Who Is Learning From Whom?
A Study of Households Forming Expectations in the US and UK[+]

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Abstract

The present paper proposes a simple learning expectations model whereby one set of agents (followers) follows the lead of another set of agents (leaders). The recent literature highlights the issue of 'absorption' by the follower. We introduce another important concept of 'acceptance'. It relates to the direct relevance of the leader's forecasts, which allows the follower to use the leader's forecast as a reference point. The dynamic learning model that is developed is used to empirically investigate how households in the US and UK form their expectations. We find that the US household's forecasts follow UK household when forming their forecasts.

Keywords: expectations formation, beliefs, reference points, absorbing information, agent-based modeling.

JEL Classification Codes: D84, E31

"The Fed's interest-rate cut suggests that it is worried about a possible American recession. But if it arrives, does the rest of the world have to catch a cold too?"

('When America Sneezes", *Economist*, January 4th, 2001)

The Economist article expresses a commonly held sentiment that the US economy is a dominant one and any shocks it experiences will eventually be experienced by economies elsewhere. One can, therefore, assume that agents, such as households, in other economies, for example the UK, when forming their expectations about their own economy or personal income or wealth will learn from the expectations of US households about their own economy.

The purpose of the present paper is twofold. One objective is to investigate whether households in the UK and the US learn from each other and, if so, who learns from whom. Agents, whether households or professionals, when forming their expectations may learn from other agents. We consider a significant extension of this. Do agents learn from other agents abroad as the latter forms expectations about their own economy? While developing a theoretical framework for empirical analysis we consider the more important objective of the paper, that is, the issue of how representative agents learn from each other when forming their expectations. This is a topical issue with significant implications for economic theory (see Mankiw and Reis (2002) and Carroll (2003)). We develop important theoretical and modeling extensions to the existing literature.

The notion that household's 'animal spirits' plays a role in their decision-making process is not a new one. Indeed, Simon (1997) was inclined strongly to attribute the origins of the economics of bounded rationality to the Keynesian notion

of ‘animal spirit’. Both Hall (1993) and Blanchard (1993) attribute the 1990-91 US recession to ‘a spontaneous decline in consumption’. Blanchard (1993) also argued that these fluctuations in household consumption is in part caused by households’ ‘animal spirits’ and this, in turn, result economic fluctuations[1]. Therefore, when investigating how households form expectations it is important to consider the interaction between households’ expectations with those abroad. This could provide valuable insights into the economic cycles of these economies.

In an important recent paper Carroll (2003) introduce an agent-based learning model where one agent learns from another agent. The paper shows how households learn from professional forecasters. Households form their expectations (or forecasts) in the current period by ‘absorbing’ a proportion of the professionals’ forecast, which is transmitted through the news media. The media also provides economic news from abroad[2]. In the present analysis we introduce the concept of ‘acceptance’. This concept allows the agent (follower) who learns from another agent (leader) the discretion of accepting the latter’s forecasts in entirety. When the follower forms expectations, whether it is in an international or domestic context, they may question the direct relevance or credibility of the leader’s forecasts. This implies that the agent is not merely following the other with a lag. They may, in fact, be using the leader’s expectations as a point of reference as they form their own expectations. The follower may acknowledge that other agents may have better information set and optimize them better but, nevertheless, may question its direct relevance when forming their own expectations.

[1] Matsusaka and Sbordone (1995) found that consumer sentiments (or confidence) indicators could cause economic fluctuations.

[2] *CNN International*, *BBC 24* and *The Economist* are examples of both the news and print media that report international economic performance and expectations of both professionals and households.

The new theoretical extension enables us to outline a more generalized framework for studying how agents learn from each other. The paper proposes a dynamic agent-based learning process that captures both 'absorption' and 'acceptance'. The postulated long-run relationship between the follower and leader expectations reflects the degree of acceptance. The follower, on the other hand, adjust, or absorb, to this long-run relationship as they update their information set in each period. This is represented in the follower's dynamic learning process.

Section I outlines the agent-based learning model incorporating both 'absorption' and 'acceptance'. The dynamic learning process is modeled using a Vector Auto-Regression (VAR) framework, which provides a basis for empirical analysis. Section II outlines the data and undertakes the empirical investigation. The data is complied by Survey Research Center, University of Michigan and the *GfK* (on behalf of the European Commission) for the US and UK respectively. It is a survey-based dataset, which complies the households' forecast of the general economic conditions, personal income and wealth and consumption behavior. These forecasts relate to aggregate output and consumption cycles and, thus, business cycles. We investigate how the representative household in the US and UK form expectations about the economic conditions in their respective economies, their personal income and wealth and their durable, or discretionary, consumption. In particular, we test whether they learn from each other when forming their expectations. The results clearly indicate that the US household when forming their forecast follows UK household's forecasts. This is contrary to popular perceptions and widely held beliefs. Finally, Section III summaries and concludes.

I: The Model: Leader-Follower Dynamic Learning Process

In this section we outline a simple model describing a learning process where one agent (follower) learns from the other's (leader) forecasts (or expectations). A similar type of model was outlined in Carroll (2003) where the household's expectations are formed following professional forecast. In the present model we generalize this leader-follower learning process by introducing an additional concept, that is, the degree of 'acceptance' of the leader's forecast. More specifically the model assumes that the follower forms their expectations by using the leader's expectations as a reference point. The leader's expectations, on the other hand, evolve independently of the follower. When the follower is forming their expectations both 'absorption' and 'acceptance' of the leader's expectations is equally important. Whilst the follower adjust (or absorb) their expectations to that of the leader's in each period, the degree of acceptance is part of the followers long-run relationship. In a way this nests the usual rational expectations process.

The model outlined in Carroll (2003) shows that the professionals' forecast is transmitted via the news media. Households are assumed to absorb a proportion of the professionals' forecasts as they adjust their own expectations. Consider a scenario where agents', whether households or professionals, learn from other agents abroad, as these agents form expectations about their respective economy, which is transmitted via the news media. The issue of 'acceptance' is important. If followers take the lead of the expectations of agents aboard they are probably using it as a reference point about what might happen in their own economy. Differences in the structure of the economies and asymmetric shocks raise the issue of direct relevance and the level of expectations that is accepted. Indeed, the issue of 'acceptance' is just as important when domestic agents are learning from each other. For example,

households or professional forecasters may question the credibility of their government's or other professionals' forecasts of the economy. We present a model where we assume that the long-run relationship between the leader and follower's expectations reflect this degree of acceptance. The adjustment, or absorption, to this long-run relationship is represented via the followers' dynamic learning process.

A representative household forms expectations about general economic outcomes in their respective economies, for example economic growth, as well as their own personal income and wealth. In the long-run the agent, who is a follower, when forming their expectations will include a certain level, or amount, of the leader's expectations. This level represents what the follower accepts. In addition, the follower believes that the economic growth rate (and also personal income or wealth) is also affected by any permanent innovation to their economy (or personal income and wealth). Expectations about the permanent innovation in the *ith* period ahead is made in the *jth* period previous ($\eta^{e}_{t-j,t+i}$ or $\zeta^{e}_{t,t+i}$), where *i=0,1,…,12* and *j=1,…,12*. The postulated long-run relationship of the representative follower's twelve-months ahead forecasts or expectations of their economic growth rates (or personal income or wealth) ($M_t(G^{M}_{t,t+12})$) can be depicted as follows:

$$M_t(G^{M}_{t,t+12}) = \beta + \alpha S_t(G^{S}_{t,t+12}) + \eta^{e}_{t,t+12} \tag{1}$$

where β is a constant and $\alpha > 0$. Together they denote the level of the representative leader's year-ahead forecast ($S_t(G^{S}_{t,t+12})$) that is accepted by the follower. Finally, $\eta^{e}_{t,t+12}$ denotes the follower's year-ahead expected permanent innovations formed in the current period. In the leader's case, on the other hand, they believe that their economy follows a fundamental growth rate. Any changes to this rate are

determined by a permanent innovation to the economy. Changes in the leader's year-ahead economic growth rate forecast, therefore, depends on expectations about the permanent innovation to the growth of their economy formed in the current period ($\zeta^{e}_{t,t+12}$):

$$S_t(G^S_{t,t+12}) = S_{t-1}(G^S_{t-1,t+11}) + \zeta^{e}_{t,t+12} \tag{2}$$

The dynamics of the long-run relationship can be depicted by reformulating equations (1) and (2), multiplying throughout using a lag operator. The change in the respective agents' forecast for *t+12* is:

$$\Delta M_t(G^M_{t,t+12}) = \alpha \Delta S_t(G^S_{t,t+12}) + \Delta \eta^{e}_{t,t+12} \tag{3}$$

$$\Delta S_t(G^S_{t,t+12}) = \zeta^{e}_{t,t+12} \tag{4}$$

where $\Delta \eta^{e}_{t,t+12}$ denotes the change, in the current period, of the forecast of permanent innovation for period *t+12* which was formed period *t-1*. The next stage to deriving the dynamics leader-follower learning model is to compute a VAR representation of the relationship. Firstly we rearranging equation (3) as follows:

$$\Delta M_t(G^M_{t,t+12}) = \alpha \Delta S_t(G^S_{t,t+12}) + \eta^{e}_{t,t+12} - \eta^{e}_{t-1,t+12} \tag{5}$$

and, subsequently, substituting equation (4) and using $M_t(G^M_{t,t+12}) - \alpha S_t(G^S_{t,t+12}) = \eta^{e}_{t,t+12}$ from equation (1), we obtain:

$$\Delta M_t(G^M_{t,t+12}) = \alpha \xi^{e}_{t,t+12} + \eta^{e}_{t,t+12} - [M_{t-1}(G^M_{t,t+12}) - \beta - \alpha S_{t-1}(G^S_{t,t+12})] \tag{6}$$

The VAR representation of equations (3) and (4) can now be written as:

$$\begin{bmatrix} \Delta M(G^M_{t,t+12}) \\ \Delta S(G^S_{t,t+12}) \end{bmatrix} = \begin{bmatrix} \beta \\ 0 \end{bmatrix} + \begin{bmatrix} -1 & \alpha \\ 0 & 0 \end{bmatrix} \begin{bmatrix} M_{t-1}(G^M_{t,t+12}) \\ S_{t-1}(G^S_{t,t+12}) \end{bmatrix} + \begin{bmatrix} \eta^{e}_{t,t+12} + & \alpha \zeta^{e}_{t,t+12} \\ \zeta^{e}_{t,t+12} & \end{bmatrix} \tag{7}$$

Corollary 1 demonstrates that the representative agent's forecasts have a long-run relationship, that is, they are cointegrated.

Corollary 1 *Given the coefficient matrix of equation (7) has a rank of one, the agents' forecasts is a single cointegrating vector.*

Equation (7) can also be respecified to include an error-correction term as follows:

$$(8)\quad \begin{bmatrix} \Delta M(G^{M}_{t,t+12}) \\ \Delta S(G^{S}_{t,t+12}) \end{bmatrix} = \begin{bmatrix} -1 \\ 0 \end{bmatrix} \left[M_{t-1}(G^{M}_{t,t+12}) - \beta - \alpha S_{t-1}(G^{S}_{t,t+12}) \right] + \begin{bmatrix} \eta^{e}_{t,t+12} + \alpha\zeta^{e}_{t,t+12} \\ \zeta^{e}_{t,t+12} \end{bmatrix}$$

The result is the following proposition:

Proposition 1 *In the long-run equilibrium the follower uses the leader's forecast as a point of reference, if the 'acceptance level' is* $\alpha > 0$ *and* β *can take any finite value.*

Proposition 1 and Corollary 1, together, specify the long-run relationship between the follower's and leader's forecast. A single cointegrating vector suggests the existence of a long-run relationship between the two forecasts, while the 'acceptance level' demonstrates how the follower formulates their forecast using the leader's forecasts in the long-run equilibrium. The acceptance level is denoted by both α and β. β, which is a constant, represents the fundamental (or long-run) difference in the economic conditions and personal income faced by the two agents. When depicting a learning process between representative agents from two economies, the fundamental differences between these economies, for example growth rates or inflation rates, need to be accounted for. This may represent, for example, the different growth rate or inflation rate targets set by the respective governments and monetary authorities. This is also an important issue when considering learning between domestic agents,

as the follower assesses the relevance of the leader's forecasts while using it as a reference point[3].

We now make an important assumption following Carroll (2003). We assume that an agent, regardless of a follower or leader, is unable to forecast (F_t) beyond the next period (*t+1*). Therefore, the agent's forecast of general economic growth (G_t) made in a particular period will be the same if it is made for the next period or any periods ahead. For example, it follows:

$$F_{t-1}[G_{t-1,t+11}] = F_{t-1}[G_{t,t+12}]$$

$$F_{t-2}[G_{t-2,t+10}] = F_{t-2}[G_{t,t+12}]$$

……

Similarly, the permanent innovation, η_t or ζ_t, cannot be forecast beyond period *t+1* It is, therefore, depicted as unforecastable white noise ($\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ respectively). Equation (8) is now depicted as:

$$(9) \qquad \begin{bmatrix} \Delta M(G^M_{t,t+12}) \\ \Delta S(G^S_{t,t+12}) \end{bmatrix} = \begin{bmatrix} -1 \\ 0 \end{bmatrix} \left[M_{t-1}(G^M_{t,t+12}) - \beta - \alpha S_{t-1}(G^S_{t,t+12}) \right] + \begin{bmatrix} \varepsilon_{1,t} + \alpha\varepsilon_{2,t} \\ \varepsilon_{2,t} \end{bmatrix}$$

or alternatively:

$$(9') \quad \begin{bmatrix} \Delta M(G^M_{t,t+12}) \\ \Delta S(G^S_{t,t+12}) \end{bmatrix} = \begin{bmatrix} -1 \\ 0 \end{bmatrix} \left[M_{t-1}(G^M_{t-1,t+11}) - \beta - \alpha S_{t-1}(G^S_{t-1,t+11}) \right] + \begin{bmatrix} \varepsilon_{1,t} + \alpha\varepsilon_{2,t} \\ \varepsilon_{2,t} \end{bmatrix}$$

Given that the equation for $\Delta S\left(G^S_{t,t+12}\right)$ conveys no additional information about the long run relationship, (9') may be reformulated as a conditional equation by shifting the term $\Delta S\left(G^S_{t,t+12}\right)$ to the right hand side of the equation. This implies estimating a single equation model of the form:

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[3] If such fundamental difference does not exist then β may also be zero.

$$(10)\quad \Delta M\left(G^{M}_{t,t+12}\right)=(-1)\left[M_{t-1}\left(G^{M}_{t-1,t+11}\right)-\beta-\alpha S_{t-1}\left(G^{S}_{t-1,t+11}\right)\right]+\Delta S\left(G^{S}_{t,t+12}\right)+\omega_{t}$$

We, therefore, have a second proposition.

Proposition 2 *If the 'absorption' rate (λ) is* $0<|\lambda|\leq 1$, *where 1 represents complete 'absorption' ('adjustment'), the follower's forecast adjust to any deviation in the long-run equilibrium. The leader's forecast evolves independently of the follower.*

Equation (10) gives the dynamics of the leader-follower learning process where change in the postulated long-run relationship affects the change in the follower's expectations but not the leader's. The long-run relationship shows that the follower uses the leader's forecasts as a point of reference for their own forecasts, as indicated by the level of acceptance (α). Equation (10) also shows the adjustment (or absorption) process of the follower's expectations in each period to its long-run relationship, albeit normalized. Most importantly, the equations clearly distinguish between 'absorption' and 'acceptance'. Hence, any empirical investigation of the follower's dynamic learning process is able to estimate and compare the concepts separately.

We now have a theoretical framework, or model, which forms the basis of our empirical analysis of the representative household's expectations formation in the US and UK. The testable implications of the model are as follows:

i. by Corollary 1, in the first instances, agents' forecasts are a single cointegrating vector;

ii. by Proposition 1, in the long-run equilibrium the follower has an 'acceptance level' of the leader's forecasts when formulating their own forecast, therefore, the estimated is $\alpha>0$ and $-\infty\leq\beta\leq+\infty$.

iii. by Proposition 2, the 'absorption' rate lies between zero and one (inclusive).

II: Empirical Analysis and Results:

The present section focuses on investigating empirically whether households in the US and UK learn from each, and who learns from whom. The empirical analysis is based on the theoretical model using a VAR framework outlined in the preceding section. The investigation will estimate explicitly both the 'absorption' effect, as the follower learns in a dynamic context, and the level of 'acceptance' in the follower's long-run learning process. The empirical investigation uses monthly household expectations data based on surveys. The sample covers the period from January 1983 to December 2000, accounting for most of the 1980s and all of the 1990s.

A. *The Data: Michigan/SRC and EU/GfK*:

The household-based survey data used in the current analysis is that complied by *Survey Research Center*, University of Michigan, (*Michigan*) for the US and the *Gesellschast fur Konsum-markt-und Absatzforschung* (*GfK*) (on behalf of the European Commission) for the UK. From the surveys consumer confidence (or sentiment) indicators have been constructed that depict the consumer's (or household's) view of the current and expected state of the economy. They are also indicators of household consumption behavior and, consequently, economic cycles (see Matsusaka and Sbordone (1995)). Hence, these indicators have been the focus of a number of studies of household consumption behavior. The most notable of these are Carroll *et al* (1994) and Acemoglu and Scott (1994) for the US and UK respectively.

In the present paper we will focus on the individual indices that make up the composite consumer sentiments indicator. The exact wordings of the two questions for the surveys conducted by the *Michigan* that we are concerned with are:

1. "Now looking ahead – do you think that a year from now you (and your family living there) will be better off financially, or worse off, or just about the same as now? (PFEM)

2. "Now turning to business conditions in the country as a whole – do you think that during the next twelve months we'll have good times financially, or bad times, or what? (BUSM)

3. "About the big things people buy for their homes – such as furniture, a refrigerator, stove, television, and things like that. Generally speaking, do you think now is a good or bad time for people to buy major household items?" (PURM)

The exact wordings for the equivalent questions for the survey conducted by the *GfK* are:

1. How do you think the financial position of your household will change over the next 12 months? (PFEG)

2. How do you think the general economic situation will develop over the next 12 months? (BUSG)

3. Do you think there are benefits in people making major purchases such as furniture, washing machines, TV sets at the present time?(PURG)

The responses to these questions are weighted:
(a) a lot better (+1); (b) a little better (+0.5); (c) the same (0);
(d) a little worse (-0.5); (e) a lot worse (-1)

The Figure 1 below depicts the respective indices for the *Michigan* and *GfK* surveys:

Figure 1 [about here]

Both indices are then calculated by computing the relative scores; the percent giving favorable replies minus the percentage giving unfavorable replies. In the case of the *GfK* survey respondents are also allowed some expression of the strength of their opinions The complied indices, essentially, reflect the forecast of the majority surveyed, which we use as a proxy for the representative agent's forecast , that is, $M_t(G^M_{t,t+4})$ and $S_t(G^S_{t,t+4})$)[4].

[4] This follows the voting literature on how the representative voter is defined (Rothstein (1991))

In the case of the household's personal finance question, the *Michigan* asks the respondents to forecast their personal finance in a year's time. The *GfK* question, on the other hand, as the respondents to consider the change in their personal finance over the next twelve months. Both the *Michigan* and *GfK* ask about general the business conditions in the country as a whole during the next year. The questions are fairly broad but, essentially, they try to ascertain the representative consumer's, or household's, expectation about their personal finance and general economic conditions in their respective economies in a year's time. The third questions relates directly to household's consumption decisions. While it also reflects household's expectations about general economic conditions and personal finances, more importantly gauges household's reaction, or decision-making, in view of these expectations. Substantial changes in household's expectations would alter their decision to make major purchase, which, in turn, effects the economic cycles and, therefore, just as important to examine.

Most survey data of consumers', or households', expectations are based on qualitative judgments. Consumers respond to questions that require them to make qualitative statements on the expected state of their personal finances or the economy in general. These statements are as simple as, for example, 'expect to be better (or worse) off financially' and 'expect the general economic conditions to be better (or worse) off'. The direction and magnitude of change and its associated business cycle turning points, nevertheless, matters greatly. Such qualitative information about households' and economy's relative position in the near future can inform other agents, in particular other agents abroad. Therefore, when considering agents learning behavior in an international context, such broad qualitative judgments, or forecasts, could be used as reference points.

B. *Estimation*

When considering long run relationships between the data, it becomes necessary to consider the underlying properties of the processes that generate time series variables. That is, we must distinguish between stationary and non-stationary variables, since failure to do so can lead to a problem of 'spurious regression' (Granger and Newbold, 1974). Accordingly, all series used in this study are tested for their order of integration as a prelude to the examination of the relationships that exist between them.

Table 1 reports the results of the unit root tests. The standard ADF tests for the series in levels and differences are displayed in Table 1 below.

Table 1 [about here]

The ADF tests confirm that apart from the series *BUSG* and *BUSM* which are stationary I(0), all the other series are non-stationary I(1) processes.

A cointegrating VAR approach (Johansen (1988)) is employed to test for cointegration. Using this method the long run parameters in the VAR can be factorized into a matrix of cointegration (steady-state) vectors and a matrix of loading (or speed of adjustment coefficients). This decomposition enables a neat interpretation to the theoretical model since the cointegration vectors contains all information pertinent to the degree of acceptance and the restrictions on the speed of adjustment parameters (exogeneity inference) provide evidence on the degree of absorption. A test (Johansen (1992)) is based on the notion that variables that do not respond to 'disequilibrium' in the system of which they are a part, that is, they may be considered weakly exogenous to that system. This enables us to identify the series in each pair that adjusts to maintain the cointegrating relationship, and thereby

indicating evidence of ‘leadership’. When neither series is weakly exogenous to the other, but jointly determined, a 'leader' cannot be identified.

The following pairs, (*PURG*, *PURM*) and (*PFEG*, *PFEM*) were analyzed to see if any pair forms a cointegrating relationship using (2). The results of the cointegration tests using Johansen's maximum likelihood method are summarized in Table 2 below. Lag length (k) for each bivariate VAR was determined using the Schwarz-Bayesian (SB) criteria and the Hannan-Quin (HQ) criteria. In each case the lag length was set equal to 2.

Table 2 [about here]

The results in Table 2 offer a clear picture of the long run relationship between the respective *GfK* and *Michigan* series. Cointegration is found using both the Trace and Maximum Eigenvalue statistics to evaluate the null. The upshot is that both series co-move and thus behave in a similar manner over time. The cointegrating vectors in the last column provide information on the level of acceptance. Assuming that the representative US household uses the UK forecast as a point of reference, the acceptance level of the US is approximately half that of the UK in the case of the purchase series (0.41) and expected personal finance (0.53).

Tests of weak exogeneity establish causal priority in regression models. With relatively high frequency data they can be employed usefully to indicate whether some variables 'lead' others, or indeed whether they are simultaneously determined. In the current empirical application, the concept of weak exogeneity is akin to the principle of 'leadership'. The results of the weak exogeneity tests are reported in Table 3 below.

Table 3 [about here]

Conducting inference, the test statistics indicate that the *Michigan* series adjusts to maintain the cointegrating relationships that manifests as co-movement of the *GfK* and *Michigan* series. As such, the *GfK* series can be thought of as to 'lead' the *Michigan* series. We, therefore, conclude that the representative US household's forecasts follow, or adjust, to the representative UK household's forecast, while the latter evolves independently.

The foregoing analysis sheds light on the long run aspects of the relationships between the *GfK* and the *Michigan* series. Reformulating the model as equation (10) in which the error correction term is explicitly included, and conditioning the weakly exogenous variable allows the dynamics of these relationships to evaluated. The empirical analysis would provide estimates of the speed of adjustment coefficients, which are interpreted in this case as the level of absorption. The results of the estimation of equation (10) for each pairing are given in Table 4 below.

Table 4 [about here]

The error correction term for the purchase data is – 0.09 suggesting that deviations from the long run relationship are corrected at a rate of around 9% per month. Alternatively, the level of absorption is 9%. Thus the speed of adjustment (or level of absorption) to long run changes in the variables is slow but significant. The impact coefficient ($\Delta PURG$) given by 0.19 implies that around 19% of changes in the *GfK* purchases are incorporated in the *Michigan* purchases in a single month. Overall the results imply that the process of adjustment is characterized by a relatively large immediate response followed by a relatively sluggish one. The error correction term for the expected personal finance data is in the region –0.22 suggesting that deviations from the long run relationship are corrected at a rate of around 22 % per month,

implying that the level of absorption is higher than the purchase data. Overall the speed of adjustment (or level of absorption) is slow, but significant.

Given that the series, *BUSG* and *BUSM* are stationary I(0) processes, they were estimated in an unrestricted VAR model to observe causality or feedback in the system. Both variables are treated symmetrically in this system. Lag length (k) for the bivariate VAR was determined using the Schwarz-Bayesian (SB) criteria and the Hannan-Quin (HQ) criteria. The lag length was chosen to be equal to 1. The results of the unrestricted VAR (1) model are given in Table 5 below.

Table 5 [about here]

The results show that the *GfK* series to be affected by its own lagged value. The *Michigan* series is found to be Granger non-causal to the *GfK* series. However, the *GfK* series was found to Granger cause the *Michigan* series. This implies that current expectations of the business conditions by the UK households can used to predict the US household expectations of the business conditions.

Given that there is evidence of the business conditions data is mean reverting, it may be hypothesized that 'desired' year – ahead forecasts of the follower can be depicted by the following long run relationship:

$$M_t^*(G_{t,t+12}^M) = \beta + \alpha S_t(G_{t,t+12}^S) + u_t \tag{11}$$

where $M_t^*(.)$ denotes the desired year – ahead forecasts of the follower. This argument follows from the theory outlined in section II, that is, the postulated long-run relationship denoted by equation (1). It is assumed in this case, that the actual forecasts adjust slowly towards the desired year – ahead forecasts in order to smooth the level of expectations making up only a fraction λ of the difference between the

desired level of acceptance and the past level. Thus, the actual forecasts may be subject to a linear partial adjustment process

(12) $$\Delta M_t = \lambda[M_t^*(G_{t,t+12}^M) - M_{t-1}(G_{t-1,t+1}^M)] + v_t$$

or,

(12') $$M_t = \lambda[\beta + \alpha S_t(G_{t,t+12}^S)] + (1-\lambda)M_{t-1}(G_{t-1,t+11}^M) + v_t + \lambda u_t$$

At one extreme when $\lambda = 1$, there is full adjustment in the next period, and on the other extreme when $\lambda = 0$ there is no adjustment at all. Estimating (12') yields the estimates recorded in Table 6 below:

Table 6 [about here]

The results show that $\lambda = 0.09$, implying adjustment is slow. This can be compared to the degree of absorption when compared with the previous cases. The degree of absorption is found to be similar to that of the purchase data. The estimated signs of the α and β coefficients are found to be positive as expected. According to Proposition 2 the estimated value of β can take any finite value and the absorption coefficient should be positive. The estimated values of β and α in (12) are 38.6 and 2.4 respectively. The absorption coefficient for *BUSG* and *BUSM* data is found to be relatively higher than the other data used in this study.

C. *Discussion of Results*

The test for unit roots on the survey data lend support to the view that there is no predictive structure in the agents' year-ahead economic forecasts. The only exception is the survey data on business conditions, which are found to be stationary. This implies that the changes in the agent's year-ahead forecasts on business conditions depend on transitory rather than permanent innovations to the growth of their economy formed in the current period.

The survey data was found to be non-stationary in the case of major purchases, current and expected finances for both the US and UK. These data were analyzed in pairs between the US and UK. A long run relationship between the US and UK series is found to exist in each of the pair of series. A single cointegrating vector for both the US and UK series implies that the data tend to co-move, thereby sharing a common trend. Any deviations that arise between the two series are transitory. An explanation for transitory deviations might be due to inertia in households forming their expectations. The long run equlibrium acts as an attractor, such that if the leader's expectations drift away from the attractor, the follower's expectations adjust to revert back to the long run equilibrium.

Given that a long run linear relationship exists between the US and UK series, the level of acceptance α can be obtained by normalizing on any of the series. In this case the US series are normalized and the acceptance coefficient is found to be positive. We expect this result from Proposition 1, that followers base their expectations on the leaders forecasts, with a positive acceptance coefficient. The β coefficient, which measures the partial difference between the two series assumes a positive significant value, which is what we expect from Proposition 1. The finite partial difference between the series, β, measures the different growth rates and inflation rate targets set by the respective governments and monetary authorities in the US and UK. The present analysis find that the follower are using the leader's forecast as a point of reference given that the acceptance level is some positive value and the finite partial difference between the series takes some finite value.

For the stationary data on business conditions, a partial adjustment model (PAM) is constructed to make estimates on the level of acceptance and the level of absorption. The results are no different from those obtained using the cointegration

methodology. The level of absorption is found to be low but comparable to that of the data on major purchases. The α and β coefficients are found to be positive as expected.

Turning to the question of 'who learns from whom?', the weak exogeneity tests suggest that the UK is behaving as a leader and the US is adjusting its expectations using the UK as a reference point. For any transitory disequilibrium that may arise between the two series, the US series responds to correct the disequilibrium. The results are contrary to popular sentiments and priors, as expressed by the Economist's article. The results, therefore, pose a conundrum that needs to be addressed. There are two separate, but related, issues. First and foremost, the representative US household directly uses the UK household's forecasts as a 'reference point' when forming their own forecasts. Clearly US householders engage in gathering as much relevant information as possible when formulating their forecasts. The UK is an important trading partner of the US and a dominant economy in the European Union (EU) and, thus, her householders' forecasts is a valuable source of information for the US household. The second issue relates to the representative UK household's forecast evolving independently of the US, that is, not referring to the US householder's forecast directly. A possible reason for this is the UK households may feel affected more directly by the economic policies conducted in the UK and EU. The actions of the Bank of England and the European Central Bank are of greater importance. These monetary authorities would obviously be gathering information, not least the actions of the US Federal Reserve Bank. From the present analysis, we, however, can only conclude that the US householder refers to UK householder's forecast directly.

To sum up the key findings we find existence of a long run relationship between the follower and leaders forecasts, showing evidence of learning between household's expectations in the US and the UK. Agents in the UK show no predictive structure in their year-ahead economic forecasts, while agents in the USA form their expectations using the UK as a reference point. The absorption of the US's household expectations in the long run relationship between the US and UK household expectations is found to be slow but significant.

III: Conclusion:

The purpose of this paper is twofold. Firstly, we outline a simple agent-based dynamic learning model. There are broadly two types of agents: leaders and followers. The followers use the leader's forecast as a reference point when forming their own forecasts, while the leader's forecast evolves independently. Secondly, this is used as the basis to investigate empirically whether the representative households in the US and UK learn from each other and, if so, who learns from whom.

In the present analysis we investigate the representative US and UK households' forecast of the general economic and business conditions of their respective economies, their personal finances and consumption behavior. The results of the empirical investigation clearly indicates that the US household uses the UK household's forecast as a reference point directly when forming their own forecast, while the latter's forecast evolves independently. We attribute this to the way the two households gather information as they form their forecasts.

The importance of agent-based learning for economic theory is outlined in Carroll (2002) and Mankiw and Reis (2002). We outline a dynamic agent-based learning model that allows for heterogeneity in the long-run expectations and 'sticky-

information'. Mankiw and Reis (2002) outline an important model of inflation where the agents' information is sticky. Heterogeneous expectations (or beliefs), reflected in the 'acceptance' level, highlight different preferences and credibility, which is also important in understanding the dynamics of inflation. Agents learning and forming beliefs in this way also have implications the behavior of firms in oligopoly markets and households' decision-making process. Indeed, Allen and Carroll (2001) highlight the importance of social learning to understand household consumption behavior. Rules of thumb that are learned are passed from one consumer to another. This suggests that some agents have better information sets and/or are able to utilize them better. Others, subsequently, use these agents' beliefs as a 'reference point' for their own beliefs. Nevertheless, there must be lags in the transmission of information from one agent to another.

We discussed in the introduction the expectations of agents lead to actions that have implications for economic cycles. The empirical investigations undertaken in this paper highlight the importance of expectations formed by agents abroad. In recent years the US Federal Reserve and Bank of England have kept a watchful eye on household sentiments when conducting counter-cyclical policies (Garratt (1999)). Policy-makers clearly need to also need to monitor the relevant sentiments and expectation of households abroad.

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Figure 1

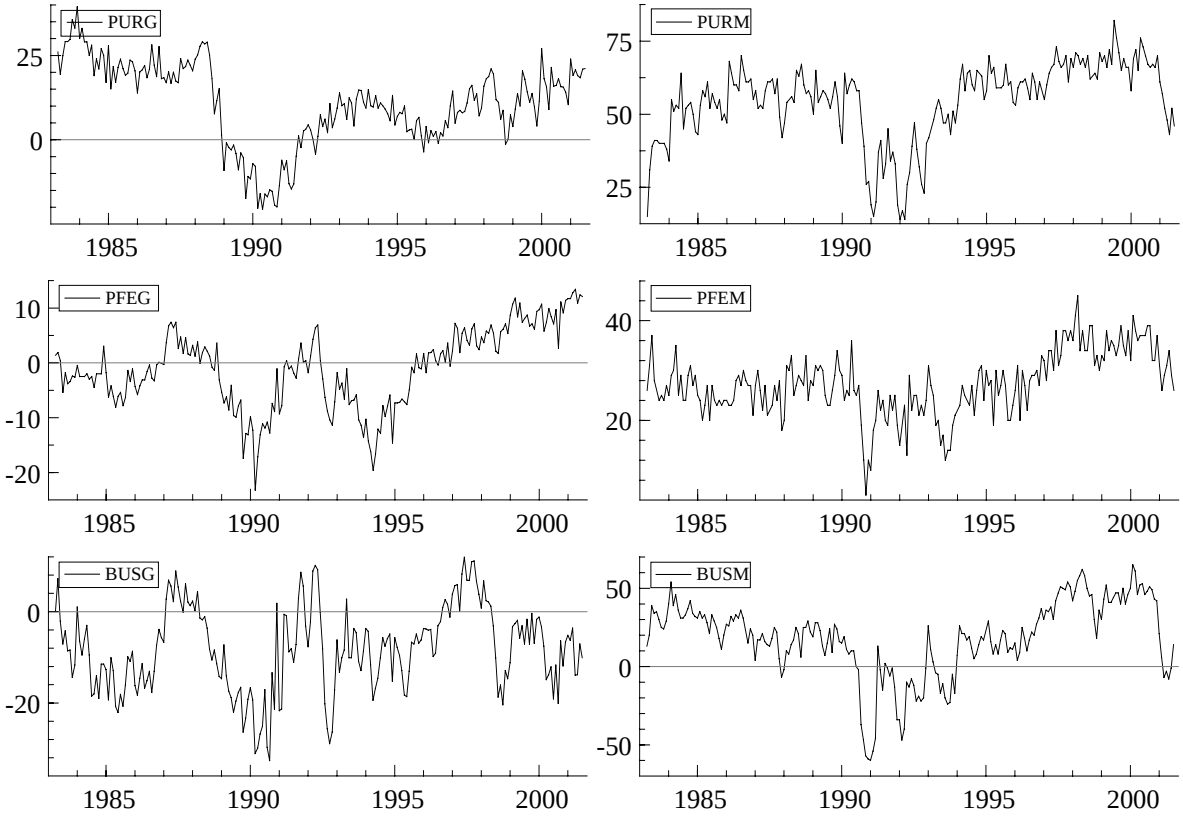
PURG
25
0
1985
1990
1995
2000
PURM
75
50
25
PFEG
10
0
-10
-20
PFEM
40
20
BUSG
0
-20
BUSM
50
0
-50

Table 1. Unit root tests.

Variables [lags]	ADF [levels]	ADF [differences]
PURG [2]	-1.96	-13.95**
PURM [7]	-2.23	-7.89**
PFEG [1]	-2.04	-20.28**
PFEM [5]	-2.26	-10.07**
BUSG [0]	-5.15**	N/A
BUSM [0]	-3.07*	N/A

*Notes: *Indicates rejection of null hypothesis at the 5% level and ** for rejection at the 1% level.*

Table 2 Cointegration Results

Pair	Trace	Max Eigenvalue	α^{++}	β
PURG, PURM	20.3*	17.3**	0.41	51.02*
PFEG, PFEM	24.42*	20.3**	0.53	27.69*

*Notes: *Significant at the 5% level; **Significant at the 10% level.*
$^{++}$ Normalized on Michigan series

Table 3. Weak Exogeneity Results

Pairs	Potentially Exogenous	Chi-sq Statistic
PURG, PURM	*PURG*	0.01[0.91]
	PURM	11.4[0.00]
PFEG, PFEM	*PFEG*	1.52[0.21]
	PFEM	13.9[0.00]

Note: The p-value is given in the parentheses

Table 4. Parsimonious Conditional ECM

Independent variables	**Dependent variable** $\Delta PURM$	 $\Delta PFEM$
ΔPURM(-1)	-0.16[0.01]	
ΔPURG	0.19[0.02]	
ΔPFEM(-1)		-0.30[0.00]
ΔPFEG(-3)		-0.19[0.02]
ECM(-1)	-0.09[0.00]	-0.22[0.00]
Serial Correlation	1.68[0.11]	1.52[0.16]
Heteroscedasticity	1.44[0.19]	1.90[0.08]
Functional Form	1.04[0.40]	1.41[0.18]
Normality	8.61[0.01]	1.30[0.52]

Note: The p-value is given in the parentheses

Table 5: Unrestricted VAR

	BUSG	***BUSM***
Constant	-1.37[0.027]	2.92[0.006]
BUSG(-1)	0.29[0.00]	0.14[0.04]
BUSM(-1)	-0.017[0.285]	0.91[0.00]
Serial Correlation	13.35[0.34]	15.46[0.21]
Functional Form	0.91[0.34]	0.09[0.75]
Normality	16.91[0.00]	134.03[0.00]
Heteroscedasticity	2.05[0.15]	0.79[0.37]

Note: The p-value is given in the parentheses

Table 6: Partial Adjustment Model
Dependent variable: $BUSM_t$

Independent variables	**Coefficient**	**Standard Error**	**t-ratio**
Constant	3.485	1.0195	3.41
$BUSG_t$	0.221	0.0703	3.14
$BUSM_{t-1}$	0.909	0.0267	34.1
R-Squared	0.846		
Durbin's h-statistic	0.30306[0.76]		
LM test for serial correlation:	χ^2_{12}=12.68[0.39]		
Functional form:	χ^2_1=0.029[0.86]		