Report on the Appropriateness of the Three Pivotal Supplier Test and Alternative Competitive Screens

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Summary and Conclusions

In its March 1, 2012 Order,[1] the Federal Energy Regulatory Commission (FERC) accepted the proposed tariff revisions of the California Independent System Operator (ISO) to the ISO's local market power mitigation (LMPM) mechanism. As part of that ruling, the Commission ordered that

> "*the CAISO's market surveillance committee is hereby directed to report its findings regarding the appropriateness of the three-pivotal-supplier test and whether an alternative competitive screen to identify market power opportunities for generation in load pockets is necessary by May 1, 2013.*"

On April 24, 2013, the California ISO filed on our behalf a motion for an extension of time until June 28, 2012, which was approved by FERC.[2]

The purpose of this report is to respond to the Commission's charge. We first describe the role of a LMPM mechanism in a bid-based, short-term wholesale electricity market and briefly explain the difference between structure-based mitigation approaches such as LMPM and other alternatives such as the conduct and impact-based mitigation. We then discuss the potential for both over-mitigation and under-mitigation of generation units under the California ISO's LMPM procedures. Over-mitigation is defined as a false positive in which bids are adjusted by a LMPM procedure to levels that subsequently result in market inefficiencies. Under-mitigation is similarly defined as a false negative, in which bids that should have been mitigated are not, resulting in prices that are not just and reasonable, unjustified wealth transfers from consumers to producers, and possible market inefficiencies. In particular we examine how a market screen based on a number of joint pivotal suppliers could result in such over- or under-mitigation. Finally, with the assistance of the California ISO Department of Market Monitoring (DMM), we have analyzed market data drawn from the CAISO first year implementation of LMPM in the day-ahead market in order to assess the outcomes of the three pivotal supplier screen relative to counterfactual screens based on two or four pivotal suppliers. These outcomes include frequency of bids that are significantly above default energy bids (DEBs), which are proxies for marginal costs, and the frequency of mitigation. However, for two reasons, it is not possible to assess whether the outcomes of alternative screens would result in significant changes in market prices and efficiency. The first reason is that it is not possible for us to re-run the market software to generate prices based on alternative pivotal supplier tests. The second reason is that we cannot predict how bidding might change in response to changes in the LMPM system.

Thus, the focus of this report is on evaluating the effects of criteria used in the CAISO LMPM mechanisms, rather than on a comprehensive assessment of the performance of local market power mitigation. Based on the analyses we were able to do of the CAISO data we conclude that

[1] 138 FERC ¶ 61,154, UNITED STATES OF AMERICA, FEDERAL ENERGY REGULATORY COMMISSION Docket ER12-423-000, ORDER ACCEPTING TARIFF REVISIONS (Issued March 1, 2012).

[2] FERC, Notice of Extension of Time - Analysis of Alternatives to Pivotal Supplier Test, Docket ER12-423-000 (Issued April 30, 2013).

there is no compelling justification for changing the three pivotal supplier screen in the LMPM competitive path assessment (CPA). However, we do identify some potential ways in which the definition of path competitiveness and the determination of DEBs might be improved in order to decrease the likelihood of false negatives and false positives.

In our report, we discuss a number of conceptual and practical issues involved in designing LMPM procedures, and examine data from 2012 on day-ahead bidding behavior of merchant and utility-owned generation under different congestion and competitive conditions. The following are our primary conclusions.

In comparing the pivotal supplier/CPA-type structure-based test with conduct-and-impact LMPM procedures, we conclude that both the structural- and conduct-and-impact-based approaches have pros and cons. In both methods, the details of implementation have a critical impact, with the risk of over- or under-mitigation hinging both on the specific thresholds and screens and on the design of the tests.

We conclude that, in theory, if there is adequate competitively-priced counterflow available to decongest a path even if the three largest suppliers of counterflow withdraw their supply, then it it will be highly difficult to exercise market power. This may indeed be true even if this is not the case, but there is adequate competitively-priced counterflow if the two largest suppliers withdraw. However, this does not mean that the present three pivotal supplier-based definition of non-competitive paths is necessarily overly conservative in practice. This is because pivotal suppler tests, as they can currently be practically implemented for defining competitive paths, do not properly account for the ability of generators to raise prices in several circumstances even when a generator is not fully pivotal. There are at least two major reasons why a pivotal supplier test may overestimate the competitiveness of paths, and hence a three pivotal supplier test is in practice less stringent than it could appear in theory. First, competitive path assessment does not account for the competitiveness of supply bids, which is a shortcoming because uneconomic residual supply is ineffective in restraining market power. Second, the present inability of the CPA process to consider how unit commitment costs affect the amount of economic residual supply is also a shortcoming, and may result in overestimation of the competitiveness of paths, particularly in day-ahead markets. However, although it appears impractical to modify the CAISO structure-based test at this time to remedy these shortcomings, such changes could be considered in future.

On the other hand, the present LMPM system can result in over-mitigation if variable costs are significantly and consistently underestimated. Both opportunity costs that arise from energy or start limits, and very short-term variations in natural gas costs (including within-day imbalance charges) may mean that the default energy bid for some units will understate their actual variable costs. In the case of opportunity costs, the result can be overuse of energy- or start-limited units early in the summer and consequent unavailability later in the season when their energy might be more needed by the system. Although generators can petition to have energy opportunity costs considered in their DEB, we reiterate our concern expressed in past opinions that the process for doing so lacks transparency and, therefore, risks being applied inconsistently.

Therefore, for these reasons we conclude that while the use of a three pivotal supplier test to evaluate the potential for the collective exercise of market power is not ideal, it could provide a reasonable balance. Hence, even if there is not a strong theoretical basis for building local market power mitigation around a three pivotal supplier test versus a two pivotal supplier test, such a test might be found to be a reasonable approach in practice because of the imperfect way in which a pivotal supplier test must be applied in practice. Moreover, empirical data on how competitive status of congested paths and counterflow bidding behavior interact is highly relevant to analysis of alternative criteria for defining noncompetitive paths. Of course, there are still shortcomings to such an empirical analysis, as we discuss below, not the least of which is that bidding behavior is likely to change when confronted with a different mitigation standard.

Therefore, with the cooperation of the CAISO Department of Market Monitoring, we have examined day-ahead data on bidding behavior since June 2012 under various congestion and competitive conditions for individual paths that are sometimes non-competitive. The following are our conclusions:

- There is a significant portion of merchant generator bids that are several multiples of their DEBs. There is a slight increase in the proportion of merchant bids that are 120% of the DEB or above when a three pivotal supplier (3PS) test is failed but a two pivotal supplier (2PS) is passed compared to when the present 3PS test is passed (Section 5.1). However we have not assessed the statistical significance of this trend. We also note that the existing bidding data under the 3PS fail/2PS pass condition may reflect an expectation by bidders that their bids would be mitigated, and so there could be significantly less incentive to raise those bids presently than there would be if the 3PS standard was dropped in favor of a 2PS standard. On the other hand, we also found a tendency for a higher proportion of high merchant bids when a 3PS was passed but a 4PS was failed; those bids would not be restrained by such an expectation.

- Another test of a relationship between concentration in counterflow supply and bidding behavior is to examine whether suppliers providing counterflow on paths that passed a two, three, or four pivotal supplier test were more likely to submit bids that were less than 95% of the default energy bid (Section 5.2). We had hypothesized that if generators were more able to exercise market power in some cases than in others, we would see a greater tendency for bids to bump up against the DEB level in the former cases. However, we found no evidence for such behavior in the least competitive conditions (when paths fail the 2PS or 3PS tests).

- We examined the twelve paths that were most often designated as noncompetitive in the period June-September 2012 (Section 5.3). We found that units that have a higher probability of providing counterflow on those paths when they are congested also have a statistically higher divergence between their bid and DEB.

- Considering the potential impact of changing from a 3PS to 2PS standard for all potentially non-competitive paths, we find, for example, that roughly 4,000 hourly bid segments above 1.2DEB that were mitigated under the 3PS standard in August would not have been mitigated because of that constraint under a 2PS standard (Section 5.4). This assumes that bidding behavior would not change under a different PS standard. Over the five month period documented here, about 285 GW-hr of effective counterflow that simultaneously (1) bid over 1.2DEB and (2) would be mitigated under the 3PS standard on a path would risk *not* having mitigation triggered by that path constraint under the 2PS standard. This 285 GW-hr, which averages about 75 MW in each hour, of course corresponds to much more than 75 MW of actual generation capacity, because the effective MW number is obtained by multiplying capacity by the appropriate shift factor. This 285 GW amount is slightly more than half of the overall 552 GW-hr of effective MW (~150 MW per hour) exposed to mitigation under the present 3PS standard.

Overall the analysis in Section 5.4 indicates that a large fraction of merchant units bid in excess of 1.2 times DEB during congested hours. Further a non-trivial number of units bid in excess of five times DEB. It is also clear that many of these bids are currently mitigated using the 3PS standard for defining non-competitive paths. Although the tables in that section are an approximation of the impact of a hypothetical 2PS standard, we believe that it does indicate that there would be a substantial number of additional bids in excess of 1.2 times the DEB that would have gone unmitigated had a 2PS standard been in place. (Note, however, that we are unable to assess what, if any, price differences would result.) In analyzing these data we were unable to identify a clear and material change in bidding behavior associated with higher or lower concentration that would provide support for use of a higher or lower (*e.g.*, 2PS or 4PS) threshold for defining competitive paths and applying local market power mitigation. Hence, our conclusion is that our analysis of Section 5.4, as well as the other analyses of Section 5, do not provide support for a change in the current three pivotal supplier threshold.

We suggest that future analyses examine changes in bidding behavior year-on-year between 2012 and 2013, to analyze the impact of switching from a static CPA to dynamic CPAs day-ahead and subsequently in real-time This switch has changed the probability of certain lines being uncompetitive, and may be accompanied by changes in bidding behavior that can be observed and analyzed.

1. Introduction

In its March 1, 2012 order in Docket ER12-423-000[3], The Federal Energy Regulatory Commission approved the local market power mitigation and competitive path assessment (CPA) design revision proposed by the California ISO. The design details are summarized in the ISO's "Local Market Power Mitigation Enhancements Draft Final Proposal,"[4] "Draft Final Proposal – Dynamic Competitive Path Assessment,"[5] and "Revised Draft Final Proposal: Dynamic Competitive

[3] *Op. cit.,* Footnote 1.

[4] " Local Market Power Mitigation Enhancements, Draft Final Proposal," California ISO, May 6, 2011, www.caiso.com/2b76/2b76e05c46990.pdf.

[5] "Draft Final Proposal – Dynamic Competitive Path Assessment," California ISO, Department of Market Monitoring, May 23, 2011, www.caiso.com/2b88/2b8871044e720.pdf. Some additional details on the Dynamic CPA analysis are contained in "Proposed Modifications to Methodology for Competitive Path

Path Assessment."[6] Possible revisions of the ISO LMPM and CPA procedures along with preliminary versions of these proposals were discussed at MSC meetings on Oct. 15, 2009, Jan. 22, March 19, June 4, and Oct. 8, 2010, and April 29, 2011.[7] We have also submitted a report requested by FERC on the performance of the LMPM mechanism during the first year of the new Market Redesign and Technology Upgrade (MRTU) market in May of 2010.[8] In that report, we concluded that the LMPM mechanism was working satisfactorily, and that no changes were called for at that time. However, we cautioned that although the competitiveness of the market was very high in the first year, that period was characterized by relatively low loads and little transmission congestion. In addition, we stated that too much reliance over the long-term upon cost-based DEBs can weaken incentives for reducing costs, so it remained important for the CAISO to continue to improve the precision of the timing of its mitigation. Our May, 2010 report was followed by a majority written opinion of the MSC on June 17, 2011 concerning modifications to the LMPM system proposed by the California ISO in which CPA would be changed to a system based on path designations based on dynamic conditions, rather than static quarterly analyses.[9] Most recently, in December 2012 we issued an Opinion on the California ISO's proposed change to the LMPM system to determine mitigation in the occasional situations in which the CPA analysis fails to run.[10]

The market power mitigation provisions in the California ISO tariff are based upon the principle that, system wide, the market is large enough and includes enough competitors to provide reasonable, competitive outcomes. Although even large geographic markets can be subject to the exercise of market power, experience has shown that a regional market with many actual and potential suppliers and robust forward contracting can produce competitive prices and supply.

Designations for Local Market Power Mitigation," Department of Market Monitoring, March 18, 2011, www.caiso.com/2b45/2b45e56d50fb0.pdf.

[6] "Revised Draft Final Proposal - Dynamic Competitive Path Assessment", California ISO, July 5, 2011, www.caiso.com/Documents/RevisedDraftFinalProposal-DynamicCompetitivePathAssessment.pdf

[7] www.caiso.com/271f/271f93564bde0.html

[8] F.A. Wolak, J. Bushnell, and B.F. Hobbs, "Report on the Performance of the California ISO's Local Market, Power Mitigation Mechanism During the First Year", Market Surveillance Committee of the California ISO, May 28, 2010, Submitted to the Federal Energy Regulatory Commission, www.caiso.com/27a4/27a4df0514630.pdf. An additional conclusion was that although there is significant promise in basing a LMPM mechanism on residual demand curves facing individual generators or collection of generators, further analysis would be needed of its effectiveness and practicality before it could be recommended as a basis for a LMPM mechanism.

[9] Market Surveillance Committee of the California ISO, "Opinion on Local Market Power Mitigation and Dynamic Competitive Path Assessment", July 1, 2011, www.caiso.com/Documents/110713Decision_LocalMarketPowerMitigationEnhancements-MSC%20Opinion.pdf.

[10] Market Surveillance Committee of the California ISO, "Opinion on Mitigation Measures for Exceptional Dispatch in Real-Time", Dec. 5, 2012, www.caiso.com/Documents/FinalOpinion-ExceptionalDispatchMitigation-Real-Time.pdf. The ISO's proposed changes were submitted as "Stage Two Amendments to Local Market Power Mitigation and Default Competitive Path Assessment Tariff Provisions," FERC Docket ER13- 967-000, February 21, 2013.

However, if the market is fragmented by binding transmission constraints, suppliers within the resulting sub-markets can have an unacceptable degree of local market power. There are several ways in which transmission constraints can bestow market power, the most obvious of which is when generation ownership in a transmission-constrained “load pocket” is concentrated and transmission limits the amount of imports from other suppliers.[11] This local market power can be more than a transient phenomenon if it is difficult or impossible to site new generation in the load pocket. However, even if such market power is temporary, it can result in significant unjustified transfers from consumers to producers and should be mitigated to prevent such transfers. Potentially high degree of market power created by transmission constraints may result in high prices (as high as 20 times the normal prices). When combined with a lack of forward contracting by either consumers or load serving entities in retail access electricity markets, such market power may have severe adverse impact even if it is a few days in duration and can warrant more active and extensive forms of regulation than are normally applied in other markets. This regulation can in some circumstances include the “mitigation” or adjustment of supplier offers to levels estimated to reflect competitive offers.

All ISO coordinated spot electricity markets in the U.S. feature some form of local market power mitigation. Each features three broad steps to the mitigation process. First, conditions that define a market as ‘local’ are established. Second, estimated competitive offer prices are determined for some or all suppliers within the local market. The third step is to define conditions under which the ISO or market monitor mitigates the offers of some or all suppliers to the estimated competitive level.

However, there are two distinct prevailing approaches to implementing market power mitigation. One approach, known as “conduct and impact,” mitigates generator offer prices based on bidding behavior and its impact on prices within predefined market regions. The alternative approach adopted by the California ISO, known as “structure-based mitigation”, is to mitigate generator offer prices when market conditions (defined considering the competitiveness of supply to relieve congestion on individual paths or transmission constraints) could enable generators to exercise market power regardless of whether they actually do so. Thus, the two approaches differ as to whether the focus is on prices, which might be impacted by a number of transmission constraints, (conduct-and-impact) or on the competitiveness of individual transmission constraints (structure-based). We will discuss the differences between the two approaches in greater detail in Section 2 below, however it is important to note that both approaches have been approved by FERC in different ISOs and hence they are *de facto* deemed to meet the “just and reasonable” criteria of Section 205 of the Federal Power Act. Our discussion in this report will focus primarily on the structure-based mitigation adopted by the California ISO in its LMPM mechanism

[11] Market power in networks can, in theory, be exercised in other ways as well. Examples include: generators in generation pockets restricting output to decongest export lines so that the local price will be the same as the system-wide price (S. Oren, *Energy Journal*, Vol. 18, No.1 (1997) pp. 63-83.); deliberate expansion of output of one plant to cause congestion that benefits another plant owned by the same firm elsewhere in the network (J. Cardell et al, *Resource and Energy Economics* Vol. 19, Issues 1–2, March 1997, pp. 109–137); and manipulation of phase shifters or other FACTS devices to the detriment of rival firms (R. Baldick and E. Kahn, *IEEE Transactions on Power Systems*, Vol. 12, No. 2, May 1997, pp. 749-755). However, market power potentially exercised by generators within load pockets is the major concern of local market power mitigation procedures.

and in particular on the narrow issue of the adequacy of the joint three pivotal supplier screen as a structure-based mitigation approach.

Under the market design adopted in California as part of the MRTU, the approach to the local market power mitigation process has been to identify specific transmission constraints that potentially present opportunities for the exercise of unacceptable levels of local market power. These constraints are termed non-competitive. Other constraints, while potentially binding, can be relieved by the output of a sufficiently broad set of potential providers of supply to the impacted region whose offers remain competitive even when the constraints are binding. Such constraints are termed competitive.

The main test of the competitiveness of constraints in the MRTU LMPM design focuses on the presence of market concentration in the available supply of counterflow; in particular, if withdrawal of such supply by three generation companies would result in violation of the constraint, then it is considered non-competitive ("three pivotal supplier test"). One goal of the MRTU LMPM design was to avoid modifying market participant's bids, even if such bids are well in excess of estimated cost, unless they potentially reflect the exercise of market power arising from binding non-competitive transmission constraints. In this way, market processes would determine supply offers except at times and in regions in which there is an unacceptably high potential for the exercise of local market power. On the other hand, when binding non-competitive transmission constraints create opportunities for the exercise of market power, all generation units that could relieve the constraint are subject to bid mitigation regardless of their behavior or their competitive significance. Specifically, if their bids are above their "default energy bid" (DEB) (defined as 110% of their estimated variable cost), then their offer prices are reduced to their DEB.

While this philosophy of local market power mitigation is relatively simple, its implementation can be complex. The determination of which transmission constraints are sufficiently competitive such that no offer price mitigation is necessary and which are instead potentially non-competitive involves the application of rough heuristics based, if possible, upon empirical estimates of bidding behavior in the presence of transmission constraints. The competitiveness of transmission paths, as well as the identity of the binding transmission constraints, can change rapidly as a result of generation and transmission outages, the evolution of load, and other changes in system conditions. Lastly, the competitiveness of transmission constraints can be impacted by other constraints such as limitations on generator ramp rates.

In its approval of the LMPM mechanism proposed by the California ISO as part of the MRTU, FERC ordered the ISO to revise its design so as to properly take account of convergence bidding and other forms of demand bids in the day-ahead market mitigation process (as opposed to basing LMPM on forecasted load).[12] The current version of the LMPM mechanism implementing the Dynamic CPA was motivated by the need to address the FERC order. Nevertheless the current LMPM design is still based on the joint three pivotal supplier screen. In its orders approving the MRTU, FERC expressed concern about whether the three pivotal supplier screen might be

[12] *California Independent System Operator Corp.*, 116 FERC ¶ 61,274 (2006) (MRTU Order), *order on reh'g*, 119 FERC ¶ 61,076 (2007).

overly stringent.[13] This concern was stated again in FERC's order concerning the revised LMPM procedures.[14] Specifically the FERC order requested that the Market Surveillance Committee assess the appropriateness of basing the screen on a three pivotal supplier test and whether an alternative competitive screen to identify market power opportunities for generation in load pockets is necessary. Hence, most of our discussion that follows will focus on the question of whether alternative pivotal supplier tests, namely two and four pivotal supplier tests, might represent a more appropriate balance of the costs of over- and under-mitigation.

The remainder of this report is structured as follows. In the next section, we summarize the fundamental differences between mitigation based on structure (as in the California ISO LMPM system) and those based on conduct-and-impact tests. Then in Section 3, we describe some broad considerations relevant to assessing the relative risks and costs associated with over- and under-mitigation (false positives and negatives, respectively). In Section 4, we turn to a discussion of pivotal supplier tests as used to assess the competitiveness of individual constraints, and summarize our approach to analyzing bidding behavior in the California market. Section 5 presents the approach we took to analyzing recent bidding behavior under the CAISO day-ahead LMPM system. Four separate set of analyses are undertaken, whose results are briefly summarized in the Summary and Conclusions section, *infra.*.

2. Structure-based Mitigation vs. Conduct-and-Impact-based Mitigation[15]

A "structure-based approach" to market power mitigation assesses the prospect for market power abuse by analyzing the structure (*e.g.*, concentration) of supply. Examples include the Hirschman-Herfindahl index (HHI) of market concentration or residual supply indices (RSI), which can be applied to supply within defined market areas or, in the case of LMPM, the supply of congestion relief counterflow available on specific transmission constraints. On the other hand, the "conduct-and-impact approach" analyzes suppliers' specific conduct (*e.g.*, bid prices) and their potential market impact (*e.g.*, impact on market clearing prices) within predefined market regions, without regard to which specific constraints are binding. Both of these approaches are

[13] *California Independent System Operator Corp.*, 116 FERC ¶ 61,274 (2006) (MRTU Order), *order on reh'g*, 119 FERC ¶ 61,076 (2007), p. 1032.

[14] "We find that a market screen that was necessary and appropriate under the existing system may turn out to be overly restrictive in the context of the enhanced, more accurate mitigation provisions" (138 FERC ¶ 61,154, Issued March 1, 2012, *op. cit.*, p. 37).

[15] See Report of PJM Interconnection, LLC, Docket Nos EL08-34-000 and EL-08-47-000, September 5, 2008; 2007 State of the Market Report, Appendix L; H. Ni, "Look-Ahead UDS and Three-Pivotal Supplier Analysis,' February 6, 2008; H. Hass and P. Scheidecker, "Three Pivotal Supplier Test: Theory and Application, August 20, 2007; Comments of the Independent Market Monitor of PJM, Docket EL08-47-000,October 6, 2008; PJM Reply comments; Reply Comments of the Independent Market Monitor for PJM, Docket No. EL08-47-000, November 5, 2008; Reply Comments of PJM Interconnection LLC, Docket EL08-47-000, November 5, 2008; Monitoring Analytics, 2010 State of the Market Report for PJM: Technical Reference for PJM markets," March 10, 2011, pp. 40-49. See also, The Brattle Group "Review of PJM's Market Power Mitigation Practices in Comparison to Other Organized Electricity Markets" September 14, 2007.

used in RTO-based electricity markets as a basis for imposing *ex ante* mitigation through automated mitigation processes. Each approach has its advantages and disadvantages, and each has its own data requirements. Depending on the details of their implementation, both approaches can produce false positives or false negatives in the process of addressing market power abuse. Evaluating the effectiveness and reliability of specific mitigation approaches is an elusive task given the enormous amount of data and complexity of the electric power system.

2.1 Structure-Based Tests

One approach to assessing actual or prospective market power is to rely on "structure-based tests." Structure-based tests (such as the HHI) examine the concentration of effective suppliers, sometimes relative to demand levels, in order to form a hypothesis concerning sellers' market power.
While such tests provide only an indirect means of assessing the potential for market power abuse, they can be applied readily in *ex ante* mitigation processes, and the data needs to implement them can be less demanding relative to other alternatives.

One particular structural issue affecting electric power markets is the potential for pivotal suppliers. By definition a supplier is pivotal if demand cannot be met without including its output in supply because of capacity limitations or transmission constraints affecting the supply offered by other market participants. With a highly inelastic short-run demand for electric power (*i.e.*, highly price-insensitive), there is a potential for a pivotal supplier to profitably exercise substantial market power. Even if a supplier or a group of suppliers are not pivotal , the supply conditions in electric power markets may be such that individual firms may perceive that the quantity of "residual demand" for their output is relatively insensitive with respect to their offer price within some range. The existence of such an inelastic residual demand can provide an incentive for suppliers to withhold output by raising the prices at which they are willing to sell power or through physical withholding of supply, whether through outages, deratings or other strategies. Both PJM and CAISO use a variant of a "joint pivotal supplier" test as the primary screen for *ex ante* market power mitigation. In California, as we describe in more detail below, individual paths are first screened for competitiveness. If a path fails the three pivotal supplier test, then if the sum of a generator's potential impacts on all noncompetitive constraints is positive (*i.e.*, it provides counterflow, on net), its bids are subject to mitigation to its default energy bid (DEB). The measure of impact of a generator on a constraint (in $/MWh) is the product of its shift factor and the constraint shadow price in the initial market run.[16] It is not necessary for a generator to be one of the three pivotal suppliers for a congested constraint in order to be subjected to mitigation, so even a very small generator in the fringe would be mitigated by this process if a constraint it impacts fails the competitiveness test.

[16]Thus, this is a test as to whether the net economic value of counterflow from that generator on noncompetitive paths is positive. Then, in a sense, withdrawal of supply by such a generator would, on net, increase congestion costs on noncompetitive paths. The CAISO system would then subject that generator to mitigation. Clearly, then, this depends on what reference bus (or set of distributed reference buses) is assumed in determining the shift factors used in the calculations, an important issue we have discussed in our earlier opinions on LMPM, *op. cit.*.

The mechanics of such structural screens can enable them to be relatively simple to implement and quick to compute. Of course, the flip side of this simplicity is that important complexities may be disregarded (such as the limited competitive restraint provided by offers from high cost fringe suppliers or the role of unit commitment costs in limiting the competitive restraint provided by fringe suppliers). Also, both basic approaches require estimates of actual costs (default energy bids, in CAISO parlance), which are subject to a number of ambiguities and uncertainties that we discuss later.

A disadvantage of structure-based approaches is the difficulty of devising screens and thresholds that are able to identify the likely exercise of unilateral and multilateral market power within relevant markets. Consequently, while the choice and specific implementation of a structural screen might appear to be relatively simple and less controversial than choosing explicit conduct and impact thresholds, there are substantial uncertainties about the ultimate reliability of a structure-based mitigation process that can lead to both under- and over-mitigation. In the context of markets for "congestion relief" on individual transmission constraints, a screen's ability to reliably reflect suppliers' actual incentive to exercise market power is uncertain. For example, a supplier's ability and incentive to exercise market power may depend on its load obligation, the extent of vertical integration, the type of regulatory constraints (*e.g.,* cost-of-service regulation of vertically integrated utilities), the costs of competitors, unit commitment costs, the predictability of congestion on the relevant transmission constraint or constraints, as well as the extent to which the pricing and availability of resources is constrained by long-term contracts.

As discussed in the MSC 2010 report to FERC, [17] the residual demand curve of an individual firm, defined as the total market demand less the supply (or capacity) offered by rival producers at a given price considering all transmission constraints, could potentially provide a better measure of the potential for the unilateral or multilateral exercise of market power than a structure-based approach based on competitive paths. This is because it could in principle be used to calculate whether a significant increase in bids above the estimated marginal cost would increase revenue and profits at a particular demand level, given the units commitment by rival producers and (if the firm's costs are known) profit. However, in our earlier report, we concluded that calculating such residual demand curves in a congested electricity network for each interval for each supplier who could potentially exercise market power is unlikely to be a practical basis for LMPM mechanisms at this time.[18]

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[17] *Op. cit.,* Footnote 8. As examples of proposed uses of transmission-constrained residual demand curves to assess local market power, see L. Xu and R. Baldick, "Transmission-constrained Residual Demand Derivative in Electricity Markets," *IEEE Transactions on Power Systems*, 22(4):1563-1573, 2007; Y.-Y. Lee, R. Baldick, and J. Hur, "Firm-based Measurements of Market Power in Transmission-Constrained Electricity Markets," *IEEE Transactions on Power Systems*, 26(4):1962-1970, 2011; and H.S. Oh and R.J. Thomas, "Estimation of a Sensitivity-Based Metric for Detecting Market Power," *Journal of Energy Engineering*, 136(2), 32–41, 2010. Note, however, that these proposals have not considered unit commitment costs and, in some cases, consider marginal incentives to exercise market power rather than the ability to materially raise prices.

[18] Further, examining the slope of the residual demand curves is not sufficient to determine whether market power has actually been exercised, which like the structural and conduct-and-impact tests would require consideration of conduct (the actual bids relative to costs) as well.

Using screens based on the number of joint pivotal suppliers is appropriately viewed as being a crude approximation of an ideal residual demand – based screen. For instance, a residual demand curve considers the level of offers of all suppliers, while the residual supply index counts as fringe "supply" any offer, no matter how low or high its cost.[19] Also, the residual demand approach could in principle be applied to consider the simultaneous effect of all transmission constraints, while RSI-based screens of path competitiveness consider only one constraint at a time. The fact that structural screens focus on a supplier's ability, rather than its incentive, to individually (or collectively with other suppliers) exercise market power under a market environment that does not consider fully suppliers' supply obligations and contracts, pricing, constraints, or actual competitive interaction, reduces the reliability of the structure-based screening process.

2.2 Conduct-and-Impact Tests

The second common approach to identifying market power in LMPM mechanisms is to directly assess the impact of supplier conduct on market prices within a predefined market region, such as bidding above cost or engaging in physical or economic withholding of output. In theory, the exercise of market power by a firm can be observed directly by comparing the price level determined by the actual offers with a benchmark price level calculated substituting cost-based offers for that firm in the market calculations.

This approach allows the regulator to specify thresholds in the form of the price-cost markup threshold and market price impact threshold that are together are unacceptable and should trigger mitigation. The conduct of individual market participants is evaluated prior to determining the market-clearing prices and schedules. Several RTOs (*e.g.*, the Midwest ISO, New York ISO, and ISO New England) have used screens for specific conduct (*e.g.*, output withholding or bidding in excess of costs). If the conduct threshold is violated by a participant, the market price impact of supplier conduct is assessed by comparing outcomes from running the market software with the original bids with bids based on estimated costs for that participant. If the market impact (measured by some function of market prices) is above the impact threshold, market participant bids are mitigated to a reference level, similar to the California ISO's DEBs, and the market software is then run with the mitigated bids to determine schedules and settlement prices.

The main advantages of the conduct-and-impact type of mitigation are that this mitigation approach 1) explicitly takes account of the effectiveness of competition provided by alternative suppliers, based on their actual bids and offers, including unit commitment costs; 2) takes account of the impact on competition of all binding transmission constraints as well as other operational constraints, and 3) explicitly identifies and mitigates the exercise of market power based on *explicit* bid and market impact thresholds. In addition, simple price-based bid and price impact thresholds that trigger mitigation generally also yield a mitigation process that is relatively transparent to market participants and the process lends itself to relatively easy *ex post* analysis

[19] Both residual demand curve and RSI methods disregard unit commitment costs associated with supply from other producers, unlike the conduct-and-impact test. If these are not taken into account in analyzing competition, a constraint could be found to be competitive when in fact the fringe competitors would not be committed unless prices rose substantially.

that can facilitate refinements. By focusing on actual market impacts, conduct-and-impact-based mitigation can effectively addresses unilateral exercise of market power.

Conduct-and-impact-based mitigation would be ineffective, however, if the impact thresholds set by regulators are too high, allowing significant exercise of market power. This is not a flaw of the fundamental approach, but rather an issue of regulator judgment. Even if the thresholds are relatively tight, however, the approach's use of a bright line for impact that may make it easier for market participants to unilaterally or through coordinated behavior exercise market power while staying just below the impact thresholds that would trigger mitigation. Of course, both the structure-based and conduct-and-impact approaches establish a bright line in terms of conduct (in the case of structural approaches, the DEB).

In summary both the structure- and conduct-and-impact-based approaches have pros and cons but in both cases the details of implementation have a critical impact, with the risk of over- or under-mitigation hinging both on the specific thresholds and screens and on the design of the tests. Consequently, several ISOs including NYSO, ISO-NE, MISO, and pre-MRTU CAISO have adopted conduct-and-impact tests whereas, PJM, post-MRTU CAISO, and ERCOT have adopted a constraint-specific structure-based approach to market power mitigation. By accommodating both approaches, FERC has *de facto* recognized that at least in principle both approaches meet the "just and reasonable" criterion of section 205 under the FPA which, as pointed out in the FERC order of March 1, 2012[20] does not require that a proposed tariff that meets the above criteria be compared to other alternatives that also meet the criteria.

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3. Balancing the Risks of Over- and Under-Mitigation under the Current California ISO LMPM Mechanisms.

A key question to ask in evaluating a market-power mitigation mechanism is whether its effectiveness in enhancing competition produces efficiency benefits that exceed the potential costs and burdens of additional regulation, including the efficiency losses of possible over-mitigation.

The main concern expressed in the FERC orders of March 1, 2012 with regard to the revised California ISO LMPM mechanisms and the dynamic CPA design has been with regard to the three joint pivotal supplier screen which some petitioners argued could result in over-mitigation. This issue has been addressed by the MSC in its 2010 report to FERC[21] where it was argued that over-mitigation is not possible if default energy bids are equal to or above actual marginal costs. Mitigating bids down to actual marginal cost cannot worsen market efficiency, in the absence of second-best considerations that would somehow mean that higher bids would yield more efficient short- or long-run outcomes.[22] However, actual marginal cost can be difficult to accurately measure, particularly in the time frame in which electricity markets operate.

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[20] *Op. cit.*, Footnote 1 (see page 7, paragraph 20).

[21] *Op. cit.*, Footnote 8.

[22] For instance, if there is no scarcity pricing, as was formerly the case in many RTO markets, then bidding above variable cost may be necessary to secure a return to capital investment for peaking facilities. However, with appropriate scarcity pricing, this is not necessary, as scarcity prices can in theory provide

It is important to emphasize that the failure of spot energy prices to provide a sufficient margin to cover fixed operating costs and return on and of investment is not evidence of over-mitigation. The correct price signal in short-run markets is generally short-run marginal cost.[23] Whether energy prices alone provide the necessary margin to support needed investment or must be supplemented by some form of capacity payments or out of market contracts is a matter of market design. Only a few North American electricity markets are designed so that energy prices alone will support investment in new capacity.

With the very important exception of limited-energy and limited-start units, the California ISO's current market LMPM mechanism constructs the cost-based DEB for gas fired generation unit owners in a manner will generally, but not always, equal or exceed competitive offer prices.[24] First, the process used to compute a mitigated supplier's variable cost is based on technical specifications and cost information submitted to the California ISO by the market participant. Participants can also seek to establish a negotiated default energy bid that reflects marginal operating or opportunity costs. Second, a 10 percent adder is applied to this variable cost estimate to produce the DEB.

However, where constraints of various types limit the amount of energy or number of starts over some period of time, and such constraints are likely to be binding, opportunity costs arise that make the actual cost of operations greater than just the short-run variable costs. These constraints can arise for a number of reasons, including water and other fuel limitations, environmental rules that constrain hours of operation, number of starts, or tonnage of emissions, and maintenance requirements. The magnitude of opportunity costs due to such limits can be diffi-

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gross margins to all facilities that provide the correct investment incentives. See, *e.g.*, F. Schweppe et al., *Spot Pricing for Electricity*, Kluwer Academic Publishers, 1988; W.W. Hogan, "On an 'Energy Only' Electricity Market Design for Resource Adequacy," Working Paper, Harvard University, September 23, 2005; W.W. Hogan, "Electricity Scarcity Pricing Through Operating Reserves," Working Paper, Draft, April 25, 2013, www.hks.harvard.edu/fs/whogan/Hogan_ORDC_042513.pdf.

[23] Of course, the presence of lumpy unit commitment costs and other short-run nonconvexities complicate this argument. We also note that the failure of energy and ancillary services markets to provide sufficient margin to new generation can be an indication of market failure when such generation is immediately needed and is the least-cost way to meet load requirements; this is a major rationale for resource adequacy requirements and capacity markets. However, variable costs, including a scarcity component when appropriate, should still be the basis of short-run prices.

[24] We note however that use of gas prices from a day or more before bidding can result in inaccuracies, and indeed as prices can even vary within the day due to the nomination process and other reasons. Other ISOs adjust gas prices in the mitigation process to reflect last minute variations. See, *e.g.*, Potomac Economics, *2012 State of the Market Report for the New York ISO Markets*, April 2013, pp. 20-21; ISO New England, "Winter Operations Summary: January-February 2013," February 27, 2013, www.iso-ne.com/committees/comm_wkgrps/strategic_planning_discussion/materials/winter_operations_summary_2013_feb_%2027_draft_for_discussion.pdf; ISO New England, "Addressing Gas Dependence," July 2012, www.iso-ne.com/committees/comm_wkgrps/strategic_planning_discussion/materials/natural-gas-white-paper-draft-july-2012.pdf. We have not examined short-run gas price variations to determine whether they are large enough to approach the 10% head room allowed in the definition of default energy bids (which are set at 110% of estimated variable cost).

cult to estimate because they depend on the probability distribution of energy and ancillary services prices at times when the limited energy or starts might otherwise be used. As another example, opportunity costs for units that provide cogeneration can also be large, if heat supplied to a process must be reduced to boost power production.[25] Finally, when the gas pipeline system is constrained, it is also important from both a market efficiency and reliability standpoint that day-ahead offer prices reflect current spot gas prices and that real-time offer prices reflect current intra-day gas prices. If the actual marginal costs of some mitigated units are underestimated to the extent that DEBs (set to 110% of estimated marginal cost) are significantly below actual costs, then over-mitigation is a risk. In particular, economic efficiency can be damaged either by over-utilizing mitigated units with limited starts or energy, which then could be unavailable at later times when power is more valuable, or by substituting the mitigated unit's output for resources (either generation or demand-side) that are actually less expensive.

Thus, when considering whether a two pivotal supplier test should be substituted for the CAISO's present three pivotal supplier test, there should be, in theory, a balancing of the risks and costs of under-mitigation versus over-mitigation. Unfortunately, as we explain below, the impacts upon the exercise of market power of changing the test are difficult to ascertain, as are the likely impacts on the costs of possible over-mitigation.

4. Two versus Three Pivotal Supplier Tests: Basic Considerations

There are two types of rationales for applying a pivotal suppliers test as a test of structural market power. First, a pivotal supplier test accounts for the possibility that it can be profitable in electricity markets for a supplier to raise its offer price to a level that causes prices to rise to an extremely high level relative to its incremental costs, even if the market is relatively unconcentrated and the supplier loses most of its sales. Second, even if it is not profitable for a supplier to forgo a huge proportion of its sales to raise prices to the cap, a supplier that is individually pivotal but faces competition from a high-cost competitive fringe can find it profitable to raise prices to the relatively high prices offered by that fringe. The Ontario IESO applies such a single pivotal supplier test. In both cases, the pivotal supplier loses sales but is more than compensated by the fact that prices rise sufficiently above their marginal cost to increase profit.

The California ISO and PJM both apply a three pivotal supplier test, considering whether the market has enough supply so that even if the three largest suppliers in a market withdraw their capacity, transmission constraints can still be met. There are some factors that tend to make a three supplier test highly conservative, but other factors may cause the more lenient two supplier test to miss situations in which there exists significant market power.

As pointed out above, all versions of a pivotal supplier measure are attempting to approximate the central fundamental condition of a local market, the supply elasticity (or price responsiveness) of the residual demand faced by any individual supplier. When a given supplier expects

[25] Generators with significant opportunity costs and major maintenance and risk adders can apply on a case-by-case basis for alternative, higher DEBs that are reviewed by Potomac Economics. However, such a process, by its nature, is nontransparent and is challenging to apply consistently.

that their competitors cannot or will not expand their own output in response to a high offer-price, then that single supplier faces relatively inelastic residual demand. They can raise prices with reasonable confidence that it will not result in a substantial reduction in sales. Clearly if a single firm is pivotal in serving some portion of the market, then at least that portion of demand will be very inelastic and can effectively be monopolized by that firm. Even if a firm is not, by itself, pivotal, it may expect other firms to behave in a less than perfectly competitive way and still find it profitable to raise prices. The key point is if the remaining amount that is pivotal is very small, then the reduction in sales required to raise prices can be so large as to make any attempt to do so unprofitable. The key trade-off is therefore the anticipated reduction in sales against the expected increase in price. Pivotal supplier measures can detect conditions in which this trade-off may favor exercising market power, but they are not perfect measures of this underlying elasticity.

Three supplier tests can be overly conservative for at least two reasons. First, if all suppliers in a market have similar costs of providing counterflow on a given constraint, a three pivotal supplier test would be extremely stringent. This because it suggests a potential for the exercise of market power even in situations in which the fringe has enough capacity to completely replace the output of the two largest suppliers and most of the output of the third largest suppliers. In other words, the underlying residual demand is in fact quite elastic, or price-responsive. Hence suppliers will only be able to pass a three pivotal supplier test when there is an extremely large amount of surplus supply. Moreover, these pivotal supplier tests generally take imperfect account of forward contracts and other supply obligations that would make it unprofitable for the affected suppliers to withhold output. This is because in the short run, revenues cannot be increased on sales of power output that is forward contracted at fixed or indexed prices.

Exercise of local market power by suppliers failing a three pivotal supplier test but passing a two pivotal supplier test would be even more unlikely if the relevant transmission constraint bound only sporadically during conditions that were difficult or impossible for market participants to predict, so that the successful exercise of local market power would require withholding supply during many hours when the resource lacked local market power.

However, these considerations do not lead us to conclude that a three pivotal supplier test is necessarily overly conservative compared to the two pivotal supplier test. There are at least three points to make in this regard. First, in practice, all suppliers generally do not have the same cost of providing counterflow on a given constraint and no workable method exists to accurately account for these cost differences in applying pivotal supplier tests. Suppliers can be costly sources of counterflow not only if they have high energy offer prices but also because they have a relatively low impact on the constraint. Moreover, fringe suppliers with competitive incremental energy costs will not effectively constrain prices in day-ahead markets if they have high commitment costs. Hence, there is a potential for suppliers that pass a two pivotal supplier test that does not consider the cost-effectiveness of competition to possess material local market power because a significant portion of the fringe supply is a high cost source of counterflow.

Second, because pivotal supplier tests are applied to individual constraints, there is a potential for competitition to be less effective than suggested by the result of a pivotal supplier test because some of the counterflow potentially available from fringe suppliers to reduce congestion on a particular constraint cannot be dispatched because the output of the fringe is limited by another transmission constraint.[26]

Third, although it might be preferable from a theoretical standpoint to apply a single or two pivotal supplier test together with another test that evaluates the potential for the joint exercise of market power, it is not workable to apply multiple tests within the timeframes of the day-ahead market or the real-time dispatch. It is possible that a three pivotal supplier test might provide a better test for coordinated conduct than a two pivotal supplier test, although we are not aware of any empirical analysis supporting this conclusion.

In summary, pivotal suppler tests, as they can currently be practically implemented, do not properly account for the ability in several circumstances to raise prices even when a firm is not fully pivotal. This can be due to a high-cost fringe, or the ability of firms to profitably raise prices in an oligopoly fashion. The greater restrictiveness of a three pivotal supplier test is therefore directionally appropriate for compensating for this short-coming of pivotal supplier tests. However, we have not been able to carry out any analysis that would allow us to definitively conclude whether the adjustment provided by using a three pivotal supplier test instead of a two pivotal supplier test is typically too large or too small to compensate for the failures to consider fringe supplier costs.

Therefore, for these reasons we conclude that while the use of a three pivotal supplier test to evaluate the potential for the collective exercise of market power is not ideal, it could provide a reasonable balance. Hence, even if there is not a strong theoretical basis for building local market power mitigation around a three pivotal supplier test versus a two pivotal supplier test, such a test might be found to be a reasonable approach because of the imperfect way in which a pivotal supplier test must be applied in practice. Hence, there is a need for careful analyses of the practical importance of these considerations.

5. Approaches to Analysis of Bidding Behavior Under Different Competitive Conditions

With these considerations in mind we sought the assistance of the California ISO Department of Market Monitoring in developing data and carrying out empirical analyses that would shed some light on the relative merits of a two, three, or four pivotal supplier test. (For brevity, we refer to these below as the 2PS, 3PS, and 4PS tests, respectively.) We summarize four separate analyses below:

1. Comparisons of general bidding behavior of suppliers providing counterflow on congested paths under varying degrees of supplier concentration (as measured by the 2PS, 3PS, and 4PS tests) (Section 5.1);
2. Relationship between bidding less than the DEB and passing/failing pivotal supplier tests on particular paths (Section 5.2);

[26]This might be the case, for example, if some the fringe supply were located within a binding generation pocket.

3. Relationship between frequency that a unit impacts uncompetitive paths and bidding behavior (Section 5.3); and
4. Frequency of mitigation of above-DEB bids under alternative standards (Section 5.4).

5.1 Relationships between Path Pivotal Supplier Test Levels and Bidding Behavior

We initially proposed to compare the extent to which suppliers who pass the different tests submit offers that exceed the DMM competitive benchmark, the default energy bid.[27] The rationale for this comparison is that although the DEB does not always accurately measure resource costs, we would not normally expect there to be a correlation between suppliers whose costs are mismeasured and those that fail a 2PS, 3PS, or 4PS test. Hence, if we observe that there is a significant increase in the proportion of offers materially exceeding the DEB by suppliers failing a 3PS test relative to a 4PS test, or a 2PS test relative to a 3PS test, this change in bidding behavior might suggest an appropriate threshold for applying mitigation.

Importantly, this test distinguishes between firms who contribute a large amount of counterflow supply (*i.e.*, are one of the three largest potential contributors of counterflow to a congested non-competitive constraint) from other, smaller firms whose offer prices would nevertheless likely be subjected to mitigation under the CAISO LMPM mechanism. Combining bid data from all firms subjected to mitigation would treat identically the offers of fringe and pivotal suppliers who could have different bidding incentives. This might obscure the bidding behavior of the large suppliers that potentially possess market power.

To this end, in response to our request, DMM has aggregated the market bids of participating units into five broad categories ranging from slightly below the DEB (<0.9DEB, approximately equal to the estimate of variable cost) to well above (> 1.2DEB). The DMM also evaluated the relative competitive ranking of all congested flowgates during the period of August through December of 2012. In addition to statistics on whether a "path" (which could be a path, nomogram, or single line) passed or failed a competitive assessment at the 3PS level, they provided us with a count of hours each month that each flow-gate would have failed at the 2PS level and a 4PS level. Table 1 summarizes the flow-gates that were most frequently deemed uncompetitive (as a percentage of their hours of congestion) during this five month span.

[27] Recall that the pivotal supplier test is not directly used to determine if a generator is mitigated; rather the test is applied directly to paths instead. The test is used to decide if a path is noncompetitive. A subsequent aggregation of the shadow prices for noncompetitive constraints weighted by the relevant shift factors is the basis for deciding if mitigation is to be applied to a particular resource.

Table 1. Most Frequent Uncompetitive Paths, August-December 2012

Flow Gate Name	Total Hours of Congestion	Hours Failing 2PS Test	Hours Failing 3PS Test	Hours Failing 4PS Test
22342_HDWSH_500_22536_N.GILA_500_BR_1_1	455	447	453	455
22569_NCMTGTAP_138_22264_ESCNDO50_138_BR_1_1	201	192	192	192
24301_BIGCRK1_230_24235_RECTOR_230_BR_1_1	19	19	19	19
33514_MANTECA_115_33526_KASSONJ1_115_BR_1_1	19	19	19	19
33541_AEC_TP1_115_33540_TESLA_115_BR_1_1	13	13	13	13
33542_LEPRINO_115_33546_TRACYJC_115_BR_1_1	44	44	44	44
33543_AEC_TP2_115_33540_TESLA_115_BR_1_1	29	29	29	29
34112_EXCHEQUR_115_34116_LEGRAND_115_BR_1_1	39	39	39	39
37650_TESLATP_115_33544_ELLSGTY_115_BR_1_1	29	29	29	29
SLIC2025712DRUM-RIOOSO_2FL1	12	12	12	12
T-165SOL-12_NG_SUM	70	68	68	68
T-167SOL1_NG_SUM	51	51	51	51

Table 2 lists the six flow-gates for which a 2PS standard would have yielded at least 10 fewer hours of non-competitive designation compared to the present 3PS test.[28]

Table 2. Paths for which a 2PS Test would Result in a Reduction of 10 or More Hours of Non-Competitive Designation, August-December 2012

Flow Gate Name	Total Hours of Congestion	Hours Failing 2PS Test	Hours Failing 3PS Test	Hours Failing 4PS Test
SCE_PCT_IMP_BG	948	0	19	50
7830_SXCYN_CHILLS_NG	546	262	275	351
BARRE-LEWIS_NG	373	72	146	149
6110_TM_BNK_FLO_TMS_DLO_NG	310	87	99	105
30060_MIDWAY_500_24156_VINCENT_500_BR_1_2	188	42	103	168
SOUTHLUGO_RV_BG	135	41	85	113

Aggregating over all six of these congested flow-gates during the last five months of 2012, we can examine the distribution of market bids, relative to DEB, from units significantly impacting these paths. Figure 1 contrasts the breakdown of bids from the largest three scheduling coordinators on each constraint compared to those offered by fringe schedule coordinators (fourth largest and smaller).

Each color set of bars in this figure is a histogram of the bidding levels for bids during hours from each of last three columns of Table 2. In other words, the blue bars represent the rough distribution of bids for the hours contained in the 2nd column of Table 2, the hours failing a 2PS test, for those unit-segments impacting those lines that fail that test. The red bars are the distribution of bids over the (larger) number of hours in which lines fail the more stringent 3PS test. Note

[28] This is not exactly the same as measuring the decrease in the number of hours in which mitigation would have been applied, since mitigation of a given unit is determined by its relationship to all paths that are declared non-competitive, as described earlier in this section.

that these hours include the hours in the second column. The green bars are for the yet larger number of hours in which those lines fail the 4PS test, the most stringent of the tests. Both unit-segments from "pivotal" (3 largest suppliers) as well as "fringe" (not controlled by one of the three largest suppliers) are represented in Figure 1. Note that in each case, the pivotal group is composed of the three largest suppliers, even when the screen used is 2PS or 4PS. Fringe sellers are in the left-hand panel and pivotal sellers in the right hand panel.

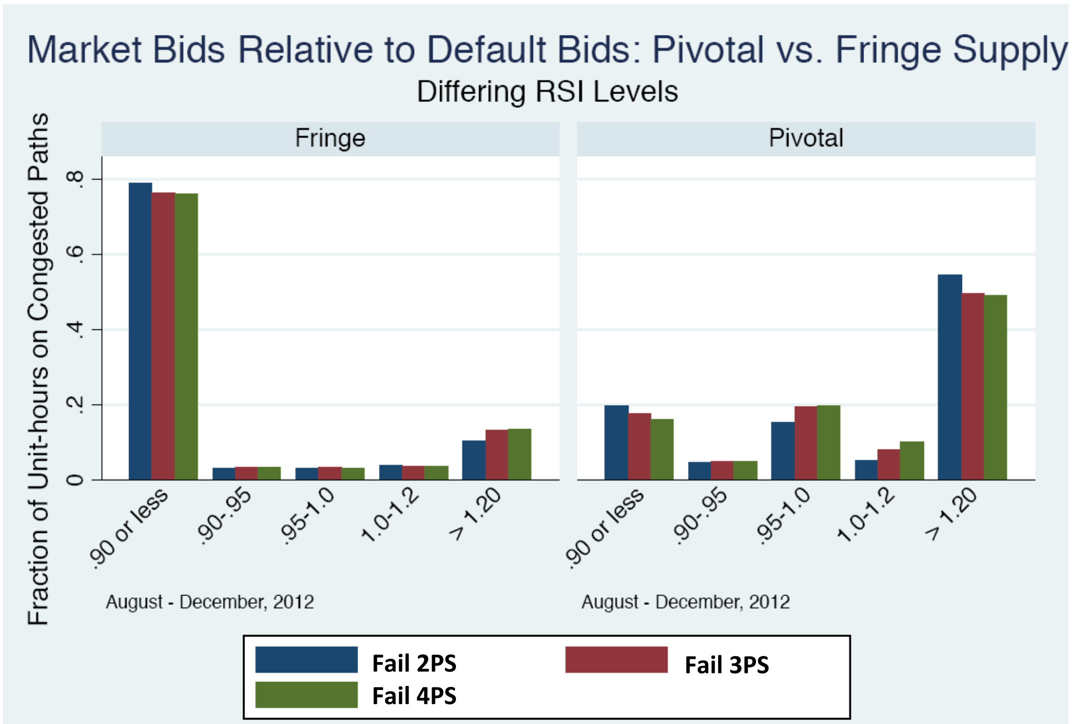

Figure 1. Distribution of Bids on Lines with Varying Pivotal Supplier Test Levels

For both categories of suppliers, there are a substantial number of bids well below the DEB. In fact, for merchant units a very large portion of bid segments are negative. However, there is a clear difference between the fringe group and the pivotal group in the propensity to bid above DEB, in particular the propensity to bid more than 1.2 times DEB, with the firms that are pivotal submitting higher bids much more often than the fringe.

We now examine Figure 1's distribution of bids for unit-segments that impact one or more of the six paths in Table 2 above. These are the paths for which there was the most variation between the 2 and 3 pivotal supplier tests. For pivotal firms, there appears to be a very weak relationship between the propensity to bid above 1.2DEB and the concentration of supply, as measured by whether the 2PS, 3PS, or 4PS tests are failed. Note that each PS category is a subset of the more stringent test in the columns to its right in Table 2. That is, failure of 2PS implies failure of 3PS and 4PS, while failure of 3PS implies failure of 4PS. For unit-hours failing even the least stringent 2PS test, the data shows about a 5 percent higher propensity for unit-segments to bid above 1.2DEB (blue vs. red bar in the right-hand panel of Figure 1) relative to unit-segment hours that fail both the 2PS and 3PS. The lack of more substantial difference in the apparent bidding behavior between units failing a 2, 3 and 4 pivotal supplier test could be because the pivotal group includes the same largest three firms in all three bars, so that may reflect the same firms bidding the same way, perhaps because they cannot predict when they would be pivotal.[29]

We also repeat the same analysis using the *effective MW* bid in each category, instead of just a count of unit-segment bids. The effective MW measure is calculated by taking the MW amount of a bid segment and multiplying it by the shift factor for that unit on a given path. The result is the amount of MW counterflow that bid segment can provide to that path. Figure 2 illustrates the distribution of effective MW for pivotal and fringe suppliers. The results are qualitatively the same, more MW are bid at higher levels for the subset of bids that fail even the most lenient test, but the differences across units impacting constraints that fail a 2, 3 or 4 pivotal supplier test are even smaller than when measured by unit-bids.

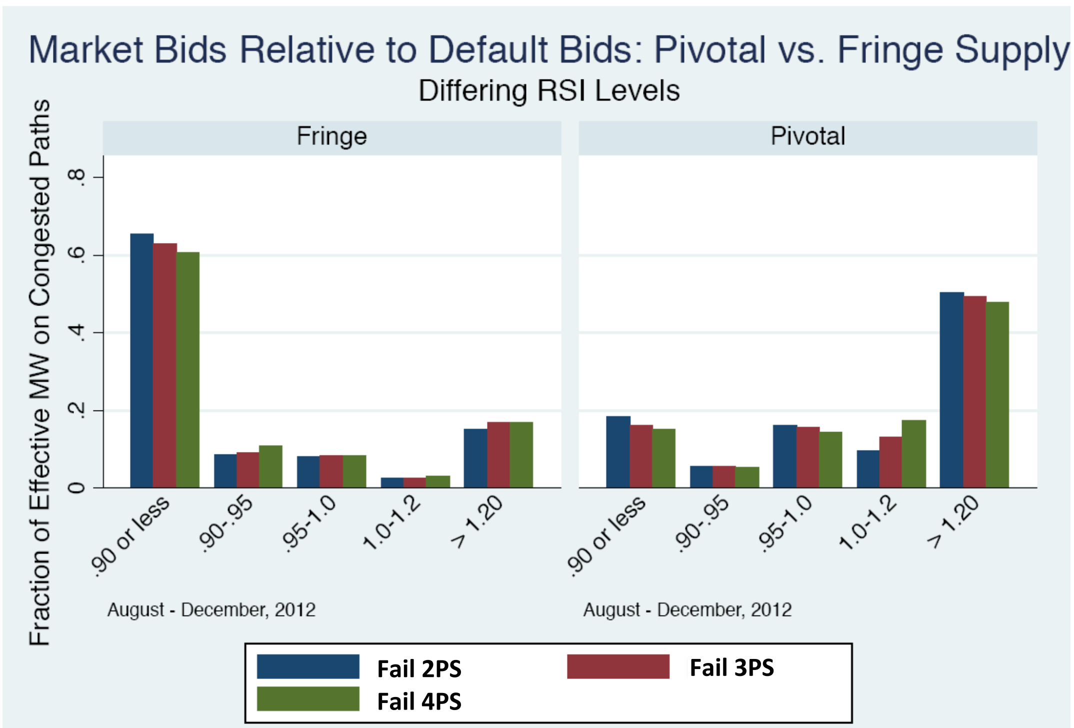

Figure 2. Distribution of Effective MW on Lines with Varying PS Test Levels

Note that in the unit-hours data (Figure 1) there appears to be less of a difference between the behavior of pivotal firms that fail only the most stringent test (4PS) and not the 3PS (denoted by the green column), and those that fail the 3PS as well (but not the 2PS) (red column). However, these two differences are of roughly equivalent magnitude in the MW-hour data (Figure 2).

While Figure 1 highlights the contrast between pivotal as opposed to fringe providers of counter-flow, a more pronounced distinction arises between units classified as "utility-controlled" vs.

[29] We have also examined distributions of bids grouped in a different manner: those failing 2PS; those passing 2PS but failing 3PS; and those passing 3PS but failing 4PS. The trends are the same. A similar conclusion applies to the analysis of Figure 2.

merchant owned. Figure 3 illustrates the same distribution as Figure 1 but broken down by those two categories. Figure 4 illustrates the same calculation as Figure 1 but restricts the bids to only those from merchant units. Bids from both pivotal and fringe scheduling coordinators are included in this figure.

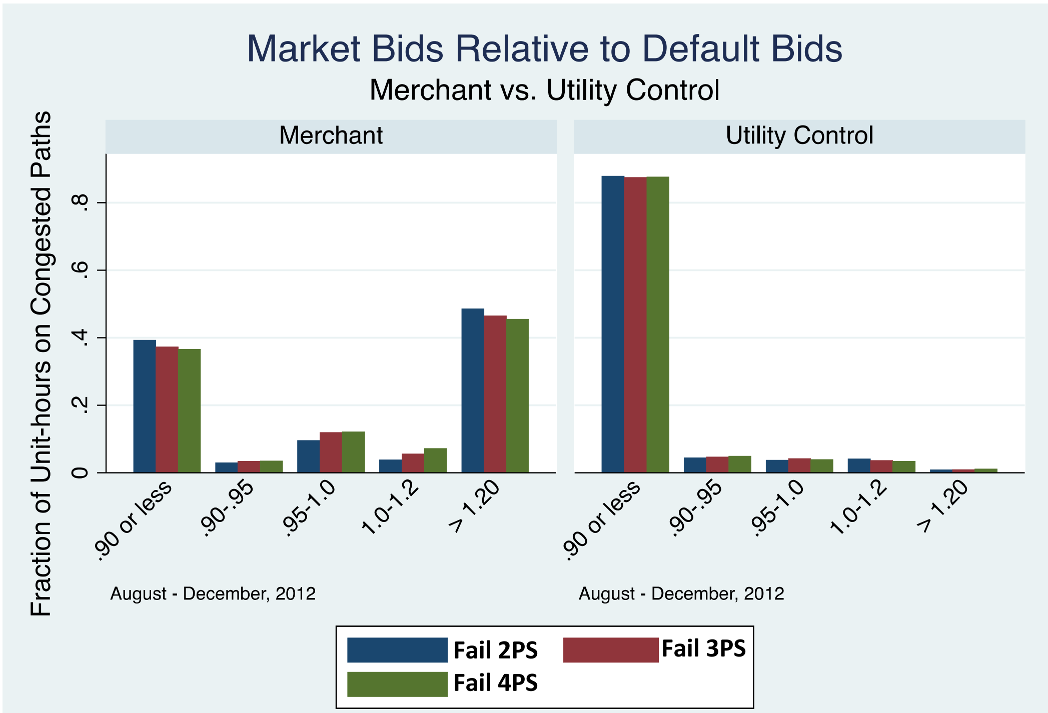

Figure 3. Distribution of Number of Unit-Segment Bids on Lines with Varying PS Test Levels by Schedule Coordinator Type

Figure 3 shows that the propensity to offer high bids for units on paths failing the 2PS (highly concentrated, blue column), 3PS (red column) and 4PS (green column) seen in Figure 1 holds only for merchant units and not for units that are utility-controlled. Because DMM aggregated the utility bids over all bids less than 0.9DEB (a level roughly equal to the estimated variable cost), we cannot tell from these data whether the bidding pattern for utility generation in Figure 3 reflects bids that are consistent with estimated costs or bids that are well below estimated costs. Figure 4 illustrates the same calculation as Figure 1 but restricts the bids to only those from merchant units. There we see a very slight tendency for merchant units to bid higher when the path has high concentration (fails 2PS, blue column) for pivotal units and not for fringe units. In addition, there is much less difference between the blue, red and green columns for pivotal merchant units and the fringe units that what appeared to be the case in Figure 1, which included utility generation. Moreover, the fringe bids mainly fall into two categories, less than 0.9DEB or greater than 1.2DEB when utility units are excluded (Figure 4). For that fringe, the fraction of bids in the >1.2DEB category does not monotonically increase as we proceed from “fail 4PS” to “fail 2PS”, unlike the pivotal group.

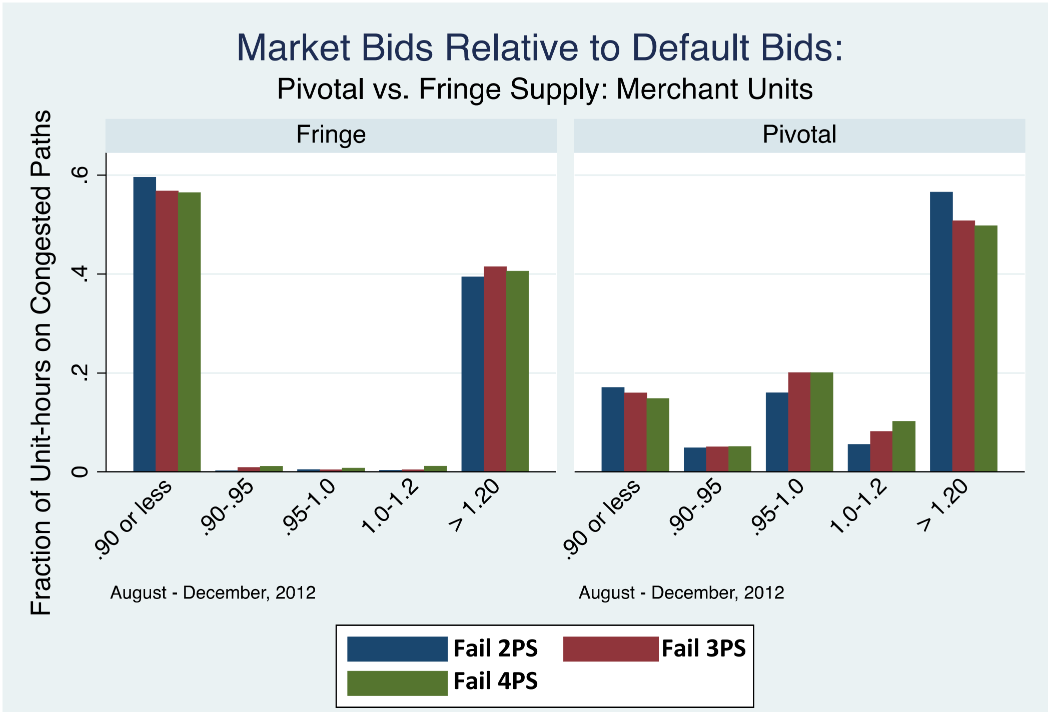

Figure 4. Distribution of Bids on Lines with Varying PS Test Levels: Merchant Plants Only

These trends for unit-hours (Figs. 1, 3, and 4) are consistent with the hypotheses that

- Merchant units of the largest three schedule coordinators (SCs) that impact constraints that fail the pivotal supplier test are slightly more likely to offer at somewhat higher prices (relative to their DEB) when paths are highly concentrated (fail the 2PS test) than when they are not (do not fail the 2PS test).
- Units from merchant SCs that are pivotal offer more frequently above their DEBs than units that are not pivotal for paths that fail a pivotal supplier screen. Note, however, that these may include many negative bids by renewable providers, which could skew the results for fringe providers.

These are both results that indicate that the level of market bids to DEBs are somewhat related to market competitiveness, which should not be the case if there were random errors in the accuracy of DEB levels.

Note however, a few other points that can also be made about these figures.

- Even merchant units that are fringe suppliers to these paths bid greater than 1.2 times DEB around 40% of the time. This could reflect understated DEBs or that some of these may in fact be pivotal on other paths during the same hour.
- Even utility controlled plants bid more than 1.2 times DEB some of the time.
- A large portion of merchant units bid extremely low prices. This is essentially self-scheduling the units, either explicitly or through bids expected to be well below market prices. The problems associated with the lack of participation in the real-time market

(*i.e.*, dispatchability), have been noted in many contexts, but are not the focus of this analysis, which is also limited to analysis of day-ahead market data.[30]

This analysis has at least three shortcomings, however. First, since the current pivotal supplier test does not take account of the cost-effectiveness of competition on a constraint, there is a potential for some suppliers that pass a 3 or 4PS test to possess market power because the "competition" is limited to a high cost (or low-impact) fringe. This would tend to muddy the results, as it could be the case that some suppliers passing a 3 or 4PS test that does not take account of supplier incremental energy costs or unit commitment costs might actually possess more market power than a unit that is pivotal under a 2PS test.

Second, since suppliers failing a 3PS test are subject to mitigation, a lack of observable differences in bidding behavior between those failing a 2 or 3PS test might reflect the fact that the suppliers failing the test might also know they would be subjected to mitigation in any case, rather than reflecting the impact of the underlying market structure.

Third, since the data includes all six of the constraints in Table 2, which includes some constraints that only sporadically and unpredictably bind, the pattern could be muddied by suppliers with no knowledge that they would have the ability to exercise market power in the hour.

Last it should be noted that the data above group most of the very high bids into a single category (greater than 1.2 times DEB). This may mask the differences within this last bidding category. In fact, examination of all merchant bids from June through September of 2012 illustrates that there is a great diversity of bids from merchant units (see Figure 5). In a later subsection, we explore the distribution of these merchant bids during congested and uncongested hours.

[30] We did not have detailed bid data for utility controlled units so we cannot evaluate the propensity for low bids for these unit-segments. For all merchant unit bids from June - September, about 60% of them are < -$1 and about 10% are more than $50/MWh above the DEB, and 5 % are more than $450/MWh above the DEB. We do not have a breakdown of the low priced, or very high price merchant bids based on whether they impact constraints that failed pivotal supplier tests at all or failed at a particular threshold.

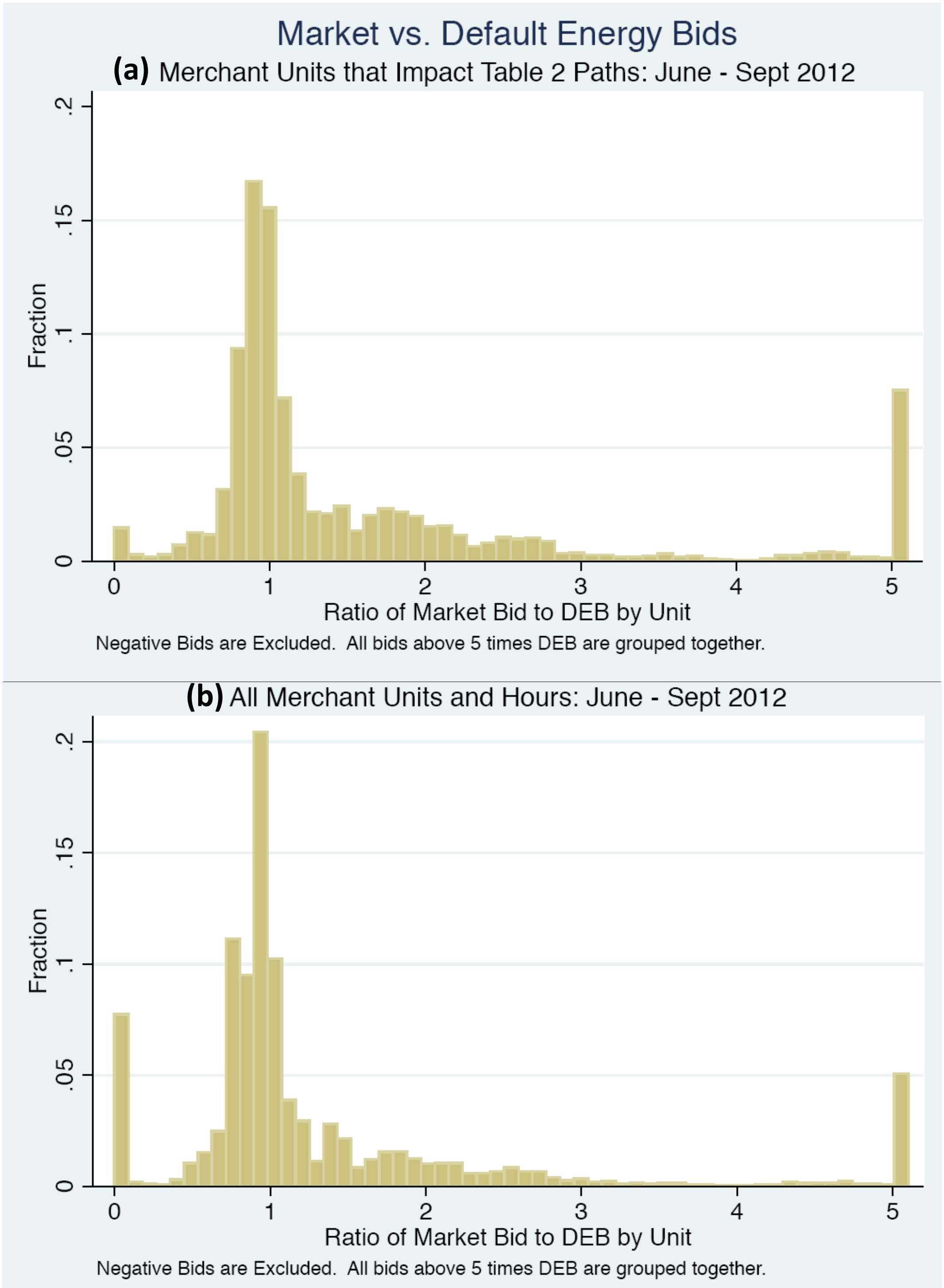

Figure 5. Bids (Unit Segments) from Units that Significantly Impact Uncompetitive Paths: (a) Only Units That Impact Six Lines in Table 2; (b) All Merchant Units

The breakdown of bids above 1.2 times DEB is more detailed in Figure 5. One can see a long "tail" in the spread of offer prices up to 3 and 4 times DEB, and there is a large cluster of bids (about 7%) with extremely high offer prices above 5 times DEB. A corresponding distribution for effective MW of counterflow bids is not available.

5.2 Relationship between Passing/Failing Pivotal Supplier Tests on Particular Paths and Bidding Less than DEB

One way to account for the impact of different levels of concentration on bidding behavior would be to consider only units that provide significant counterflow on paths that pass the presently implemented version of the 3PS test, which does not attempt to account for the cost-effectiveness of competition. Within that set of suppliers, all of whom have been unmitigated, we could test whether there are differences in the bidding behavior of four subsets of suppliers:

(1) those that provide counterflow on paths that would fail a 2PS test modified to exclude ineffective competition from the supply calculation;
(2) those providing counterflow on paths that would pass the modified 2PS test but fail a 3PS test similarly modified;
(3) those providing counterflow on paths that would continue to pass the 3PS test despite its modification, but fail a 4PS test so modified; and
(4) those providing counterflow on paths that would pass such a 4PS test.

We were unable to carry out such an analysis for this report with the available resources, in part because of a number of difficulties in deriving and applying a practical definition of effective competition for each path for each interval.

Another but more practical test of a relationship between concentration in counterflow supply and bidding behavior is to examine whether suppliers providing counterflow on paths that passed a 2, 3 or 4PS test were more likely to submit bids that were less than 95% of the default energy bid. The rationale for such a comparison is that firms possessing market power and subject to mitigation would be more likely to submit offer prices that were close to the default energy bid, rather than well below, as their ability to submit bids up to the default energy bid is not impacted by mitigation.[31] Since the default energy bid includes a 10% margin over estimated incremental energy costs, firms possessing market power would likely seek to earn this extra 10% margin, while those lacking market power would tend to bid their incremental energy costs. Again, this test takes advantage of the expectation that while the default energy bid imperfectly measures costs, errors in the measurement of costs should not be correlated with whether the supplier passes a two, three or four pivotal supplier test.

In fact, as can be seen in Figure 1 above, the propensity to submit a very *low* bid, while much lower overall for pivotal merchant sellers than for utility or fringe merchant suppliers, does not appear to be strongly related the concentration of a local market. Those providing counterflow on paths failing 2PS tests are actually slightly *more* likely to bid at a level below 90% of DEB (as well as below 95% of the DEB), compared to the set of unit segments providing counterflow on paths that fail the 3PS test. Therefore, this particular approach to detecting a relationship be-

[31] We propose to use a dividing line of 95% of the default energy bid rather than 100% or more of the default energy bid as there may be some uncertainty among suppliers as to the exact level of their default energy bid.

tween concentration and bidding fails to find that increased concentration results in higher bids. Note that this is true whether we look at unit-segment hours of bids (Figure 1) or at the effective MW provided by individual units (Figure 2).[32]

5.3 Propensity of Units to Impact Uncompetitive Paths and Bidding Behavior

Another way to measure the relationship between bidding behavior and their influence on congested paths is to focus on the frequency with which individual units impact paths that are frequently uncompetitive. This is a very rough proxy for the probability that a given unit's offer price may influence the cost of congestion on a given path. For example, if a unit impacts congested paths during 90% of the hours, it is reasonable to assume that such a unit expects its offer to potentially impact congestion costs almost all the time.[33] We then explore whether there is a relationship between offer prices and either the frequency with which the unit is dispatched to relieve congestion, or the *ex post* existence of actual congestion. We have selected a set of 12 paths that fail the 3PS almost always when they are congested. We call these the "usually uncompetitive paths." These are the 12 paths listed in Table 1.

Limiting our examination to these 12 paths, we focus on units that impact these paths or nomograms. The time period for this evaluation was the four month summer period of June through September 2012. A unit is considered to have an "impact" if it provides a non-trivial amount of counterflow (shift factor of 0.05 or more) against one of our 12 paths that is also congested in that hour. These data do not distinguish between the different levels of concentration (*e.g.*, 2PS or 3PS) but rather include all hours of congestion. As indicated in Table 1, these paths failed the 3PS test in almost all hours of congestion. Figure 6 summarizes the distribution of unit frequencies of impact for merchant units. In other words, among the merchant units that could potentially impact one of the 12 paths, this figure highlights how frequently those units potentially could have provided counterflow to a congested path. The horizontal axis describes the frequency with which a given unit impacts a path. The vertical axis measures the fraction of units that have a given level of frequency of impacting a non-competitive constraint. This is a rough measure of the likelihood of potentially being dispatched to supply counterflow on a non-competitive con-

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[32] However, one weakness of this test concerns the residual demand curve's shape. It is possible that the shape of the residual demand curve facing suppliers who are jointly pivotal might be such that it would be unprofitable for them to bid slightly above their costs because the lost profits would swamp the minor gains from raising prices, but they might still find it profitable to exercise market power if they could raise their prices above the default energy bid. For this to be the case, profit as a function of quantity supplied would have to be multimodal. This situation can occur in markets in which suppliers submit supply curves in the form of step functions, which in turn yields step functions for residual demand (assuming consumer demand is highly inelastic), which can have this multimodal characteristic. In this situation, removing mitigation for those jointly pivotal suppliers might result in large increases in bids, even though their previous offers were at or below their marginal cost. However, we cannot say if this situation occurs frequently enough to account for the apparent lack of relationship between bids closer to the DEB and concentration.

[33] For lower percentages, the measure is less descriptive. Although a unit may only impact congestion in 10% of those hours, those hours may be predictable based upon observable conditions such as unit outages or weather.

straint. It should be noted that none of these paths was congested with high frequency during June through September (the most congested path having 455 hours of congestion). Figure 6 shows that the most impactful merchant units are providing counter-flow to at least one of these uncompetitive lines about 12% of the hours (both congested and uncongested) between June and September, 2013.

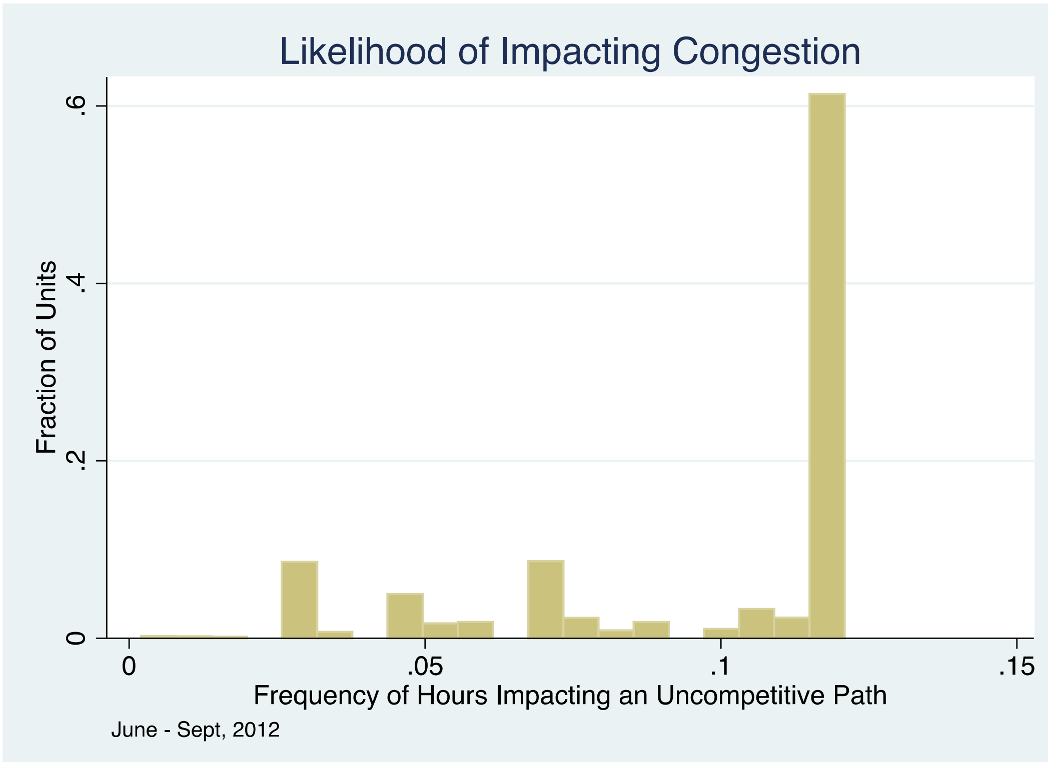

Figure 6. Distribution of the Frequency of Merchant Units Impacting Usually Uncompetitive Paths

Now we can also examine the relationship between merchant market bidding and the probability of impacting an uncompetitive line by measuring the level of the dollar difference between a market bid and the DEB for each unit and portraying the relationship between this dollar markup and the likelihood of providing counterflow to one of the twelve lines in Table 1 when congested. It is useful to focus on the difference in offer prices and DEB rather than on the ratio of offer to DEB, because high percentage markups are sometimes a result of very low DEBs.[34] Figure 7 illustrates the relationship between hourly bid-margins for non-negative bids and the frequency with which the unit submitting the bid impacts one of the uncompetitive (based upon a 3 PS standard) paths. There is a positive relationship between these two measures. In other

[34] A market offer price of $1.50/MWh on a resource with a DEB of $0.50/MWh, for example, would be a 300% markup but would be very unlikely to reflect an attempt to exercise market power. Note that there are a large number of negative price bids, many at negative $1000/MWh or below (which are in effect self-schedules, since they fall below the bid floor). We exclude negative price bids from these figures as the relative magnitude of a negative price bid conveys very different information than the magnitude of a positive bid.

words, units that impact are more likely to impact counterflow on of the twelve most frequently uncompetitive paths tend to bid higher absolute margins above their DEBs.[35]

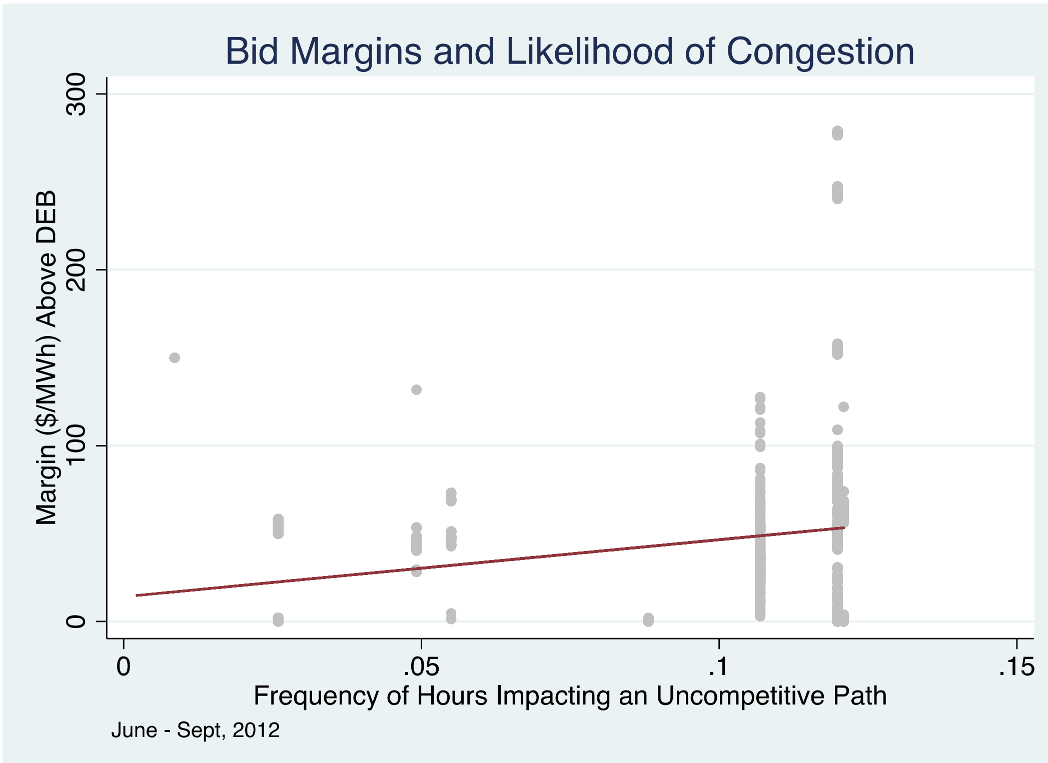

Figure 7. Relationship of Bid Margin to Frequency of Impacting Usually Uncompetitive Paths

The fraction of hours in which a unit impacts an uncompetitive, congested path is only one rough measure of the relative ability of a unit to take advantage of uncompetitive paths. Another such measure is the *ex post* actual congestion status of paths. In Figure 8, we compare the bids from units in hours in which they impacted one of the paths in Table 1 (the almost always uncompetitive group) *and* one or more of those lines were congested with bids in hours when none of the lines were congested. In other words, the congested flag is only active in hours in which a unit impacts at least one congested path from Table 1.

[35] A linear regression of bid margin as a function of frequency *margin* $=\alpha + \beta$**frequency*, that excludes negative price bids, yields a positive coefficient of 323 on frequency, with a standard error of 17.17, which is highly significant. This coefficient can be interpreted as follows: an increase of 0.1 (10%) in the fraction of the hours during this period when a unit provides significant counterflow on one or more of the twelve lines is accompanied by an increase of $32.3/MWh in the divergence between the bid and DEB. Of course, correlation is not causation, and there may be other underlying factors that cause these two variables to covary in this manner.

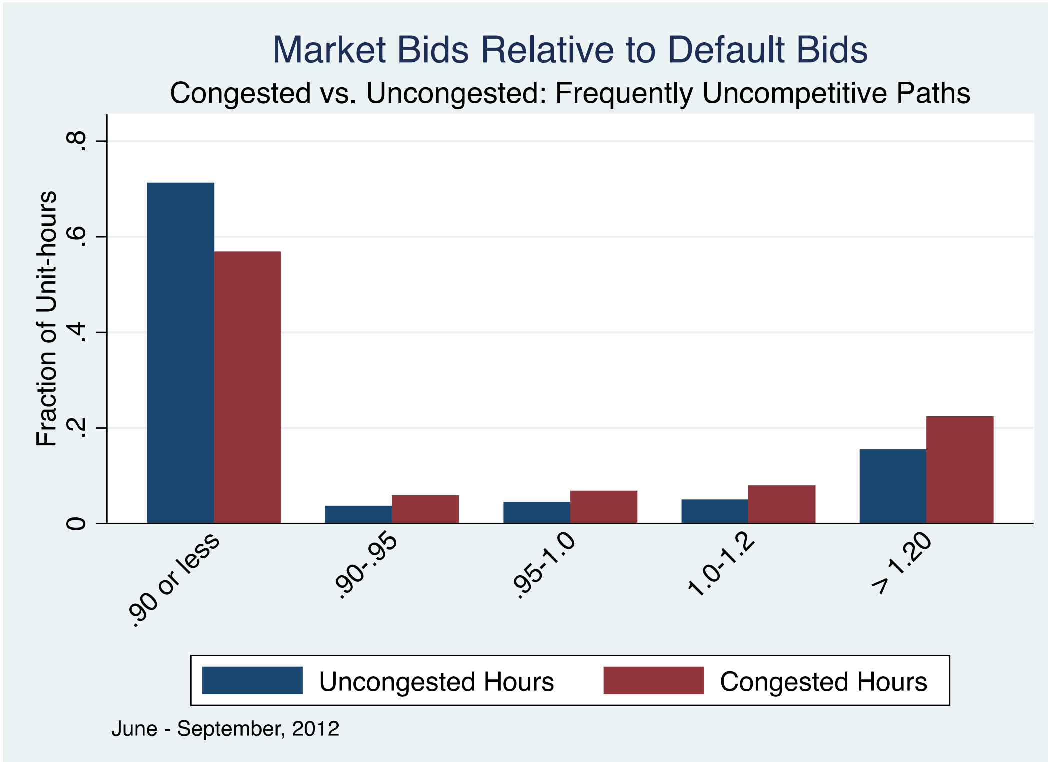

Figure 8. Merchant Unit Bids Impacting Usually Uncompetitive Paths

Figure 8 indicates that bids higher than DEB were offered proportionally more often during hours in which congestion occurred (and the unit significantly affected counterflow on one or more lines) than when our twelve lines were uncongested. This is consistent with behavior seeking to take advantage of the congestion on these interfaces, although it should be noted that these bids had a positive probability of being mitigated if these lines were in fact congested. Unless congestion hours were correlated with other factors that could cause a bias in the DEB estimates (*e.g.*, congestion was correlated with intra-day shocks to gas prices), this pattern is consistent with bidders seeking to exercise market power on congested lines rather than high bids due to a random error in the DEB level. In other words, this bidding behavior is more consistent with strategic behavior than an explanation that it is due to mis-measurement of DEBs.

5.4 Mitigation of Above-DEB Bids under Alternative Standards

We have presented some, albeit ambiguous, evidence that bidding behavior is less competitive when local markets fail more liberal screens, *i.e.*, when the market is more concentrated as measured by the screen. We are also able to utilize data evaluating the total impact of a hypothetical 2PS standard under the assumption that bid behavior would remain unchanged if the mitigation standard were changed. The DMM has compiled data at our request showing the total number of unit-segment hours as well as effective MWs of supply for the relief of each and every congested interface (not just those in Tables 1 and 2), again for the latter five months of 2012. We can use these data to examine how many bids of different types would have avoided the risk of mitigation under an alternative standard. In particular, we look at the change in the frequency of designation of individual paths as uncompetitive, and the resulting change in the frequency that bids of unit-segments able to relieve congestion on those paths would risk being subject to mitigation.

Table 3. Unit-Segment Hour Count of Bids at All Price Levels for Segments that Fail 2PS and 3PS Tests for Congested Paths, 2012

	Merchant Plants				Utility Controlled Plants			
Month	Total Unit-Segment Hours	Failing 2PS	Failing 3PS	Difference	Total Unit-Segment Hours	Failing 2PS	Failing 3PS	Difference
August	27730	8334	12357	4023	51177	14493	19429	4936
September	29606	11766	18529	6763	33422	12923	18779	5856
October	28980	5057	9209	4152	34268	4969	8114	3145
November	66658	3418	6851	3433	114127	2831	5486	2655
December	22985	1125	2088	963	33125	259	839	580
Total	175959	29700	49034	19334	266119	35475	52647	17172

Table 3 summarizes the total number of unit-segment hour bids from both merchant (left-hand panel) and utility-controlled (right-hand) plants. The table lists the total number of bids during congested hours, and the subsets of those bids that were submitted in hours in which the resource impacted a line that failed a pivotal supplier test at a 2PS or 3PS level. (By "impact", we mean that a unit provides counterflow on the congested constraint, and has a shift factor of 0.05 with respect to that constraint.) For example, in August of 2012, there were 27,730 unit-segment hour bids that impacted congested paths, and 12,357 of those impacted paths that were deemed uncompetitive by a three pivotal supplier standard. Only 8334 of those unit-segments would have impacted lines that would have been deemed uncompetitive under a two pivotal supplier standard.

The numbers in Table 3 are not weighted by MW capacity, so a bid from a very small generating unit-segment is counted the same as a large unit. Table 3 only addresses the question of how many bids would potentially have been mitigated, as bids at or below DEB would not be affected by the mitigation. Table 2 provides a lower bound on the difference in the number of bids that would actually be exposed to the risk of mitigation under the two standards.[36] This is a lower bound for at least two reasons. First, the data compiled by the CAISO DMM only count the frequency of bids above 1.2 times DEB in the table, not bids above the DEB. Second, and less trivially, the table assumes that those failing the 3PS test but not the 2PS test (included in the fourth column in each section) would not increase their bids if a 2PS test for paths were used instead of a 3PS test.[37]

[36] By "exposed to the risk of mitigation", we mean that the constraint would be designated as non-competitive and its shadow price times the appropriate shift factor would be added to the calculation of whether the unit would be mitigation.

[37] It might be expected that a unit that anticipates being mitigated under the present 3PS standard but which would not be mitigated under a 2PS system might find it more profitable to raise its bid at such times if the more liberal 2PS standard is used. This is because under a 3PS system there would be no point to raising its bid if it would be mitigated anyway at times when it possessed market power and

Table 4. Bids Exceeding 1.2 times DEB in Congested Hours for Units that Fail 2PS and 3PS Tests for Congested Paths, 2012

	Merchant Plants				Utility Controlled Plants			
Month	**Total Unit-Segment Hours**	**Failing 2PS**	**Failing 3PS**	**Difference**	**Total Unit-Segment Hours**	**Failing 2PS**	**Failing 3PS**	**Difference**
August	11893	4013	5818	1805	668	142	217	75
September	14959	6866	9915	3049	394	97	160	63
October	12522	2603	4686	2083	1054	32	45	13
November	20268	1588	3158	1570	5224	17	17	0
December	5328	95	249	154	1098	0	0	0
Total	64970	15165	23826	8661	8438	288	439	151

The organization of Table 4 is similar to Table 3, except that only bids greater than 1.2 times DEB are included in the totals. Therefore Table 4 provides the subset of bids from Table 3 that exceed a 1.2 times DEB threshold. Again looking at the row for August, we see from Table 3 that of over 12,000 merchant bids impacted uncompetitive (under 3PS) paths. From Table 4, we see that roughly 5800, or a little under half, of those bids were in excess of 1.2 times DEB. A similar comparison between the two tables shows that roughly half of the unit-segment bids failing the more lenient 2PS test were above 1.2 times DEB. Looking at the difference, this implies that roughly 4,000 unit-hourly bids above 1.2DEB that were mitigated under the 3PS standard in August *would not have been* mitigated because of that constraint under a 2PS standard.[38]

This evaluation is only an approximation for two reasons. First, several units impact multiple transmission paths, and even if a bid would not be mitigated because one path it impacts passes a 2PS test, it may still be mitigated if another path that is impacted by that unit fails a 2PS test. In this way the counts above may overstate the impact of a change.[39] However, the above data also focuses only on bids above 1.2 times DEB, and not the mitigation threshold of 1.0 times DEB. In this respect, the counts may understate the impact of a change to 2PS standard on bid levels.

Ideally, one would like to have a sense of the price impact of the differences in mitigation. Unfortunately this would require re-running the market software under alternative mitigation scena-

might lose money as a result of raising its bid in the hours in which there was no congestion and it lacked market power. Such an expectation assumes that (1) generators can correctly anticipate when it would be mitigated and (2) if subject to mitigation, it would prefer to bid the DEB and not actually be mitigated. Both assumptions are, of course, not easy to defend.

[38] That is, that constraint would not have contributed to the calculation of the shift factor-weighted sum of non-competitive path shadow prices that is used to determine if a unit is mitigated.

[39] Note that the reverse is also true—a unit that provides counterflow on a 2PS non-competitive constraint might nevertheless not be mitigated because its generation contributes positively to congestion of some other non-competitive constraint.

rios, and the resources were not available for that level of review. However, we can get another measure of the relative magnitudes of the mitigation by looking at the effective MW from generation that would possibly be mitigated under the two standards, as opposed to a simple count of units. This effectively weights the bids in the previous table according to the size of the unit-segments submitting the bids and the proportional impact of those units on the lines to which they are providing counterflow (*i.e.*, the shift factor on the constraint).

Tables 5 and 6 tell a similar qualitative story to that of Tables 3 and 4. Note that roughly half of the effective MWs bid by merchants that fail both pivotal supplier screens are bid at levels exceeding 1.2 times DEB. By contrast, a much smaller fraction of utility-controlled capacity impacts uncompetitive paths and is bid in at such a high level relative to DEB. Over the five month period documented here, roughly 285 GW-hr of effective counterflow that both (1) bid over 1.2DEB and (2) was mitigated under the 3PS standard would *not* have mitigation triggered by that constraint under the 2PS standard (total from column 4 of Table 6). This 285 GW-hr, which averages about 75 MW in each hour, of course corresponds to much more than 75 MW of actual generation capacity, because the effective MW number is obtained by multiplying capacity by the appropriate shift factor. This 285 GW amount is slightly more than half of the overall 552 GW-hr of effective MW (~150 MW per hour) exposed to mitigation under the present 3PS standard (from the total of the third column of Table 6).

Table 5. Effective MW Bid at all Price Levels in Congested Hours (Effective MW = Unit Capacity Times Shift Factor with Respect to Congested Constraint) for Units that Fail 2PS and 3PS Screens for Congested Paths, 2012

	Merchant Plants				Utility Controlled Plants			
Month	Total Unit Segment-Hours	Failing 2PS MW-hr	Failing 3PS MW-hr	Difference MW-hr	Total Unit Segment-Hours	Failing 2PS MW-hr	Failing 3PS MW-hr	Difference MW-hr
August	27730	179311	314815	135504	51177	146287	219123	72837
September	29606	306984	594778	287794	33422	185934	323163	137228
October	28980	133093	305298	172206	34268	83753	155465	71712
November	66658	93249	141021	47772	114127	27204	51748	24544
December	22985	49188	76255	27068	33125	6692	13334	6641
Total	175959	761824	1432168	670344	266119	449869	762832	312962

Table 6. Effective MW Bid at Levels Exceeding 1.2 times DEB for Units that Fail 2PS and 3PS Tests for Congested Paths, 2012

	Merchant Plants				Utility Controlled Plants			
Month	**Total Unit Segment-Hours**	**Failing 2PS MW-hr**	**Failing 3PS MW-hr**	**Difference MW-hr**	**Total Unit Segment-Hours**	**Failing 2PS MW-hr**	**Failing 3PS MW-hr**	**Difference MW-hr**
August	11893	57784	120686	62902	668	4893	10468	5575
September	14959	108880	255402	146522	394	1488	3393	1905
October	12522	46728	113600	66872	1054	1543	2726	1183
November	20268	51671	60218	8547	5224	22	22	0
December	5328	1165	1568	403	1098	0	0	0
Total	64970	266228	551474	285247	8438	7947	16609	8662

It is also worth highlighting the marked contrast in bidding between the merchant-classified group and the utility-controlled group illustrated in these tables as well as previous figures. Of all bids in these tables, roughly one-third of all bids from merchant sellers were submitted at levels greater than 1.2 times DEB during congested hours while less than 5% of bids from utility-controlled units reached those extremes.

Overall the analysis in this section indicates that a large fraction of merchant units bid in excess of 1.2 times DEB during congested hours. Further a non-trivial number of units bid in excess of 5 times DEB. It is also clear that many of these bids are currently mitigated using the 3PS standard for defining non-competitive paths. Although the tables in that section are an approximation of the impact of a hypothetical 2PS standard, we believe that it does indicate that there would be a substantial number of additional bids in excess of 1.2 times the DEB that would have gone unmitigated had a 2PS standard been in place. In analyzing these data we were unable to identify a clear and material change in bidding behavior associated with higher or lower concentration that would provide support for use of a higher or lower (*e.g.*, 2PS or 4PS) threshold for defining competitive paths and applying local market power mitigation. Hence, our conclusion is that our analysis does not provide support for a change in the current three pivotal supplier threshold.