Can Dogs Alleviate the Desolation Created by Having Fewer Children? An Empirical Study in the Japanese Context
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Citation

Abstract
Over the last several decades, in Japan, the young population (YP; less than 14 years old) has decreased whereas the number of registered dogs (RDs) has increased as a result of various socioeconomic factors. The total sum of YP and RD has remained virtually constant since the early 1990s. In this paper, we employ veterinary economics analyses to empirically examine the following hypothesis: the decrease in the number of children being reared has been compensated for by the increase in the number of pets. We find a statistically significant relationship between RD and the total fertility rate, which confirms that our hypothesis is valid in the case of Japan.

INTRODUCTION
In recent times, under the influence of various socioeconomic factors such as the declining number of births and the trend towards late marriages, our affinity for animals has deepened and become more varied. Traditionally, animals have been classified as pets, industrial animals, and wild animals. In recent times, in addition to these categories, the term ‘companion animal’ has been used quite frequently; this indicates that animals are now being viewed not as mere properties of human beings, as implied by the word ‘pet’, but as valuable companions to humans. There has been a significant increase in the number of people who treat their pets as individuals that coexist closely with humans.

How did companion animals come about and how did they become so popular? The first possibility can be explained by the existence of an animal welfare Kuznets curve (AWKC). Frank (2008) applied the Kuznets curve to investigate the relationship between economic indices and animal welfare, and conducted both theoretical and empirical research on the subject. The Kuznets curve has previously been applied to explain the relationships between per capita GDP and income inequality and between per capita GDP and environmental quality. Frank concluded that both quantitative and qualitative measures sometimes assume inverse U-shaped relationships; the negative slope of this inverse U-shaped curve implies an improvement in the situation with respect to animal welfare, whereas a positive slope indicates an overall deterioration. It follows that it is inappropriate to state that an AWKC always exists as a distinct inverse U-shape.

The second possibility is that the increase in the number of companion animals has compensated for the decrease in the number of children being reared. It is interesting to note that in Japan, after the early 1990s, the sum of registered dogs (RDs) and young population (YP; less than 14 years old) has been around 24 million and the ratio of this sum to the total population of Japan has remained at around 19%; these figures have remained virtually unchanged over a long time (Figure 1). The number of RDs has increased whereas that of YP has decreased. It appears as though the decrease in the number of children has been compensated for by the increase in the number of domestic dogs. In fact, married couples in recent years who have completed their child rearing duties, having had fewer children as compared to those in previous generations, have shown a marked increase in their tendency to buy pets. In addition, with the onset of the trend towards late marriages, some unmarried people develop the habit of visiting pet shops at night, after they have finished their day jobs, looking to buy puppies. They wake these puppies up in the middle of the night to choose the best ones to buy. The harmful influence that this behaviour may have on the growth of these animals has recently been brought to light. Returning to the subject of this paper, we may formulate the following hypothesis:
against the background of the declining number of births and the trend towards late marriages, people have been compensating for the decrease in the number of children being reared by breeding pets.

The purpose of this paper is to empirically examine the above hypothesis in the case of Japan. It is extremely difficult to distinguish between companion animals and mere pets, more so because no separate data on companion animals are available. The most popular pets in Japan are dogs and cats. According to JPFA (2009), in 2008, 18.2% and 11.4% of all households reared dogs and cats, respectively, while the third most popular pet, the goldfish, accounted for 6.8% of all household pets. It is often observed that the owner of a dog or cat regards their pet not as a mere possession but as a special individual. It is mandatory for owners to register their dogs to pre-empt possible rabid attacks; therefore, we were able to access time series as well as local government-level registration data on dogs across the nation. Thus, we are in a position to apply veterinary economics analyses on time series and cross-sectional data to examine our hypothesis.

MATERIALS AND METHODS

For the time series analysis, we used the 1980 and 1984–2008 values for the variables given below. The explained variable was the per capita RDs (Table 1). The explanatory variables were as follows: infant mortality rate, per capita real gross national income, total fertility rate, rate of children born out of wedlock, rate of artificial abortions, divorce rate, and average marriage age. The number of per capita RDs was expected to decline with an increase in the total fertility rate, and vice versa.

For the cross-sectional analysis, we used the following variables and their 2006 values across 47 local governments. (In cases where 2006 data were not available, we used available data from the nearest year.) The explained variable in this case was the total number of RDs per local government (Table 2). This is because when we used per capita RDs as the explained variable alongside the explanatory variables mentioned below—some of which were adjusted—we had unfavourable results (the adjusted R² was around 0.25 at the most). The explanatory variables employed were as follows: infant mortality rate, foetal death rate, neonatal mortality rate, real gross prefectural income, total fertility rate, rate of artificial abortions, divorce rate, average marriage age, overall unemployment rate, rate of tenement house dwellers, and number of households. We also analysed a case where the infant mortality rate, foetal death rate, and neonatal mortality rate were combined into one explanatory variable, but the results were the same as the ones obtained when these variables were treated separately.

In both the time series and cross-sectional analyses, we used the logarithmic values of all variables for the sake of simpler interpretation of the regression coefficients.
A common perception is that those living in the countryside tend to marry earlier and have more children. Generally speaking, it is also easier to have pets in the countryside than in urban areas. Therefore, in the cross-sectional analysis, there is a possibility that the total number of RDs per local government may increase with the increase in the total fertility rate. If the total fertility rate takes a negative sign, it suggests that ‘the impact of substituting the rearing of children with dog breeding’ is greater than ‘the impact of the differences among prefectures on the total number of RDs’; on the other hand, if the total fertility rate takes a positive sign, it suggests that ‘the impact of the differences among prefectures on the total number of RDs’ is greater than ‘the impact of substituting the rearing of children with dog breeding’.

We used the EViews 6 software for the estimation. When using time series data, if both explanatory (at least one) and explained variables are not stationary (or has a unit root), it could result in a spurious correlation problem—a phenomenon that results in the depiction of false causal relationships between variables (Granger and Newbold, 1974; Wooldrige, 2006). In order to prevent this situation, we conducted a unit root test. We applied the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. The null hypothesis, was that variable is stationary. When the null hypothesis was rejected, we applied the co-integration test to confirm that we could avoid the spurious correlation problem when using the ordinary least squares (OLS) method. If the null hypothesis was rejected outright, we applied the OLS method as the next step. If the serial correlation estimated on the basis of Durbin-Watson statistics (D.W.) was found to be suspicious, we applied the Cochrane-Orcutt method.

When selecting explanatory variables, we used both step-down and step-up procedures for the time series and cross-sectional analyses. In the step-down procedure, we selected the best model on the basis of p values and Akaike’s information criteria (AIC). One by one, we removed the explanatory variables whose p values were greater than 0.1, until all the remaining explanatory variables had p values of less than 0.1. Out of the several models that were in contention, we used the AIC to select the best model. If the total fertility rate variable was eliminated, we stopped the estimation and regarded the model as flawed.

In the step-up procedure, we included the total fertility rate as one of the explanatory variables in order to empirically examine our hypothesis as to ‘whether the decrease in the number of children being reared is compensated by the increase in the number of pets’. We selected explanatory variables one by one on the basis of both the p values and the AIC, while taking care to restrict our selection to only those explanatory variables that had p values of less than 0.1. Out of the several models in contention, we used the AIC to select the best model. In both the step-down and step-up procedures, when the difference in the AIC values between the models is less than 1, the superiority of a model cannot be determined (Sakamoto et al., 1983). In such cases, we considered more than one model as potential best model and continued with the procedure.

RESULTS
TIME SERIES ANALYSIS
The results of the unit root test were as follows (Table 3). We show the result when both the trends and intercepts were included. The null hypothesis (the time series is stationary) was rejected at the 5% significance level for average marriage age, per capita real gross national income, and total fertility rate. The null hypothesis was not rejected at the 5% significance level for the other explanatory variables and the explained variable. Since the explained variable was considered to be stationary, we applied the OLS.
The results of the step-down and step-up procedures did not concur with the choice of the best model. In the step-up procedure, two models (Models 1 and 2) were selected (Table 4), both of which had low D.W. values. In Table 4, we present the results obtained after applying the Cochrane-Orcutt method. In the step-down procedure, one model (Model 4) was selected (Table 5). In Table 5, we present the results obtained when all explanatory variables were used, as in Model 3. We cannot determine the superiority of Models 1–4 on the basis of the AIC. Moreover, since the sign of the explanatory variables is the same across all models, the interpretations of the variables are consistent regardless of the models they constitute. Further, since the sign of the total fertility rate is negative, it is empirically confirmed that, as expected, the decrease in the number of children being reared is compensated for by the increase in the number of pets.
CROSS-SECTIONAL ANALYSIS

In this case, the step-down and step-up procedures chose the same model as the best one (Table 6). We present the results when all the explanatory variables were used (Model 5), and the best model was selected on the basis of the p values and AIC (Model 6). The superiority of Models 5 and 6 cannot be determined on the basis of the AIC. Since the signs of the explanatory variables are the same for the two models, the interpretations of the variables are consistent between the models. The sign of the total fertility rate is positive. This suggests that ‘the impact of the differences among prefectures on the total number of RDs’ is greater than ‘the impact of substituting the rearing of children with dog breeding’.

Figure 7

Table 6. Results of Cross-sectional Analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 5</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>11.99 (0.93)</td>
<td></td>
</tr>
<tr>
<td>Total number of RDs per local</td>
<td>-0.10 (-0.40)</td>
<td></td>
</tr>
<tr>
<td>government</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infant mortality rate</td>
<td>-0.26 (-0.70)</td>
<td></td>
</tr>
<tr>
<td>Foetal death rate</td>
<td>0.11 (0.66)</td>
<td></td>
</tr>
<tr>
<td>Neonatal mortality rate</td>
<td>0.01 (0.03)</td>
<td></td>
</tr>
<tr>
<td>Total fertility rate</td>
<td>0.87 (1.63)</td>
<td>0.79 (2.23)</td>
</tr>
<tr>
<td>Rate of artificial abortions</td>
<td>-0.12 (-0.60)</td>
<td></td>
</tr>
<tr>
<td>Divorce rate</td>
<td>0.44 (0.80)</td>
<td></td>
</tr>
<tr>
<td>Average marriage age</td>
<td>-4.44 (-1.19)</td>
<td>-1.14 (-1.16)</td>
</tr>
<tr>
<td>Overall unemployment rate</td>
<td>-0.04 (-0.14)</td>
<td></td>
</tr>
<tr>
<td>Rate of tenement house dwellers</td>
<td>-0.33 (-1.72)</td>
<td>-0.31 (-2.42)</td>
</tr>
<tr>
<td>Number of households</td>
<td>1.08 (2.84)</td>
<td>1.08 (17.18)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.935</td>
<td>0.945</td>
</tr>
<tr>
<td>F-statistic</td>
<td>61.002</td>
<td>***</td>
</tr>
<tr>
<td>AIC</td>
<td>-0.283</td>
<td>-0.545</td>
</tr>
</tbody>
</table>

DISCUSSION AND CONCLUSION

On the basis of the unit root tests conducted as part of the time series analysis, the time series data were found to be stationary, thus suggesting that the results of the OLS method would not suffer from a spurious correlation problem. Applying other unit root tests such as the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test may cause the results to change. We explain why we did not use these unit root tests: These tests postulate large sample sizes, but our data were limited to only 26 samples; further, the ADF and PP tests are weak in terms of power, and when the value of the root is almost 1, these tests tend to accept the null hypothesis. Therefore, in this paper, we used the KPSS test. Although the results of the unit root tests depend heavily on the type of test employed, we found, on the basis of a particular factor, that our results were appropriate. Matsuura and McKenzie (2001) state that when spurious regression occurs, the value of the adjusted R² tends to be greater than the value of the Durbin-Watson (D.W.) statistics. In our case, Models 1–4 have substantially large values of the D.W. statistics as compared to those of the adjusted R². Therefore, there is little possibility that our results suffer from the spurious regression phenomenon.

On the basis of the regression analysis, the total fertility rate was found to be a significant explanatory variable to the explained variables (per capita RDs and total number of RDs per local government) in both the step-down and step-up procedures. Since the sign of the total fertility rate variable was negative, it was empirically confirmed that dogs can compensate for the desolation created by the presence of fewer children in Japan. As already shown in Fig. 1, after the early 1990s, the ratio of RD + YP to the total population of Japan has remained nearly constant at around 19%. Under the long-term recession, dog breeding has, to an extent, evolved as a substitute for child rearing in Japan.

Total fertility rate refers to the average number of children that one woman gives birth to in her lifetime. When the total fertility rate is less than 2, it results in a declining number of births. In Japan, the total fertility rate fell below 2 in 1975 and, as shown in Fig. 1, the number of births has continued to decline over the years. On the other hand, the number of RDs has increased at a nearly identical rate. However, when assessing the analysis period as a whole, the marginal increase in the number of RDs is found to be less than the marginal decrease in the average number of children in terms of absolute value, as is implied by the regression coefficient of the total fertility rate. Since we used double logarithmic models for the regression analysis, the regression coefficients can be interpreted as values of elasticity. In Models 2–4, if the total fertility rate decreases by 1%, the per capita RDs will increase by 0.68–0.71. In
Model 1, it increases by 0.94.

As for the other explanatory variables, divorce rate and average marriage age were selected in Models 1 and 2, respectively, with positive signs. It seems reasonable that increases in divorce rate and average marriage age result in increase in per capita RDs. In Model 4, per capita real gross national income takes a negative value. This result seems justified because as the income increases, it becomes financially easier to have more children and the per capita RDs decreases as a result. The rate of children born out of wedlock takes a negative value. This seems understandable because under the adverse circumstances created by the recession, it is more difficult to have another child. Intuitively, the rate of artificial abortion takes a positive value, because as this rate increases, more people will be prone to seeking pets as a substitute. The rate of artificial abortions takes a negative sign; further investigation is required on this point, which may form the basis for future studies.

In the cross-sectional analysis, the total fertility rate takes a positive sign. This may be because ‘differences in the number of children being reared is less varied across prefectures than other prefectural differences’. As for the other variables, on the basis of Model 6, the sign of the average marriage age was negative. This seems appropriate since, generally speaking, urban dwellers tend to get married late and find it difficult to have pets. On the contrary, countryside dwellers tend to get married early and own more dogs. The sign of the rate of tenement house dwellers is negative. This, too, seems apt because it is more difficult to have pets in a tenement house. The number of households takes a positive sign, possibly because the total number of RDs per local government increases with the increase in the number of households in a prefecture.

Finally, we summarise our results as follows:

1. The number of dogs has compensated for the desolation created by having fewer children to rear in Japan.

2. As the values of the regression coefficients (which are the same as the values of elasticity) suggest, in the long run, the increase in the number of RDs has not completely substituted the decrease in the number of children being reared. However, when considering recent trends, especially those after the early 1990s, the increase in the number of RDs has almost completely substituted the decrease in the number of children being reared, as implied in Fig. 1.

3. A cross-sectional analysis is not suitable to examine this topic since the differences among the prefectures are too large. A time series analysis is preferable and sufficient for this purpose.

References

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8. MIAC (2009c) Statistical Observations of Prefectures 2009, Ministry of Internal Affairs and Communications (MIAC)
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