「実験で学生たちが学ぶことと学ばないこと」報告要旨*

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1 報告の概略

経済学をどのように教えるかと、来経済学を教えられると学生はどのように変るかについて、現在進行中の研究を報告します。前者は、灰谷綾平（京都産業大学大学院研究科博士後期課程）との、後者は飯田善郎（京都産業大学経済学部助教授）との共同研究です。前者の研究は 2007 年 2 月に大阪大学で開催される Asia-Pacific Regional Meeting of the Economic Science Association で報告予定なので、その報告論文 [1] を参考資料 A として添付し、概略を次節で説明します。後者の研究成果は 2006 年 3 月の研究成果報告書に [2] として収められているので、その後の研究も含めて概要を参考資料 [3] として添付し、本稿の本文では言及しません。

2 実験で経済学を教えられるか？

少人数の演習で学生たちに実験を設計・準備・実施・分析・報告させることが経済学の勉強と一般的能力の向上に効果のあることは数年の経験で分りましたが（ただし教員の負担がかなり大きいので、現在はこのような演習をしていません）[4]、2005 年度と 2006 年度の春学期に多人数の講義科目での実験による経済学教育の効果を調べました。講義科目は、私が京都産業大学経済学部で担当している 2 年生配当の『ミクロ経済学 A』で、出席者は毎回 100 名程度でした。実施した実験は市場実験で、屋外での 100 余名のオーラル・ピット・マーケットと経済実験室の情報環境を利用するダブル・オークションを、設定を少しずつ複雑にしながら 3 回実施し、実験ごとに試験・質問調査・解説の講義を行いました。

実験では金銭でも成績でも動機づけを与えていませんが、学生たちは真剣に実験に取組みました。各実験の翌週の授業で実験の理解を試す試験をしました。試験は、学生たちに学生たちが体験した実験の設定と結果を教え、実験における市場供給曲線と市場需要曲線を描かせるものでしたが、学生たちの解答には様々な誤りが見られました。これらの誤りは、京都産業大学経済学部における経済学教育の改善すべき点を明らかにすると

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ともに、学生たちが熱心に実験に取組むことが必ずしも経済学の勉強になっていないことを暗示します。

じっさい実験あるいは試験の終了後に学生の実験への取組や感想を知るために実施した質問調査への回答も考慮すると、学生たちの実験への参加と実験の理解は本稿の「流れ図（図 1)」のように進む（進まない）ことが示唆されます。

- 学生たちは現金報酬がなくても実験に取組みます。そして熱心に実験に取組む学生ほど実験での儲け（売手または買手として余剰をどれだけ獲得したか）は大きくなる傾向がありますが（モザイク図 1)、実験でどれだけ稼いだかと試験での得点（自分の経験した市場の需要曲線と供給曲線を正しく描けたか）は相関しないので（モザイク図 2)、学生が真面目に実験に取組むか取組まないかは試験の得点とは無関係になります（モザイク図 3)。
- 実験で演じやすい役割をするときのほうが実験で経験することが多く（モザイク図 4)、実験で直接的に経験することの効果は間接的に経験することの影響よりも正しく推察できますが（モザイク図 5)、正しく推察できても、それを経済学の言葉で的確に表現できるとは限りません（モザイク図 6)。

3　まとめ

研究要実験では、「実験での成績に応じて支払われる現金報酬 $\Longrightarrow$ 被験者の実験への真剣な取組 $\Longrightarrow$ 実験での高得点 $\Longrightarrow$ 現金報酬」という円環で被験者は動機づけられます。被験者をこのように実験内に没入させることで、実験者は被験者の行動やその経済全体に対する影響を考察できますが、被験者たちは（実験によってはスキナー箱のなかのラットのような学習を求められることはあっても、それを観察する研究者の視点で）実験について考えることを求められません。けれども教育用実験では、実験者ではなく実験参加者が学ばなければなりません。実験参加者たちにどのように体系についての推論をさせるか、理論研究 [5], [6] とと実験による経済学教育の実践を進めています。

参考文献

[1] Ryohei Haitani and Sobei H. Oda (2007): “Students Learn from Market Experiments and What They Don’t” to pe presented at *2007 Asia-Pacific Regional Meeting of the Economic Science Association*, Osaka University, 10-12 Feoruary 2007; in 『第 6 回行動経済学ワークショップ報告要旨集』

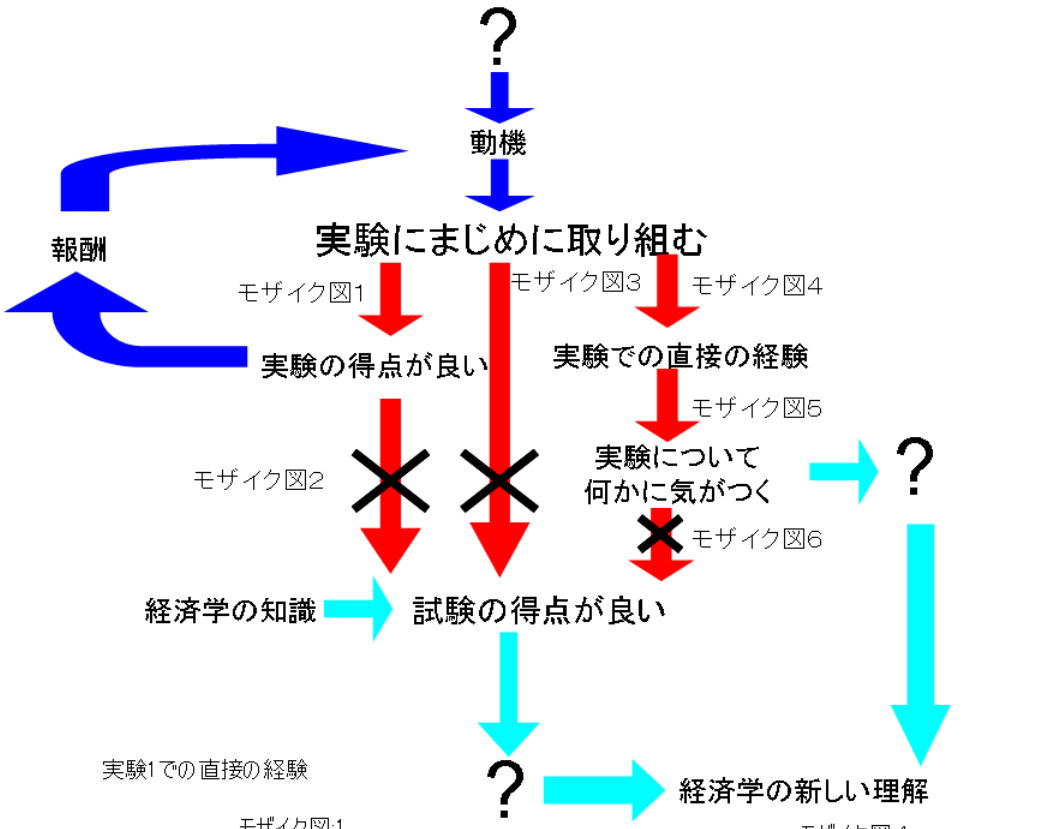
[2] 飯田善郎・小田宗兵衛 (2006): 「経済学教育の効果：協調行動分析からの検証」 in 『平成 13 年度-平成 17 年度私立大学学術研究高度化推進事業「オープン・リサーチ・センター」「実験経済学：経済学教育の新しい方法と、それによる経済学教育の社会的効果の研究」』研究成果報告書, pp. 250-267.

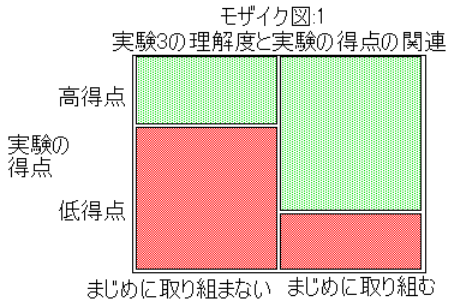
[3] 飯田善郎・小田宗兵衛 (2007): 「経済学部の学生は他学部の学生より非協力的か？」 in 『第 6 回行動経済学ワークショップ報告要旨集』

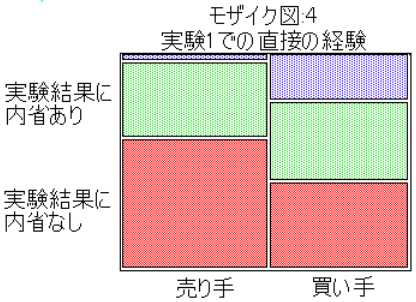
[4] 小田宗兵衛 (2003): 「役に立つ経済学教育を目指して：学生に経済実験を作らせる」 in 『第 8 回大学コンソーシアム京都ファカルティー・ディベロップメント・フォーラム報告要旨集』

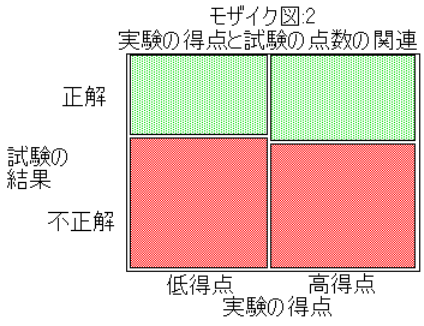
[5] Yasugi, Mariko and Sobei H. Oda (2002): “A Note on the Wise Girls Puzzle” in *Economic Theory*, vol. 19 (no. 1), pp. 145-156.

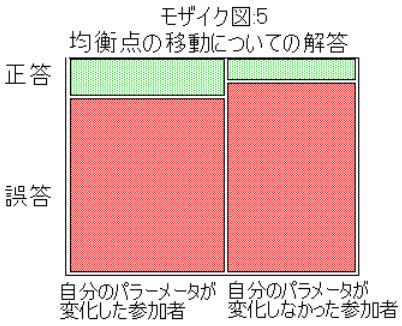
[6] Yasugi, Mariko and Sobei H. Oda (2003): “Notes on Bounded Rationality” in *Scientiae Mathematicae Japonicae*, vol. 57 (no. 1), pp. 83–92.

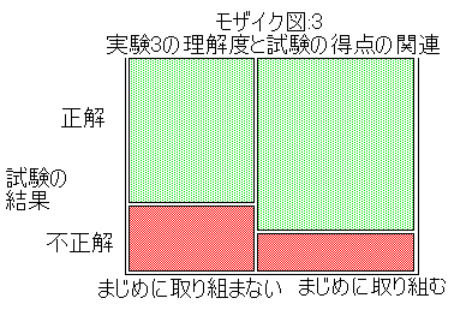

?
動機
報酬
実験にまじめに取り組む
モザイク図1
モザイク図3
モザイク図4
実験の得点が良い
実験での直接の経験
モザイク図5
モザイク図2
実験について
何かに気がつく
?
モザイク図6
経済学の知識
試験の得点が良い
実験1での直接の経験
?
経済学の新しい理解


モザイク図:1
実験3の理解度と実験の得点の関連
高得点
実験の
得点
低得点
まじめに取り組まない
まじめに取り組む


モザイク図:4
実験1での直接の経験
実験結果に
内省あり
実験結果に
内省なし
売り手
買い手


モザイク図:2
実験の得点と試験の点数の関連
正解
試験の
結果
不正解
低得点
高得点
実験の得点


モザイク図:5
均衡点の移動についての解答
正答
誤答
自分のパラメータが
変化した参加者
自分のパラメータが
変化しなかった参加者


モザイク図:3
実験3の理解度と試験の得点の関連
正解
試験の
結果
不正解
まじめに取り組まない
まじめに取り組む

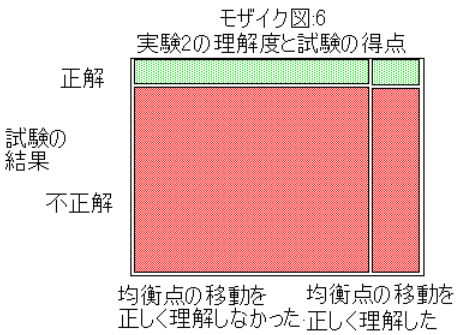

モザイク図:6
実験2の理解度と試験の得点
正解
試験の
結果
不正解
均衡点の移動を
正しく理解しなかった
均衡点の移動を
正しく理解した

図１　流れ図

経済学部の学生は他学部の学生より非協力的か？*

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1　研究の概要

経済学を勉強すると非協力的になるか？この問に対して実験や質問調査で答えようとする研究が 1980 年代からいくつかなされた。初期には経済学教育を受けると利己的になると主張されたが、その後の研究ではそのような傾向は見られず、経済学を学ぶ学生が他分野を学ぶ学生よりも非協力的とはいえないと報告されている。

じっさい 1980 年代から 90 年代前半までの研究は、結論を急ぎすぎていたように思われる。まず Marwell and Ames (1981) は、繰返しのない公共財ゲームで経済学専攻の学生たちはそうでない学生たちよりも利己的に行動すると主張したが、比較された集団が高校生であるうえに両集団の男女比も大きく異なっていた。この比較では、経済学部を学ぶ学生たちのほうが他の科学を学ぶ学生たちよりも非協力的とは結論づけられない。次に Carter and Irons (1991) は、繰返しのない最後通牒ゲームで経済学専攻の学生のほうが利己的に振るまうと報告したが、その最後通牒ゲームでは先手を別のゲームの勝者としていた。この設定で経済学部を学ぶ学生のほうが先手の有利さを遠慮なく行使する傾向があるとしても、それは「運良く有利な立場にたった個人は、運悪く不利な立場にいる個人を搾取してよい」と思っているからではなく、「正当な理由があって有利な立場を獲得した個人は、それを利用してよい」と考えているからかもしれない。さらに Frank, Gilovich and Regan (1993) は、囚人のジレンマゲームにおける行動が、学生の専攻、性別、学年によって異なると主張したが、実験の精度と統計解析に難点があった。

1990 年代後半にはもっと厳密な研究が行なわれ、集団によって協力度に差が見受けられるが、特に経済学専攻の学生が非協力的とはいえないという報告がなされた。じっさい Seguino, Stervens and Lutz (1996) は、囚人のジレンマゲームにおける学生たちの行動を観察したが、性別と学年の効果は認められるものの専攻の影響を見いだせなかった。Yezer, Goldfarb, and Poppen (1996) は、現金の入った封筒を教室に放置して学生が正直に届けるかどうかを調べたが、経済専攻の学生のほうが正直に届け出たと報告している。さらに Cox (1998) は、公共財実験に近い状況での選択を尋ねる質問調査を学生に行ったが、学年や年齢の影響は見られたもの

* 本稿の研究は、京都産業大学経済学研究科が 2001 年度から 2005 年度まで実施した私立大学学術研究高度化推進事業「オープン・リサーチ・センター」『実験経済学：経済学教育の新しい方法と、それによる経済学教育の社会的効果の研究』と、その継続事業として同研究科が 2006 年度から 2008 年度の予定で推進している私立大学学術研究高度化推進事業「オープン・リサーチ・センター」『経済実験による研究と教育：実験から誰が何を学ぶか』の研究の一貫として行われている。同事業による助成と京都産業大学の支援に感謝する。本稿は、大阪大学社会経済研究所附属行動経済学研究センターと大阪大学 21 世紀 COE プログラム『アンケート調査と実験による行動マクロ動学』の主催による『第 6 回行動経済学ワークショップ』（千里ライフサイエンスセンター、2007 年 2 月 10 日）の、小田宗兵衛の報告「経済学教育：実験で学生たちが学ぶことと学ばないこと」において、京都産業大学で現在継続中の研究を紹介するための参考資料である。

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の、専攻の差が与える影響は必ずしも明確ではないと述べている。

我々は、これらの研究を参考に、7 つの質問（仮想的状況を示し、そのとき他人あるいは自分は協調的行動をとると思うかを尋ねる質問）と 1 つの実験（匿名の相手との 1 回限りの囚人のジレンマ）を、2002 年から京都産業大学の経済学部および他学部（経営学部、法学部、外国語学部、文化学部、理学部、工学部）の学生に対し実施している（現時点で 399 名）。質問に対する解答と実験での行動を分析すると、経済学部の学生は他学部の学生よりも（状況も報酬も仮想的な）質問調査では非協力的傾向を示すが、（状況が具体的で小額の現金所得が自分と相手の行動に応じて得られる）実験での行動には差は見られなかった。我々の得た結論の概略は以下の通り。

< 1 > **質問と実験の全体に対する学生の反応の相関（学生の属性ごと）**　8 つの課題において協力的選択肢を選んだ課題の数を「協力度」と定義し、学生の属性ごとの協力度を比較したところ、経済学部学生の協力度は他学部学生の協力度よりも有意に低く、男子学生の協力度は女子学生の協力度よりも有意に低かった。経済学部学生が他学部学生より非協力な程度は、男子学生が女子学生より非協力な程度と同じであった。いっぽう学年による協力度の有意な差は認められなかった。

< 2 > **質問に対する学生の回答の相関（学生の属性ごと）**　7 つの質問において協力的選択肢を選んだ数と学生の属性との相関は、上述の協力度と学生属性との相関と同じ。質問の各々と学生属性との相関は質問ごとに異なる。7 つの質問のうち 5 つは学生の何らかの属性と有意な相関を示したが、背後に説得的な理由を見いだすことは難しい。

< 3 > **実験での学生の行動の相関（学生の属性ごと）**　実験での行動と学生の所属学部と性別には相関は見られなかったが、4 年生は 3 年生以下よりも有意に協力をする割合が大きかった。

< 4 > **各質問に対する学生の回答の相関（各学生ごと）**　質問に対する回答と実験での行動に一致がないだけでなく、学生たちの各質問への回答にも一貫がなかった。多くの学生たちは、異なる質問—たとえば **B1**：「あなたは、あなたの名前と住所の書かれている封筒に現金を入れて落としました。拾った人は、あなたに返すと思いますか？」と **B2**：「あなたは、現金の入っている封筒を拾いました。封筒には誰かの名前が書かれています。あなたはその人に届けますか？」—に対して異なる回答をするだけでなく、抽象的には同じ意味の質問—たとえば **B2** と **A2**：「10 個の納品に対して 9 個分の請求書しか来なかったら、あなたはそれを正直に請求者に伝えますか？」—に対して異なる回答をした。同一人物が同一時点で十分に時間をかけて回答や意思決定をしたにもかかわらず回答が一貫しなかったことは、個人の回答が質問されている状況をどう想像するかに依存することと、個人の利己心や協力の程度を簡単な調査や実験で一般的に推量することの困難さを示唆する。

< 5 > **質問に対する学生の回答と実験での行動の相関（各学生ごと）**　実験での行動（協力と裏切のいずれを選ぶか）と質問に対する回答に相関は、1 つの質問を除いて見られなかった。質問全体（7 つの質問のうち協力的回答をした質問の数）は実験での行動に対して相関がなく、各々の質問も、**B1** を除けば、実験での行動に有意な相関を示さなず、実験での行動を予測する能力をもたなかった。

2　質問調査と実験

2.1　実験

京都産業大学の経済実験室で京都産業大学学部学生を被験者として行われる様々な経済実験の終了後の追加実

験として、追加実験を行った。追加実験は、表 1 の利得行列をもつ 1 回かぎりの囚人のジレンマ・ゲームであるが、フレーミングが影響するのを避けるため、2 つの選択肢を協調と裏切ではなく **C** と **D** と呼び、いずれかを選ぶように求めた。

対戦相手は実験参加者から無作為に抽出され、互いに匿名のまま対戦し、結果に応じて 100 円から 400 円が当日の主実験で得た報酬（3000 円程度）に加算して支払われた。主実験からの報酬の計算方法は主実験の前に説明されているとはいえ一般に複雑なので、追加実験をするときに自分の謝金がいくらになるか計算できている被験者は、実験の種類と結果に依存するが、ほとんどいないと思われる。主実験の参加者は最大 28 名であり、数人ずつ友人と一緒に参加する学生たちもいるが、大部分は相互に京都産業大学の学生であるという以上の知識のない間柄である。特に確認をしていないが、内容を考えれば、以上は参加者全員の共有知識となっていると考えられる。

追加実験の理解を確認するために、実験の説明書を配布し、それを実験者が読み上げ、さらに理解を確かめる試験を行った。そして参加者全員が正解したことを確認し、参加者全員にそれを周知してから追加実験を行った。被験者は、各自の端末から **C** または **D** を入力した。

表 1　実験の利得表（被験者への追加謝金＼対戦相手への追加謝金）

		匿名の対戦相手	
		C	D
被験者	C	300 円＼ 300 円	100 円＼ 400 円
	D	100 円＼ 400 円	200 円＼ 200 円

2.2　質問調査

追加実験終了後に表 2 の 8 つの質問を追加実験の参加者全員に尋ねた。ただし、追加実験の入力は終わっているが、実験結果は質問調査が完全に終わるまで被験者に知らされなかった。質問は、Frank *et.al.* (1993) および Cox (1998) の仮想的質問調査や実地調査（実際に教室に現金の入っている封筒を放置して学生の行動を調べた）に対応するものである。同じ質問でも、意味が 20 世紀末の米国の大学生に対するのと 21 世紀の日本の大学生に対するのでは異なるかもしれないが、既存研究との比較のためあえて同じ質問をした。ただし **C2** については、選挙権を持たなかったり持っていてもまだ行使の機会のない学生がかなり多かった上に、この質問だけが仮想的状況での本人あるいは他人の構想ではなく本人についての事実を尋ねていて分析を複雑化するので、以下の分析から省いた（説明を複雑にしないため、概要では初めから 7 問からなる質問調査をしたように説明した）。

3　結果

追加実験と質問調査は 2001 年以降、主実験の後に時間的余裕があるときに断続的に行われている。そのため複数回参加している被験者がいるが、以下の分析では、何年前でも 1 度でも追加実験と質問調査に参加した学生については初回の記録だけを対象にする。分析対象者は、京都産業大学の各学部（経済学部、経営学部、法学部、外国語学部、文化学部、理学部、工学部）の 1 年生から 4 年生までの男女合計 399 名である。

表 3 は、各集団ごとに、各課題に協力的応答（ただし協力的応答とは、二者択一問題に対しては YES と回答すること、金額を答える問題に対して平均値以上を答えること、実験においては協力を選ぶこと）を選んだ

学生の数を、括弧内の各々の集団の人数に占める百分率とともに示す。ただし **V** 列の値は、その集団の個人が平均的にいくつ協力的応答をするかを、括弧内にその $\frac{1}{8}$ の値とともに示す。括弧内の値は、その集団の学生が各課題（7 つの質問と 1 つの実験）に対して協力的応答をする割合の平均であり、以下「協力度」と呼ぶ。

表 4 は、各質問と実験に対する係数と括弧内にその p 値を示す。ただし係数は、行の属性が → の左から右へ移ることに対する列の変数に対する効果を表す。第 1 節の < 1 > から < 3 > は、この表から導かれる。表 5 は、各質問に協力的回答を返すこと（0 または 1）と実験での協力的行動との相関、および 7 つの質問に対して協力的回答を返す割合（0, $\frac{1}{7}$, $\frac{2}{7}$, ..., $\frac{6}{7}$, 1）と実験での協力的行動との相関を、括弧内の p 値とともに示す。< 5 > は、両表から導かれる。< 4 > の分析については、本稿は省略する。

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表 2　質問表

ある事業者がパソコンを 10 個購入したところ、請求書には 9 個分の金額しか書かれていませんでした。

A1　あなたはこの事業者は正直に 9 個分しかないと売り手に言うと思いますか？

A2　あなたが事業者なら正直にミスを売り手に伝えますか？

あなたは 1 万円の入った封筒を落としました。封筒にはあなたの住所と名前が書かれています。

B1　拾った人は所有者（あなた）に返すと思いますか？

B2　あなたが拾ったなら、所有者に返しますか？

C1　水不足のため、市がトイレの貯水タンクに水を入れたペットボトルを沈めるように呼びかけています。ペットボトルを入れると水の節約になりますが、トイレの水流は弱くなります。あなたはこの呼びかけに応じますか？

C2　あなたは一番最近の選挙で投票に行きましたか？

D1　あなたは海外旅行先の人気のレストランで 3 人の友人にご馳走しました。勘定は 56 ドルでした。あなたについたウェイターは愛想がよく、充分なサービスをあなたに提供しました。あなたはチップを何ドル払いますか？

D2　あなたが 10000 円持っていて、それを 1 年間投資しなくてはならないとします。クラスのほかの人も同じ条件です。あなたは 10000 円を自由に資産 A と資産 B に分けて投資できます。資産 A はあなたが投資した額に比例して 5 %の利子があなたに支払われます。資産 B はそれに投資した人全員の投資が集められ、それに 10 %の利子がつきます。利子はクラスの人間全員に等分に分けられます。たとえばクラスが 20 人で、全体で資産 B に 100000 円集まった時、利子は 10000 円、それを 20 で等分した 500 円が全員に支払われます。このときあなたは資産 B にどれだけ投資しますか？

表 3　各問に対する学生の反応

			A1	A2	B1	B2	C1	D1	D2	E	V
経済学部 154 名	男子 116 名	1 年生 34 名	13 (38.2)	22 (64.7)	9 (26.5)	24 (70.6)	29 (85.3)	12 (35.3)	14 (41.2)	10 (29.4)	3.91 (48.9)
		2 年生 38 名	21 (55.3)	27 (71.1)	10 (26.3)	22 (57.9)	29 (76.3)	8 (21.1)	17 (44.7)	14 (36.8)	3.89 (48.7)
		3 年生 28 名	13 (46.4)	17 (60.7)	12 (42.9)	21 (75.0)	26 (92.6)	6 (21.4)	13 (46.4)	7 (25.0)	4.11 (51.3)
		4 年生 16 名	10 (62.5)	14 (87.5)	3 (18.8)	7 (43.8)	11 (68.8)	3 (18.8)	7 (43.8)	6 (37.5)	3.81 (47.7)
	女子 38 名	1 年生 9 名	8 (88.9)	9 (100.0)	3 (33.3)	9 (100.0)	7 (77.8)	3 (33.3)	6 (66.7)	3 (33.3)	5.33 (66.7)
		2 年生 17 名	9 (52.9)	10 (58.8)	9 (52.9)	15 (88.2)	14 (82.4)	6 (35.3)	8 (47.1)	5 (29.4)	4.47 (55.9)
		3 年生 6 名	3 (50.0)	5 (83.3)	4 (66.7)	6 (100.0)	6 (100.0)	1 (16.7)	2 (33.3)	0 (0.0)	4.5 (56.3)
		4 年生 6 名	5 (83.3)	5 (83.3)	3 (50.0)	4 (66.7)	6 (100.0)	0 (0.0)	5 (83.3)	4 (66.7)	5.33 (66.7)
他学部 245 名	男子 156 名	1 年生 40 名	26 (65.0)	37 (92.5)	16 (40.0)	32 (80.0)	28 (70.0)	17 (42.5)	19 (47.5)	14 (35.0)	4.73 (59.1)
		2 年生 37 名	23 (62.2)	32 (86.5)	13 (35.1)	28 (75.7)	29 (78.4)	9 (24.3)	19 (51.4)	8 (21.6)	4.35 (54.4)
		3 年生 53 名	30 (56.6)	42 (79.2)	16 (30.2)	40 (75.5)	41 (77.4)	16 (30.2)	32 (60.4)	18 (34.0)	4.43 (55.4)
		4 年生 26 名	20 (76.9)	23 (88.5)	6 (23.1)	20 (76.9)	19 (73.1)	7 (26.9)	14 (53.8)	15 (57.7)	4.77 (59.6)
	女子 89 名	1 年生 26 名	15 (57.7)	22 (84.6)	12 (46.2)	23 (88.5)	19 (73.1)	5 (19.2)	15 (57.7)	10 (38.5)	4.65 (58.2)
		2 年生 19 名	13 (68.4)	15 (78.9)	6 (31.6)	17 (89.5)	18 (94.7)	1 (5.3)	12 (63.2)	5 (26.3)	4.58 (57.2)
		3 年生 22 名	13 (59.1)	21 (95.5)	5 (22.7)	20 (90.9)	14 (86.4)	7 (31.8)	14 63.6	7 (31.8)	4.82 (60.2)
		4 年生 22 名	15 (68.2)	19 (86.4)	6 (27.3)	17 (77.3)	18 (81.8)	5 (22.7)	12 (54.5)	12 (54.5)	4.73 (59.1)

表 4　回帰式

	A1	A2	B1	B2	C1	D1	D2	E	(V)
定数項	-0.269	-1.561	0.478	-1.669	-1.316	0.748	-0.006	0.679	0.567
	(0.180)	(0.0000)	(0.019)	(0.0000)	(0.0000)	(0.0004)	(0.976)	(0.001)	(0.0000)
他学部	-0.200	-0.454	0.050	-0.239	0.206	-0.066	-0.156	-0.075	-0.024
→ 経済学部	(0.062)	(0.0005)	(0.656)	(0.054)	(0.130)	(0.583)	(0.139)	(0.505)	(0.014)
女子	-0.087	-0.084	-0.167	-0.522	-0.256	0.178	-0.161	-0.009	-0.024
→ 男子	(0.442)	(0.560)	(0.146)	(0.0006)	(0.077)	(0.167)	(0.145)	(0.937)	(0.014)
1 年	0.147	-0.345	-0.12	-0.375	0.26	-0.612	0.067	-0.223	-0.027
→ 2 年	(0.594)	(0.314)	(0.673)	(0.260)	(0.435)	(0.047)	(0.804)	(0.445)	(0.275)
2 年	-0.282	-0.028	0.029	0.326	0.339	0.274	0.188	-0.001	0.017
→ 3 年	(0.310)	(0.932)	(0.921)	(0.326)	(0.352)	(0.390)	(0.494)	(0.998)	(0.494)
3 年	0.735	0.65	-0.446	-0.757	-0.55	-0.283	-0.114	0.991	0.012
→ 4 年	(0.026)	(0.134)	(0.194)	(0.037)	(0.162)	(0.438)	(0.715)	(0.002)	(0.658)

表 5　各質問への回答に基づく実験結果の予想

	定数項	A1	A2	B1	B2	C1	D1	D2
係数	0.858	-0.013	0.341	0.102	-0.075	0.063	0.025	0.000
(p 値)	(0.001)	(0.917)	(0.036)	(0.394)	(0.581)	(0.643)	(0.143)	(0.174)

	定数項	協力的回答の割合
係数	1.018	0.649
(p 値)	(0.003)	(0.232)

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What Students Learn from Market Experiments and What They Don't*

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Abstract

This paper describes what students learn from economic experiments and what they do not. The authors did a series of classroom experiments, questionnaires, quizzes and lectures to teach microeconomics. The results show that students learned from the experiments, but what they learned may have been quite different from what they had been expected to learn by teachers; most students who have participated in market experiments learned simply how to make profits as individual traders while getting no idea about how market functions as a whole. The analysis suggests that students can get the most benefit from experiments only when they have learned or learn economics concurrently.

1 Introduction

Experimental economics has contributed to education of economics as long as it has to economic research. In fact, Chamberlin (1948) and Smith (1962) developed market experiments to teach economics to their students. Since then many classroom experiments have been developed; teachers can now use textbooks (Bergstro and Miller 2000, Holt 2007) and web sites to teach economics with experiments.[1] Students enjoy experiments, claiming that they have learned much about economy from the experiments. Dickie (2000), however, reports that all students who have participated in classroom experiments may not deepen their understanding of economics.

We conducted a series of classroom experiments, questionnaires, quizzes and lectures to teach microeconomics at Faculty of Economics, Kyoto Sangyo University in 2005 and in 2006. This paper reports some findings from these activities, suggesting what students learn from experiments and what they don't.

This paper is organised in the following way.

Section 2 outlines our experiments, which were well-established classroom market experiments: oral pit markets and double auctions. Students produced such outcomes that would be done by those subjects who are paid real money according to their performance in the experiments. It confirms that students took part in experiments seriously.

Section 3 summarises students' answers for the quizzes which we did after each experiment to check students' understanding of the experiment they had participated in. No significant correlations were

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[1]The textbooks mentioned in the text have their site: <http://zia.hss.cmu.edu/miller/eep/eep.html>; <http://aw-bc.com/holt>.

seen between students' performances in experiments and their answers for the corresponding quizzes. It suggests that students' enjoying experiments is one thing, but their learning economics is quite another.

Section 4 examines students' answers to the questionnaires that we did after each experiment. Together with students' answers to the quizzes, they suggest the following. (a) Those who take part in experiments more diligently are more likely to produce better performances in the experiments, but all of them may not obtain better understanding of the experiments. (b) Students can learn something from experiments particularly when they have first-hand experience on it, but they may not always be able to express it properly in technical terms.

Section 5 provides concluding remakes on our findings from a broader viewpoint. We shall discuss briefly what our findings imply between experiments for economic research and experiments for economics education.

Since we repeated the same series for two years to obtain basically the same results, we shall reports our activities and findings in 2005 in the text. The appendix provides data about our activities in 2006, which we shall examine to see how general or special the analysis in the text would be.

2 Experiments

We organised a series of six classes (90 minutes each) to teach students microeconomics with experiments at Kyoto Sangyo University (KSU) in the first half of the spring semester in 2005. Most of the attenders were two-year students of the Faculty of Economics, KSU, who had attended introductory classes of microeconomics and macroeconomics in the previous year. The course was composed of three units, each of which consisted of a classroom experiment, a questionnaire, a quiz and a lecture. Although all students did not attend all classes, about one hundred students attended a class; see Table 1.

Table 1: Classes and attenders

Date	Class		Number of Students
14 April 2005	1	Experiment 1 and Questionnaire 1	110
21 April 2005	2	Quiz 1 and Lecture 1	118(=91+27)
28 April 2005	3	Experiment 2 and Questionnaire 2	101
12 May 2005	4	Quiz 2 and Lecture 2	108(=84+24)
19 May 2005	5	Experiment 3	118
26 May 2005	6	Quiz 3,Questionnaire 3 and Lecture 3	80(=57+23)

Number of classes attended	1	2	3	4	5	6
Number of students	110	91	81	66	58	26

The number of students who attended a class to do a quiz is expressed as a sum of two terms in the parentheses: the number of students who also attended the previous class to take part in the experiment about which they were asked in the quiz (the first term) and the number of students who did not (the second term).

The series of experiments was designated to deepen students' understanding about cost and supply: what determines the market supply curve is cost (Experiment 1), more precisely variable cost (Experiment 2) and even more precisely marginal cost (Experiment 3).

Experiment 1 An oral pit market experiment which was done at Koyama Coliseum (an outdoor stage of KSU). It was a standard pit market experiment where each student could buy or sell a unit of a commodity. Each seller had his cost; he earned a positive profit if he sold a unit of a commodity at a price higher than his cost, while he did not make any profits or losses if he did not trade. Each buyer had her reservation price; she enjoyed a positive surplus if she buys a unit of the commodity at a price lower than her reservation price. Four sessions are repeated without changing the distribution of costs and reservation prices as a whole.

The distribution of sellers' costs and buyers' values was given by Table 2. Prices and the number of units traded converged adequately to the intersection of the market supply and demand curves; see Figure 1 and Table 5.

Experiment 2 Another oral pit market experiment which was done at Koyama Coliseum. Six sessions are repeated without changing the distribution of sellers' costs and buyers' values as a whole. In the first three sessions (**Experiment 2a**) the protocol of the experiment was the same as that of Experiment 1, while in the other three sessions (**Experiment 2b**) a half of every seller's cost was assumed to be fixed so that a seller suffered as large a loss as his fixed cost if he did not sell a unit of the commodity.

The distribution of sellers' costs and buyers' values was given by Table 3. Results were shown in Figure 2 and Table 5. In Experiment 2a, prices converges toward the equilibrium level while the number of units traded exceeded the equilibrium quantity. In Experiment 2b, a downward shift of the market supply curve increased the equilibrium quantity and decreased the equilibrium price, but students experienced that the number of units traded remained unchanged and that, apart from the fact that prices were scattered more widely, prices scarcely changed on average. As a result, prices are much higher than the new equilibriums price while the number of units traded were near the new equilibrium quantity.

Experiment 3 A double auction experiment which was done at Kyoto Experimental Economics Laboratory (KEEL), Kyoto Sangyo University. In the experiment each student was allowed to trade more than one units of a commodity. Since the capacity of the KEEL is twenty-eight persons, students were divided into five groups to took part in the experiment without training sessions.

Sellers' marginal costs and buyers' marginal values were given by Table 4. Results were, as shown in Figure 3 and Table5, different from group to group.

Table 2: Sellers' costs and buyers' values for Experiment 1

Seller's cost	Number of sellers	Buyer's value	Number of buyers
230	4	300	4
210	1	260	10
170	18	220	18
130	9	180	12
90	14	140	8
50	10	100	2
Total	56	Total	54

Before the first session started, students were divided randomly into two groups: sellers and buyers. Then a seller card on which the possessor's cost was written was given to every seller while a buyer card on which the possessor's value was written was given to every buyer. Every time a session was over, every student was asked to change his/her card with someone in his/her group for the next section. By this procedure, though the possessor of each card altered as the session changed, two groups remained unchanged as a whole. The same applies to Experiment 2 too.

Table 3: Sellers' costs and buyers' values for Experiment 2

Seller's cost	Number of sellers	Buyer's value	Number of buyers
250	3	260	17
170	20	220	15
90	10	140	10
50	13	100	13
Total	46	Total	55

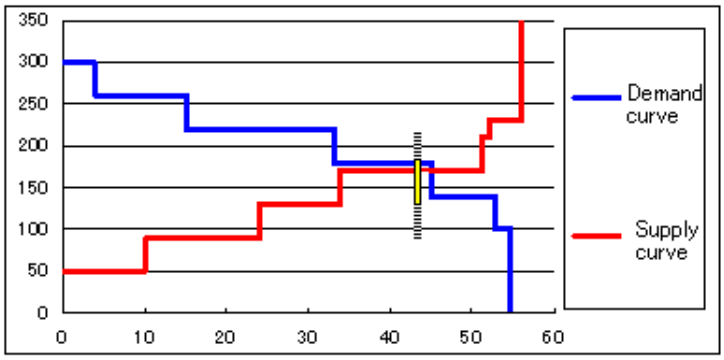

Figure 1: Results of Experiment 1

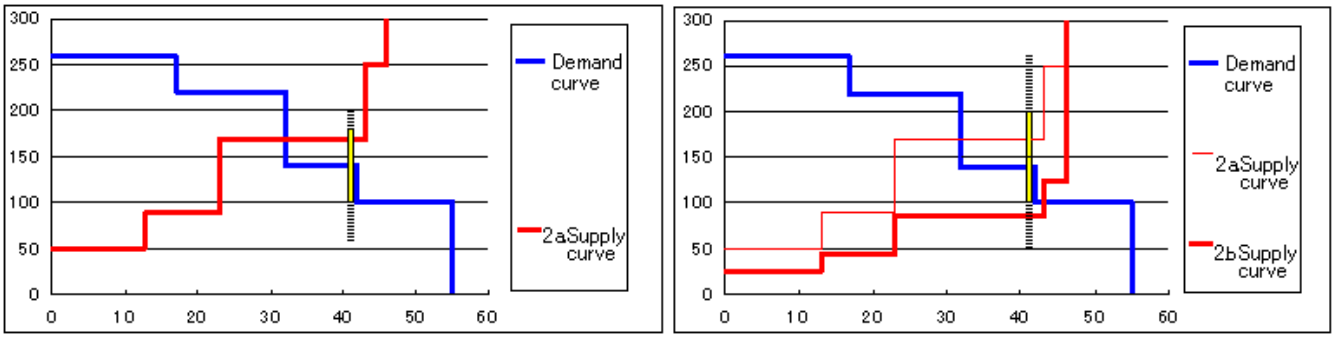

Figure 2: Results of Experiment 2

Table 4: Seller's marginal costs and Buyer's marginal values for Experiment 3

	Seller's marginal cost		Buyer's marginal value
First Unit	20	First Unit	400
Second Unit	120	Second Unit	330
Third Unit	200	Third Unit	250
Fourth Unit	300	Fourth Unit	150
Fifth Unit	∞	Fifth Unit	0

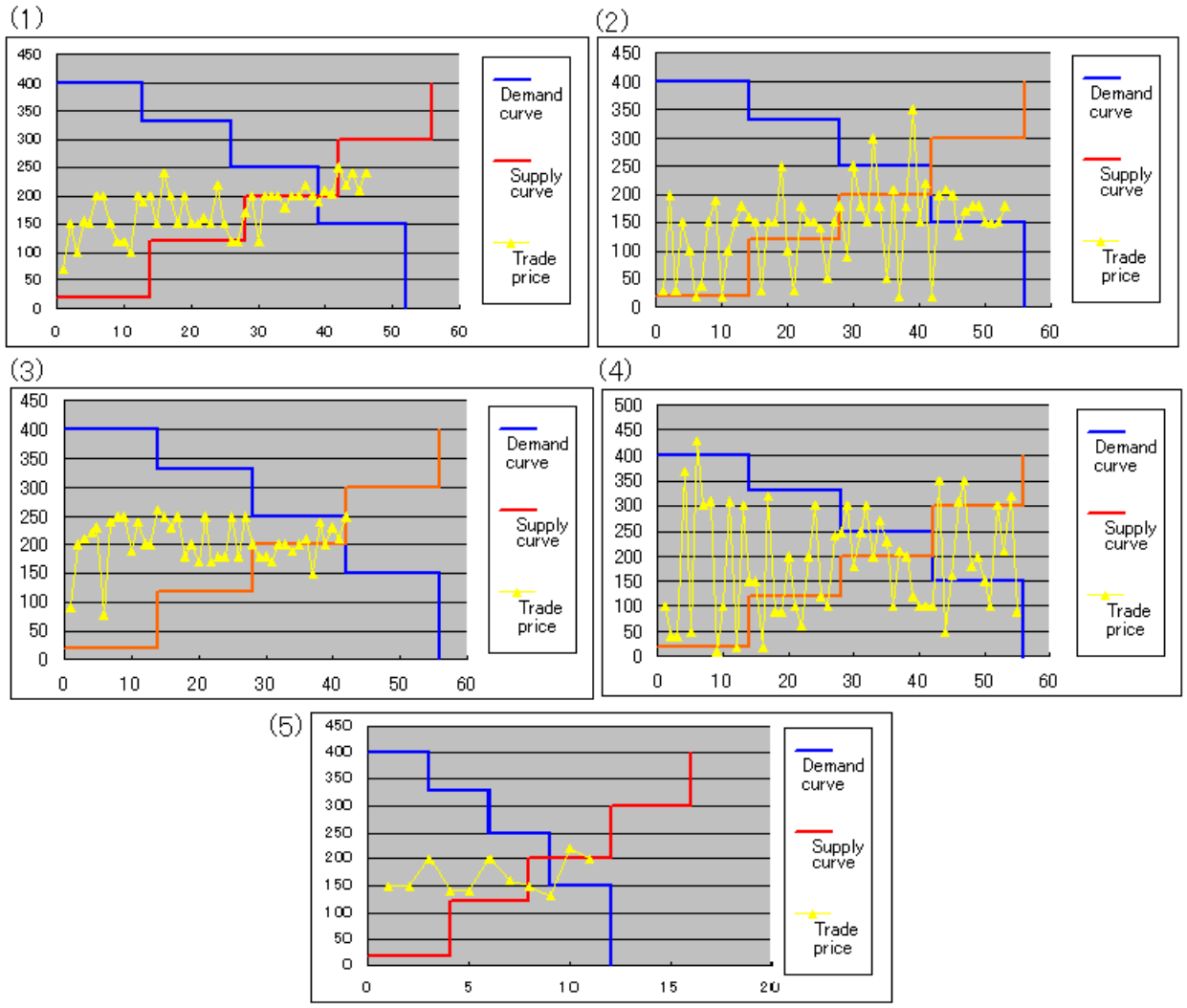

Figure 3: Results of Experiment 3

Table 5: Results of Experiments

Experiment (Group)	1	2a	2b	3				
				(1)	(2)	(3)	(4)	(5)
X^*	45	32	43	39	42	42	42	9
P^*	170	170	100	200	200∼250	200∼250	200∼250	200
SS^*	2680	2360	1825	3640	4690	4690	4690	1040
BS^*	2440	2280	4920	4940	4270	4270	4270	1140
TS^*	5120	4640	6745	8580	8960	8960	8960	2180
$\bar{X}$	43	41	41	46	53	42	55	11
$\bar{P}$	156	159	154	176.5	143.9	205	185.4	167.2
$P_{\max}$	215	200	260	250	350	260	430	220
$P_{0.75}$	180	180	200	200	180	230	300	200
$P_{0.5}$	150	150	150	190	150	200	180	150
$P_{0.25}$	140	100	100	150	180	90	100	140
$P_{\min}$	90	60	50	70	80	20	10	130
$\overline{SS}$	1972	1825	1433	1501	-532	2170	1540	220
$(\overline{SS}/SS^*)$	(0.736)	(0.773)	(0.791)	(0.412)	(-0.113)	(0.462)	(0.328)	(0.211)
$\overline{BS}$	2508	2075	2432	5569	7742	4200	5470	1830
$(\overline{BS}/BS^*)$	(1.028)	(0.910)	(0.462)	(1.127)	(1.813)	(0.983)	(1.281)	(1.605)
$\overline{TS}$	4480	3900	3875	7070	7210	6370	7010	2050
$(\overline{TS}/TS^*)$	(0.875)	(0.841)	(0.574)	(0.824)	(0.804)	(0.710)	(0.782)	(0.940)

X^* : number of units traded in equilibrium
P^* : price in equilibrium
SS^* : sellers' surplus in equilibrium
BS^* : buyers' surplus in equilibrium
TS^* : total surplus in equilibrium

$\bar{X}$: number of units traded in experiment
$\bar{P}$: average price in experiment
$P_{\max}$: maximum price in experiment
$P_{0.75}$: upper quartile price in experiment
$P_{0.5}$: median quartile price in experiment
$P_{0.25}$: lower quartile price in experiment
$P_{\min}$: minimum price in experiment
$\overline{SS}$: sellers' surplus in experiment
$\overline{BS}$: buyers' surplus in experiment
$\overline{TS}$: total surplus in experiment

All data mentioned in the lower half of the table are calculated from the data of the last session of each experiment: the fourth session of Experiment 1; the third session of Experiments 2a; the third session of Experiment 2b; the first session for Experiment 3.

Let us examine each experiment closely.

Experiment 1 produced a representative outcome as a classroom pit market experiment. It is our experience that, probably because some some students put trading with someone before making profits, the number of units traded exceed the equilibrium quantity more frequently than it did not. In Experiment 1, however, the number of units traded was marginally smaller than the equilibrium quantity. Considering that the market supply and demand curves were much closer to each other in the left of the equilibrium point than they were in its left, we could regard it as an effect of students' earnest efforts to make profits.

Experiment 2 gave a representative result too. Certainly prices and the number of units traded did not react a change in market equilibrium, but it is often observed even in double auction market experiments with monetary motivated subjects particularly when either the market supply curve or the market supply curve has shifted (Davis and Holt 1993, pp. 141-149). No students made such trade that would bring about negative surplus to themselves in Experiment 2a or in Experiment 2b.

The results of Experiment 3 suggest that all students may have not understood the protocols or the meaning of their marginal costs or values in terms of surplus maximisation. Except for Group 3, prices did not cease to change until the end of session in Groups 2 and 4 and/or more units were traded than they would have done in equilibrium. Market efficient was not very bad, but the market supply and demand curves were set in such positions that even random trading could achieve a certain level of performance: as is readily checked, if every trader had traded all the four units that he or she could have sold or bought, market efficiency would have been 0.77 (=6860/8960). An interesting example is Group 3, where prices converged into the range of the equilibrium price and the number of units traded was just equal to one in equilibrium. Apparently the group's efficiency seemed excellent. Certainly it would have been 100 per cent if every trader would have sold or bought three units. However, it was not the case, as a result of which the efficiency of Group 3 was the lowest of the five groups, even lower than 0.77. It suggests that some students may have traded without considering how many units they had already sold or bought and actually not a few students made such erroneous trades that decrease their own surplus. We shall return to this point in Section 4.

Despite the above-mentioned qualifications about Experiment 3, we believe that overall results of experiments are sufficiently comparable with those of experiments for research which pay subjects real money according to their performances. From our data obtained from experiments and our observation of students, we could fairly claim that students made serious efforts to maximise their surplus in all experiments.

3 Quizzes

We gave a quiz to students in a week after each experiment. Students were given the results of the experiment and the data about sellers' costs and buyers' values, and asked the same question: "Draw the market supply and demand curves for the experiment you participated in last week."

Quiz 1 In total 118 students were given the distribution of sellers' costs and buyers' values (Table 2) and the trading records (Table 6). Only three students gave the correct answer. Common wrong answers are shown in Figure 4.

Quiz 2 In total 110 students were given the distribution of sellers' costs and buyers' values (Table 3) and the trading records (omitted). **Quiz 2a** asked the market supply and demand curves in Experiment 2a, to which 45 students gave an correct answer; **Quiz 2b** asked the market supply and demand curves in Experiment 2a, to which 13 students gave an correct answer.

Quiz 3 In total 80 students were given the distribution of sellers' costs and buyers' values (Table 4), the numbers of sellers and buyers of every group as well as its trading records (omitted). Sixty-one students drew the right market supply and demand curves.

Overall results, which are summarised in Table 7, suggest defects in the present curriculum at the Faculty of Economics of KSU, which might exist in other institutions. The small percentage of correct answers for Quiz 1 suggests that most students had seen the market supply and demand curves only in conceptual terms before they experienced Experiment 1. It can be confirmed by Figure 4: a large

Table 6: Trading records of Experiment 1

Trade	Session 1	Session 2	Session 3	Session 4
1	100	200	180	180
2	200	130	160	130
3	220	200	150	200
⋮	⋮	⋮	⋮	⋮
40	220	180	175	150
41	100	260	180	215
42	160	180	200	180
43	200	200	180	200
44	200	180	170	
45	200			
Maximum Price	250	260	260	215
Average Price	167.4	158.4	158.3	156.0
Minimum Price	90	90	80	90

majority of students drew just an upward-sloping curve and a downward-sloping one, without mentioning any data given to them. That conjecture is reinforced by the low percentages of correct answers for Quiz 2b. Although they have seen shifts in the market supply and demand curves again and again on the blackboard and in the textbook, they seem to have difficulties in applying what they have learned to a simple classroom experiment.

Were students who earned more in an experimental market more likely to draw the correct supply and demand curves of the market? Table 8 shows it was not the case: whether students showed good performances in experiments were not correlated significantly with whether they gave correct answers to corresponding quizzes. This fact is not surprising, because market is such a system that does not require traders to have "intelligence" (Gode and Sunder 1993). In experiments students only had to concentrate their efforts to make good deals, without worrying about the market supply and demand curves. In more general terms of Hofstadter (1979), students did not need to "jump out of the system" to be successful within the system. It is quite possible in the circumstances those who earned much in a market experiment did not coincide with those who understood well about it.

Table 7: Students' answers for quizzes

	Quiz 1		Quiz 2a		Quiz 2b		Quiz 3	
Experience of the experiment about which the quiz asks	Yes	No	Yes	No	Yes	No	Yes	No
Correct answers	3	0	34	11	11	2	42	19
Wrong / No answers	88	27	52	13	75	22	15	4
Total	91	27	86	24	86	24	57	23
Percentage of correct answers	3.3	0.0	38.1	45.8	13.1	8.3	73.7	82.6
p-value	—		0.14		0.71		0.40	

It cannot be said that those who had participated in Experiment k were more likely to gave a correct answer for Quiz k: for $k = 2a$ and $k = 3$ correlations are negative (those who had not taken part in the experiment were more likely to give correct answers!), while for $k = 1$ and $k = 2b$ correlations are positive, but p-values are so large that they are not significant. Here it should be noted that most students who did not attended an experiment but answered the corresponding quiz correctly had experienced all or some of the previous experiments and/or quizzes.

Table 8: Correlations between students' performances in experiments and their answers for quizzes

Performance in Experiment 1	Bad	Good	Total
Correct Answers for Quiz 1	1	2	3
Wrong/No Answers for Quiz 1	44	44	88
Total	45	46	91

p-value=0.57

Performance in Experiment 2a	Bad	Good	Total
Correct Answers for Quiz 2a	16	18	34
Wrong/No Answers for Quiz 2a	26	26	52
Total	42	44	86

p-value=0.79

Performance in Experiment 2b	Bad	Good	Total
Correct Answers for Quiz 2b	8	3	11
Wrong/No Answers for Quiz 2b	35	40	75
Total	43	43	86

p-value=0.11

Performance in Experiment 3	Low	High	Total
Correct Answers for Quiz 3	19	23	42
Wrong/No Answers for Quiz 3	9	6	15
Total	28	29	57

p-value=0.33

A student's performance is defined by $\bar{\pi}_i - \pi_i^*$. Here $\bar{\pi}_i$ represents the profit that the student could have earned if all units were traded at the equilibrium price in all sessions of the experiment; π_i^* stands for the total profit he or she actually earned in the experiment. In the tables above a student's performance is called "good" if it exceeds the median percentile of all the participants of the experiment; otherwise it is classified as "bad".

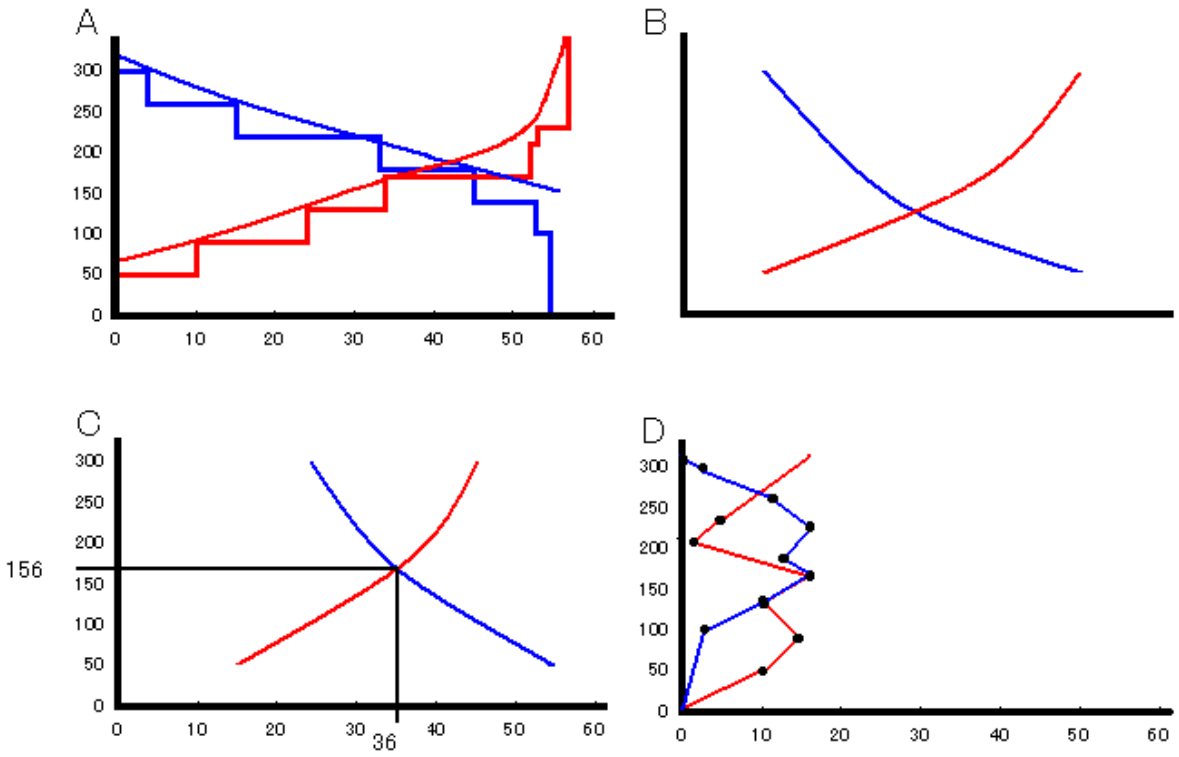

Figure 4: Common wrong answers to Quiz 1

A.Sixteen students plotted correct points but draw such smooth curves that pass through them (dotted lines were not drawn in their answers). They may have been accustomed to such curves too profoundly to draw step functions as market supply and demand curves.
B.Thirty-eight students draw an upward-sloping curve and a downward sloping curve without giving any quantitative specification. As stated in the text, most students regard supply (demand) not as something which can be derived concretely from individual sellers' cost structure (buyers' preference) but as a degree of intensity to sell (buy) in abstract terms.
C.Six students draw an upward-sloping curve and a downward sloping curve which cross each other at $(\bar{X}, \bar{P})$. It might be reasonable that such curves were drawn by those students who had been taught repeatedly that the market supply and demand curves cross each other at the equilibrium point.
D.Fifty-five students seemed to be helpless against the quiz. An example is shown above: data in Table 2 are directly plotted.

4 Questionnaires

We gave a questionnaire to students just after each experiment. Unlike the quizzes mentioned in the last section, we asked different questions about each experiment.

Questionnaire 1 In total 110 students were asked: "How did you find the experiment?" Since free description is allowed, they provided various answers to us, though most numerous one was simply "I enjoyed!" Nevertheless 54 students referred to their strategies, claiming that they had learned much about market. As Table 9 shows, some mentioned only how they have behaved while some discussed also how they should have done. No students, however, explicitly connected their experiences as traders in the experiment with their knowledge of economics or consideration of how market works as a whole.

Questionnaire 2 In total 101 students were asked: "How equilibrium changed from the first three sessions to the last three sessions?" As is shown in Table 10, fifteen students gave the correct answer that the equilibrium price fell while the equilibrium quantity increases.

Questionnaire 3 In total 80 students were asked three questions: $\mathbf{Q_{3a}}$"Did you understand the instruction of the experiment perfectly?', $\mathbf{Q_{3b}}$"Did you pay attention to the trading records shown on your display during trading periods?" and $\mathbf{Q_{3c}}$"Did you pay attention to how many units you had already traded when you propose or accept a next trade?"Those who answered in the affirmative were 42, 47 and 43 for $\mathbf{Q_{3a}}$, $\mathbf{Q_{3b}}$ and $\mathbf{Q_{3c}}$ respectively.

Table 9: Students' answers to Questionnaire 1

	those who stated how they had behaved alone	those who stated how they have behaved and how they should have behaved	those who stated nothing on their strategies
Sellers	20	2	34
Buyers	20	12	22
Total	40	14	56

Table 10: Students' answers to Questionnaire 2

Sellers' answers		Number of units traded in equilibrium: X^*			
		Increased	Decreased	No answer	Total
Price in equilibrium: P^*	Increased	4	1	5	10
	Decreased	10	0	7	17
	No answer	2	1	25	28
	Total	16	2	37	55

Buyers' answers		Number of units traded in equilibrium: X^*			
		Increased	Decreased	No answer	Total
Price in equilibrium: P^*	Increased	0	1	0	1
	Decreased	5	1	21	27
	No answer	1	1	16	18
	Total	6	3	37	46

Table 9 suggests that buyers were more regretful for their trades than sellers were. It may seem unreasonable because, as Table 5 shows, they earned more than they would have if market was in equilibrium! Yet it is often observed in classroom experiments with students who are familiar with buying but are strangers to selling.[2]

Table 10 shows that in sellers and buyers gave different answers for Quiz 2: More sellers (16 students or $\frac{16}{55} = 29$ per cent of sellers) gave the correct answer about the change of the equilibrium quantity: "Equilibrium quantity increased" than buyers (6 students or $\frac{6}{46} = 13$ per cent of buyers) did, while fewer sellers (17 students or $\frac{17}{55} = 31$ per cent of sellers) gave the correct answer about the change of the equilibrium price: "Equilibrium price decreased" than buyers (27 students or $\frac{27}{46} = 59$ per cent of buyers) did. The difference between sellers' answers and buyers' probably came of differences in their subjective experience in the experiment. Sellers may have thought they could have sold more in Experiment 2b (in fact they sold a little smaller units of commodity than they would have if market were in equilibrium) while buyers may have suspected that they could have bought at lower prices in the experiment (actually they bought at prices higher than the equilibrium price.)

The above is a subtle remark on *jumping out of the system* mentioned at the end of the last section. Although they were not motivated to consider about the experiments they participated, many students discovered something about the experiments during or after the experiments. It suggests generally that students will not devote themselves to trading completely in classroom experiments. In particular their

[2]Buyers were more regretful in 2006 too; see Table 22 in Appendix.

first-hand experience in experiments could be helpful — though sometimes regulating — for their finding out something behind the experiments.[3]

However, though students' acquiring a viewpoint from which they can see the whole system is one thing, it may be quite another that they can express their observation properly. In fact, as Table 11 shows, the percentage of students who answered Quiz 2 correctly among those who answered Questionnaire 2 correctly was $\frac{2}{15} = 13.3$ per cent, which is not higher significantly than the corresponding percentage among those who gave no/wrong answers for Questionnaire 2: $\frac{9}{71} = 12.7$ per cent. It seems to us that students who lack a minimum knowledge of economics were not able to express their experience in the experiment properly in terms of economics, while those who had sufficient knowledge of economics were able to express a shift of the market supply and demand curves whether or not they realised its effects in the experiments. [4]

Correlations were seen between whether or not students took part in experiments seriously and whether of not they were successful in the experiments. Table 12 shows that those students who understood the protocols of Experiment 3 better and who made more careful efforts in the experiment earned more profits or surplus in the experiment: correlations are observed significantly in Table 12. [5]

As a natural result of Table 7 and Table 12, those who gave correct answers to Questionnaire 3 are not necessarily more likely to gave correct answers for Quiz 3, which is confirmed by Table 13.

Table 11: Correlations between answers for Quiz 2 and answers to Questionnaire 2

	Wrong/No Answers to Questionnaire 2	Correct Answers to Questionnaire 2	Total
Correct Answers for Quiz 2	9	2	11
Wrong/No Answers for Quiz 2	62	13	75
Total	71	15	86

p-value=0.94

Table 12: Correlations between answers to Questionnaire 3 and performance in Experiment 3

Table 12a

	Performance in Experiment 3		
	Bad	Good	Total
YES to $\mathbf{Q_{3a}}$	13 (9)	29 (22)	42 (31)
NO to $\mathbf{Q_{3a}}$	27 (17)	11 (9)	38 (26)
Total	40 (26)	40 (31)	80 (57)

p-value=0.0003
(p-value=0.0060)

Table 12b

	Performance in Experiment 3		
	Bad	Good	Total
YES to $\mathbf{Q_{3b}}$	16 (11)	31 (23)	47 (34)
NO to $\mathbf{Q_{3b}}$	24 (16)	9 (7)	33 (23)
Total	40 (27)	40 (30)	80 (57)

p-value=0.0006
(p-value=0.0075)

Table 12c

	Performance in Experiment 3		
	Bad	Good	Total
YES to $\mathbf{Q_{3c}}$	13 (10)	30 (22)	43 (32)
No to $\mathbf{Q_{3c}}$	26 (15)	9 (8)	35 (23)
Total	39 (25)	39 (30)	78 (55)

p-value=0.0001
(p-value=0.0125)

Numbers in the parenthesis are the number of students who attended Class 6 to answer Quiz 3 too. Two of them gave no answer to $\mathbf{Q}_{3c}$.

[3] In 2006 sellers and buyers gave different answers differently: a majority of sellers (31 students or 69 per cent of sellers) gave the correct answer: " the equilibrium price decreased while the equilibrium quantity increased)", while only one of 49 buyers gave it; see Table 23 in Appendix. This difference also seem to be explainable by difference between sellers' experience and buyers' in experiments, which are summarised by Figure 7 in Appendix.

[4] we got a similar result in 2006 too; see Table 24 in Appendix.

[5] In 2006 significant correlations were not observed among the same data; see Table25 in Appendix. We shall mention the reason in Appendix.

Table 13: Correlations between answers to Questionnaire 3 and answers for Quiz 3

Table 13a

	Answers for Quiz 3		
	Wrong	Correct	Total
YES to $\mathbf{Q_{3a}}$	6	25	31
NO to $\mathbf{Q_{3a}}$	9	17	26
Total	15	42	57

p-value=0.1925

Table 13b

	Answers for Quiz 3		
	Wrong	Correct	Total
YES to $\mathbf{Q_{3b}}$	7	26	33
NO to $\mathbf{Q_{3b}}$	8	16	24
Total	15	42	57

p-value=0.3048

Table 13c

	Answers for Quiz 3		
	Wrong	Correct	Total
YES to $\mathbf{Q_{3c}}$	9	25	34
No to $\mathbf{Q_{3c}}$	4	19	23
Total	13	44	57

p-value=0.3778

5 Concluding Remarks

What can we conclude from the analysis in the previous sections? Figure 5 outlines our analysis.

The upper-left circle describes experiments for research: subjects are motivated by monetary rewards to be paid according to their performance in the experiment. What is expected for subjects is not discovering something *about* the experiment but devoting themselves to finding out a winning strategy *within* the experiment. It is not subjects but the experimenter who is expected to discover something about the experiment from the observer's (outsider's) viewpoint.

It is quite natural that students who participated in experiments for research often learn only within the experiments as guinea pigs in Skinner boxes. Certainly students can be motivated without monetary rewards. In fact, as Table 12 shows, those who are more earnestly motivated are more likely to achieve better performances in classroom experiments. However, this motivation does not necessarily lead students to think about the experiments from the outsider's standpoint. Table 8 is a natural result: there is no correlation between students' performance in experiments and their answers for quizzes about the experiments. In fact, as Table 7 verifies, experiencing an experiment are neither sufficient nor necessary for understanding it. A students showing good performance in an experiment is no more a researcher who understands the meaning of the experiment than a guinea pig producing good performance in the Skinner box is.

Of course human beings cannot be worker ants. As Dostoevsky descried in *The House of the Dead*, human beings cannot but considering what they are doing from the outsider's viewpoint even in such hardest circumstances as prison camps. Human beings jump out of the system quite naturally or unconsciously to make use of meta-theorems for deduction within the system, which inference requires in reality systematic thinking as Yasugi and Oda (2002, 2003) demonstrate with a simple puzzle in terms of modal logic. This human ability or instinct of *jumping out of the system* should not be underestimated. It is the basis for education. Table 10 is an example in our classroom experiments: students' first-hand experience in an experiment helped students to realise something about it.

Nevertheless noticing something is not sufficient for expressing it properly. Table 11 shows that all of those students who guessed correctly how equilibrium changed in Experiment 2 were not able to express it in terms of a shift of the market supply curve. Tables 12 demonstrates that those students who participated in Experiment 3 more earnestly and carefully produced better performances, but as Table 13 shows, they did not necessarily give correct answers for Quiz 3.

Let us conclude our analysis. Teachers must motivate students to play seriously in classroom experiments; otherwise they would not produce meaningful outcomes. It is actually possible without monetary rewards, but motivating students to participate in experiments seriously does not necessarily motivate them to think about the experiments. As we examined in this paper, the upper-left circle in Figure 5 , which expresses how experiments work for research, does not imply "high scores in examinations," not to mention "new understanding of economics."

It would however be neither fair nor productive to measure the educational effects of classroom exper-

iments in terms of standard questions which students can find in standard textbooks. By participating in experiments, students can realise various institutions and mechanisms that are tacitly supposed behind the market supply and demand curves. Certainly from experiments students cannot learn everything that is explained in the textbook, but they can learn something different. In Figure 5 that the upper-left circle may be connected with "new understanding of economics" via different routes. Economics education has two goals: to teach students how to behave in the present economy for themselves and for others, and to deepen students' understanding of economy where they live for improving our world. Both are important for students themselves and society. We must continue to improve the quality of economics education towards the two goals, to which classroom experiments can contribute greatly.

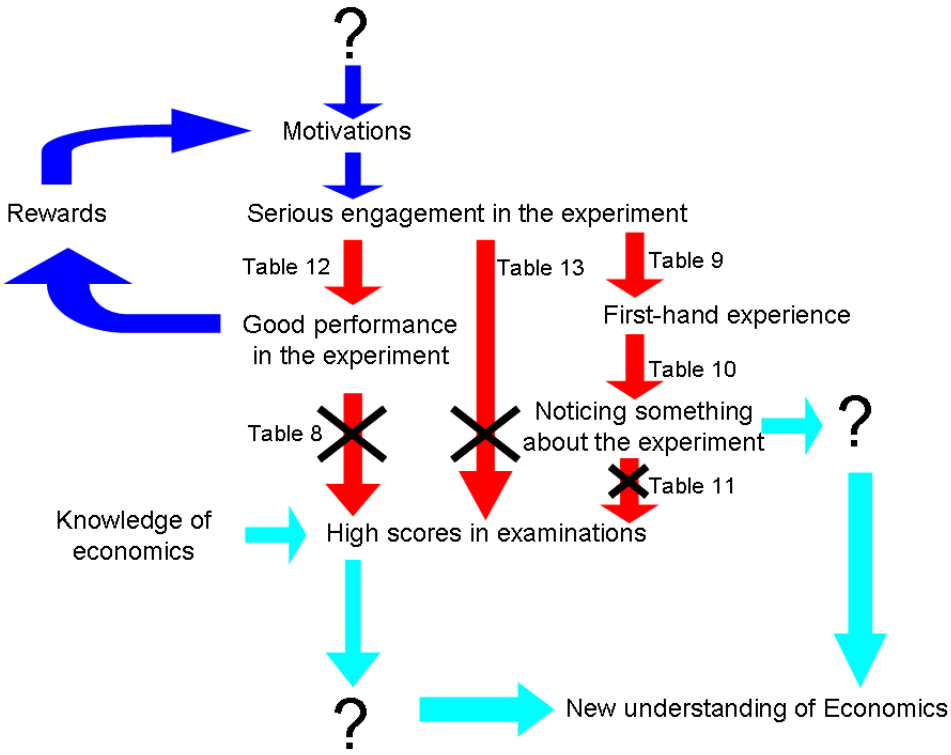

Figure 5: Classroom experiments and their educational effects

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Appendix

In 2006 we repeated Experiments 1 and 2 on the same condition while we conducted Experiment 3 on a different condition.

Experiments 1 and 2 reproduced the same results. Moreover those who participated in the experiments gave the same answers for Quizzes 1 and 2 and Questionnaires 1 and 2. Altogether the analysis in the text was confirmed about Experiments 1 and 2.

Experiment 3 produced much poorer results. It is most probably because sellers' costs and buyers' surplus were given not in marginal terms but in absolute terms. Few students seemed to calculate marginal cost or utility, which guess can be confirmed also by the fact that very few students gave the correct answer to Quiz 3; see Table 19. It seems doubtful in the circumstances to discuss the results of Experiment 3, Quiz 3 and Questionnaire 3. This is the reason why we explained our analysis with older (2005) data.

Table 14: Classes and attenders in 2006

Date	Class		Number of Students
13 April 2006	1	Experiment 1 and Questionnaire 1	108
20 April 2006	2	Quiz 1 and Lecture 1	111(=88+23)
27 April 2006	3	Experiment 2 and Questionnaire 2	94
11 May 2006	4	Quiz 2 and Lecture 2	117(=80+37)
18 May 2006	5	Experiment 3	103
25 May 2006	6	Quiz 3 and Lecture 3	138(=89+49)

Number of classes attended	1	2	3	4	5	6
Number of students	108	88	71	57	52	47

Since Experiment 3 took more time than we had expected it would take, we did not do Questionnaire 3 just after Experiment 3 in Class 5 as we have planned; we did it on a week after Class 6, to which 76 students answered.

Table 15: Sellers' costs and buyers' values for Experiment 1 in 2006

Seller's cost	Number of sellers	Buyer's value	Number of buyers
200	13	240	12
140	14	180	18
90	14	100	6
60	14	70	17
Total	55	Total	53

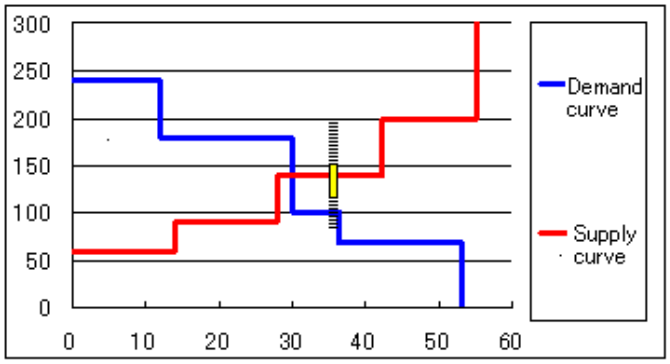

Figure 6: Results of Experiment 1 in 2006

Table 16: Sellers' costs and buyers' values for Experiment 2 in 2006

Seller's cost	Number of sellers	Buyer's value	Number of buyers
250	5	240	14
140	20	180	14
90	6	120	7
60	14	90	14
Total	45	Total	49

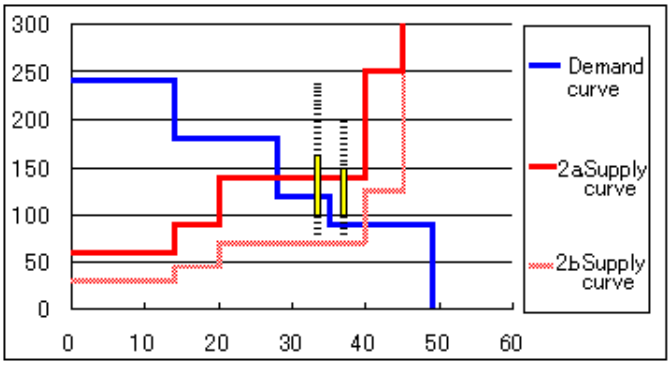

Figure 7: Results of Experiment 2 in 2006

Table 17: Sellers' total costs and buyers' total values for Experiment 3 in 2006

Number of units sold	Total cost	Number of units bought	Total value
0	50	0	0
1	100	1	430
2	250	2	780
3	450	3	1030
4	750	4	1180

Table 18: Results of Experiments in 2006

Experiment (Group)	1	2a	2b	3			
				(1)	(2)	(3)	(4)
X^*	30	28	40	39	39	39	33
P^*	140	140	90	250	250	200∼250	250
SS^*	1820	1420	1510	4550	4550	4550	3850
BS^*	1920	1960	3570	3920	3920	3460	3360
TS^*	3740	3380	5080	8470	8470	8010	7210
$\bar{X}$	43	34	36	49	48	44	40
$\bar{P}$	140	140	124	205.3	173.3	189.0	173.0
$P_{\max}$	200	240	200	500	300	250	225
$P_{0.75}$	150	160	150	210	200	200	200
$P_{0.5}$	140	140	122	190	180	190	178
$P_{0.25}$	125	100	100	180	120	170	150
$P_{\min}$	69	80	80	100	70	90	110
$\overline{SS}$	1734	1410	555	1780	320	1480	371
$(\overline{SS}/SS^*)$	(0.952)	(0.992)	(0.367)	(0.391)	(0.070)	(0.325)	(0.096)
$\overline{BS}$	1726	1820	2185	5240	6700	5520	5539
$(\overline{BS}/BS^*)$	(0.898)	(0.928)	(0.612)	(1.336)	(1.709)	(1.595)	(1.648)
$\overline{TS}$	3460	3230	2740	7020	7020	7000	5910
$(\overline{TS}/TS^*)$	(0.925)	(0.928)	(0.612)	(0.828)	(0.828)	(0.873)	(0.819)

X^* : number of units traded in equilibrium
P^* : price in equilibrium
SS^* : sellers' surplus in equilibrium
BS^* : buyers' surplus in equilibrium
TS^* : total surplus in equilibrium

$\bar{X}$: number of units traded in experiment
$\bar{P}$: average price in experiment
$P_{\max}$: maximum price in experiment
$P_{0.75}$: upper quartile price in experiment
$P_{0.5}$: median quartile price in experiment
$P_{0.25}$: lower quartile price in experiment
$P_{\min}$: minimum price in experiment
$\overline{SS}$: sellers' surplus in experiment
$\overline{BS}$: buyers' surplus in experiment
$\overline{TS}$: total surplus in experiment

All data mentioned in the lower half of the table are calculated from the data of the last session of each experiment: the fifth session of Experiment 1; the third session of Experiments 2a; the third session of Experiment 2b; the second session for Experiment 3.

Table 19: Students' answers for quizzes in 2006

	Quiz 1		Quiz 2a		Quiz 2b		Quiz 3	
Experience of the experiment about which the quiz asks	Yes	No	Yes	No	Yes	No	Yes	No
Correct answers	1	0	23	6	5	3	6	0
Wrong / No answers	87	23	57	31	75	34	83	49
Total	88	23	80	37	80	37	89	49
Percentage of correct answers	1.1	0.0	28.6	16.2	6.3	8.1	6.7	0.0
p-value	—		0.14		0.71		—	

Table 20: Common wrong answers to Quiz 1 in 2006

Type of Errors	Number of Answers	Type of Errors	Number of Answers
A	12	B	34
C	5	D	37

Table 21: Correlations between students' performances in experiments and their answers for quizzes in 2006

Performance in Experiment 1	Bad	Good	Total
Correct Answers for Quiz 1	1(5)	0(8)	1(13)
Wrong/No Answers for Quiz 1	4(39)	44(36)	87(75)
Total	44	44	88
		p-value =	0.37

Performance in Experiment 2a	Bad	Good	Total
Correct Answers for Quiz 2a	8	14	22
Wrong/No Answers for Quiz 2a	32	26	58
Total	40	40	80
		p-value =	0.13

Performance in Experiment 2b	Bad	Good	Total
Correct Answers for Quiz 2b	4	1	5
Wrong/No Answers for Quiz 2b	36	39	75
Total	40	40	80
		p-value =	0.17

Performance in Experiment 3	Bad	Good	Total
Correct Answers for Quiz 3	4	2	6
Wrong/No Answers for Quiz 3	40	43	83
Total	44	45	89
		p-value =	0.38

Table 22: Students' answers for Questionnaire 1 in 2006

	those who stated how they had behaved alone	those who stated how they have behaved and how they should have behaved	those who stated nothing on their strategies
Sellers	21	2	32
Buyers	22	7	24
Total	43	9	56

Table 23: Students' answers to Questionnaire 2 in 2006

Sellers' answers		Number of units traded in equilibrium: X^*			
		Increased	Decreased	No answer	Total
Price in equilibrium: P^*	Increased	0	2	1	3
	Decreased	31	1	2	34
	No answer	2	0	6	8
	Total	33	3	9	45

Buyers' answers		Number of units traded in equilibrium: X^*			
		Increased	Decreased	No answer	Total
Price in equilibrium: P^*	Increased	8	16	5	29
	Decreased	1	1	1	3
	No answer	2	4	10	17
	Total	12	21	16	49

Table 24: Correlations between answers for Quiz 2 and answers to Questionnaire 2 in 2006

	Wrong/No Answers to Questionnaire 2	Correct Answers to Questionnaire 2	Total
Correct Answers for Quiz 2	2	3	5
Wrong/No Answers for Quiz 2	51	24	75
Total	53	27	80
		p-value =	0.20

Table 25: Correlations between answers to Questionnaire 3 and performance in Experiment 3 in 2006

Table 25a

	Performance in Experiment 3		
	Bad	Good	Total
YES to $\mathbf{Q_{3a}}$	27(24)	25(23)	52(47)
NO to $\mathbf{Q_{3a}}$	15(13)	17(16)	32(29)
Total	42(37)	42(39)	84(76)

p-value=0.65
(p-value=0.59)

Table 25b

	Performance in Experiment 3		
	Bad	Good	Total
YES to $\mathbf{Q_{3b}}$	29(27)	32(32)	61(59)
NO to $\mathbf{Q_{3b}}$	10(8)	11(7)	21(15)
Total	39(35)	43(39)	82(74)

p-value=0.99
(p-value=0.60)

Table 26: Correlations between answers to Questionnaire 3 and answers for Quiz 3 in 2006

Table 26a

	Answers for Quiz 3		
	Wrong	Correct	Total
YES to $\mathbf{Q_{3a}}$	47	2	49
NO to $\mathbf{Q_{3a}}$	24	3	27
Total	71	5	76

p-value=0.24

Table 26b

	Answers for Quiz 3		
	Wrong	Correct	Total
YES to $\mathbf{Q_{3b}}$	55	4	59
NO to $\mathbf{Q_{3b}}$	14	1	15
Total	69	5	74

p-value=0.99