time period for the sample of recent sales, and the time period used to compute average costs used to make actual appraisals can differ. The degree to which estimated BPP over- or underpredicts will be influenced by these differences. If the time periods and average costs were all the same, we would expect estimated BPP to underestimate (or overestimate) the sample set of sales 50% of the time.

Regions 2 and 4. These Regions are considered together because they share the same appraisal zone, Inland Central. This appraisal zone is unique in that nonsawtimber products are valued higher than sawtimber products. This may reflect diverse trends, such as the lack of traditional sawtimber markets, active small log markets that range from corral poles and posts, house logs to small logs for "chip and saw" type of manufacturing, and a large volume of dead and dying timber.

Both are large data sets (Region 2 has 171 sales, Region 4 has 142) and cover 2010–2014. Comparisons of high bid and BPP for Regions 2 and 4 are shown in Figures 7 and 8. Like other Regions, both Regions 2 and 4 exhibit price spikes associated with highly competitive bidding for select sales. Prices are generally higher in Region 4, reflecting the larger proportion of nonsawtimber on sales in that Region.

In Region 2, BPP exceeded high bid 57% of the time, and in Region 4 it exceeded high bid 31% of the time. If we reduce BPP by the amount of average bid premium in each Region, we reduce the percentage of cases where adjusted BPP exceeds high bid to 49% and 19%, respectively. There are no cost adjustments or rollback factors applied to BPP in either Figure 7 or 8.

Both of these Regions are in the proposed Inland Central appraisal zone, so the price mark-up rule estimation uses sold information for both Regions. In the potential implementation, local cost adjustments will be applied across the Regions comprising this appraisal zone. There are some differences in the cost data for these two Regions, and these may account for some of the differences between the Regions

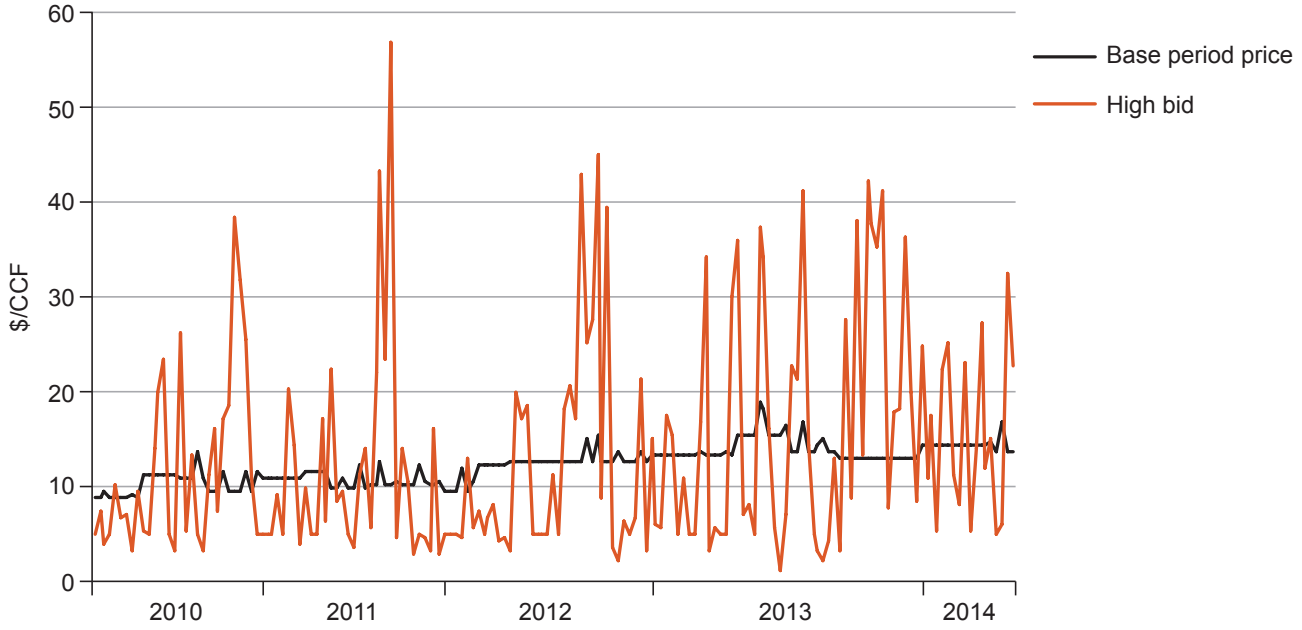

Figure 7—Region 2 BPP and actual high bid price for sales from 2010 to 2014. (BPP from mark-up equations and Table 6 applied to appraisal group volumes from USDA Forest Service Region 2 (2014); high bid from USDA Forest Service Region 2 (2014).)

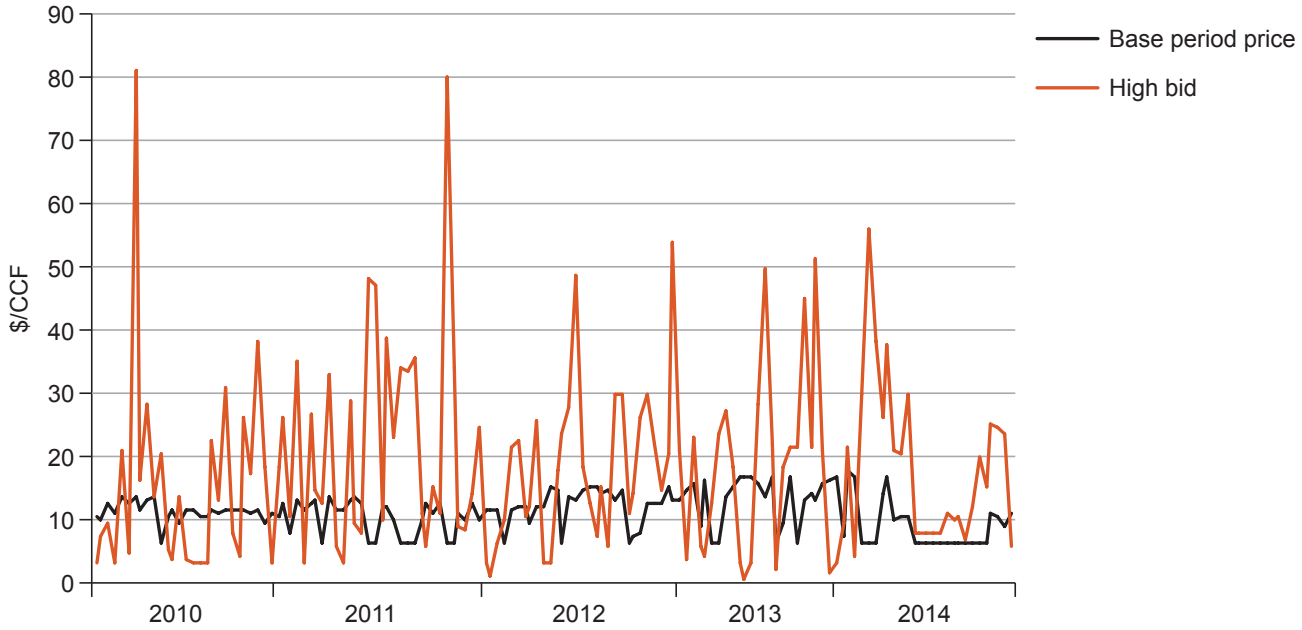

Figure 8—Region 4 BPP and actual high bid price for sales from 2010 to 2014. (BPP from mark-up equations and Table 6 applied to appraisal group volumes from USDA Forest Service Region 4 (2014); high bid from USDA Forest Service Region 4 (2014).)

shown in Figures 7 and 8. As shown in Table 7, there is a difference in sale yarding costs between the Regions that make combined cost comparisons difficult. These costs are typically the largest of the cost centers and may be due to use of more expensive yarding systems in Region 2 than in Region 4. Hauling, road, and slash costs seem more uniform between the Regions.

Some other differences would especially affect BPP estimates. Table 8 shows sawtimber, nonsawtimber, and fuelwood proportions for Regions 2 and 4. Because BPP is computed as a volume-weighted average, the differences between the regional proportions will lead to different estimates of BPP.

Table 7—Average local sales costs by cost center for Regions 2 and 4

	Sale yard	Sale haul	Sale road	Sale slash	Spec road	High bid	Appraised price
Region 2	81.47	45.24	4.48	2.95	2.32	13.68	11.15
Region 4	31.91	50.42	3.28	3.64	12.37	18.66	12.32
Average	58.98	47.59	3.93	3.26	6.88	15.94	11.68

Table 8—Average timber product mix for Regions 2 and 4

	Sawtimber (%)	Nonsawtimber (%)	Fuelwood (%)
Region 2	89.47	10.52	0.0007
Region 4	25.17	48.92	25.90
Average	60.30	27.94	11.75

Table 9—Average individual sales costs for Region 5 Coast and Sierra zones

Cost center	Cost ($/CCF)
Sale PAL Fire Protect	8.62
Sale stump to truck	94.87
Sale Haul Cost	50.35
Sale Specific Cost	4.84
Sale Slash Cost	6.90
Sale Erosion Control	5.25
Sale Specified Road Cost	6.31
Sale Road Maintenance	12.66
Sale BD Deposit	3.64
Sale Surface Replacement Deposit	4.27
Sale Road Maintenance Deposit	2.67
Sale Engineering Deposit	0.66
Sale Temp Rd	2.15

Both Regions have experienced beetle outbreaks, and perhaps appraisers in Region 4 assigned more of the beetle killed timber to the nonsawtimber and fuelwood product groups. As noted elsewhere, BPP overvalues fuelwood relative to current Forest Service practices. Because the data used to estimate the price mark-up equations relies on high bids, it does include results of sales where bidders have higher utilization expectations for nonsawtimber than used in the original appraisal. This may occur in those cases where nonsawtimber includes green small (4–9 in. (10–23 cm) small-end diameter) sawtimber. In Region 4, however, nonsawtimber prices could be low because much of this material might be dead material, not used as sawtimber and perhaps appraised as fuelwood. Another factor contributing to lower prices in Region 4 is the relatively high proportion of direct sales (a third of the sales sold without competition) in the data set.

Forest Service Region 5. Region 5 is divided into three of the proposed appraisal zones (Coast, Sierra, and Inland South). Sales data were provided for 50 sales for National Forests in the Coast and Sierra zones. The BPP and the high bid price for sawtimber are shown in chronological order (oldest to newest) in Figure 9.

Figure 9a shows five sales with an estimated negative adjusted BPP that would be appraised at base rates. The figures show that for each zone the majority of BPP estimates are above the high bid price (50% for the Coast appraisal zone). Adjusting estimated BPP for each sale by the sale's difference in costs from the average makes the most difference (reduces BPP on average) for sales in the Coast appraisal zone. To attain advertised rates that exceed high bid prices in fewer cases will require adjusting BPP with cost adjustments and rollback factors. Rollback factors would ideally provide an advertised rate that has a low likelihood of no bid and has a low likelihood of high overbid. Bidders or agencies often have expectations about adequate levels of bid premium expressed in percentage terms. If the starting point is lowered by various cost adjustments, the expectations for the high bid will be lower. For individual sales, there could be a correction to BPPs (up or down) depending on how individual sales costs differ from the average.

Region 5 costs illustrate another point: The sum of various costs is significant. Average costs for the Coast and Sierra zone sales are shown in Table 9.

Not counting log and haul costs, the average of these costs is $57.97/CCF. Most of the remaining costs are various "deposits" and have become part of the way costs are assigned in timber management programs.

Forest Service Region 6, west of the Cascade Mountains. Results for the west side of Region 6 are shown in Figure 10 for 41 fiscal year 2014 coast appraisal zone timber sales (the data set also included 19 sales from eastside national forests). As in other Regions, if the BPP was not adjusted, a majority (51%) of sales would not have sold. Three different prices are shown in Figure 10.

The BPP is computed using Equation (3) with appropriate coefficients and lumber prices. The adjusted appraised price is the BPP adjusted by the degree to which four costs in each sale differ from average cost in the recent base period (yarding, hauling, temporary roads, and specified roads). The high bid price is from each sale.

The fact that cost adjustments bring BPP closer to high bid prices suggests that cost adjustments are important. However, there are still differences between adjusted BPP and high bid for some groups of sales, which suggests further attention is needed on how to make adjustments for certain types of sales. For example, judging from sale names, nearly 50% of the westside sales are thinning sales, which typically have higher logging costs and often lower value material. As suggested by the Capital Forest Study (Curtis and others 2004) switching logging methods from two stage logging to

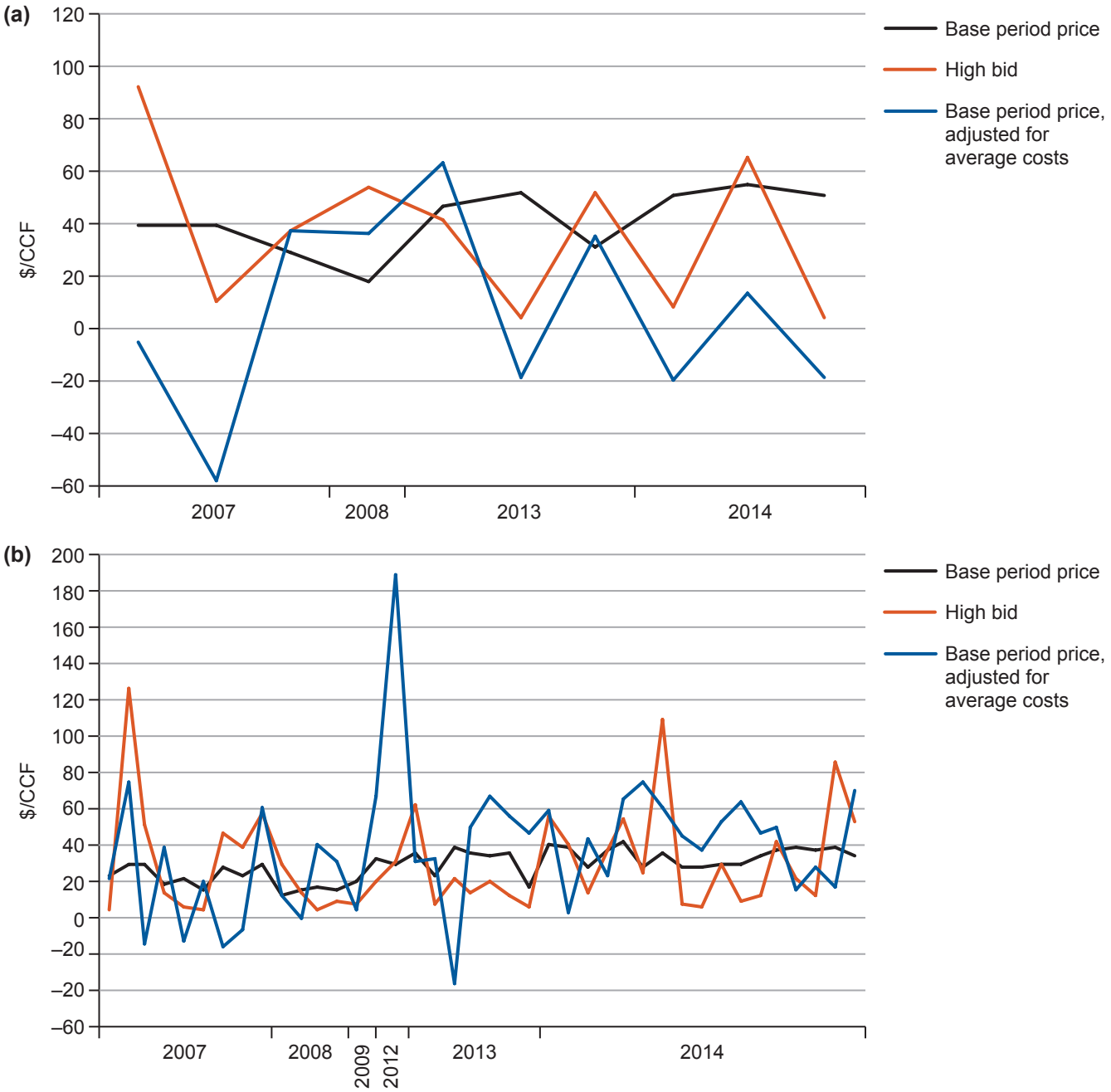

Figure 9—Region 5 (a) Coast zone and (b) Sierra zone BPP, BPP adjusted, and high bid price for sales. (BPP from mark-up equations and Table 6 applied to appraisal group volumes from USDA Forest Service Region 5 (2014); high bid from USDA Forest Service Region 5 (2014).)

thinning would increase logging costs by nearly $15/CCF (expressed in 2014 dollars) which should reduce bid prices (stumpage prices) by a corresponding amount.

Given that BPP reflects an average, not correcting for higher logging costs associated with some sales could lead to appraised prices higher than bidders would be willing to pay for that sale.

Table 10—Proportion of volume sold in fiscal year 2014 by appraisal group in the Southeast and Mid-South appraisal zones

	Softwood (%)		Hardwood (%)	
Appraisal zone	Sawtimber	Non-sawtimber	Sawtimber	Non-sawtimber
Southeast	41	40	9	11
Mid-South	68	28	2	3

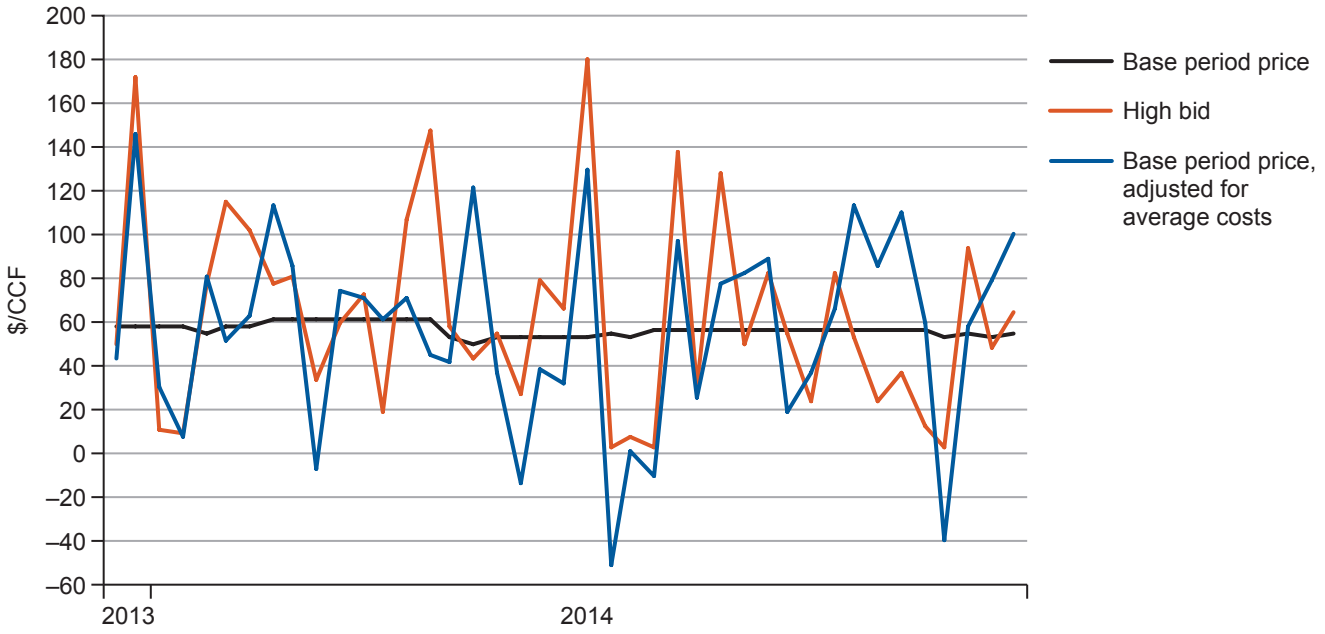

Figure 10—Region 6 West side BPP, adjusted BPP, and high bid price for sales. (BPP from mark-up equations and Table 6 applied to appraisal group volumes from USDA Forest Service Region 6 (2014); adjusted BPP is BPP adjusted by each sales difference in costs from the average costs, USDA Forest Service Region 6 (2014); high bid from USDA Forest Service Region 6 (2014).)

Forest Service Region 8. Region 8 is divided into two proposed appraisal zones, the Mid-South and the Southeast. Region 8 provided 100 FY2014 sales, and the results for the two appraisal zones are shown in Figure 11. There is a difference between the sales in the two appraisal zones in terms of species and product groupings (Table 10). Region 8 did not assign any timber to the fuelwood product group.

In spite of the Mid-South having a greater proportion of softwood sawtimber sales, average BPP values are 13% higher in the southeast because of the high proportion of relatively higher value hardwood sawtimber in the southeast.

Both figures illustrate the tendency of BPP values to exceed both high bid and advertised prices in a majority of cases. Only 37% of the BPP values fell below high bid prices in these two examples. Two points should be considered: The first is minor, but this data set included sales awarded in FY2014 and some sales may have been appraised in 2013 using lower product prices. Second, this points out the need to consider various cost adjustments. For example, when average costs and bid premium are subtracted from BPP values, they are less than high bid 99% of the time.

Forest Service Region 9. Results for the three appraisal zones in Region 9 are shown in Figure 12 (a–c) for 161 FY2014 timber sales. Region 9 is divided among three appraisal zones: Mid-South (Mark Twain NF), Lake States (6NF), and Northeast (7NF). There were 26 sales in the Mid-South appraisal zone, 103 sales in the Lake States appraisal zone, and 32 sales in the Northeast appraisal zone. The BPPs for eastern regions are computed as a volume-weighted average using the general relation shown in Equation (3).

The BPP values vary among the three appraisal zones largely because of differences in the mix of species and products among the zones. These differences are shown in Table 11 and largely account for range in BPP values that average $61.95, $42.61, and $145.11/CCF for the Mid-South, Lake States, and Northeast national forests, respectively. In these first estimates, BPP values exceed actual high bids 38% of

Table 11—Volume proportions of Region 9 sales by product group and appraisal zone

	Softwood (%)			Hardwood (%)				
				Sawtimber				Total
	Sawtimber	Nonsawtimber	Fuelwood	Low	High	Nonsawtimber	Fuelwood	(%)
Mid-South	10	14	0	49	17	0	9	100
Lake States	12	20	0	4	4	60	0	100
Northeast	2	4	0	1	48	45	0	100
Region 9	10	16	0	25		47	2	100

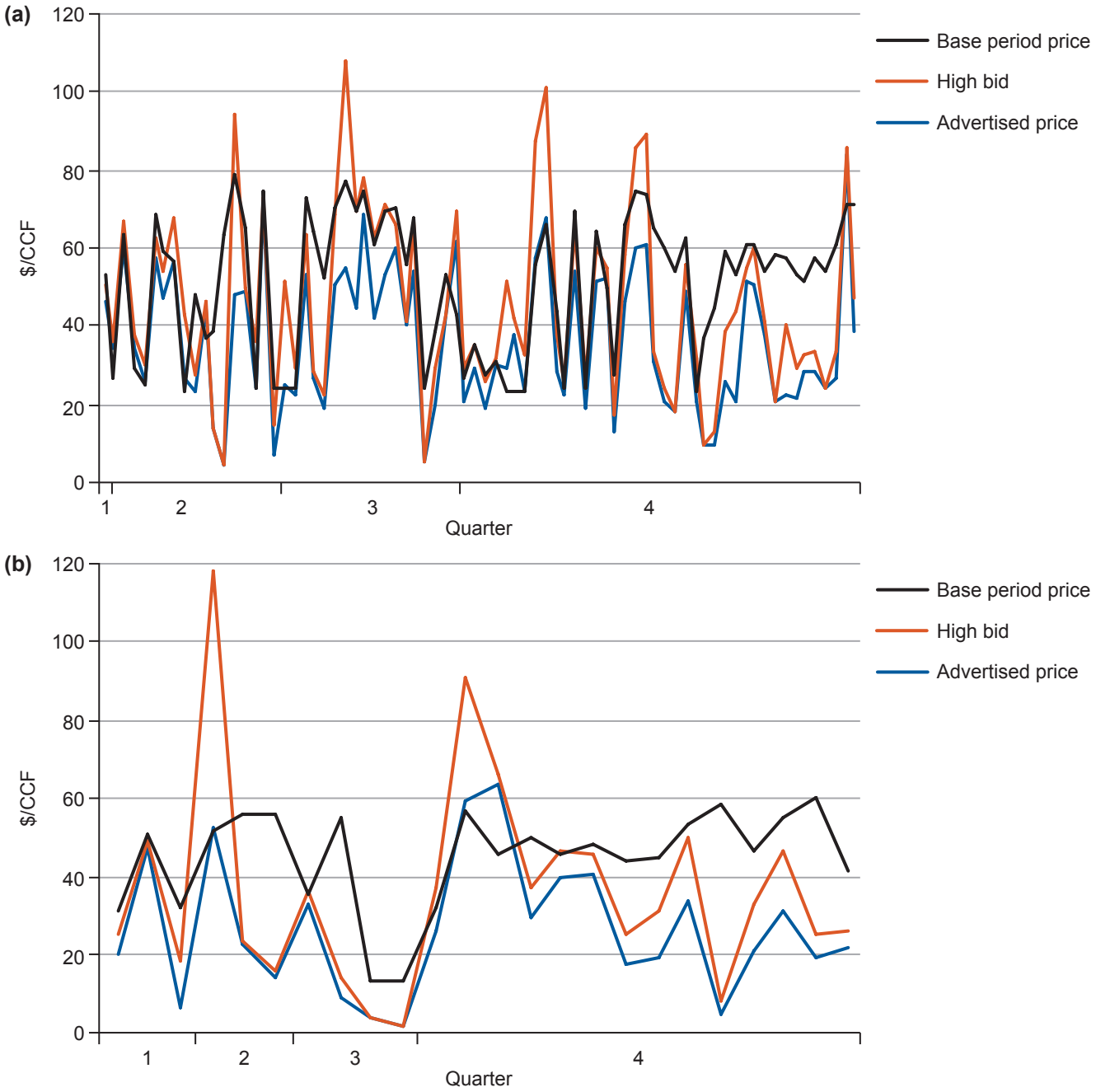

Figure 11—Region 8 (a) Southeast appraisal zone and (b) Mid-South appraisal zone BPP, advertised price, and actual high bid price for FY2014 sales. (BPP from mark-up equations and Table 6 applied to appraisal group volumes from USDA Forest Service Region 8 (2014); appraised price and high bid from USDA Forest Service Region 8 (2014).)

the time. One caution to note is that BPP values for all three zones share what is probably an overestimate of the value of fuelwood at $6.25/CCF. A more important factor illustrated here is how "low-value" hardwoods are treated. In terms of applications, hardwood species are differentiated into primary and secondary species, with primary species being those used for some type of appearance application, such as cabinet and furniture parts. Here we refer to these species as high-value species. Secondary species (or low-value species) are those used for industrial products (pallets, ties, and board roads, mats). Some species, such as oak, are used both for appearance and industrial products, complicating this differentiation. This is important because the proportion of lumber values passed on to stumpage prices is the highest for hardwood lumber. The lumber price being used is based on higher value uses and will raise the appraised price for hardwood sawtimber including lower value species such as Aspen (*Populus tremuloides*).

This raises the question of how to adjust for these low-value species. In 2014, the hardwood lumber price averaged

$836.31/MBF and the average price for aspen lumber was $348.33/MBF, a ratio of 0.417. Using this proportion and the information from Table 11, we modify Equation (3) and recompute BPP:

$$\text{BPP} = w_1 C_2^1 P_s^p + w_2 C_2^2 P^{wp} + w_3 F + y_{1a} D_2^1 P_h^p + y_{1b} D_2^1 L P_h^p + y_2 D_2^2 P^{wp} + y_3 F \quad (5)$$

where y_{1a} and y_{1b} are the low and high sawtimber proportions from Table 11 and the parameter L is the ratio of low- to high-value hardwood species appropriate to the region/appraisal zone.

Making this adjustment for the Region 9 sales in the Mid-South and Lake States appraisal zones is shown in Figure 12d. Average BPP values are reduced 36% for sales in the Mid-South and 4% for sales in the Lake States appraisal zones. This adjustment increases the number of sales where BPP values are less than the high bid, but they still exceed high bid 35% of the time. In some ways, Table 11 explains the reasons for the larger impacts in the Mid-South sales. In the Mid-South, more sawtimber is coded as low-value hardwoods (species code 4; hardwood other), whereas in the Lake States, aspen is frequently assigned to the nonsawtimber product group.

Finally, the Region 9 cost adjustment process differs from the west. In Region 9, felling/bucking and skidding/loading adjustments are not compared against a recent average. Instead, regional guidance recommends that adjustments be made when these costs fall outside a normal range. Two other costs vary notably among sales—haul costs and road maintenance costs. For the sales in FY2014, these averaged $23.54/CCF and $5.91/CCF, respectively.

The lack of cost adjustments and the somewhat higher BPP values compared to high bid values in Figures 12 (a–c) suggest that a rollback factor might be an appropriate way to adjust BPP and to increase the likelihood that sales will be sold.

Adjustments for bid premium. The BPP reflects both average costs incurred by bidders and average bid premium (difference between the advertised rate and high bid price). The excess amount bid on Forest Service sales can be large depending on the extent of competition, sale attributes, and economic conditions at the time of sale (Table 12). Some agencies, such as Oregon Department of Forestry, have bid premium targets as a measure of their appraisal system's performance. They attempt to keep appraised prices within a set ratio with final bid prices.

Adjusting BPP for the average bid premium increases the number of times it is less than the high bid price. For example, in both Regions 3 and 6, a downward adjustment of BPP for average bid premium about doubled the number of sales where the BPP is less than the high bid price.

Table 12—Average bid premium and ratio of high bid to appraised price by Region for individual sales data

Region	Appraisal zone	Average bid premium ($/CCF)	Ratio of average high bid to appraised price
1	North Inland	26.44	1.88
2	Central Inland	2.53	1.23
3	South Inland	3.99	2.30
4	Central Inland	6.34	1.51
5	Sierra	11.68	1.58
6	Coast	30.62	1.94
8	Southeast, Mid-South	9.63	1.28
9	Central Inland, Lake States, Northeast	31.88	1.70

One inference of these significant bid premiums is the need to adjust for them either directly or as part of any rollback feature of any revised appraisal process.

Lessons from these examples. First, without any adjustments, BPPs exceeded high bids for 72% of the sales nationally. Making corrections for local cost variation can improve performance, but a need for rollback factors is still likely to adjust the BPP prior to or after these adjustments. Second, there are examples of sales with higher than average nonsawtimber volumes where use of BPP would be higher than use of Minimum Rates. This was demonstrated in multiple regions and suggests more consideration if base rates are set too low Our estimates of BPP might be improved (lower rmse) if western chip prices are used as predicting variables. Third, cost adjustments are necessary and reflect how bidders differentiate among sales characteristics and the heterogeneity of the timber sales. The example from Region 3 using haul cost differences to adjust BPP illustrates this point. Sales with lower haul costs (sales that are closer to mills) often had higher bid prices.

The example from Region 9, where we adjusted for low- and high-value hardwood species, demonstrates both the ability to do this in a meaningful way and the difficulty of using the somewhat arbitrary species code assignments. If this is to be pursued, greater consistency will be needed in the use of various catch-all species codes, such as Softwood, Hardwood other (species codes 1 and 4), and combined Softwoods and Hardwoods (species codes 7 and 8). There will also need to be a general understanding of the definitions of high- and low-value hardwood sawtimber.

Although not tested as part of this study, use of higher sale-specific local costs that reduce the advertised price (the starting point in bidding) may reduce high bids overall as bidders tend to cluster about perceived levels of bid premium for competitive sales. (These local costs require justification so that there is not the perception that they are being used to manipulate an appraisal in order to achieve

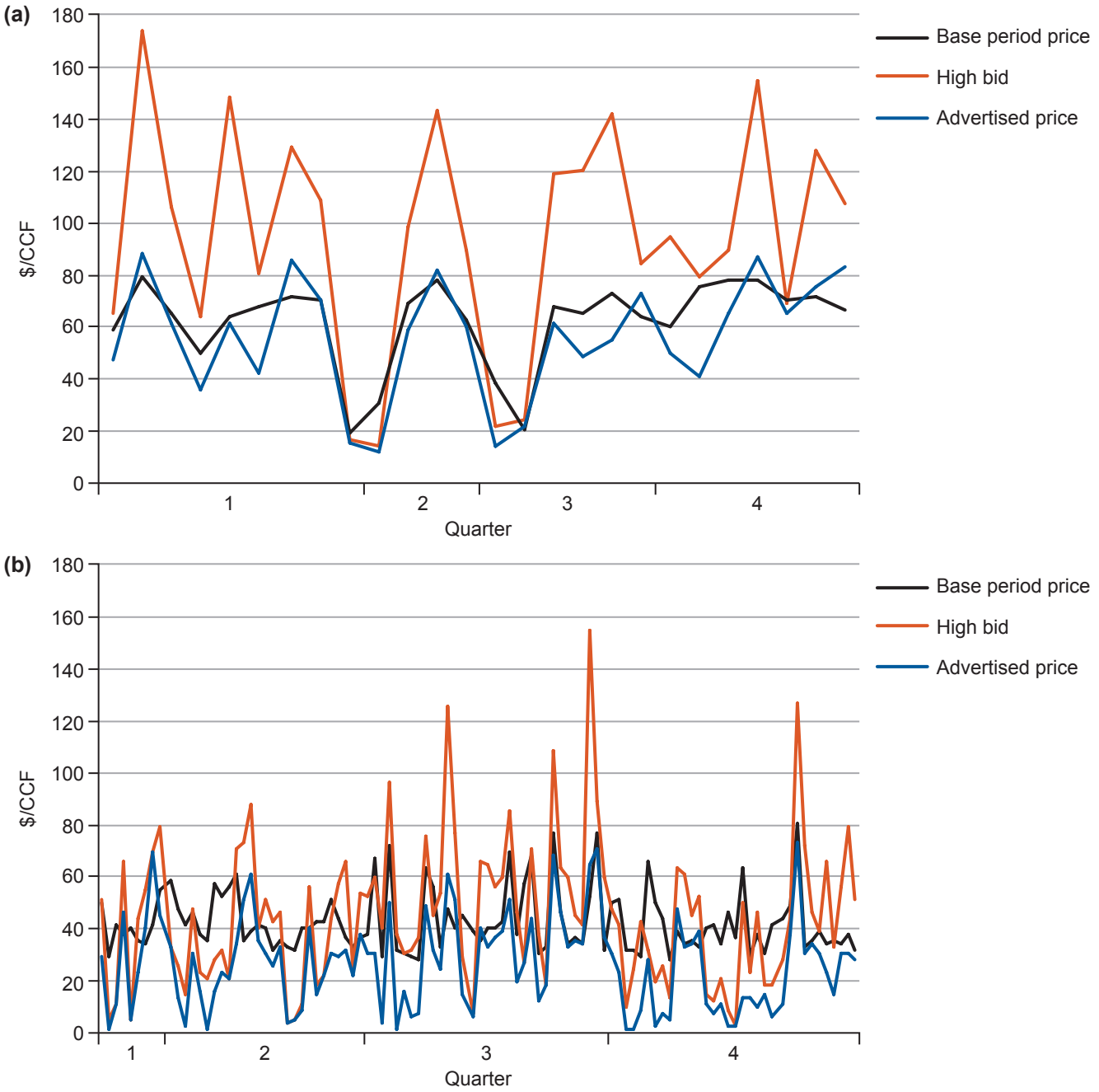

Figure 12—Region 9 (a) Mid-South, (b) Lake States, and (c) Northeast BPP, sale advertised price, and high bid price for sales. (d) Mid-South and Lake States BPP and BPP adjusted for low- and high-value hardwood sawtimber (BPP2). (BPP from mark-up equations and Table 6 applied to appraisal group volumes from USDA Forest Service Region 9 (2014); appraised price and high bid from USDA Forest Service Region 9 (2014).)

a predetermined price that may not reflect a fair market value.) For example, in Region 6, average bid premium is 94% of the advertised price but bidders may collectively consider sales that have bid premiums in excess of 50% to be "highly" competitive, regardless of the starting point (minimum acceptable bid price); once sales price reaches 50% over the minimum acceptable bid, bidding may slow except in special cases.

Escalation of Timber Sales Prices after the Sale

After a timber sale is sold, many months may go by before the timber is harvested. The value of the timber at harvest for each appraisal group (and the payment due for the timber) can be calculated by applying the percentage change in producer price indexes (from the U.S. Bureau of Labor Statistics) that drives the price for each stumpage appraisal group. The percentage increase or decrease in value of

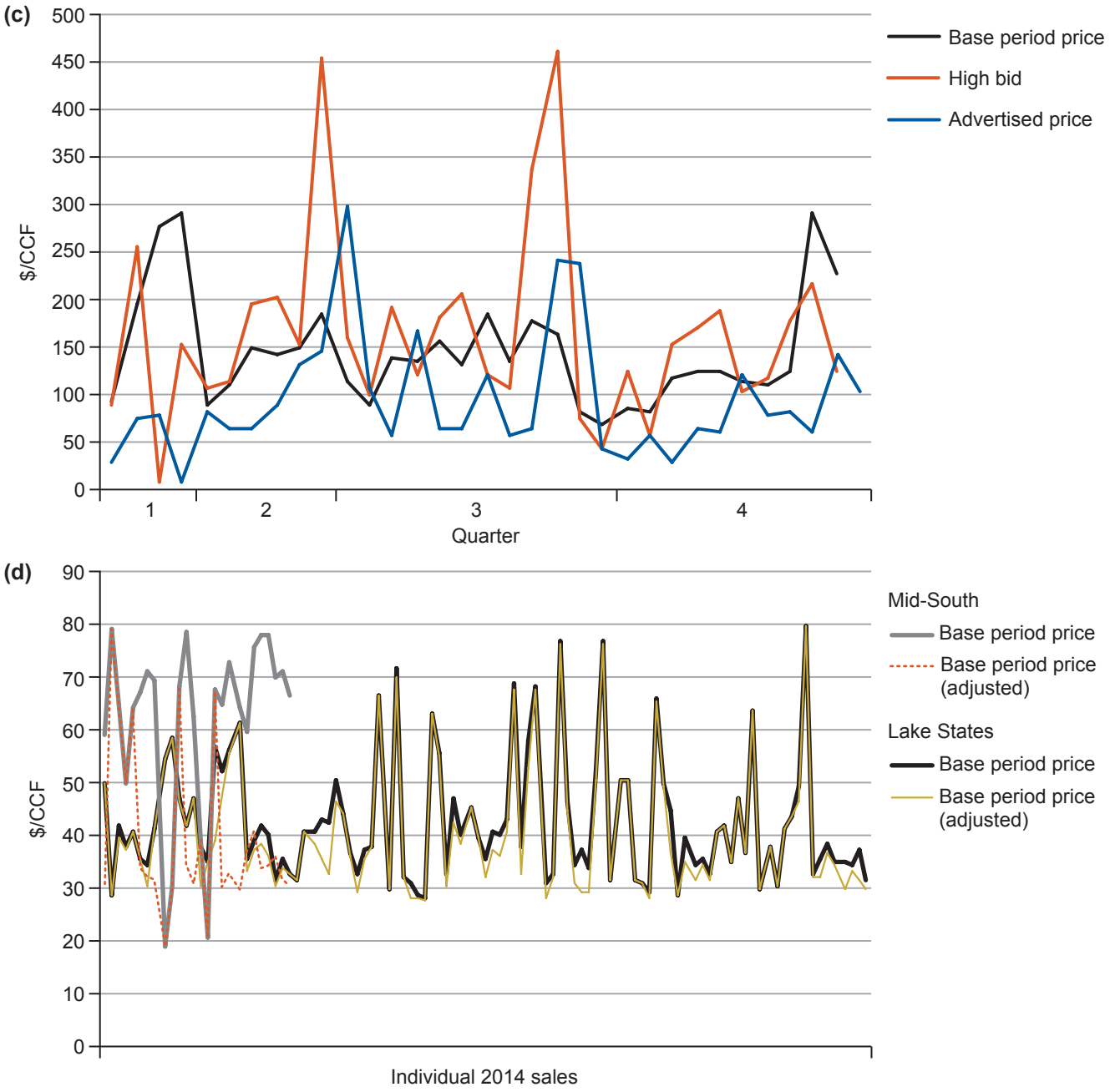

Figure 12 (con.)—Region 9 (a) Mid-South, (b) Lake States, and (c) Northeast BPP, sale advertised price, and high bid price for sales. (d) Mid-South and Lake States BPP and BPP adjusted for low- and high-value hardwood sawtimber (BPP2). (BPP from mark-up equations and Table 6 applied to appraisal group volumes from USDA Forest Service Region 9 (2014); appraised price and high bid from USDA Forest Service Region 9 (2014).)

timber in each appraisal group would be determined by the percentage increase or decrease in the primary product producer price index between the month of the sale and the month of the harvest.

The basis for using changes in producer price indexes is the same as the basis for using changes in product prices to predict BPP. Economic theory and empirical evidence indicate that as product prices increase, the ability of mills to pay higher prices for stumpage increases as well. Conversely, as product prices decrease, the ability of mills to pay for stumpage decreases.

Three producer price indexes (not seasonally adjusted) could be used to increase price for sawtimber and nonsawtimber. To adjust softwood and hardwood sawtimber prices in each appraisal zone, these are the national level softwood and hardwood lumber producer price indexes, WPU0811 and WPU0812, respectively (USBLS 2015a). For nonsawtimber in the West, the softwood lumber price index would

be used. For softwood and hardwood nonsawtimber in the East, the wood pulp producer price index, WPU0911, could be used.

The Bureau of Labor Statistics provides guidance on how to include language in contracts that would escalate prices from a base month to a final sales month (USBLS 2015b). The producer price indexes for a particular month are typically published on the BLS web site by the 10th to 18th of the following month. All producer prices indexes that are not seasonally adjusted are routinely subject to revision once, four months after original publication (USBLS 2015b). The BLS recommends that escalation adjustments always use the latest version of the PPI data available at the time escalation calculations are made.

Discussion

Here we discuss several inferences for implementation. These include two adjustment issues in timber appraisal that are frequently made to reduce the likelihood of no bid sales; some thoughts on the question "Does the Forest Service receive a fair price for timber it sells?"; guidance for the Forest Service price adjustment mechanism after a sale is made; and finally some thoughts about how to implement the approach described here.

Adjustment Issues

Local cost adjustments. The examples illustrate the importance of cost center adjustments to BPPs and the variety of approaches to these adjustments. Many of the examples illustrate that adjusting for sale-specific local costs are a necessary and important step to reduce the likelihood of no bid sales. Adjustments for logging and hauling costs are the largest; as illustrated in Region 6, adjustments for different logging systems may be important, especially considering the increased costs associated with thinning sales. Adjusting for haul costs is important especially in areas with limited processing facilities. The example from Region 3 is such a case. It also provides an empirical example of how transportation costs can impact market prices in a way that is consistent with our understanding of spatial economics.

Implications for rollback factors. In the original discussion of adoption of TEA systems, rollback factors were seen as a way to reduce the likelihood of no bid sales. No bid sales were and still are seen as being unnecessarily time consuming.

Below is an equation we suggest as a framework for discussing the components that determine a final high bid price for an individual sale in the context of many sales in an appraisal zone over a historic time period. We use this equation to suggest how to estimate a rollback factor for a current sale (after the historic period) given historic sales data.

We discuss a simplified situation where sales have an Indicated Advertised Rate (the rate before comparison to Base Rates) that is the same as the Advertised Rate. We represent these as each having timber in a single appraisal group. The discussion would be similar if sales had timber in multiple appraisal groups and Advertised Rate differed from Indicated Advertised Rate.

Over a number of quarters, $t = 1$ to n, in a given appraisal zone, a number of timber sales will provide sale prices for timber in various appraisal groups. We may view those sales prices as being composed of several components:

$$\mathrm{HBP}_{t,i} = c_2 P_t^{\mathrm{p}} + \left(\overline{C} - C_i\right) + \left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right) \qquad (6)$$

where $\mathrm{HBP}_{t,i}$ is the high bid price per unit volume for sale i that occurs in quarter t; $c_2 P_t^{\mathrm{p}}$ is the BPP per unit volume calculated by multiplying the primary product price (such as softwood lumber) by coefficient c_2, which was computed by a mark-up equation over the periods $t = 1$ to n; $\left(\overline{C} - C_i\right)$ is the volume-weighted average costs for all sales over quarters $t = 1$ to n minus the total cost for sale i; and $\left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right)$ is bid premium for sale i minus the volume-weighted average bid premium per unit volume for all sales over the quarters $t = 1$ to n.

Equation (6) can be used in two ways. First, it can be used to retrospectively explain the components that make up high bid price for a set of sales over a historic period; and second, it can be used prospectively for a sale in a quarter soon after the historic period (such as for four quarters after) to discuss how to estimate a roll back factor based on historic data for $\left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right)$.

Retrospectively, Equation (6) gives components that explain high bid price for sales over a historic period. These include the first two terms that would be used to compute advertised rate—before any rollback—for a given new sale i during the historic period. The first term is a computed BPP, $c_2 P_t^{\mathrm{p}}$. For this retrospective evaluation (and prospective use of the equation is discussed later), we assume that the c_2 coefficient is estimated using sales data over the historic period. This BPP already includes an adjustment for average costs and an adjustment for average bid premium. For an individual sale i in the historic period, we need the second and third terms to adjust for sale i specific costs and bid premium, $\left(\overline{C} - C_i\right) + \left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right)$.

The bid premium adjustment will only be known retrospectively for a group of sales. Note that the bid premium values used are the difference between an advertised rate (without any rollback), given by the first two terms, and the high bid. The bid premium we compute is not exactly the one a bidder would have computed because they could have different estimates of a BPP and cost adjustments. The bid premium adjustment term $\left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right)$ includes any errors we made in the first two terms in estimating a bidder's estimate of market value and cost adjustments.

Based on the sales that occurred over quarters $t = 1$ to n, our bid premium correction factor will have a probability distribution that will range from negative to positive values.

Now consider that we would like to estimate an Advertised Rate, including a rollback factor, for a sale j that occurs in a quarter m somewhat later than the historic period (such as up to four quarters later).

We would use the first two terms of Equation (6) to estimate an Advertised Rate (before any rollback) for sale j. We assume this estimate would include a historic average amount of bid premium. If we assume that the probability distribution in the new current quarter for $\left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right)$ is the same as for the historic period and that the distribution is symmetric around the average bid premium, then there is a 50% chance that the bid premium for sale j could be higher or lower than the average.

The historic distribution for the bid premium correction factors can be used directly to help select a rollback factor. For any given rollback factor, we can estimate the probability that the final bid will exceed the Advertised Rate minus a given rollback factor.

For example, with no rollback factor and based on our assumptions, we would estimate a 50% chance that the final bid will be higher than the Indicated Bid Price estimate. If we take a rollback factor that is equal to one standard deviation of the bid premium correction factor (and the bid premium correction factor is normally distributed), then there will be an 83% chance that the final bid will be higher.

The distribution of bid premium correction factors can be estimated using historic sales data and used to determine the probability that a given rollback adjustment will result in a high bid that exceeds the Advertised Rate.

Does the Forest Service Get a Fair Price?

Given that predicted BPPs (without individual sales cost adjustments) exceeded high bids by roughly 70% of the 378 timber sales in our regional examples, it is reasonable to ask if the initial starting points (BPPs) were a fair price. Given the assumed values for nonsawtimber and fuelwood, these are reasonable starting points. The BPP values indicate the values actually paid on average for timber sales. They include the effect of some sales with large bid premiums. That there are such large bid premiums on individual sales that are competitive is reflective of the diverse bidders with different costs structures and product utilization abilities or factors that TEA may not be sensitive to, such as restrictions on when a purchaser can operate on a specific sale.

The final high bids reflected in the BPP values will be the truest measure of average fair market stumpage prices available. They represent what an actual purchaser is willing to pay given their expectations for product recovery and their cost management. At the same time, the BPP is the point of central tendency in a non-normal distribution of a very heterogeneous product called a timber sale.

There are opportunities to reduce bid premiums, especially in the appraisal of nonsawtimber volumes. Figure 4 illustrates the way that the small sawtimber (generally less than 11 in. (28 cm)) market is differentiating itself and offering higher market values than the base rates commonly used. In the South, chip and saw technologies are widespread and create utilization opportunities that maximize returns for logs down to 4 in. (10 cm) small-end diameter. Similar technologies are evolving in the west where there are higher value market opportunities (including export markets) for clean mill residues. These opportunities in timber appraisals would not necessarily increase bid prices because bidders are already making assumptions that exceed those embedded in the current appraisal process. These types of assumptions are factors that can lead to higher than expected bid premiums on some sales.

Part of the motivation for adopting the TEA appraisal process in the mid-1980s was as an attempt to reduce bid premiums, which at the time were perceived to be too large. Recent experience shows that this goal is not currently being achieved with the present TEA appraisals. Although some of the blame may be attributed to a backward-looking system to track market volatility, other causes of high bid premiums include local supply issues, underestimating utilization abilities of potential high bidders (for material tagged as nonsawtimber or fuelwood), and excessive use of local cost reductions that reduce appraised prices relative to market prices.

Implementation Guidance

Forest Service managers could decide to use price mark-up equations to estimate BPPs for the new appraisal groups while maintaining the existing appraisal zones and the existing cost centers used to make local adjustments. Alternatively, they could use the new BPPs for some or all of the appraisal zones and/or a set of cost centers that are more standardized across appraisal zones. One strength of the method to estimate BPP is its simple, transparent approach that is also conceptually robust in that it is based on well-established theory on the relation between product and stumpage markets. Alternative appraisal zones suggested match broad lumber market indexes, such as the Coast region or the Inland north region. That is, bidders for National Forest timber in these areas are competing in similar markets. High bid prices for individual sales should primarily be due to differences in unique sale characteristics (species and grade composition, sale length, and size) and costs (such as logging costs, haul distances).

The mark-up equations needed to estimate BPPs would be updated periodically (such as quarterly or biannually) by Forest Service staff using new data on average quarterly prices by appraisal zone and prices or price indices for primary products.

The mark-up equations for each appraisal group in an appraisal zone will be estimated using quarterly average stumpage sales values for a certain number of most recent quarters. For our equations we used 23 quarters. The estimated average price (BPP) for a sale in the current quarter will implicitly include the average local costs for the sales that occurred over those recent quarters. They will also include an average bid premium over those quarters.

The local cost factors used to adjust the BPP (C_{ji} values in Eq. (1)) must be the deviations from the weighted average local costs over the *same set of quarters* where sales prices are used to estimate mark-up equations. Forest Service mangers will need to decide how many quarters of data are to be used to estimate both the mark-up equations and the average local costs. Because average local costs would be estimated by weighting by volumes sold, the mark-up equations would need to be estimated using volume-weighted sales data. To maintain the integrity of these assumptions, we assume that the BPP would be implemented with National/Regional guidance at the National Forest level. Each National Forest would use the BPP from the appraisal zone it is assigned to. It would also use the cost adjustments from average costs that are appropriate for their appraisal zone. If adjustments are to be made for low- and high-value species, there will need to be a more consistent use of species codes across National Forests.

If the new appraisal zones are used, there will need to be an effort to reorganize information on sales by the new zones that are now grouped by areas within Regions. For the new appraisal zone arrangement, most Forest Service Regions are parts of several appraisal zones, so this restructuring would involve collaboration across Regions but should lead to greater transparency for bidders who operate across Forest Service Regions.

Acknowledgments

We acknowledge the assistance of many people: Beth Boddiger and Sara Qian of the Forest Service helped develop summaries of the Cut & Sold reports; Austin Rempel (ECONorthwest) converted and summarized the Cut & Sold reports as EXCEL worksheets; Jeff Prestemon (SRS) reviewed the initial Study Plan and provided some southern lumber price series for comparisons; Xiaoping Zhou (PNW) provided various data series for western lumber species; James Howard (FPL) provided background material on the price series published at FPL; Bill Luppold (NRS) provided a hardwood lumber price set he developed and maintains as well as insights about northern hardwood lumber markets; Steve Verrill (FPL) provided statistical assistance in preparing Table 6 and guidance on how to interpret results; and Mike Niccolucci, Matt Etzenhouser, Paul Fink, Tim Howard, Mike Daugherty, Larry Mahler, Ricky Rodriguez, and Charlotte Bofinger (all of the Forest Service) helped assemble the regional sales data sets.

Literature Cited

Adams, D.M.; Haynes, R.W. 1980. The 1980 softwood timber assessment market model: structure, projections, and policy simulations. Forest Science Monograph No. 22. 62 p.

Busby, G.M. 2006 Export chip prices as a proxy for non-sawtimber prices in the Pacific Northwest. Res. Note. PNW-RN-554. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 14 p.

Curtis, R.O.; Marshall, D.D.; DeBell, D.S., eds. 2004. Silvicultural options for young-growth Douglas-fir forests: the Capitol Forest study—establishment and first results. Gen. Tech. Rep. PNW-GTR-598. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 110 p.

George, P.S.; King, G.A. 1971. Consumer demand for food commodities in the United States with projections for 1980. Giannini Foundation Monograph # 26. Berkeley, CA: California Agricultural Experiment Station. 161 p.

Hardwood Market Report. [Various years.] Memphis, TN: Hardwood Market Report.

Haynes, R.W. 1977. A derived demand approach to estimating the linkage between stumpage and lumber markets. Forest Science. 23(2):281–288.

Haynes, R.W. 1999. Export chip prices as a proxy for non-sawtimber prices in the Pacific Northwest. Res. Note. PNW-RN-537. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 25 p.

Haynes, R.W. 2008. Emergent lessons from a century of experience with Pacific Northwest timber markets. Gen. Tech. Rep. PNW-GTR-747. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 45 p.

Howard, J.L.; Westby, R.M. 2013. U.S. timber production, trade, consumption and price statistics 1965-2011. Research Paper FPL-RP-676. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 91 p.

Luppold, W. 2015. Personal communication. Economist, USDA Forest Service, Northern Research Station, Princeton, WV.

Random Lengths. 2014. 2013 yearbook. Eugene, OR: Random Length Publications. 319 p.

Spelter, H. 2005. Review of alternative measures of softwood sawtimber prices in the United States. Res. Pap. FPL-RP-629. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 16 p.

USBLS. 2015a. Databases, tables & calculators by subject. Washington, DC: U.S. Bureau of Labor Statistics. http://www.bls.gov/data/. Accessed April 1, 2015.

USBLS. 2015b. Escalation guide for contracting prices. Washington, DC: U.S. Bureau of Labor Statistics. http://www.bls.gov/ppi/ppiescalation.htm. Accessed April 1, 2015.

USDA Forest Service. 2014. Timber sale accounting system of the US Forest Service.

USDA Forest Service, Region 1. 2014. Region 1 Timber sales database.

USDA Forest Service, Region 2. 2014. Region 2 Timber sales database.

USDA Forest Service, Region 3. 2014. Region 3 Timber sales database.

USDA Forest Service, Region 4. 2014. Region 4 Timber sales database.

USDA Forest Service, Region 5. 2014. Region 5 Timber sales database.

USDA Forest Service, Region 6. 2014. Region 6 Timber sales database.

USDA Forest Service, Region 8. 2014. Region 8 Timber sales database.

USDA Forest Service, Region 9. 2014. Region 9 Timber sales database.

WWPA. 2011. Statistical yearbook of the western lumber industry. Portland OR: Western Wood Products Association. 26 p.

Wohlgenant, M.K. 2001. Marketing margins: empirical analysis. In: Gardner, B.; Rausser, G., eds. Handbook of agricultural economics, volume 1. Amsterdam: Elsevier Science B.V. 934–970. Chapter 16.

World Bank. 2015. World Bank data, global economic monitor commodities, woodpulp price, $/mt, current Statistisches Bundesamt, Germany; Allman Manadsstatistik, Sweden; Washington, DC: The World Bank Group. http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=Global-Economic-Monitor-(GEM)-Commodities. Accessed April 23, 2015.

Zhou, X. 2013. Production, prices, employment and trade in northwest forest industries, all quarters 2012. Resour. Bull. PNW-RB-265. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 163 p.

Glossary

Advertised Rates—The minimum acceptable bid rates for timber (specific condition A/AT4) in the sale advertisement and bid form. They are the indicated advertised rates, as adjusted, so that all advertised rates are at least as high as base rates.

Appraisal Zone—A geographic area encompassing a Region, a National Forest, a group of Ranger Districts, or combinations thereof. The zone boundary is usually determined by similarities in haul distance, species composition, timber quality, market area competition, or logging methods.

Appraised Value—The estimated fair market value of standing timber that will be converted to commercial products, such as lumber or pulpwood.

Base Period—The time period used for identifying competitive sales for determining the Base Period Price.

Base Period Price—With the exceptions of Regions 1, 8, and 9 and Regions 5 and 6 biomass, the value representing the appraisal group's volume-weighted average winning bid price of the competitively sold timber sales in the base period. For Region 1, it is the average of the winning bid price plus road maintenance costs, environmental costs, temporary development costs, and specified road costs and is called the "Actual Past Average Value." For Regions 8 and 9, it includes the application of a rollback factor. For Region 5 biomass, it is an estimated value. For Region 6 biomass, it is the delivered log price converted to CCF. It reflects the average sale characteristics of the base period sales and is the starting point of a transaction evidence appraisal.

Base Rates—The lowest rates of payment for timber that are authorized by the contract (specific condition A/AT4). Base rates are not subject to change by rate redetermination, except for reduction under contract provisions B/BT3.31 for environmental modification, B/BT3.32 for catastrophic damage, and B/BT3.33 for market change during suspension. Base rates are the higher of either (a) the applicable minimum rates (FSM 2431.31b) or (b) the Knutson–Vandenberg deposits for essential reforestation, plus timber property value, plus $0.25 per hundred cubic feet (CCF).

Bid Premium Rates—The amounts by which the purchaser bids in excess of the advertised rates (specific condition A/AT4). Bid premium rates remain constant during the term of the contract, except for reduction under contract provisions B/BT3.31 for environmental modification, B/BT3.32 for catastrophic damage, and B/BT3.33 for market change during suspension.

Bid Rates—The contract rates bid by the timber sale purchaser, exclusive of required deposits (specific condition A/AT4). These rates may be subject to escalation (FSM 2431.34 and contract provision B/BT3.2).

Comparative Rates—Determination of stumpage value by comparison with stumpage rates received by comparative bids on similar sales (sec. 44.5).

Competition Adjustment—*See* Rollback Factor.

Cost Adjustment—Adjustments to the Base Period Price to reflect operating cost differences between the base period sales and the sale being appraised. These adjustments are for differences in logging cost, specified road construction cost, haul cost, and other costs that significantly affect value differences between timber sales.

Deficit Appraisal—An appraisal where the average indicated advertised rate is less than the average base rate.

Fair Market Value—The value at which property (timber) would change hands between a willing and knowledgeable seller and a willing and knowledgeable buyer, neither under compulsion to sell or buy and both having reasonable knowledge of the relevant facts. In addition to type, quality, and quantity of timber, fair market value reflects the time of sale, the highest and most profitable use, the location, a reasonable time to find a purchaser, and an open and competitive market. It can be viewed as an estimate of market value that reflects the price an operator of average efficiency who is able to pay that price and retain sufficient profit to maintain long-run operations is willing to pay.

Fuelwood—Wood used by conversion to some form of energy.

Indicated Advertised Rates—The estimated value of the timber after accounting for all differences between the sale and the sales in the base period including timber property value, any market adjustments, and the rollback factor. If necessary, this value is adjusted to increase it to base rates.

Market Adjustment—An adjustment to the appraisal data so that it represents current market conditions.

Minimum Rates—The lowest rate at which the Forest Service may sell timber (FSM 2431.31b), except under contract provisions B/BT3.31 for environmental modification, B/BT3.32 for catastrophic damage, B/BT3.33 for market change during suspension, an administrative use sale or permit under 36 CFR 223.2, stewardship contracts sold under 36 CFR part 223.1, incidental amounts of material not meeting utilization standards of the timber sale contract, or to provide for the removal of insect-infested, diseased, dead, or distressed timber (36 CFR 223.61).

Nonsawtimber—Logs of insufficient size or quality to be suitable for conversion to lumber.

PAL—Project Activity Level, used in Region 5 where it is an industrial operation's fire precaution system. Its costs are assessed on a per CCF basis.

Predicted Bid Rate—With the exceptions of Regions 8 and 9, the value after cost adjustment to the Base Period Price for differences in average sale characteristics, timber quality, risk, and market conditions. With the exception of Region 1, the predicted bid rate is adjusted downwards by the rollback factor to arrive at the indicated advertised rate. For Region 1, a Rapid Market Adjustment is considered following the rollback, prior to arriving at the indicated advertised rate. The indicated advertised rate will also include any Timber Property Value in the sale.

Public Works Road Construction Cost—The total cost of constructing all permanent roads specified in the timber sale contract, estimated as if construction is to be accomplished by an independent contractor. It includes the additional costs of a public works contract.

Pulp—In the context of this paper, the wood chips from which pulp is produced, usually derived from mill edgings and small timber.

Purchaser Credit—Credit earned by purchaser's construction of specified roads. Purchaser credit was discontinued in contracts advertised after March 31, 1999, but may be a factor in redetermining rates or damage calculations for contracts advertised prior to then.

Quality Adjustment—An appraisal adjustment to reflect differences in timber quality between the base period sales and the sale being appraised.

Rate Redetermination—An adjustment of bid rates to reflect current appraised values. The rate redetermination may be necessary because of contract extension, contract modification, catastrophic damage, or other reasons specified in the timber sale contract.

Risk Adjustment—An appraisal adjustment to reflect unusual conditions not reflected in market, quality, or cost adjustments and that is tied to uncertainties surrounding the sale.

Road Construction Cost—The total cost of constructing all permanent roads specified in the timber sale contract, estimated as if construction is to be accomplished by the timber purchaser. The road construction cost is the cost amount used in timber appraisal calculations.

Rollback Factor—A downward adjustment applied to the volume-weighted average winning bid price of the competitively sold timber sales in the base period for Regions 8 and 9; and to the predicted bid rate for all other Regions. For Regions 2, 3, and 4, the downward adjustment is determined by applying the factor to the Adjusted Base Period Price. For Regions 5 and 6, the adjustment is determined by applying the factor to the predicted bid rate itself. The rollback factor may also be referred to as the competition adjustment, competition amount, or competition factor. In the appraisal process, the rollback factor is intended to (a) set advertised rates at a level to capture sufficient competition for the establishment of an actual fair market value, (b) compensate

for possible changes in the market between the base period and the bid date, (c) reflect differences in sale conditions that may not have been reflected in the appraisal, (d) allow for the risk that timber volumes, sale characteristics, or values may vary from those used in the appraisal, and (e) allow for the risk that markets or other economic conditions may change during the period of the contract.

Sawtimber—Logs of sufficient size and quality as to be suitable for conversion to lumber.

Specified Roads—Roads planned for future recurrent uses for which the timber sale contract specifies location, standards, and construction specifications.

Standard Rates—The lowest rates at which the Forest Service may sell timber without a supporting appraisal calculation (FSM 2431.31a).

Stumpage Value—The value of uncut timber.

Timber Property Value—The cost of manufacture from the standing tree to the state of manufacture where the sale is made, which is usually in decks. This would include the constructed value of felling and bucking, skidding, decking, slash treatment, erosion prevention, and a proportionate share of overhead and depreciation. In trespass cases where the timber is found at a mill, add transportation value and an estimated value for loading and unloading. This cost is added to the stumpage value of the standing tree (sec. 47.3).

Transaction Evidence Appraisal (TEA)—An appraisal method designed to estimate fair market value of timber based on bid rates of past timber sale transactions. The base data is compiled from sales sold competitively over a period of time known as the base period.

Unusual Adjustment—An adjustment to the appraisal data to reflect known unusual conditions, not reflected in other market, quality, risk, or cost adjustments.

Appendix 1—Assignment of National Forests to Appraisal Zones

Region	Appraisal zone	Forest number	Forest name
5	1	5	Klamath NF
5	1	8	Mendocino NF
5	1	10	Six Rivers NF
5	1	14	Shasta–Trinity NF: Shasta NF, Trinity NF
6	1	3	Gifford Pinchot NF
6	1	6	Mount Hood NF
6	1	5	Mt. Baker–Snoqualmie NF: Mt. Baker NF, Snoqualmie NF
6	1	9	Olympic NF
6	1	10	Rogue River–Siskiyou NF: Rogue River NF, Siskiyou NF
6	1	12	Siuslaw NF
6	1	15	Umpqua NF
6	1	18	Willamette NF
1	2	2	Beaverhead–Deerlodge NF: Beaverhead NF, Deerlodge NF
1	2	3	Bitterroot NF
1	2	4	Idaho Panhandle NFs: Couer d'Alene NF, St. Joe NF, Kaniksu NF
1	2	5	Clearwater NF
1	2	8	Custer NF
1	2	10	Flathead NF
1	2	11	Gallatin NF
1	2	12	Helena-Lewis and Clark NF: Helena NF, Lewis and Clark NF
1	2	14	Kootenai NF
1	2	16	Lolo NF
1	2	17	Nez Perce NF
4	2	2	Boise NF
4	2	12	Payette NF
4	2	13	Salmon–Challis NF: Salmon NF, Challis NF
6	2	1	Deschutes NF
6	2	2	Fremont–Winema NF: Fremont NF, Winema NF
6	2	4	Malheur NF
6	2	7	Ochoco NF
6	2	14	Umatilla NF
6	2	16	Wallowa–Whitman NF: Willowa NF, Whitman NF
6	2	17	Okanogan–Wenatchee NF: Okanogan NF, Wenatchee NF
6	2	21	Colville NF
2	3	2	Bighorn NF
2	3	3	Black Hills NF
2	3	4	Grand Mesa, Uncompahgre, and Gunnison NFs: Grand Mesa NF, Uncompahgre NF, Gunnison NF
2	3	6	Medicine Bow–Routt NFs and Thunder Basin National Grassland: Medicine Bow NF, Routt NF, Thunder Basin National Grassland
2	3	7	Nebraska NF and Grasslands: Samuel R. McKelvie NF, Buffalo Gap, Fort Pierre, and Oglala National Grasslands, Nebraska NF
2	3	9	Rio Grande NF

Region	Appraisal zone	Forest number	Forest name
2	3	10	Arapaho & Roosevelt NFs, Pawnee National Grassland: Arapaho NF, Roosevelt NF, Pawnee National Grassland
2	3	12	Pike and San Isabel NFs, Cimarron and Comanche National Grasslands: Pike NF, San Isabel NF, Cimarron National Grassland, Comanche National Grassland
2	3	13	San Juan NF
2	3	14	Shoshone NF
2	3	15	White River NF
4	3	1	Ashley NF
4	3	3	Bridger–Teton NF: Bridger NF, Teton NF
4	3	7	Dixie NF
4	3	8	Fishlake NF
4	3	10	Manti–LaSal NF
4	3	14	Sawtooth NF
4	3	15	Caribou–Targhee NF: Caribou NF, Targhee NF
4	3	17	Humboldt–Toiyabe NF: Humboldt NF, Toiyabe NF
4	3	19	Uinta–Wasatch–Cache NF: Uinta NF, Wasatch NF, Cache NF
3	4	1	Apache–Sitgreaves NFs: Apache NF, Sitgreaves NF
3	4	2	Carson NF
3	4	3	Cibola NF
3	4	4	Coconino NF
3	4	5	Coronado NF
3	4	6	Gila NF
3	4	7	Kaibab NF
3	4	8	Lincoln NF
3	4	9	Prescott NF
3	4	10	Santa Fe NF
3	4	12	Tonto NF
5	4	1	Angeles NF
5	4	2	Cleveland NF
5	4	7	Los Padres NF
5	4	12	San Bernardino NF
5	5	3	Eldorado NF
5	5	4	Inyo NF
5	5	6	Lassen NF
5	5	9	Modoc NF
5	5	11	Plumas NF
5	5	13	Sequoia NF
5	5	15	Sierra NF
5	5	16	Stanislaus NF
5	5	17	Tahoe NF
5	5	19	Lake Tahoe Basin Management Unit
8	6	1	National Forests in Alabama: William B. Bankhead NF, Talladega NF, Tuskegee NF, Conecuh NF
8	6	2	Daniel Boone NF
8	6	3	Chattahoochee–Oconee NFs: Chattahoochee NF, Oconee NF

Region	Appraisal zone	Forest number	Forest name
8	6	4	Cherokee NF
8	6	5	National Forests in Florida: Apalachicola NF, Osceola NF, Ocala NF
8	6	6	Kisatchie NF
8	6	7	National Forests in Mississippi: Bienville NF, Delta NF, De Soto NF, Holly Springs NF, Homochitto NF, Tombigbee NF
8	6	8	George Washington and Jefferson NFs: George Washington NF, Jefferson NF
8	6	11	National Forests in North Carolina: Nantahala NF, Pisgah NF, Uwharrie NF, Croatan NF
8	6	12	Francis Marion and Sumter NFs: Francis Marion NF, Sumter NF
8	6	60	Land Between the Lakes National Recreation Area
8	7	9	Ouachita NF
8	7	10	Ozark–St. Francis NFs: Ozark NF, St. Francis NF
8	7	13	National Forests and Grasslands in Texas: Angelina NF, Davy Crockett NF, Sabine NF, Sam Houston NF, Caddo–Lyndon B. Johnson National Grasslands
9	7	5	Mark Twain NF
9	8	3	Chippewa NF
9	8	4	Huron–Manistee NFs: Huron NF, Manistee NF
9	8	7	Ottawa NF
9	8	9	Superior NF
9	8	10	Hiawatha NF
9	8	13	Chequamegon–Nicolet NF: Chequamegon NF, Nicolet NF
9	9	8	Shawnee NF
9	9	12	Hoosier NF
9	9	14	Wayne NF
9	9	19	Allegheny NF
9	9	21	Monongahela NF
9	9	20	Green Mountain & Finger Lakes NFs: Green Mountain NF, Finger Lakes NF
9	9	22	White Mountain NF

Forest Service Administrative Regions and proposed appraisal zones.

Appendix 2—Product Codes and Product Names

01 SAWTIMBER	33 CONES-GRN
02 PULPWOOD	34 CONES-DRY
03 POLES	35 SEED
04 PILINGS	36 NUTS/SEED
05 MINE PROPS	37 FRTS/BERYS
06 POSTS	38 TREE SAP
07 FUELWOOD	39 TREE RESIN
08 NON-SAW	40 ROOTS
09 TIES	41 BULBS
10 COOP BOLTS	42 MUSHROOMS
11 ACID/DIST.	43 FUNGI
12 FLOAT LOGS	44 MOSSES
13 TRAP FLOAT	45 HERBS
14 MISC-CONV.	46 FERNS
15 XMAS TREES	47 WILDFLOWRS
16 NAV STORES	48 GRASS
17 NON CONV.	49 AQTC PLNTS
18 CULL LOGS	50 VINES
19 SM RND WD	51 MSLTO/SPMS
20 GRN BIO CV	52 CACTI
21 DRY BIO CV	53 GRNBIO-NCV
26 SPWOODPR	54 DRYBIO-NCV
27 BEE TREES	55 OTHER PLNT
28 TRANSPLANT	60 WORMS
29 LIMB/BOUGH	61 INSECTS
30 FOLIAGE	64 ANML ARTF
31 NEEDLES	65 OTHR ANM
32 BARK	

Appendix 3—National Forest Timber Sale Volume and Price by Appraisal Zone, FY2009 Q1 to FY2014 Q3

	Sawtimber				Nonsawtimber				Fuelwood			
Fiscal year & quarter	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)
Coast												
2009.1	41292	17.10	0	0	20	17.33	0	0	10866	6.80	3194	5.00
2009.2	40511	25.14	0	0	474	1.53	0	0	7866	6.33	2	10.00
2009.3	77464	10.90	0	0	364	14.24	0	0	17236	4.33	8	28.96
2009.4	417301	24.74	0	0	17742	1.13	1	20	8354	4.66	0	0.00
2010.1	90339	15.87	0	0	18	17.80	0	0	27056	4.90	628	10.04
2010.2	11013	24.14	0	0	17	27.35	0	0	17794	4.52	1036	10.00
2010.3	92376	25.27	0	0	1759	0.59	88	0	16767	5.64	729	10.00
2010.4	301563	33.75	0	0	12469	0.08	0	0	28441	5.36	1	19.80
2011.1	82818	62.87	0	0	10402	21.14	0	0	12057	7.58	2389	5.00
2011.2	55985	35.33	0	0	93	2.78	0	0	23635	3.77	5104	6.28
2011.3	64152	54.09	0	0	3026	0.15	0	0	12660	7.87	3294	5.00
2011.4	386108	55.88	0	0	2267	0.21	0	0	50201	2.84	5030	5.23
2012.1	32894	83.80	0	0	52	3.63	0	0	14012	18.91	3367	5.00
2012.2	65466	59.90	0	0	78	3.31	0	0	11095	8.02	4440	5.00
2012.3	39533	40.94	0	0	3069	0.38	0	0	11209	9.38	3583	5.00
2012.4	466652	54.40	0	0	9198	0.95	0	0	64593	3.16	3681	5.00
2013.1	83051	49.58	0	0	36	4.61	0	0	9545	9.64	3851	5.71
2013.2	92434	56.15	0	0	1396	5.13	0	0	12081	6.20	5778	6.32
2013.3	145296	63.00	0	0	231	1.47	0	0	13347	6.54	4364	5.95
2013.4	298408	40.19	2	10.00	7927	1.09	0	0	23587	4.05	4764	5.84
2014.1	21353	26.15	0	0	13	18.20	0	0	12296	7.77	2775	5.00
2014.2	86640	72.78	1	26.89	24	19.00	0	0	11403	8.49	6863	6.22
2014.3	80205	53.96	0	0	17	13.77	0	0	14003	6.35	3	10.00
Inland North												
2009.1	132056	18.90	0	0	23302	2.88	0	0	53554	5.92	0	0
2009.2	50193	11.35	0	0	14768	7.72	0	0	11164	1.03	0	0
2009.3	52242	18.09	0	0	25276	9.60	0	0	29374	5.19	0	0
2009.4	336695	22.51	0	0	142276	10.46	0	0	70130	3.00	0	0
2010.1	107455	24.85	0	0	41534	40.81	0	0	59242	7.71	0	0
2010.2	52368	30.93	0	0	33963	14.46	23	6	33952	1.06	0	0
2010.3	94854	11.87	0	0	62214	7.68	0	0	94741	4.79	0	0
2010.4	386815	30.53	4	8.33	128533	12.43	1	40.00	173375	6.80	0	0
2011.1	68656	35.65	0	0	9733	17.63	0	0	55763	6.36	0	0
2011.2	9902	41.11	0	0	8656	8.81	0	0	20536	4.59	0	0
2011.3	102312	25.63	0	0	29377	1.95	0	0	99111	10.33	0	0

Fiscal year & quarter	Sawtimber				Nonsawtimber				Fuelwood			
	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)
Inland North—con.												
2011.4	361141	40.37	0	0	105311	20.36	0	0	177851	19.69	0	0
2012.1	42987	29.89	0	0	17210	3.51	0	0	60484	6.17	0	0
2012.2	53699	21.52	0	0	20641	32.36	0	0	35372	15.33	0	0
2012.3	66386	50.96	4	8	14984	1.74	0	0	97366	6.69	0	0
2012.4	444313	39.22	0	0	80587	4.97	0	0	141047	9.79	6593	0.27
2013.1	46954	53.02	0	0	4012	15.57	0	0	73762	7.24	0	0
2013.2	52275	34.81	0	0	5577	1.57	0	0	12130	7.17	4	0
2013.3	72623	57.68	0	0	18970	1.43	0	0	91640	5.04	0	0
2013.4	496741	56.81	0	0	40695	9.92	0	0	151636	9.11	0	0
2014.1	64700	65.50	0	0	26920	18.59	0	0	43132	6.15	0	0
2014.2	79350	40.15	0	0	27053	0.98	0	0	9079	4.44	0	0
2014.3	79956	75.89	0	0	31482	57.42	0	0	96096	4.49	0	0
Inland Central												
2009.1	33205	34.79	17	11.76	2064	4.10	672	1.04	25275	8.30	17019	23.09
2009.2	67283	15.73	2	11.25	19	33.13	0	0	3317	8.35	7	15.71
2009.3	32493	11.68	88	11.35	4321	71.74	10	20.99	13093	7.50	102	12.89
2009.4	310583	5.29	1346	2.06	4068	7.59	67	3.17	67272	7.18	245	6.88
2010.1	78686	6.97	527	1.65	520	11.99	351	1.11	23155	10.00	98	5.91
2010.2	100475	13.11	0	0	137	4.55	0	0	5907	7.10	5	15.28
2010.3	71238	13.50	17	12.70	807	22.95	8	20.00	30439	5.48	4673	5.12
2010.4	157510	8.97	1978	1.35	2504	9.63	21	3.76	98974	6.39	3802	4.19
2011.1	95249	12.05	12	11.25	812	5.79	73	2.18	23298	9.40	34	10.66
2011.2	103327	8.78	0	0	306	1.97	517	1.00	9567	7.56	0	0
2011.3	77026	5.56	971	8.26	82	24.93	6	20.00	20849	10.90	4133	10.27
2011.4	133113	7.84	823	2.34	1437	8.57	8	21.58	85006	7.79	445	3.17
2012.1	67240	5.24	76	2.60	1440	3.47	3	28.51	23041	8.79	13915	4.02
2012.2	36513	4.46	0	0	42	24.53	0	0	6462	7.03	11560	3.95
2012.3	57006	3.60	31	11.81	3238	2.99	5	24.00	31113	7.78	4908	1.55
2012.4	270107	11.33	60	12.61	7814	12.25	95	1.63	92633	6.75	3675	11.27
2013.1	138409	10.60	16	12.37	1226	7.94	4	20.00	25299	8.86	52	11.42
2013.2	76975	13.57	0	0	724	2.02	0	0.00	10453	8.52	12	17.94
2013.3	68064	13.59	36	10.51	999	45.35	6	20.00	32180	6.11	64	10.20
2013.4	167671	15.48	1605	1.51	7345	6.68	1	20.00	99495	5.82	10824	1.22
2014.1	71216	11.34	13	12.57	38	43.21	1	40.00	18040	8.54	506	1.24
2014.2	54175	14.34	0	0	885	8.85	0	0	24618	15.01	7	8.93
2014.3	64948	19.99	40	12.13	527	6.94	29	4.95	23146	8.54	9725	5.72

Fiscal year & quarter	Sawtimber				Nonsawtimber				Fuelwood			
	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)
Inland South												
2009.1	2927	9.50	17	7.62	8165	0.15	0	0	30829	7.44	183	31.54
2009.2	901	5.48	3	11.53	546	3.30	0	0	5612	10.91	34	24.42
2009.3	6082	4.11	24	7.98	884	2.54	0	0	20481	6.54	22	12.38
2009.4	35704	6.98	38	7.04	41170	0.10	3	1.00	33876	6.11	66	14.36
2010.1	7109	9.86	17	9.82	796	3.05	0	0	30007	7.60	132	30.62
2010.2	11340	10.90	0	0	14962	0.06	0	0	6389	8.62	71	31.30
2010.3	29083	8.89	19	8.53	19798	0.14	0	0	22958	6.08	36	33.61
2010.4	43743	5.74	29	4.85	12119	0.54	0	0	48437	7.29	260	30.03
2011.1	6836	6.62	10	8.28	2219	1.24	0	0	36889	8.40	239	27.57
2011.2	164	6.79	7	8.66	268	1.65	0	0	8315	7.88	133	27.21
2011.3	5369	7.32	498	1.22	648	3.27	0	0	19139	6.26	423	13.83
2011.4	75433	4.79	125	2.19	35652	0.60	180	1.00	42806	7.30	758	5.63
2012.1	34658	6.06	2	16.54	11583	1.03	0	0	30640	7.94	211	26.92
2012.2	12267	12.48	0	0	24681	0.01	0	0	7926	9.02	118	26.68
2012.3	30894	3.94	3	19.77	5971	0.55	0	0	19566	6.08	68	33.93
2012.4	13576	7.38	101	4.34	2874	1.43	0	0	36134	7.69	160	23.65
2013.1	29649	4.28	22	30.10	5545	1.06	5	1.00	26810	8.42	193	27.89
2013.2	23416	7.33	0	0	2758	1.01	0	0	6938	9.27	75	30.50
2013.3	25351	6.06	15	23.42	9457	3.09	0	0	16519	8.66	83	14.76
2013.4	167993	11.53	9	19.30	47944	4.34	0	0	32223	7.62	132	22.83
2014.1	7597	3.86	54	3.63	1059	1.31	50	1.00	23041	8.73	154	28.42
2014.2	14472	4.31	0	0	3343	1.00	0	0	6147	9.36	80	29.13
2014.3	20475	9.81	19	32.05	2523	1.58	5	36.99	17347	6.16	36	22.10
Sierra												
2009.1	7393	17.22	0	0	1959	9.44	8	8.34	14285	9.22	535	10.18
2009.2	5014	5.07	0	0	12	2.12	0	0	494	10.99	0	0
2009.3	18976	5.61	0	0	13659	0.40	10	8.33	15344	11.00	9	20.00
2009.4	244235	12.85	18	5.56	96709	7.50	5	8.34	21158	5.94	51	20.00
2010.1	33222	10.02	16	5.56	7407	2.09	4	8.33	16212	8.75	666	11.82
2010.2	20672	19.42	0	0	6800	2.14	0	0	8674	5.12	319	14.54
2010.3	46690	18.61	0	0	23211	2.78	0	0	20114	10.31	685	11.74
2010.4	224310	18.77	0	0	107346	10.05	150	1.00	31130	7.70	1353	11.55
2011.1	44954	101.38	18	5.56	10759	32.37	0	0	12921	9.56	911	13.78
2011.2	14249	11.38	0	0	8869	2.05	0	0	5074	14.74	423	17.58
2011.3	2399	5.77	18	5.56	678	3.26	0	0	23981	8.98	1165	13.54
2011.4	177397	24.74	0	0	29292	4.81	7	8.34	80817	9.70	1163	13.49
2012.1	14007	10.34	0	0	3968	8.62	14	8.33	25535	6.05	874	14.41

Fiscal year & quarter	Sawtimber				Nonsawtimber				Fuelwood			
	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)
Sierra—con.												
2012.2	3610	37.65	0	0	462	18.85	0	0	6977	8.86	559	15.03
2012.3	41624	27.24	0	0	5912	19.39	11	8.33	24433	8.18	707	10.00
2012.4	235822	22.90	0	0	6789	0.07	0	0	84128	7.57	682	10.75
2013.1	6479	10.56	14	5.56	4	26.09	2	8.34	20837	9.06	728	12.94
2013.2	17654	19.16	4	5.56	0	0.00	0	0	9691	5.88	67	10.00
2013.3	31250	46.16	11	5.56	10	59.96	8	8.34	25140	8.81	802	10.15
2013.4	254146	24.11	18	5.56	479	0.64	0	0	28243	6.15	534	10.00
2014.1	18611	24.75	0	0	33	92.99	5	8.34	11499	10.90	464	12.05
2014.2	26453	38.54	7	5.56	17	4.41	1	1.00	17182	16.30	272	17.39
2014.3	81040	30.27	14	5.56	13	30.25	5	8.34	21987	7.14	521	10.22
Mid-South												
2009.1	18216	93.08	5766	78.26	10825	19.66	3194	4.84	0	0.00	5114	2.99
2009.2	75449	37.01	7879	80.11	11421	20.86	244	7.07	356	0.14	2093	2.23
2009.3	27634	41.82	13817	73.47	8082	16.84	119	1.72	103	0.68	1054	1.88
2009.4	64814	43.04	12130	42.31	36700	17.45	107	2.82	342	0.58	1478	4.04
2010.1	30269	54.17	10803	63.40	8565	14.15	931	8.00	0	0.00	5044	3.68
2010.2	29999	65.03	17064	52.59	12977	9.06	2914	28.02	3	13.33	3089	3.24
2010.3	56279	83.49	35916	60.83	33226	16.34	2291	9.19	1	20.00	617	2.46
2010.4	84273	56.07	55666	50.30	56243	18.62	8287	4.86	1861	0.00	2099	3.30
2011.1	35549	63.24	13604	48.05	17369	16.99	4064	11.16	12	2.50	4777	3.84
2011.2	3101	46.95	9354	67.00	2606	7.11	2371	12.79	50	1.00	1960	3.60
2011.3	83550	54.20	39257	45.79	39805	13.56	5069	11.97	0	0.00	548	2.53
2011.4	112149	30.38	34502	60.33	40343	5.71	2204	2.84	1020	21.70	2314	3.02
2012.1	23136	23.41	7604	45.62	6542	14.96	4827	5.93	794	3.59	3789	3.84
2012.2	11324	46.69	16876	53.29	15207	8.65	1321	4.83	242	4.91	1749	3.35
2012.3	37612	27.08	31213	67.45	31019	7.95	6653	11.50	1316	1.46	2266	17.49
2012.4	111885	36.49	43787	60.28	60602	14.07	5000	11.85	645	2.62	1797	12.09
2013.1	14614	40.25	6749	92.64	6745	13.72	703	1.02	642	4.08	3863	6.59
2013.2	44223	60.51	14495	95.76	31111	7.73	3449	12.33	762	11.38	4063	8.59
2013.3	47235	44.52	16660	100.35	47753	19.92	3701	11.30	81	20.37	2888	8.96
2013.4	65749	35.76	27363	54.35	58858	12.35	7641	11.45	1320	11.87	4202	13.90
2014.1	10582	46.76	8475	112.61	7944	10.37	1572	1.52	428	5.00	5102	16.41
2014.2	71177	64.43	21063	107.89	32136	12.19	7756	12.77	436	9.15	8326	8.69
2014.3	11199	19.82	22005	84.66	22905	5.07	444	1.88	75	6.60	5491	15.73

	Sawtimber				Nonsawtimber				Fuelwood			
Fiscal year & quarter	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)
Southeast												
2009.1	19146	89.73	4883	21.24	14350	19.79	3855	5.94	675	4.76	961	7.09
2009.2	23286	69.42	8086	47.86	36789	18.90	7735	12.25	694	3.92	1407	5.93
2009.3	32475	74.78	9947	46.60	74875	22.02	12451	7.02	1646	51.35	183	6.20
2009.4	59119	63.15	30900	40.07	116652	23.00	18066	4.80	619	3.55	461	5.70
2010.1	29115	62.95	10779	31.89	35117	27.64	9100	6.69	433	4.71	5796	5.58
2010.2	38907	74.33	5651	38.35	75362	25.56	11637	9.04	421	16.11	5945	5.16
2010.3	14150	75.24	1988	82.15	37241	32.53	1201	11.03	56	5.71	1147	5.36
2010.4	101002	75.49	32420	58.63	134481	20.42	18445	11.88	39950	10.71	3732	5.67
2011.1	23496	49.15	6539	34.49	41811	26.05	6123	6.82	6297	5.99	6666	5.65
2011.2	45747	67.20	10061	38.06	39033	21.00	8222	4.55	369	6.50	4318	5.51
2011.3	47909	63.76	12636	54.82	61267	22.92	9370	6.33	5746	13.87	2892	7.84
2011.4	110977	61.74	33556	52.40	160746	21.95	20041	5.90	28695	8.84	3738	5.22
2012.1	31039	64.74	5198	55.21	11330	20.55	4775	5.09	14371	7.03	2230	6.74
2012.2	25753	71.33	2162	93.03	29549	29.71	2735	8.97	1599	1.79	4348	6.38
2012.3	49015	60.11	9500	44.37	47686	22.99	10692	6.04	3666	13.87	316	5.51
2012.4	166157	62.48	60800	54.11	218664	22.80	39577	6.73	3849	15.51	3038	5.12
2013.1	11592	57.31	5067	76.37	22844	21.90	5484	7.81	634	5.24	5286	5.53
2013.2	29785	73.91	5987	47.73	33798	21.21	4146	13.39	4877	6.17	1666	6.23
2013.3	43500	60.81	4909	37.35	82108	26.98	4550	8.97	204	5.20	953	5.50
2013.4	136658	64.99	29932	48.63	139533	21.77	32281	8.92	1157	1.67	2824	5.19
2014.1	4061	55.66	2472	28.30	1050	18.85	1513	10.79	581	5.53	4926	5.52
2014.2	43323	65.81	6943	61.33	40368	23.06	14275	10.35	625	5.86	4285	5.55
2014.3	68761	73.35	7556	40.11	40472	19.22	5972	9.02	186	7.60	1295	5.31
Lake States												
2009.1	11631	77.09	3122	50.27	16303	50.23	9611	21.67	162	1.85	3317	5.36
2009.2	6296	53.72	1320	92.15	9637	51.96	31618	25.90	-516	-0.31	1118	5.03
2009.3	21871	45.34	2856	58.68	24511	40.03	15829	25.90	604	0.44	10355	5.24
2009.4	22368	54.68	9284	72.80	34000	40.21	98354	26.68	473	0.66	4614	4.89
2010.1	12824	60.02	5088	50.37	12503	28.17	30970	24.48	92	1.80	4498	5.12
2010.2	22201	75.10	4311	52.52	23693	50.66	48056	23.98	693	0.17	2111	6.03
2010.3	14114	58.31	2585	60.45	21847	30.00	48384	27.66	913	1.62	10555	4.94
2010.4	44448	67.15	9692	55.73	51892	43.10	92058	30.52	2697	1.38	5494	5.34
2011.1	20303	93.02	7932	41.73	23251	26.40	35926	26.56	2631	1.33	6023	5.94
2011.2	6769	83.69	2811	30.78	11509	36.92	24527	25.64	1021	1.22	1621	6.17
2011.3	21300	97.43	8165	59.17	23331	53.86	61908	33.42	299	5.00	10345	5.22
2011.4	32316	60.78	11419	119.64	50043	27.67	122740	32.09	1171	2.44	5213	5.32
2012.1	12372	61.78	2788	66.15	16414	59.60	15676	23.24	159	5.00	3230	4.96
2012.2	14151	79.10	4352	72.74	26344	48.87	58410	33.73	326	5.00	2430	5.82

Fiscal year & quarter	Sawtimber				Nonsawtimber				Fuelwood			
	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)	Softwood volume (CCF)	Softwood value ($/CCF)	Hardwood volume (CCF)	Hardwood value ($/CCF)
Lake States—con.												
2012.3	19728	80.15	8100	75.65	28820	47.77	75405	28.42	202	5.00	7371	5.56
2012.4	46638	86.16	10949	77.34	61253	45.48	120456	29.18	1211	3.89	4600	5.37
2013.1	9861	74.50	3135	92.14	30652	27.43	49279	24.85	354	4.12	2674	5.38
2013.2	13821	74.71	8383	49.57	29982	62.42	39385	24.06	665	2.56	1765	6.03
2013.3	28482	65.57	4448	70.31	27433	25.59	43775	28.05	2698	1.05	7735	5.21
2013.4	47973	96.94	12134	71.01	31537	41.60	114718	27.50	700	2.25	5080	5.36
2014.1	8000	91.10	2532	129.90	11703	63.23	21061	28.18	642	1.76	1830	5.34
2014.2	9500	101.80	8536	51.61	20418	29.97	56020	22.68	375	3.89	1983	5.89
2014.3	26643	103.96	11622	125.31	24188	52.58	91089	33.82	434	4.55	9001	5.29
Northeast												
2009.1	10	87.85	0	0	-767	-0.15	3408	2	0	0.00	269	11.67
2009.2	3472	22.66	4970	128	3240	3.61	2782	2	0	0.00	248	8.06
2009.3	1997	40.34	1412	30	520	1.87	4650	12	0	0.00	209	10.34
2009.4	7322	57.66	19580	167	3902	7.18	20952	7	0	0.00	22	5.45
2010.1	1019	69.87	3490	303	269	4.10	3658	3	1848	6.25	799	6.03
2010.2	631	31.29	5208	323	793	27.02	3622	2	453	6.25	1249	6.90
2010.3	221	22.50	7005	300	51	2.51	6865	2	714	6.25	3818	8.03
2010.4	7603	32.28	34652	224	2625	3.65	28085	8	497	6.25	582	7.46
2011.1	2090	159.90	4568	265	427	4.82	6464	4	1508	6.25	581	6.73
2011.2	310	14.44	6387	235	187	1.91	6270	2	402	6.25	1114	6.72
2011.3	232	5.19	8496	266	704	0.97	10181	2	650	6.25	716	9.08
2011.4	6414	46.38	32956	164	2786	4.48	25416	5	620	6.04	581	8.61
2012.1	1590	25.91	2156	362	513	1.29	2487	3	1472	6.24	606	6.61
2012.2	895	55.71	6662	202	550	4.92	8529	2	534	6.25	1473	6.34
2012.3	2621	38.63	7129	286	4559	5.18	5844	3	535	6.25	460	8.86
2012.4	13248	39.87	28301	183	3568	4.51	27998	7	423	6.25	1761	3.81
2013.1	35	37.84	4507	402	411	1.13	4605	3	1514	6.25	551	7.35
2013.2	1014	92.98	1497	266	24	23.86	1443	3	386	6.13	1330	6.85
2013.3	5336	32.18	11826	258	1380	2.04	7645	2	718	6.25	1706	4.40
2013.4	11885	35.36	16523	251	4466	3.80	22953	4	485	6.25	642	7.55
2014.1	2059	26.87	8601	104	1932	3.44	2127	2	1236	6.25	513	7.02
2014.2	860	50.28	6399	360	784	2.83	6545	3	513	6.25	1324	6.71
2014.3	308	2.39	7682	399	374	1.00	9339	2	759	6.23	670	8.72

Appendix 4—Appraisal Information Collected from Individual Sales

Administrative information
Region
Forest
FY
Quarter
Sale Number
Green/Salvage
SBA
Deficit
Timber Property
Bid Method

General sale information
Product/Unit of Measure
Species Name/Group
Species Code
Volume
Quadratic Mean DBH
Base Period Price

Cost centers and other adjustments
Market Adjustment
Rapid Market Adjustment
GBCv-Nonsaw Adjustment
Falling and Bucking
Skidding and Loading
Logging Adjustment
Base Skid-Yard Cost
Sale Skid-Yard Cost
Skid-Yard Cost Adjustment
Base Stump to Truck
Sale Stump to Truck
Stump to Truck Adjustment
Base PAL Fire Protection
Sale PAL Fire Protection
PAL Fire Protection Adjustment
Base Haul Cost
Sale Haul Cost
Haul Cost Adjustment
Base Road Maintenance Cost
Sale Road Maintenance Cost
Road Maintenance Cost Adjustment
Surface Replacement Deposit
Road Maintenance Deposit
Base Contract Cost
Sale Contract Cost
Contract Cost Adjustment
Base Slash Cost
Sale Slash Cost
Slash Cost Adjustment
Base BD Deposit
Sale BD Deposit
BD Deposit Cost Adjustment
Base Development and Other Cost
Sale Development and Other Cost
Development and Other Cost Adjustment
Base Temporary Road Cost
Sale Temporary Road Cost
Temporary Road Cost Adjustment
Base Erosion Control Cost
Sale Erosion Control Cost
Erosion Control Cost Adjustment
Base Other Costs
Sale Other Costs
Other Costs Adjustment
Quality Adjustment
Unusual Adjustment
Risk Adjustment
Sale Specified Road Cost
Engineering Deposit
Timber Property Value
Market Area Adjustment (R1 only)

Minimum bid price (advertised price)

High bid price (or “no bid”)

Appendix 5—Methods to Improve Predictions of Base Period Price and Estimate the Probability Distribution of High Bid Price

Decreasing the Error in Prediction of Base Period Price

Base Period Price (BPP) may be estimated in the current quarter for a given appraisal group in a given zone using a mark-up regression equation linking the current quarter's primary product price to stumpage price:

$$\mathrm{BPP}_t^{\mathrm{s}} = c_2 P_t^{\mathrm{p}} + u_t \qquad \text{(A1)}$$

In Equation (A1), BPP is the estimated high bid price for sales with average costs and average bid premium. Equation (A1) is fit on quarterly average stumpage price and primary product price data over a historic period and includes an error term u_t, which is the difference between the predicted average high bid price for quarter t ($c_2 P_t^{\mathrm{p}}$) and the actual average high bid for quarter t. The difference u_t is the amount by which actual quarterly average sales costs and actual average high bid premium differ from the grand average over the entire period of the data used to fit the regression equation.

For a given mark-up equation, we define an improvement in the prediction of $\mathrm{BPP}_t^{\mathrm{s}}$ as a reduction in the standard deviation of the error term u_t for the predicted value.

We would be able to decrease this error by using two or more smaller zones rather than one larger appraisal zone. The standard error of predictions would be less for at least one of the smaller zones but not necessarily all the smaller zones.

Estimating the Probability Distribution of High Bid Price for a Given Sale

If we make two key assumptions, we may use a more detailed equation that shows the components of High Bid Price for sales over a historic period and may be used to predict the probability distribution of high bid price for a sale in one to a few quarters after the historic period:

$$\mathrm{HBP}_{t,i} = c_2 P_t^{\mathrm{p}} + \left(\overline{C} - C_i\right) + \left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right) \qquad \text{(A2)}$$

$$\left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right) = \mathrm{HBP}_{t,i} - \left[c_2 P_t^{\mathrm{p}} + \left(\overline{C} - C_i\right)\right] \qquad \text{(A3)}$$

We assume that (1) the average sales costs for the follow-on quarters are the same as for the historic period and (2) the distribution of bid premium correction factors as defined in Equation (A3) are the same as for the historic period. Equation (A2) gives the components that explain the high bid price for each individual sale over the historic period. As for Equation (A1), the term $c_2 P_t^{\mathrm{p}}$ is an estimate of the high bid price for a sale with average costs and average bid premium over the historic period of data for individual sales. Note that there is no error term because we assume that we compute $\left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right)$ using data over the historic period using Equation (A3).

Technically the bid premium correction factor as defined here includes any error in using $c_2 P_t^{\mathrm{p}}$ to predict the market stumpage value when there are average costs and average bid premium in quarter t and any error in using $\left(\overline{C} - C_i\right)$ to estimate cost corrections that the high bidder used.

If we assume the distribution of $\left(\mathrm{BPM}_i - \overline{\mathrm{BPM}}\right)$ terms over the historic period remains the same for a few follow-on quarters, we may use that distribution to select a bid premium correction factor for a sale in a follow-on quarter—using Equation (A2)—where the selected bid premium correction factor gives an estimate of $\mathrm{HBP}_{t,i}$, which has a certain probability of being greater than the actual high bid price. This would be the probability of a no bid sale.

Estimation of Base Period Price by a Mark-Up Equation Given Possible Patterns in Error Terms

Recall that the mark-up equation given by Equation (A1) predicts stumpage price for a given appraisal group. It is fit using quarterly data on stumpage prices and primary product prices. The error term u_t in equation A1 may be expressed as

$$u_t = \left(\overline{C} - C_t\right) + \left(\mathrm{BPM}_t - \overline{\mathrm{BPM}}\right) \qquad \text{(A4)}$$

where C_t is the average costs for sales in quarter t of the historic period, $\overline{C}$ is the average of costs for all sales over the historic period, and the bid premium correction factor for all sales in quarter t of the historic period is defined as

$$\left(\mathrm{BPM}_t - \overline{\mathrm{BPM}}\right) = \mathrm{BP}_t - \left[c_2 P_t^{\mathrm{p}} + \left(\overline{C} - C_t\right)\right]$$

There may be patterns in the error terms u_t that can lead to incorrect estimates of the parameter c_2. For example, it is possible for the error terms to be serially correlated, or to have differing variance over time. It is also possible that certain data points are outliers and have undue influence in comparison to other data points.

The error term in Equation (A4) is composed of two variables—the cost difference and the bid premium difference. The cost difference term is determined by the choices forest managers make in selection of timber sales and the cost features of those sales. Any pattern in those differences would be due to patterns in those decisions. The bid premium difference term is influenced by many factors, including the mix of timber products for sale, the location relative to mills, number of bidders, and strength of markets for products. Also it is possible that the two terms could be correlated for some sets of time periods, and this would influence

the pattern of errors. It is not clear that even if there were patterns in the errors over some periods that these patterns would persist. Also, cost pattern conditions and bid pattern conditions in one appraisal zone would not necessarily happen in another zone.

A basic strategy in estimating mark-up equations would be to correct for serial correlation with autoregressive equations when indicated, transform variables when needed to adjust for heteroscedasticity, and trim outlier data points to reduce their influence. These methods were used for a sample of mark-up equations. Some equations exhibited serial correlation and corrections modified c_2 slightly and could be used in place of uncorrected estimates. Visual inspection of residuals could indicate if transformation of variables may help reduce heteroscedasticity. Visual inspection of several mark-up equations did not find systematic trends in variance in residuals. Inspection of residuals identified a number of outliers, and estimates without them modified c_2 values slightly.

Although the c_2 estimates can be improved by these and other measures, additional predictor variables would likely be needed to reduce standard deviation of errors for estimating Base Period Price notably.

A strategy that is very likely to reduce error in predicting Base Period Price is to use smaller rather than larger appraisal zones to the extent that there are a sufficient number of sales to fit equations for the smaller zones.