Ain’t It ‘Suite’?
Bundling in the PC Office Software Market

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IDC

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Purpose of the paper

- Explore economics of bundling in an empirical context.
- Evaluate explanations for bundling in office software markets.
- Estimate the demand for spreadsheets, word processors, and office suites.
- Assess Microsoft’s market power in office software markets.
- Evaluate competitive effects of bundling, and alternative competitive strategies for Lotus and WordPerfect.
Incentives to Bundle

(Negatively) Correlated Consumer Preferences:

• With negatively correlated consumer preferences over components, bundling reduces consumer heterogeneity and works like price discrimination (Adams & Yellen, 1976)

• “A multiproduct monopolist generally achieves higher profit from mixed bundling than from separate selling of components if consumer values for two products are negatively dependent, independent, or have limited positive dependence.

• The profitability of monopoly bundling also extends to situations where a multiproduct firm competes with a single-product rival.

Contributions of Paper

• Extends standard discrete choice model of product differentiation to case when the choices potentially include more than one product.
• Develops a model that enables estimation of both the correlation in preferences over components.
• Enables the examination of a counterfactual in which the second and third largest firms merge.
Evolution of PC Office Software Market

• The 1990’s saw dramatic structural shifts in office productivity software markets
• Shift from DOS to Windows operating system.
• Shift in market leadership away from Lotus (in spreadsheets) and WordPerfect (in word processors) to Microsoft.
• Change in marketing strategy from selling components to selling office suites.
The market grew steadily, as Windows quickly replaced DOS.
Word Processor Market: 1991
Total Market $952 Million:
DOS $567 Million, WINDOWS (W) $385 Million

Microsoft (DOS) 8%
Other (DOS) 13%
IBM/Lotus (W) 8%
Microsoft (W) 15%
IBM/Lotus (W) 8%
Corel/Novell/Borland/WP (W) 9%
Other (W) 8%
Corel/Novell/Borland/WP (DOS) 39%
Other (DOS) 13%
Figure 2: Spreadsheet Market: 1991
Total Market $809 Million:
DOS $239 Million, WINDOWS $569 Million

IBM/Lotus (DOS) 58%
Other (DOS) 2%
Microsoft (W) 19%
IBM/Lotus (W) 8%
Corel/Novell/Borland/WP (DOS) 11%
Other (W) 2%
Corel/Novell/Borland/WP (DOS) 11%
Office suites became increasingly important

Microsoft dominated the market for suites
Bundling in the PC Office Software Market

Office Suites, 1990-1998

- 1990: Windows 3.0 Office
- 1993: Lotus / AmiPro Suite
- 1994: Office 4.2
- 1995: Novell Suite, Windows 95 Office 95
- 1996: Core’s WordPerfect Suite, Lotus’ SmartSuite
Microsoft suites were priced significantly higher.
Word Processor Prices
Significant suite discount after 1995

Figure 8: Microsoft Prices

Year
$ Suite
Word Processor
Spreadsheet
Related Literature

- Computer software industry:

- Discrete choice models of product differentiation:

- Bundling
  - Theory:
  - Empirical:
    - Gentzkow (2007), Valuing New Goods in a Model with Complementarity
    - Crawford (2008), Discriminatory Incentives to Bundle in CATV
    - Crawford & Yurukoglu (2011), Welfare Effects of Bundling in Multi-channel TV Markets
      - How bundling affects welfare
      - Estimate model of viewership, demand, pricing, input market bargaining
      - Simulate à la carte pricing – consumer benefits from individual sales, but input costs rise
      - Channels sold in large bundles, but not enough data to estimate individual Channels
      - Viewing data available, but no prices associated with those data
Data

Three basic products
• Wordprocessors
• Spreadsheets
• Suites

Sample period 1992-1998
• Sales and shipments by product, vendor, and platform
Unbalanced panel
• MS offered all three product each year
• Corel/WP and IBM/Lotus began selling suites in 1993
• After 1996, IBM/Lotus stopped word processors, and Corel/WP only sold suites

52 observations

Possible “mix and match” bundles:
• Suite/Bundle = 1 if word processor and spreadsheet consumed jointly

Products characteristics
• PRICE and QUANTITY
  – Dataquest/Gartner Reports: Annual shipments and sales by product, vendor, and platform.
• QUALITY (scale of 10)
  – Liebowitz and Margolis: Indices constructed from product reviews
  – Rel qual spread = (j-lotus)/lotus
  – Rel qual word proc = (j-wp)/wp

Vendor
• Microsoft
  = 1 if MS wordproc or spreadsheet
  = 2 if MS suite

Product type dummies
\[ \kappa_{ss} = \text{spread or suite} \]
\[ \kappa_{wp} = \text{word processor or suite} \]

Year dummies
• YEARXX Dummy variable = 1 in year XX
The potential market for office software is defined to be the number of operating systems sold or distributed via OEMs.

<table>
<thead>
<tr>
<th>Year</th>
<th>(A) Windows OS sales (in millions)</th>
<th>(B) Word processor sales (in millions)</th>
<th>(C) Spreadsheet sales (in millions)</th>
<th>(D) Suite sales (in millions)</th>
<th>(B+C+D)/A Share of inside goods</th>
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<tbody>
<tr>
<td>1992</td>
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<td>4.650</td>
<td>3.442</td>
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<td>1998</td>
<td>89.489</td>
<td>2.091</td>
<td>1.867</td>
<td>38.801</td>
<td>0.478</td>
</tr>
</tbody>
</table>
Discrete choice model

- Each consumer compares “products” across four categories
  - Spreadsheets
  - Wordprocessors
  - Suites
  - Mix-and-match bundles
- Unobservable taste for spreadsheets is correlated with unobservable taste for wordprocessors. (Bivariate-normal)
- Idiosyncratic preference for individual products. (Independent double exponential)
  - For suites, can be interpreted as an unobservable degree of product complementarity
- Unobserved product characteristics
Econometric model

• Product utility: \( U_{jk} = \delta_j + \theta_{jk} \)

• Mean utility: 
  \[
  \delta_j = \beta_0 \ast \text{PRICE} + \beta_1 \ast \kappa_{ss} + \beta_2 \ast \kappa_{wp} + \beta_3 \ast \text{YEARXX} \\
  + \beta_4 \ast \text{SUITE} + \beta_5 \ast \kappa_{ss} \ast \text{rel SS} + \beta_6 \ast \kappa_{wp} \ast \text{rel WP} \\
  + \beta_7 \ast \text{MS} + \beta_8 \ast \text{MS} \ast \text{SUITE} \ast \text{YEAR}(95-98) + \xi_j
  \]

• Random utility: \( \theta_{jk} = \text{SPREADSHEET}_j \ast \mu_{1k} + \text{WORDPROCESSOR}_j \ast \mu_{2k} + \varepsilon_{jk} \)

• Error structure: \( \mu_{1k} \) discussed next slide

\[
\varepsilon_{jk} \sim \text{i.i.d. double exponential}
\]

\[
P_{jk} = \frac{e^{\delta_j + \text{SPREADSHEET}_j \ast \mu_{1k} + \text{WORDPROCESSOR}_j \ast \mu_{2k}}}{1 + \sum_{l=1}^{15} e^{\delta_l + \text{SPREADSHEET}_l \ast \mu_{1l} + \text{WORDPROCESSOR}_l \ast \mu_{2l}}}
\]

Notes: \( j \) indexes the product; \( k \) indexes the consumer; time subscript is suppressed.
Error Structure

• $Y_{1k}$ and $Y_{2k}$ - i.i.d. standard normal distribution.

• $\mu_{1k} = \sigma_1 Y_{1k}$

• $\mu_{2k} = \rho \sigma_2 Y_{1k} + \sigma_2 (1 - \rho^2)^{1/2} Y_{2k}$. 

• $(\mu_{1k}, \mu_{2k}) \sim N(0,0, \sigma_1^2, \sigma_2^2, \rho)$, where $\sigma_1^2$, and $\sigma_2^2$ are the variances of $\mu_{1k}$ and $\mu_{2k}$ respectively and $\rho$ is the correlation coefficient.

• $\sigma_1^2, \sigma_2^2, \rho$ : Non-linear parameters of model
Estimation Algorithm

- **Step 1:** Take random draws of \((Y_{1k}, Y_{2k})\) for 100,000 consumers per year. Each consumer makes a single choice.

- **Step 2:** Assume initial values for \(\sigma_1^2, \sigma_2^2, \rho\) and find \(\delta\) using the following contraction mapping until convergence obtained

\[
\delta_{j,\text{new}} = \delta_{j,\text{old}} + \ln(\text{actual market shares}) - \ln(\text{simulated market shares})
\]

- **Step 3:** Run the GMM regression \(\hat{\delta} = X\beta + \xi\). Obtain estimates

\[
\hat{\beta} = (X'ZWZX)^{-1} X'ZWZ \hat{\delta}
\]

where \(X\) is the matrix of right hand side variables, \(Z\) is the matrix of exogenous right hand side variables and instrumental variables, and the weighting matrix \(W = (Z'Z)^{-1}\)

- **Step 4:** Compute the implied values of the unobservables \(\hat{\xi} = \hat{\delta} - X\hat{\beta}\) and evaluate GMM objective function \(\hat{\xi}'ZWZ\hat{\xi}\)

- **Step 5:** Update the values of \(\sigma_1^2, \sigma_2^2, \rho\) & return to step 2.
Instrumental Variables

• Since price is endogenous, we instrument for it. Following other authors, we use the quality of other products as instruments and a ‘cost-shifter’ as instruments

• “Rel_qual_Other” - For Lotus and WP: relative quality of Microsoft’s product within the same category. For Microsoft, the relative quality of the larger value between Lotus and WP within the same category. The idea here is to find alternatives that affect the firm’s ability to raise prices.

• “Rel_qual_Own” – for each vendor:
  • For components: the contribution of the components’ quality relative to the quality of the vendor’s suite (i.e., qA/(qA+qB)).
  • For suites, the highest value among the component’s relative contribution.
  • Hence, this IV looks at ‘limits’ coming from other products the firm offers.

• Dummy Variable for Year 95-98 – The idea here is that prices declined beginning in 1995 due to the exogenous technological change in OS to Windows95, which made it easier (cheaper) to produce office software (Also, one could work with different components at the same time.)
Intuition for Identification

- Our data set contains sales and shipments by products and by year. Thus, both variation across products and variation across time are a source of identification of the parameters of the model.

- The year dummy variables obviously vary over time only. Variation in the share of potential consumers who elect the outside good identify the coefficients on these variables.

- The vendor dummy (for Microsoft) varies across products, but not over time. Variations of shares of Microsoft products relative to other products identify the coefficient here.

- The quality and price variables vary both by product and by year. Consequently, shifts in market shares of products over time identify the coefficients on these variables.

- Given the linear parameters and $\rho$, an increase in $\sigma$ increases the sales of the relevant class of products (spreadsheets and word processors respectively).

- Because of complementarity and/or additional packages, the variable (Bundle/Suite) adds value to suites and mix-and-match combinations, the market share of suites (and combinations) identifies the coefficient on this variable (for a fixed $\rho$.)

- An important element of price variation in our data is that Microsoft dramatically lowered the price of its suite in 1996. A price cut increases the share of suites, but a simulation shows that the magnitude of the effect varies depending on the values of $\rho$ and the coefficient on Bundle/Suite. Therefore, variation in the share of suites due to price variation identifies $\rho$ separately from the coefficient on Bundle/Suite. This is essentially a second derivative (i.e., technical) effect. It says that $\frac{\partial^2 Sales}{\partial \text{price} \partial \text{Bundle}} > 0$, while $\left. \frac{\partial^2 Sales}{\partial \text{price} \partial \rho} \right|_{\text{Bundle}=1} \approx 0$. 
<table>
<thead>
<tr>
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<th>Coef.</th>
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<tbody>
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<td>sigma WP</td>
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<td>GMM</td>
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<td>y95</td>
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<td>1.52</td>
<td>0.74</td>
<td>2.05</td>
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</table>
Examining GMM objective function

fixing $\sigma_1$ and $\sigma_2$

setting different values for rho and estimating $\beta$
Competitive effects of bundling

Counterfactuals

1. Microsoft is a monopolist selling Office suite

2. Microsoft suite competes with Lotus spreadsheet and WordPerfect word processor

3. Microsoft, Lotus, and WordPerfect compete in the market for suites

Counterfactuals (1), (2), (3)

We set marginal costs so that simulated prices are close to actual prices. All simulations are done for the year 1998.

We 'find' that Microsoft's marginal cost for its suite in 1998 is $115.

With this marginal cost, simulation (1) yields an optimal price of $185 for the MS suite in 1998.

We find that Microsoft's "predicted" prices, market shares, and profits are essentially the same under all the first three scenarios.
Forth scenario in which Microsoft competes with a merged Lotus/IBM - Corel/WP Suite.
- QUALITY is the highest quality possible (20).
- Simulated marginal cost for merged suite - $28

<table>
<thead>
<tr>
<th></th>
<th>Simulated monopoly price for MS suite (1998)</th>
<th>Simulated prices Competition vs. Merged suite</th>
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</thead>
<tbody>
<tr>
<td>Prices ($)</td>
<td>Microsoft suite - $185</td>
<td>Microsoft suite – $163</td>
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<tr>
<td></td>
<td></td>
<td>Merged suite - $66</td>
</tr>
<tr>
<td>Unit Costs ($)</td>
<td>Microsoft suite - $115</td>
<td>Microsoft suite - $115</td>
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<tr>
<td>simulation</td>
<td></td>
<td>Merged suite - $28</td>
</tr>
<tr>
<td>Consumer share (%)</td>
<td>Microsoft suite - 57</td>
<td>Microsoft suite - 49</td>
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<tr>
<td></td>
<td></td>
<td>Merged suite - 32</td>
</tr>
<tr>
<td>Sales Weighted Price</td>
<td>$185</td>
<td>$125</td>
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</tbody>
</table>
Conclusions

• Consumer demands for word processors and spreadsheets are negatively correlated.

• Lotus and WordPerfect should have merged.

• A bundle is a good entry barrier against single product competitors, but not against another bundle. (Nalebuff)
## Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
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<td>sales (000)</td>
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<td>5,964</td>
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<td>32,683</td>
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